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Technical Report 1013

Interactive Hypermedia for Tactical Training

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U.S. Army Research Institute

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13. ABSTRACT *(Maximum 200 words)*

This effort applied the technology of hypermedia to the problem of organizing and presenting field training exercise data to provide training for military personnel using recent advances in informational science computer hardware and software technology. The data produced during a large-scale training exercise was structured into a hypermedia-based proof-of-principle system for training ground war tactics. The prototype lesson, which runs on an 286-based MS-DOS computer, features hypermedia structuring of textual information and high-resolution color static and dynamic graphics. The findings of this effort will contribute in several ways to future work in this area. (1) Future work can build directly upon the progress achieved in this project. (2) Guidelines are presented for resources necessary for a full-scale development of a tactical training system based on interactive hypermedia technology. (3) This project shows the value of a hyper-textual approach as a way of organizing and integrating diverse types of training exercise data for use in computer-based training but with potential for a variety of other uses.

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Technical Report 1013

Interactive Hypermedia for Tactical Training

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FOREWORD

A major mission of the U.S. Army Research Institute for the Behavioral and Social Sciences is to find ways to improve Army training. The application of technological developments to training is one of those. Advances in computer hardware and software at diminishing cost have opened up new opportunities for computer-based training. The work reported in this report explores the application of ideas in this area. The findings will be of interest not only in the training community of the Army but also in business and industry.

EDGAR M. JOHNSON
Director

INTERACTIVE HYPERMEDIA FOR TACTICAL TRAINING

EXECUTIVE SUMMARY

Requirement:

Field training exercises at the National Training Center generate a wealth of data. A significant need exists to determine how these data can be used to improve training for Army personnel.

Procedure:

This effort applied the technology of hypermedia to the problem using readily available and affordable computer software technologies. The data produced during a large-scale training exercise was structured into a hypermedia-based proof-of-principle system for training ground war tactics.

Findings:

The potential of the technology was successfully demonstrated. The prototype lesson, which runs on a 286-based MS-DOS computer, features hypermedia structuring of textual information and high-resolution color static and dynamic graphics. The lesson includes training objectives and an independent evaluation and feedback component.

Utilization of Findings:

The method employed shows the high potential of the hypermedia-based approach to the synthesis of training exercise data for training. The findings of this effort will contribute in several ways to future work in this area.

1. Future work can build directly upon the progress achieved in this project.

2. Guidelines are presented for resources necessary for a full-scale development of a tactical training system based on interactive hypermedia technology.

3. This project shows the value of a hypertextual approach as a way of organizing and integrating diverse types of training exercise data for use in computer-based training.

INTERACTIVE HYPERMEDIA FOR TACTICAL TRAINING

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INTERACTIVE HYPERMEDIA FOR TACTICAL TRAINING

INTRODUCTION

Consider the following training situation:

A lieutenant sits at a personal computer.
He depresses the computer's mouse button, click...
- reads the Brigade Mission Order of an actual training exercise conducted at the National Training Center, click...
- reads the Battalion Task Force Mission Order, click...
- views a terrain map with maneuver graphics, click...
- reads the Operation Order of the Task Force, click...
- views a time-tagged replay of the battle with color-coded vehicles moving across a display of 3-D terrain, click...
- views a video clip of the first contact with the Opposing Force, click...
- hears a sound bite of the exercise Observer-Controller critiquing the battle and discussing with Opposing Force Commander what his objectives were, click...
- sees a chart of Battle Damage statistics, click...
- is asked a question about the adequacy of the Fire Support planning of the unit being trained, click...
- reviews the Operation Order, click...
- responds to a question and receives feedback about his answer and about his performance on the training module he has just completed.

The lieutenant smiles, he did well and he likes it!

This vignette illustrates the functionality of an effective, interactive, computer-based training system for military tactics. The technology for realizing the setting describes is both at hand today and affordable. Indeed, most of the features illustrated exist in the prototype training system that is the subject of this paper.

Army Training

The U.S. Army expends tremendous effort and resources to assure that its personnel are adequately trained. Training and skill sustainment are a complex and continuous endeavor because of many factors, including the implementation of new systems, personnel turbulence and skill decay, and an enormous variety of specific jobs to be trained. Not only must soldiers and leaders be proficient in their individual specialties, but it is essential that they be capable of working together as crews, teams and progressively larger units. The Army refers to the training of groups as collective training. Today all of these challenges must be met under the shadow of diminishing resources.

As a part of collective training, Army units train to operate in a combined arms and services environment. Army Combat, Combat Support and Combat Service Support branches must all function together with the personnel, high technology weaponry and systems from other services in a highly integrated manner to survive on the battlefield and accomplish the mission. To prepare for such integrated operations requires extensive training in a simulated combat environment.

The Army conducts collective training operations at its Combat Training Centers. The National Training Center (NTC) is prime facility for large-scale armor and mechanized infantry combat training. It is the most developed of the Combat Training Centers. It is located in the Mojave Desert at Fort Irwin near Barstow, California. The NTC consists of over 1,000 square miles of terrain accommodating large maneuver and live fire exercises plus nap-of-the-earth flying, firing of air defense weapons and practice in the use of electronic warfare.

Since 1981, training at the NTC has focused on the battalion task force level and has recently expanded to include support for brigade operations. A permanent Opposing Force, a full-time cadre of observer-controllers, consisting of some of the best commissioned and noncommissioned officers in the Army, and an instrumented simulated battlefield (Sulzen, 1986) contribute to the realism and value of the training the visiting unit experiences at the NTC during a typical two weeks of on-site training. Extensive training feedback and analysis are provided to maximize the improvement in tactical capability. The performance of units at the NTC is also used to provide senior commanders a measure of the Army's readiness for combat (U.S. General Accounting Office, 1991).

Training operations at the NTC have been important in identifying common training deficiencies among Army units (U.S. General Accounting Office, 1984) and in providing a data source upon which to base improvements in training, organization, equipment and operational doctrine. The U.S. Army Research Institute for the Behavioral and Social Sciences has established an archive of data generated by these training exercises conducted at the Combat Training Centers. It develops methodologies for utilization and supports a wide range of analyses conducted with sponsorship of interested agencies throughout not only the Army but other military services and non-defense agencies.

One of the challenges of Army training is how to exploit modern technological advances to improve the effectiveness and efficiency of training, especially collective training. There have been significant advances in both learning technologies and computer sciences which together offer important contributions not only to Army training but to training in other institutional settings. One such advance serves as the foundation for the project reported here.

Terminology

The origins of the concept of connecting ideas electronically in an other than sequential way are traceable back nearly fifty years. An automated information access scheme was envisioned which included the capability of fast accessing and linking of information, of storing the trail of links, and of annotating the retrieved information (Bush, 1945). Englebart (1963) discussed the functionalities necessary for computers to augment human abilities including links between texts, document libraries, and separate private space for computer users' personal files, computer screens with multiple display windows, and the facilitation of work done by multiple persons working in collaboration. Later, he introduced the mouse computer pointing device, outliner and idea processor, and on-line help systems.

The term hypertext was coined by T.H. Nelson in 1965. The simplest definition is that hypertext is "nonsequential writing or reading" (Nelson, 1987). Other writers (Slatin, 1991) have emphasized that a true hypertext can only be realized in a computer-based system, that it is a system the existence of which is completely dependent upon a computer. When the concept of hypertext was first implemented in operational programs they contained textual material exclusively simply because textual display were the first non-numerical output of early computers.

In a broader context, hypertext can be thought of as a mode of information organization which is like an n-dimensional web. Items of information are associated without bound. What is important about it is that a hypertext user or reader can proceed through the information in a highly individual way consistent with his or her information requirements. In fact, a personal system of information storage based on just this principle of information organization has been recently implemented (Phillips, 1991).

As a generalization of hypertext, hypermedia is a technology for organizing discrete quantities of information, termed information nodes, for utilization in an arbitrary, nonsequential manner by traversing links between information nodes. Conceptually, an information node is unrestricted as to type of information or amount of information it may contain. It may consist of textual material, still or moving pictures, video and/or sound recordings, independent computer programs, or other entire hyperdocuments. A link is an association between nodes enabling the user to move from the current node to another. A hyperdocument is a structure of nodes and links which is self-contained, dealing with a particular subject domain for some specific purpose. These concepts are well developed and extensive discussions are available (Nielsen, 1990, Berk & Devlin, 1991).

Simple interaction is implicit in the concepts of hypertext and hypermedia. Therefore, referring to <u>interactive hypermedia</u> might appear redundant except for the explicit emphasis placed on the concept of interaction. Interactivity in this context has been defined as "the incorporation of repetitive, frequent and meaningful iterations of a stimulus-response-analysis-feedback cycle into material that is presented in a medium that permits it" (Gery, 1987). Further, the sort of interaction necessary--making choices regarding navigation--distinguishes use of a hypertextually organized information base from the highly structured stimulus-response-analysis-feedback cycle which characterizes interaction in a typical computer-based training system.

Several dimensions of interactivity computer-based systems have been identified: (1) the nature and complexity of the interactions (questions or decisions, fixed or open-ended options, inherent complexity of required responses), (2) response analysis and feedback (nature, depth, programming of anticipated or unanticipated responses, tolerance for variable input), (3) branching (amount, conditionality), and (4) degree of learner versus trainer control. Gery (1987) discusses detailed considerations for measuring the degree of interactivity between learner and system.

The concept of interactive hypermedia emphasizes the fact that the user actively participates in utilization of a system that possesses a hypertextual organization of multiple media. The payoff of such a system is parsimoniously expressed by the ancient Chinese:

> I hear, I forget.
> I see, I remember.
> I do, I understand.

Findings of modern psychological research substantiate this proverb (Laurillard, 1987; Packer, 1988; Sculley, 1990). Learners progress faster, retain more, and enjoy it more when they are meaningfully involved in the process.

What is novel about the current time is that the technologies have now matured sufficiently that these techniques are readily available for application in training systems and direct application to the training environment can be made using currently available hardware and software at a realistic cost (Hannafin and Peck, 1988).

Technological Leverage

Constrained resources is emerging as the keynote of the decade. In the arena of Army training as elsewhere the message is to make do with less. One of the ways of moving toward this goal is to take advantage of technological advances when they produce higher quality output at the same or reduced cost, or same output at reduced cost. Using technology for this purpose has been termed technological leverage.

The application of computers for training has held such promise for decades. The effectiveness of interactive videodisc technology in certain Department of Defense training systems has been established in an extensive meta-analysis (Fletcher, 1991; Fletcher, 1990). Therefore, the effectiveness of interactive hypermedia, of which interactive videodisc is merely one form, can reasonably be assumed. Thus, the time for fulfillment of the promise of using computers for more effective training is now at hand. Furthermore, because delivery costs continue to decrease, quality training using computers and related technologies is becoming more and more affordable. In the area of information technology, the power is doubling at half the cost every two years on the average (Feigenbaum, McCorduck & Nii, 1988).

Project Goals

The purpose of the research reported here was to explore the integration of existing training exercise data from the NTC into a functioning computer-based system employing interactive hypermedia technology. It is also intended to provide a preliminary evaluation of the principle of coupling this technology and the NTC data to provide effective training in fundamental ground-warfare military tactics. The desired outcome was to develop a proof-of-principle system (POPS) for evaluation of this training methodology.

METHOD

One of the greatest strengths of interactive hypermedia for training is that the learner is an active participant in the training process. Beyond making responses and receiving feedback the learner actively structures the sequence in which the material is encountered. The metaphor guiding the project from its beginning is the idea of placing the learner into the highly stimulating environment of an intellectual playpen. The envisioned environment has boundaries but the concept is to have it filled with all sorts of wonderful and stimulating information objects so that the learner's biggest problem at any point is what to explore, experience and learn about next. The assessment and feedback module assures that all material will be mastered to standard prior to completion by the learner, while leaving the ordering largely to the choices of the learner.

POPS was designed as a single module requiring the learner approximately two hours to complete. The target learner was envisioned as a junior Army leader familiar with basic military terminology. Emphasis was placed on exploring the principles and the range of possibilities of the technologies involved rather than on developing an operational training system.

The targeted delivery platform is the 286-based MS-DOS computer with EGA graphics and Winchester drive. These are widely available throughout the target population and seem to offer a reasonable compromise between functionality and cost at this time. However, because technological advances occur quite regularly, determination of an appropriate targeted delivery platform will soon need to be readdressed.

Training Exercise Selection

To focus the development effort on a single training event, the assistance of a senior observer/controller at the NTC was obtained. Several exemplar training events were identified and finally one selected for use in POPS.

One characteristic distinguishing the selected training event is that the same mission was executed twice on successive training days by the training unit. The first day, the unit failed to accomplish its mission. On the second day, it performed the mission almost flawlessly and did succeed. Thus, from a training perspective the selected exercise provides an illustration of the same mission being carried out ineffectively as well as effectively, inviting direct comparisons between the two.

Another feature associated with the chosen training exercise is that it has a relatively complete data set compared to other training exercises under initial consideration. Data completeness enables a thorough understanding of what occurred during the training exercise and offers a basis for clear judgments of the training significance of events that occurred.

The senior observer/controller who aided in selecting the training exercise used for the development also assisted in identifying the task-force-level tactical training lessons learned. These lessons learned became the key training objectives around which the lesson submodules were produced.

Information Sources

The NTC training exercise used in the development of POPS provided several different types of information which, together constitute the training exercise data set. Each type of data will now be described. For a more thorough discussion of data generated at the Combat Training Centers, including at the NTC see Hamza (in press).

Instrumented data at NTC are collected through a telemetry system. They include digital records of vehicle positions, firing and engagement information of instrumented players, and several other types of information pertinent to the specific training event. The development of POPS used these data collected at one- and five-minute intervals. Data for air players based on 10-second intervals were also explored.

These data are very useful for studying the details of player movements and unit formations. Several software systems have been developed to replay the NTC battles using these data. However, transient behavior of the telemetry system coupled with terrain phenomena introduce aperiodic anomalies. Also, not all vehicles/players participating in the training exercise are instrumented.

Take-Home Packages (THPs) are textual descriptions and evaluations of the training unit's performance during the exercise for various echelons and subunits that comprise the battle task force. Tables provide quantified battle damage assessment data. The THP data are particularly useful for providing a comprehensive perspective of the training exercise and the specific lessons learned for each of the elements. These documents are intended primarily to provide the unit a training focus upon its return to home station. Much of the THP information is general in its observations and recommendations concerning what occurred during the training exercise.

Video tape recordings were available of After Action Reviews (AARs) following completion of the training exercise. These are conducted at various echelons within hours of the exercise conclusion and recorded without editing. An after action review is essentially a debrief of the exercise participants where intentions, actions, and outcomes are reviewed. Causes and alternatives are also discussed. AARs are lead by the observer/controller responsible for that particular element. AARs are the best source for obtaining information about the reasons behind a particular aspect of the training event but are sometimes of a quality that precludes extracting detailed graphical information.

Audio communications are recorded on 40 channels with time tagging. This is a rich source of detailed information on various radio nets used during the training event but is resource intensive to utilize fully.

Additional information about the training exercise was collected through interviews with personnel who participated in the training exercise and with personnel who are generally knowledgeable about NTC training operations. This information was valuable in obtaining an overview understanding of the training event and a framework for integrating the details of the simulated battle.

Finally, several additional data sources were available and used in developing POPS. These included acetate overlays to maps and a variety of paper-based information such as orders and task organization listings.

The data set contains an extensive record of the events that occurred during the training exercise. It is sometimes incomplete and occasionally ambiguous or erroneous in minor ways. Frequently it is necessary to infer the cause, reason or purpose behind a particular action or event. The possibility of making an erroneous inference are small, but not non-zero. The reasons behind particular events in the training exercise record are of substantial importance from a training perspective.

Design Considerations

Although the training exercise data set contains extensive audio and video material, the decision was made at the design phase of the project to exclude audio and video capabilities from POPS for reasons of economy. However, the information contained in these data sources can still be used although in a textual medium. Vocal audio recordings can be transcribed to text and video material can be represented in various graphical forms or described textually.

No hardware acquisition was necessary in support of the project. MS-DOS computers, scanners and a variety of software were available and used in the project.

The assumption was made at the initiation of the project that the training exercise data set is sufficiently complete and rich enough to develop POPS. Based on the data it is necessary, first, to determine what occurred during the training exercise, next, to provide a basis for inferring the reasons behind occurrences. Finally, it is necessary to establish the training relevance and significance of what happened.

Software

In order to implement POPS, selection of suitable computer-based training software was necessary. More than 70 MS-DOS based authoring systems are on the market and nearly as many development tools exist for the Microsoft Windows environment (Wilkens, 1991). While capabilities of such systems change at a rapid pace, none meets every purpose. Any decision involves tradeoffs among alternatives. Gery (1987) identifies three dimensions of tradeoffs--productivity versus creativity, structure versus freedom, and power versus simplicity--and discusses these considerations in detail. She identifies a number of additional factors along which software systems vary: training needs and the training audience; system features, functions and requirements; authoring features, support and training; costs; vendor capabilities; existing courseware; and consultation services.

The authoring system software chosen for this implementation was HyperWriter (Ntergaid, 1990). It satisfied the paramount criteria for the project: authoring and system capabilities and requirements, and immediate availability.

In addition, three specialized stand-alone software systems were utilized in the development of POPS. The first was a graphic tool which supports the merging of data from two graphic files into a single file for display on the screen.[1] It is used to automate the insertion of terrain labels and time stamps into graphics of the type shown in Figures 8 through 11.

Second, a routine was adapted from another software system, the TBAT/MPART (Nichols & Shillcock, 1990) into a stand-alone mode to present an animated display of the trace of the battle on a three-dimensional terrain representation.[2]

Third, the assessment and feedback module required a level of interaction and learner-generated information storage not supported by HyperWriter. Therefore, a text-based module was developed to provide the requisite functionalities which include: (1) multiple entry points depending upon from where it is called in the lesson, (2) maintenance of learner records using a learner-generated password, (3) presentation of fixed response items and context-dependent responses, (4) capability of being exited for return to lesson at any point with restart at the same position, and (5) presentation of learner performance record and current progress through

[1] This routine was developed by Richard Crenshaw, ARI. His assistance is appreciated.

[2] This software was adapted by Jack Briscoe, BDM Inc. His assistance is appreciated.

assessment and feedback module including identification of sections of lesson requiring completion.

RESULTS

The functioning POPS is comprised of 129 nodes with nearly 300 links among them. POPS incorporates two stand-alone software entities into the commercial authoring system. Approximately two and a half megabytes of disk storage are used for the system and its various supporting data files. Each of the distinct types of display is now described and illustrated to provide a detailed understanding of POPS.

Textual Material

Several types of textual material can be distinguished within POPS. First is textual data directly from the data source with minor editing, such as correcting a misspelling or expunging a date or other identification. Figure 1 shows an example of the display of such textual material as it appears on the screen. This particular example was taken from the written take-home package for the training exercise. A transcription from an audio or video sound track would have an identical format.

Observe the small box in the upper right corner of Figure 1. It is termed a note in the nomenclature of the authoring system. The link to the note was traversed by placing the arrow cursor on the abbreviation "R&S" and activated by depressing the mouse button or the appropriate key on the keyboard. In Figure 1 other links are indicated where triangular symbols enclose text. The information in the note shown in Figure 1 functions like a footnote, giving additional information. It illustrates, generally, the second kind of textual information, which provides explanatory or interpretative information which is directly based on the data or an interpretationof the data but which is not actually a part of it.

There is another possible type of textual information which has not been employed extensively in POPS. This is simulated data. Where a critical item of information is unavailable in the training exercise data sources, for example, a portion of the detail of the planning process, it is often possible to fabricate the missing information in reasonably accurate fashion based upon generalized experience with NTC operations and the specific training environment and situation of the training unit. The rationale for such simulated data is to provide the learner a complete and consistent picture of the training event without the confusion of these data problems.

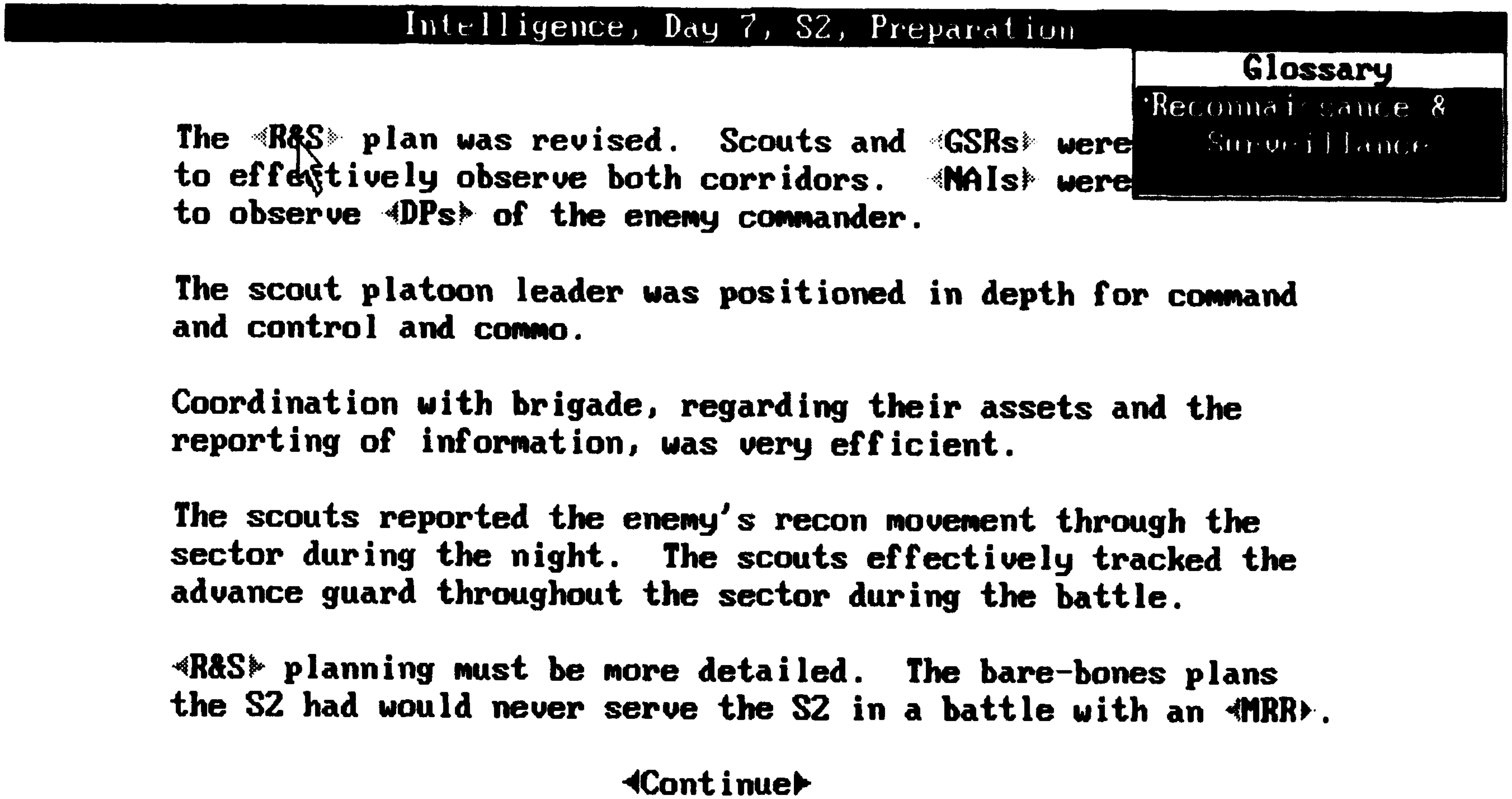

Figure 1. Screen display of textual information with activated note link.

Static Graphics

Five types of static graphics can be distinguished in POPS. They are terrain maps, data graphs, system linkage maps, adorning graphics and responsive graphics.

Maps are an integral part of any military planning and of the understanding of a military operation. Several varieties are included in POPS. Figure 2 shows a large-scale display of the NTC used to show the general operational sectors, axes of advances and phase lines for the training event. Color coding provides a representation of the gross geographical features of the NTC and five kilometer grid lines and map reference coordinates are presented. Color has been shown to contribute substantially to data presentation (Hudson, 1985). The graphics on this map were constructed from acetate overlays included in the training event data set.

Figure 3 shows a topographical map which was scanned into a monochrome digital format from a standard military terrain map and subsequently annotated to make key terrain features more apparent. Contour intervals are 20 meters. Major anthropogenic features such as roads are shown as well as natural features such as streams.

A second type of static graphic included in POPS is data graphs generated by other software. The input is various statistical data from the training event data set and the output is a screen display. Figure 4 shows a screen of information precomputed by a popular spreadsheet program and saved as a graphic display. Such data displays are shown on the screen in color which provides an additional channel for encoding training relevant information such as emphasizing some aspect of the information.

A third type of static graphic display available in POPS is a system linkage map, in some hypertext systems termed a graphical browser. Figure 5 shows a sample screen of the system link map. This display shows the structure of links between all nodes in the currently open file. It scrolls to display various parts of the hyperdocument and supports interaction with the user. When a node is selected, the user sees the window title, type of link, and if the node is textual, the first few lines of text, as shown in the figure. The user can actuate any link displayed on the map and consequently move directly to that node. Thus, the link map provides a random access means for navigation of the hyperdocument. Although the form of the link map shown in the figure is specific to the hypermedia software used, the principle is general and most hypermedia packages support a similar functionality.

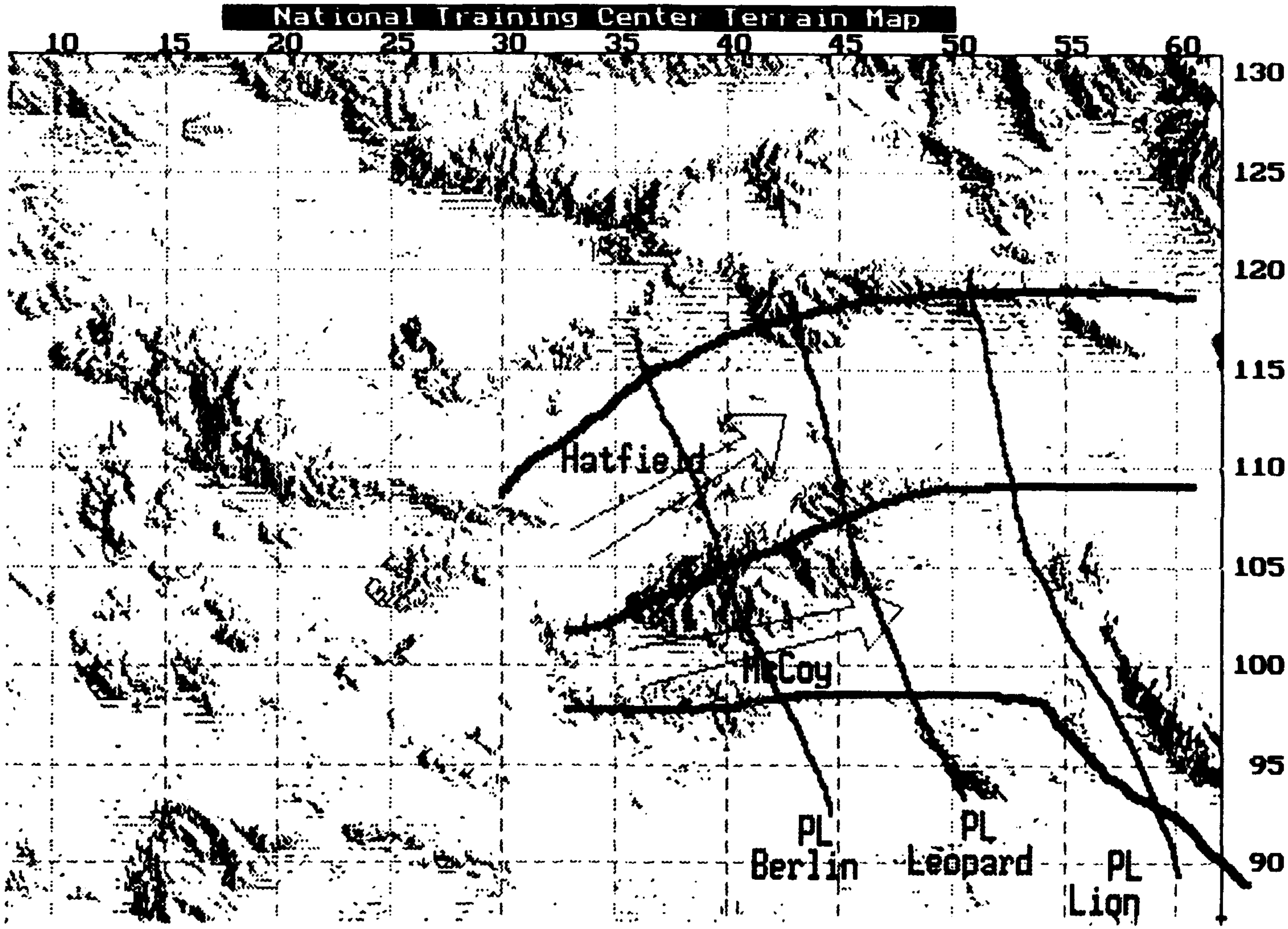

Figure 2. Large-scale NTC map showing battlefield graphics.

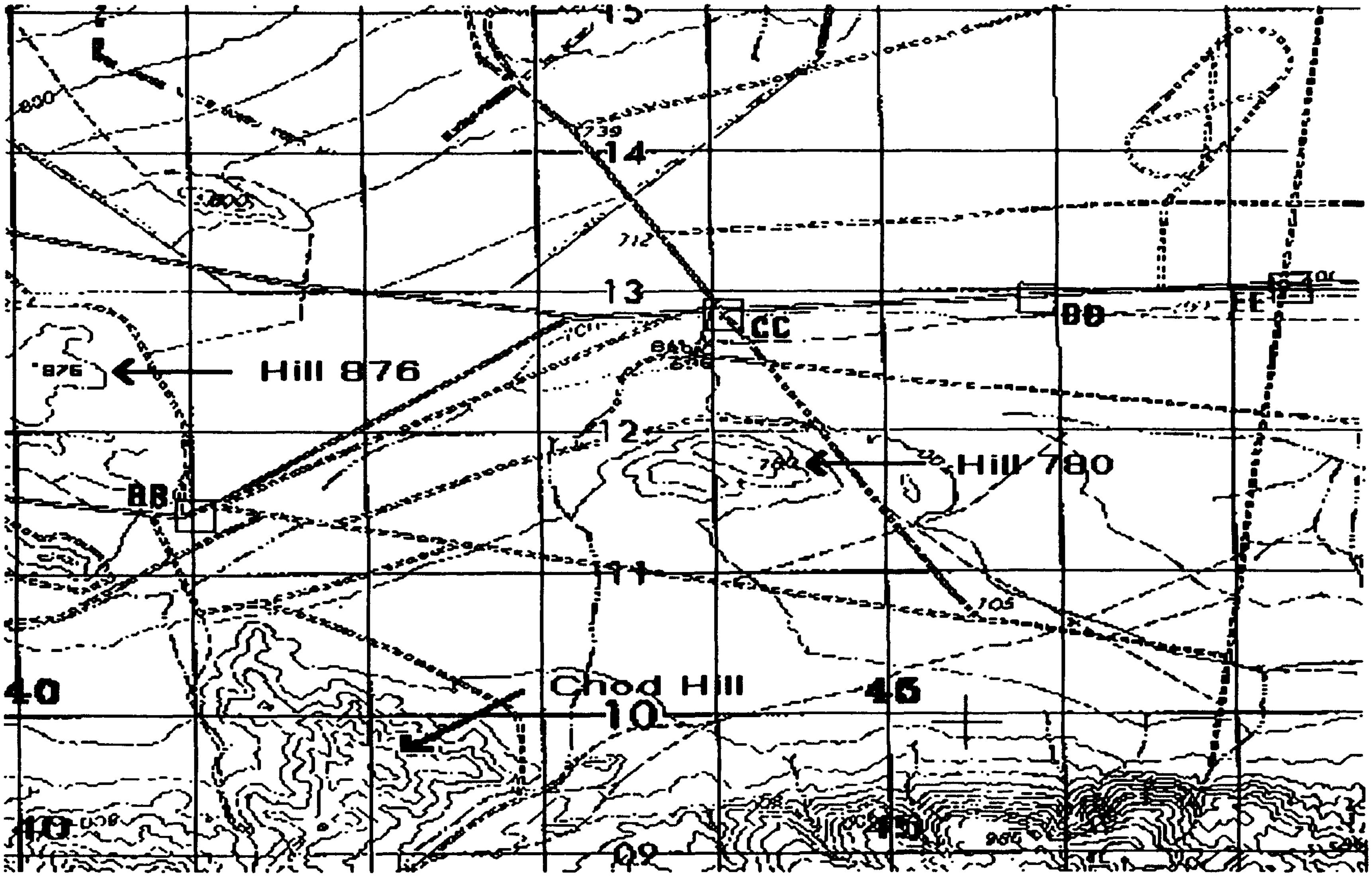

Figure 3. Graphic of annotated scanned topographic map.

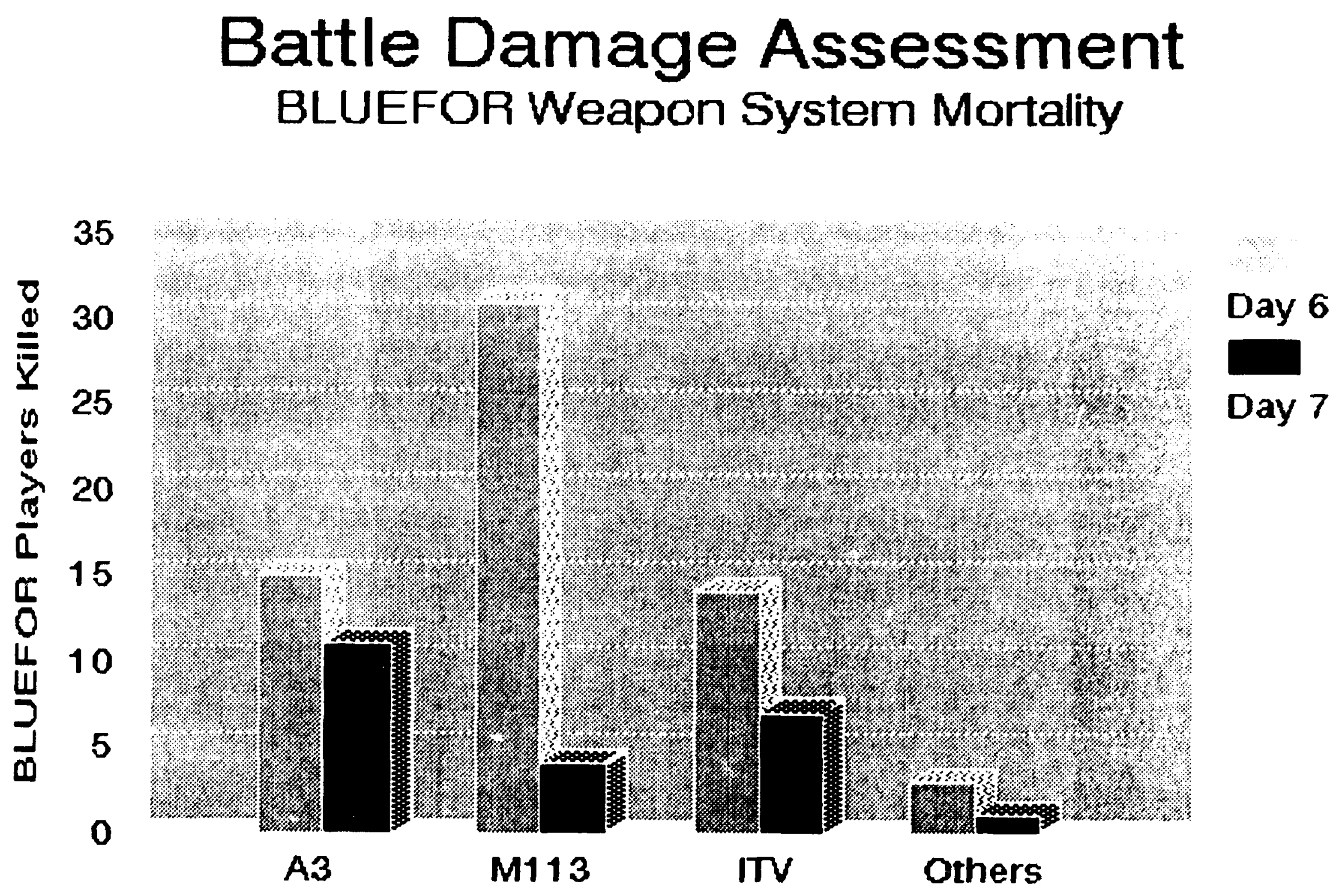

Figure 4. Screen display of data graph.

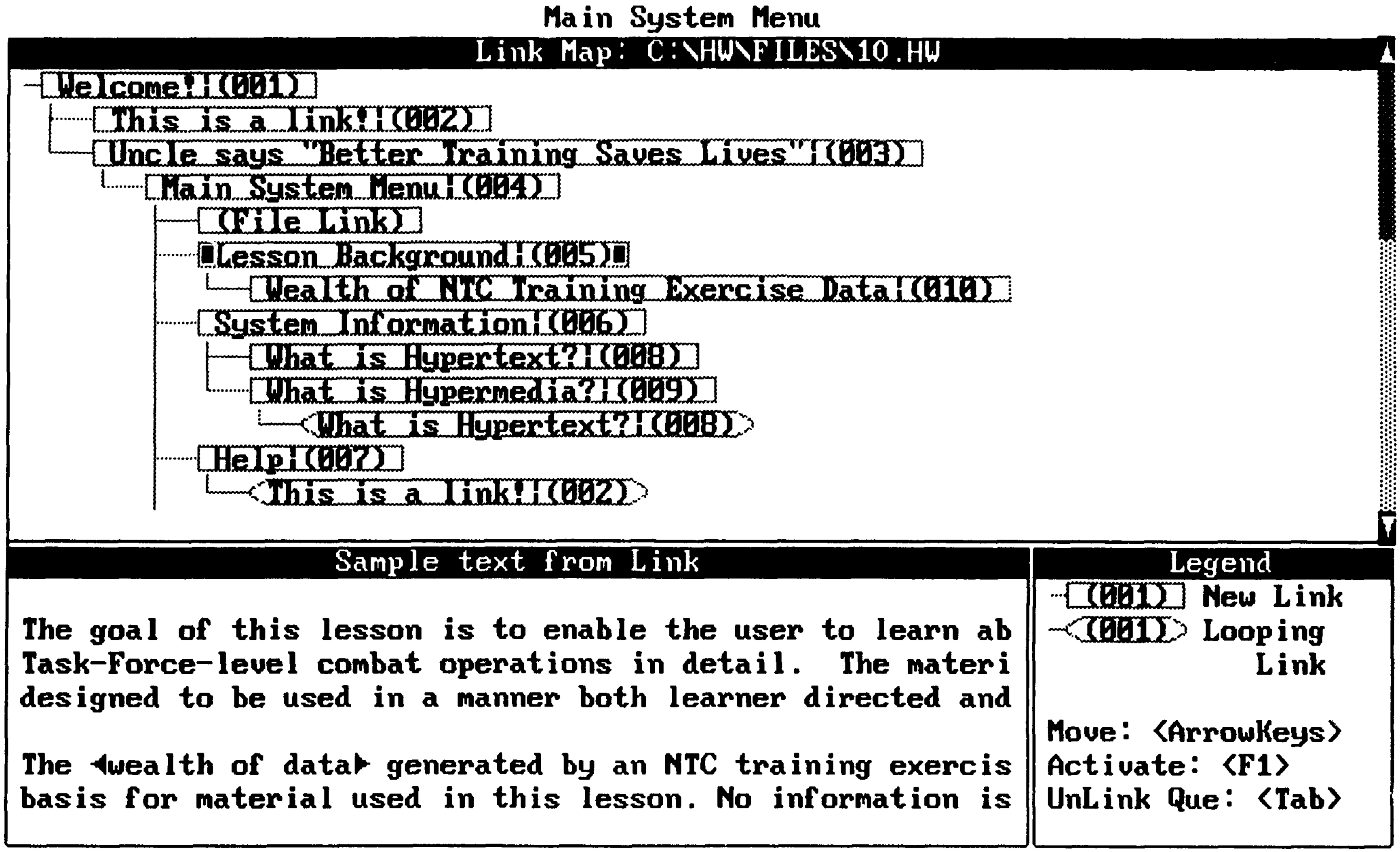

Figure 5. Screen display of graphic showing system link map.

The fourth type of static graphics is adorning graphics. These are intended to give the screen visual appeal and to maintain the interest and motivation of the learner.

The fifth type of static graphics used in POPS is responsive graphics. Responsive graphics are characterized by producing an action in the system when activated. Typically they are an area of the screen where, when the cursor is placed within the boundary and the mouse button or key is depressed, some activation of the software occurs. The sensitive area of the screen is typically graphically visible to the learner, as in form of an icon such as a three-dimensional-appearing button. Most often this action is traversing a link to another node but it may perform other functions, such as terminating the hypermedia program. Figure 6 shows a screen from POPS which contains both adorning and interactive graphics.

Responsive graphics can be incorporated into any static graphic display by designating a sensitive area or "hot spot." So, for example, the labels for vehicle types in Figure 4 or the terrain feature labels in Figure 3 could be linked to textual annotations.

Dynamic Graphics

Two types of dynamic graphics, based on the instrumented data of the training exercise data set, have been incorporated into POPS. One is a software package adapted from TBAT/MPART (Nichols & Shillcock, 1990) and the other is an animation effect created by displaying an automatically changing sequence of screen displays. Both are used in POPS to support visualization of the vehicle positions as a function of time.

Figure 7 shows a screen from the TBAT/MPART software intended to provide a trace of the battle. The software replays all of the available player position data in specially prepared files and through color encoding preserves a history of where players of both sides were located. The display is shown on a three-dimensional representation of the terrain viewed from the perspective of a static point above. The learner can both pause and repeat the replay without restriction.

The other dynamic graphic system uses a sequence of graphic files, generated by existing external software that scales and replays NTC instrumented player location data. These files are then displayed to the learner as a sequence by the authoring system to show player movement. Annotations are added by specially developed software described on page 9.

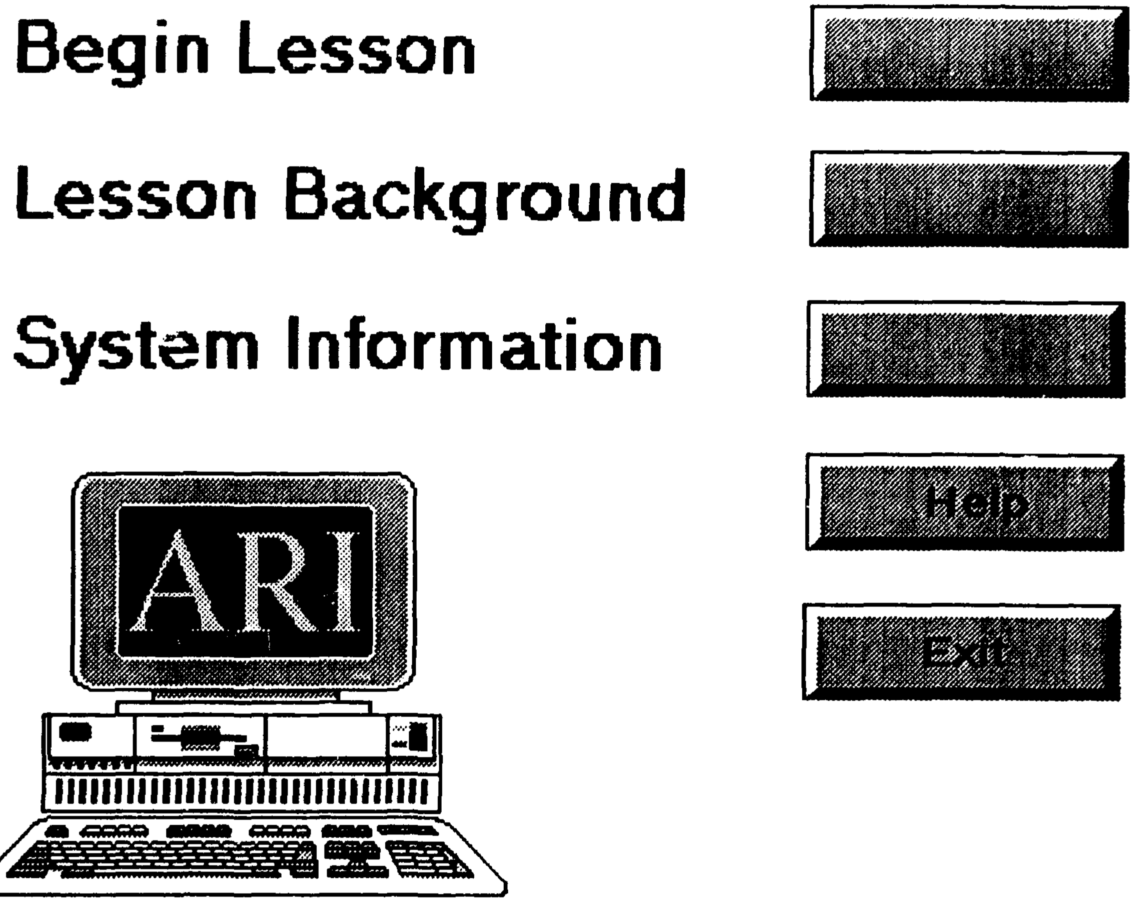

Figure 6. Screen illustrating both adorning and interactive graphics.

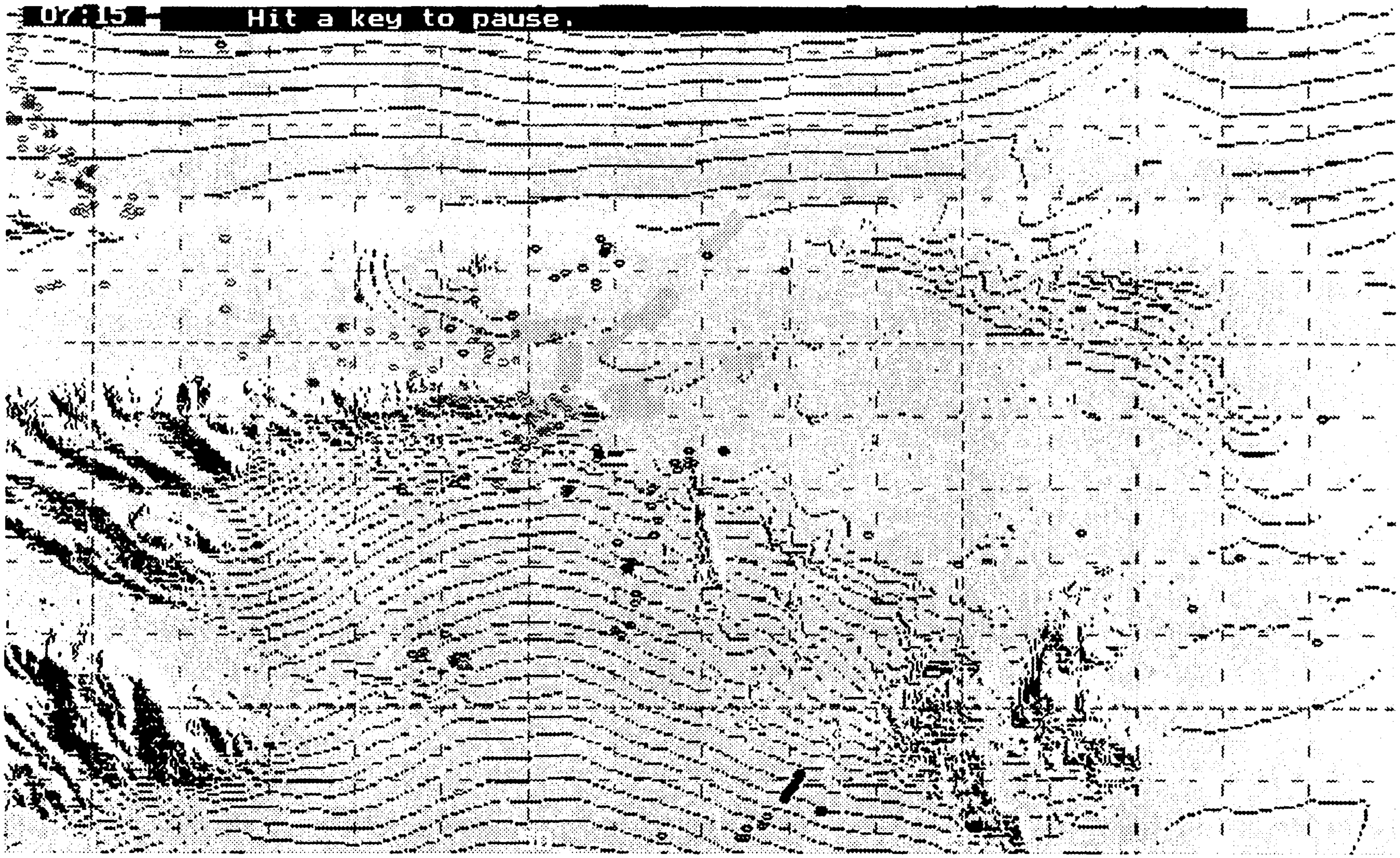

Figure 7. Screen from dynamic graphic battle trace software.

The entire sequence of graphic screens is placed under the control of the learner for self-paced advancing or backing up of the displays. Figures 8 through 11 show a sequence from such a graphical display in POPS. It shows players of the training force occupying key terrain in the vicinity of Hill 780 and engaging and knocking out of play opposing force players as they approach from the East.

On 286-based computers with 65 ms mean access time Winchester drives (relatively slow) frames are changed in the automatic mode at a rate of a little faster than one per second. A faster computer, especially with a faster drive, would improve this performance.

Evaluation and Feedback Component

The software developed for the evaluation and feedback component of POPS met all of the specifications described in the software section above. Responses of the learner are restricted in POPS to fixed options. The decision simplified the development of the information presented the learner as feedback. Figure 12 shows a screen from the evaluation and feedback component of POPS. It shows a simple question, the learner's response, and feedback from POPS for the particular response.

Practically speaking there does not seem to be a limit on how much computer intelligence can be added to this component, although the latest opinion of the relevant technologies, including so-called artificial intelligence, is that they have been over-sold (Wilkes, 1992).

DISCUSSION

This project led to several conclusions about using hypermedia technology for training military tactics by employing extant NTC data. It is feasible to combine the data and technology for training purposes; the concept of the project is sound. However, it seems clear that while most of the data is usable, some filling of gaps in the training exercise story through the generation of simulated data will be necessary to provide the learner with a complete picture of the training event. The need to minimize the risk of erroneous inferences and interpretations in producing such simulated data underscores the necessity of including staff with expertise in NTC and Army training on the project development team. Further, the full development of the training system will be difficult, requiring a range of talents and sufficient resources and appropriate institutional support. In the paragraphs which follow attention will first be given to some of the issues of the technology which remain unresolved and then to considerations of the resources which are necessary for full development of the hypermedia-based training system.

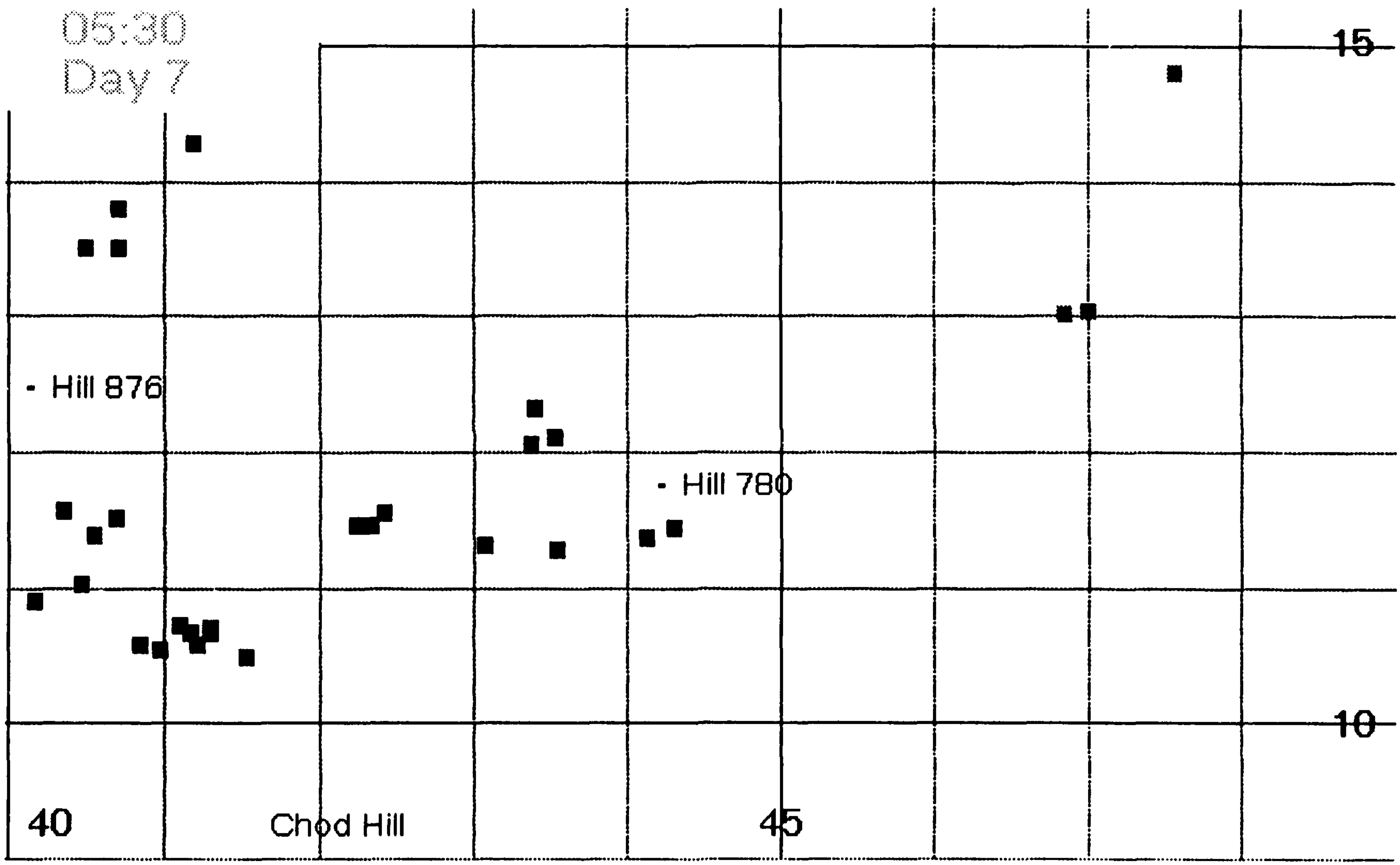

Figure 8. First screen of dynamic graphic sequence.

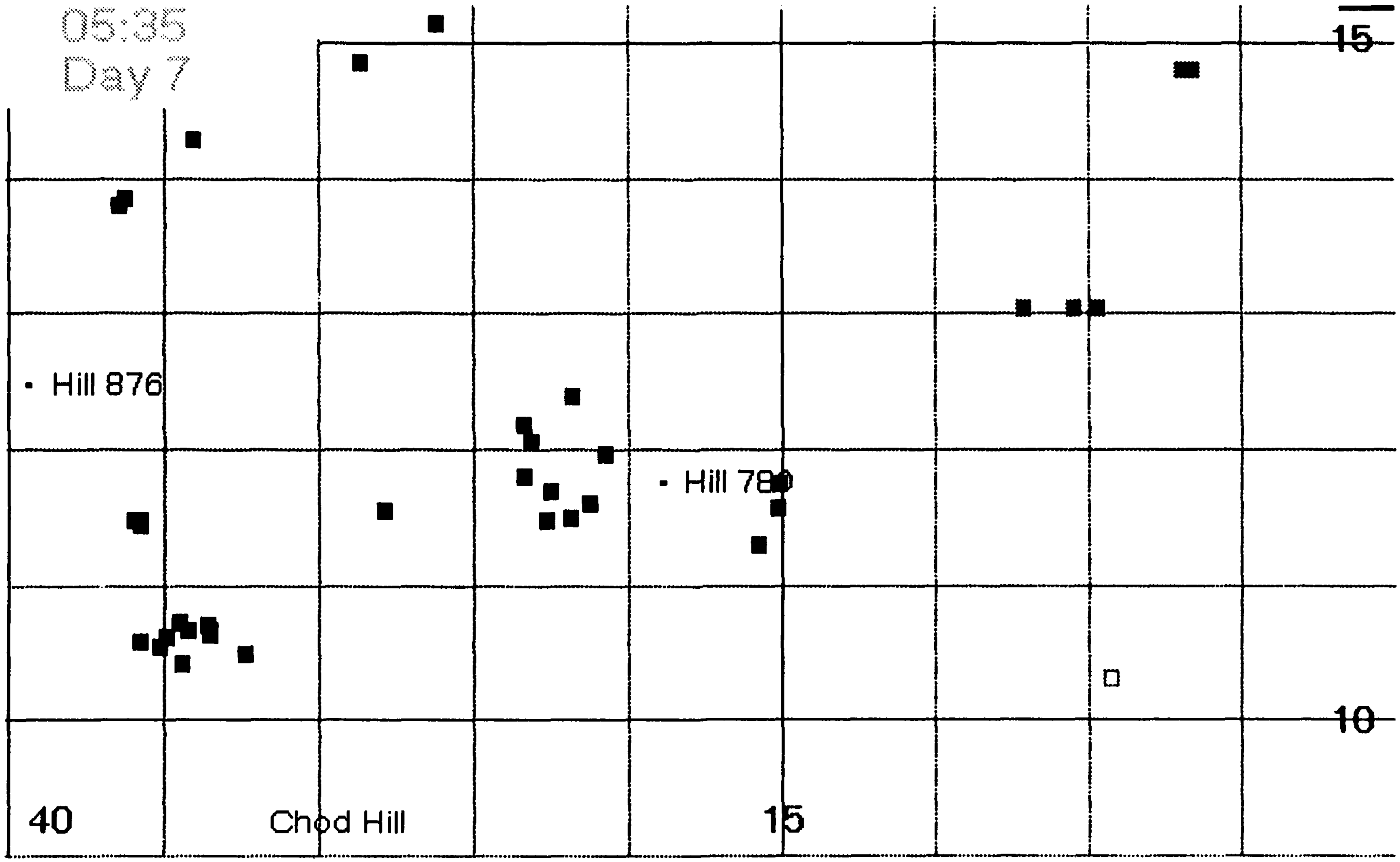

Figure 9. Second screen of dynamic graphic sequence.

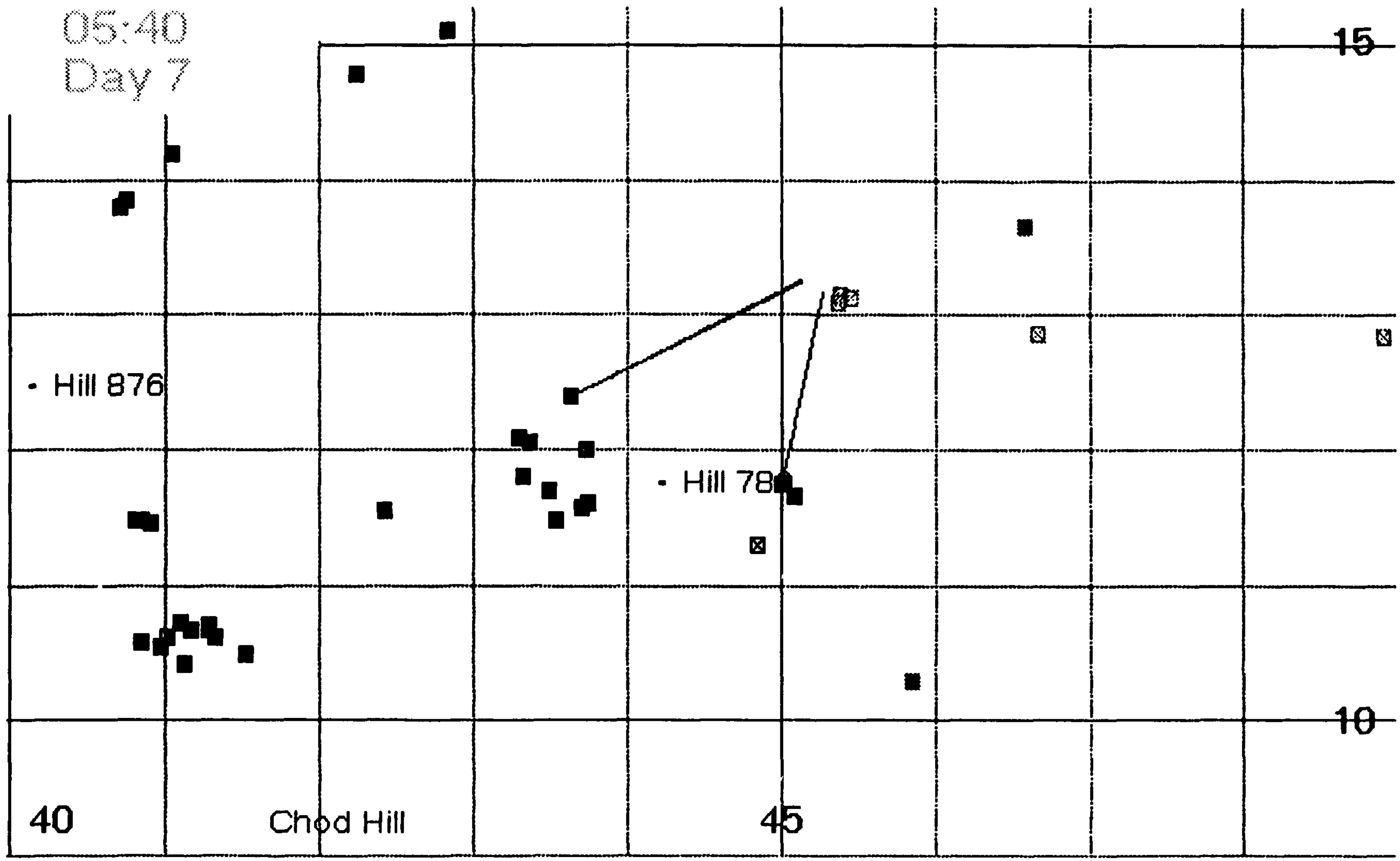

Figure 10. Third screen of dynamic graphic sequence.

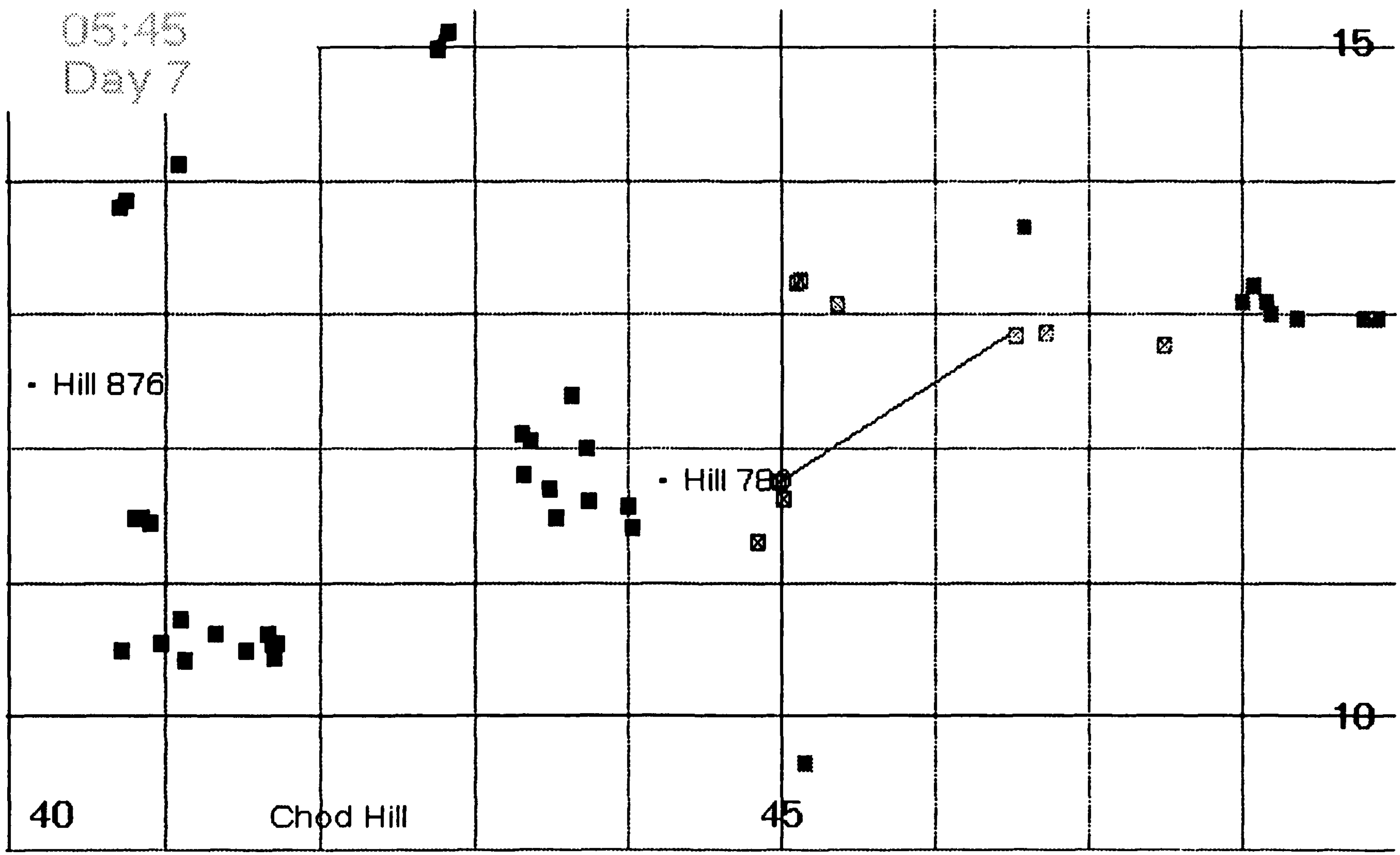

Figure 11. Fourth screen of dynamic graphic sequence.

LEARNER PROGRESS
Operating System Module

Operating System information for Day 7 indicates:

(1) Improvement is indicated for most Operating Systems.

(2) Only NBC needs substantial work.

(3) The TF performed almost perfectly.

(Type 9 to return to lesson)   Your answer? 2

No. You may want to spend more time in the lesson.

Figure 12. Sample screen from Evaluation and Feedback component.

During the several decades during which the presence of computers has increased in the workplace, a great deal of information has accumulated about how humans and computers interact (Laurel, 1990). Increasingly computers have been used successfully for training purposes. For example, in 1983, IBM was faced with rapidly escalating training costs and began a major restructuring of its corporate education programs using computer-based training, interactive videodisc, and video conferencing on a wide scale. The training delivery approach developed has become a model for cost effective employee education throughout the world (Bowsher, 1989). Common sense and evidence suggest that nothing about the computer is inherently superior to other instructional media (Hannafin & Rieber, 1989)

Specifically concerning the hypertextual organization of information, it has been demonstrated that novices find on-line hypertext easy and effective to use for finding facts (Marchionini & Shneiderman, 1988) and that a hypermedia environment can facilitate advanced learning by allowing the users to formulate their own knowledge representations and to perfect them while exploring the content of the hypermedia structure (Lacatis, Letourneau & Banvard, 1989). But merely computerizing something does not necessarily make it better. For example, drastically altering the structure of text in a journal article for the hypertext version did not aid the reader (Verreck & Lkoundi, 1990). Further, numerous interactive systems have required specialized training (MacKnight, 1991) and often novice users, and occasionally experienced users, report a disorientation as a consequence of non-sequential movement through large hyperdocuments (Bevilacqua, 1989). This phenomenon has been termed the 'lost in hyperspace' problem.

Then there are graphics. Are they effective in contributing to learning? For example, graphic animation has been found to aid learners in visualizing complex concepts, but it has been found to have little impact on learning without integration into a larger instructional context (Rieber, L. 1990).

The work here has been intended as a feasibility demonstration of what is possible and a determination of what is required for full system development rather than an evaluation of effectiveness. Business and industry are recognizing the need to change the methods of evaluation for interactive systems and multimedia because traditional methods based on verbal methods are simply not appropriate for evaluation of visual processes (Marlino, 1990) The development of POPS demonstrates that interactive hypermedia technology exists today to produce quality instructional materials of moderate complexity for training fundamental tactics.

To comprehensively evaluate this technology in terms of its effectiveness in comparison to traditional tactical training methods has been beyond the scope of the current effort. However, this is research which needs to be done prior to a resource-intensive full development effort is undertaken. Such an evaluation if properly planned and conducted may also serve as the basis for a thorough cost-benefit analysis of various methods for training fundamental tactics.

What is needed for a full development of the concept demonstrated by POPS? As with most projects the key to a successful development of the interactive hypermedia tactical trainer will depend upon the planning phase. Solid sponsorship and elucidation of project goals and objectives will be critical. Quality is expensive but is often a savings in the long run.

The complexity of computer-based training development should not be underestimated. Fourteen distinct roles involved in the development process of the typical computer-based trainer have been identified (Gery, 1987). These include Project Manager, Program Sponsor, Instructional Designer, Subject Matter Expert, Writer, Editor, Data Entry Specialist, Authoring System Host Computer Programmer, Media Expert, Graphics Designer, Authoring System Specialist, Learner Evaluator, Production Administrator, and Trainer Administrator. Assembly of the development team and resourcing it adequately are critical for project success.

Computer-based instruction development ratios reported in the literature range from 1 to 4000 hours of development time for every hour of instruction with modal dominance in the 200 to 350 range. Reasons for high costs vary, most are situationally dependent (Orlansky & String, 1979; Jay, 1989). Gery (1987) presents the basis for a more refined model of cost estimation for a computer-based trainer development. Fourteen courseware variables, five technological factors, twelve human variables and five additional factors impact the cost and development time. Collectively these factors yield a range of from 85 to 300+ development hours per computer-based training hour.

Judging the complexity of POPS on the relevant dimensions produces an estimate near the low end of the range. Substantial enhancement of the evaluation and feedback component as discussed above could be expected to move the cost toward the center of the range. Adding video and audio components would likely have costs toward the higher end of the range. Further, a shorter lesson, 4-8 hours of instruction, could be expected to have higher per hour development costs than a longer lesson of 60-80 hours of instruction.

CONCLUSION

Indiscriminate application of technology is not the answer to the challenges of Army training. However, judicious use of information technology holds exhilarating potential. This has been expressed succinctly, "because information technology moves so very much more quickly than other kinds of technology--halving in price and doubling in power every two years on the average" (Feigenbaum, McCorduck, & Nii, 1988).

Finally, interactive hypermedia, and hypertext more generally, may be viewed as one stop along the technological roadway toward training worlds based on virtual reality (Krueger, 1991). Such training worlds in which the learner is immersed in a simulated sensory environment to maximize learning and transfer to the real thing have been identified as particularly appropriate (1) in hostile environments, (2) where there is a high benefit from rehearsal and practice, and (3) where there is high potential for damage to equipment or danger to individuals (Middleton, 1991). These characteristics accurately describe combat on the modern battlefield.

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