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ABSTRACT

The Structured Analysis and Design Technique (SADT) analyzes a problem through building a model of the problem on paper which is top-down, modular, hierarchic, and structured. It is a communications vehicle using an iterative author-commenter cycle which focuses attention on defined topics, increases management control, creates a systematic work breakdown structure, and minimizes error through disciplined flexibility. The U.S. Army Training and Doctrine Command (TRADOC) has responsibility for two programs: a combat development program and a training program. TRADOC has developed such innovations as Skill Qualification Tests (SQTs), criterion referenced performance tests based on job analysis for each MOS; training and evaluation collectives, various simulators (such as a laser simulator for the M16 rifle), and various battlefield simulators. SADT was developed to expedite innovations in training and to achieve improvements in Army training as a unified system. The evaluation of SADT was conducted in three phases, based on the opinions and attitudes of participating personnel. Although the SADT process was only partially implemented, participating officers expressed increasingly positive attitudes and confidence with increasing experience; a six-week follow-up indicated these opinions remained stable. (CTM)

AN EVALUATION OF AN ADVANCED SYSTEM ANALYSIS TECHNIQUE FOR MODELING A DoD TRAINING ENVIRONMENT

Final Report

September 1977

Contract Title: "Demonstration and Evaluation of an Advanced System Analysis Technique in Modeling a DoD Training Environment"

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The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either express or implied, of the Defense Advanced Research Projects Agency or the United States Government.

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Executive Summary

The following report describes an evaluation of the utility and perceived effectiveness of a specific structured analysis and design technique as an aid in managing a complex military training environment. In this study SofTech, Inc., a Boston-based computer software firm, applied their Structured Analysis and Design Technique (SADT®) to the problems confronting the U.S. Army Training and Doctrine Command (TRADOC) in managing rapidly occurring innovations in training.

These changes include the self-pacing of a large number of training courses, evaluating training effectiveness both in terms of the individual soldier and the unit, and the development of management strategies to improve TRADOC's ability to allocate resources, establish accountability, improve teaching quality, and to achieve a better match between training content and job objectives.

If use of this particular analysis and planning methodology significantly improved TRADOC's ability to manage proposed changes in training, more widespread use of SADT in the DoD training environment would be warranted. Thus, the project included an independent evaluation commissioned by the Advanced Research Projects Agency (ARPA) and conducted by The Instructional Systems Laboratory at The University of Texas at Austin. The evaluation staff was responsible solely to ARPA for evaluative procedures, results, and conclusions. The goals of this evaluation were to assess the utility and effectiveness of SADT in a training environment. This document constitutes the final report of this evaluation.

Overview of SADT

SADT analyzes a problem through building a model or representation of the problem on paper which is top-down, hierarchic, modular, and structured.

SADT consists of two major components, graphic notation and a disciplined process which specifies how individuals in clearly defined roles are to interact to produce a model of the training program. The benefits of applying this technique to a complex system problem derive from the model produced. This model serves as documentation of the best thinking of experts as to the status of the system and evolves through an iterative author-commenter cycle.

Project Tasks and Evaluation Phases

SofTech was to perform their work in 4 tasks. Task 1 was a "start up" activity in which SofTech analysts produced an overview model of the training and evaluation system. In Task 2 SADT analysts from SofTech and TRADOC jointly produced an SADT model of a tank weapons system. In Task 3 TRADOC and SADT analysts used Tasks 1 and 2 models as starting points to produce a fully elaborated model of Army training and evaluation as it should be conducted. Task 4 was to consist of a plan for implementing the training and evaluation system conceptualized in Task 3, but was subsequently altered and did not fall within the timeframe of this evaluation.

The evaluation was conducted in three phases. A primary source of data used in all three phases was the expressed opinions and attitudes of participating TRADOC personnel towards SADT. The purpose of the Phase 1 evaluative phase was to determine initial attitudes towards SADT and to measure the kinds of activities occurring in the project. The Phase 2 evaluation reported attitudes towards SADT after development of the major SADT models were completed. The Phase 3 evaluation followed Phase 2 by 6 weeks and was concerned with examining discrepancies between Phase 1 and Phase 2 results along with obtaining summary impressions and conclusions about SADT from participating TRADOC personnel.

Results and Conclusions

Extensive data were collected early in the project to determine if the SADT process had been implemented as specified in the contract proposal. These data suggested that the participation of TRADOC officers in the project had been approximately half that originally expected. The number of officers trained to create SADT diagrams was less than expected throughout the project and the failure to fully implement this aspect of the SADT process at TRADOC may have lowered the impact the technique had on the client organization.

Participating TRADOC officers were polled about halfway in the project concerning their impressions of SADT and the progress of the project thus far. The general opinion expressed was that while the technique appeared to be a good one in a general, context-free sense, most officers believed it was too early to conclude whether SADT would ultimately affect the training concepts held by TRADOC. Some officers were skeptical of this project having any impact on TRADOC or the status of training.

Participating TRADOC officers were polled again following the completion of Task 3. It was found from comparing these two samplings that attitudes towards SADT had become more positive following the completion of Task 3. At this point participating officers had gained confidence in the ability of the technique to focus attention on relevant issues and elucidate the interrelationships of various components of the training system. These officers were particularly pleased with the Task 3 model, which appears to have documented a level of understanding and insight into the training system which had not been achieved or at least so vividly portrayed previously. A follow-up interview and questionnaire six weeks later indicated that these expressed opinions remained stable.

Summary and Conclusions

Articulation of Army training and evaluation represented by the Task 3 model represented the most direct tangible benefit of this project to TRADOC. This model integrated the previously independently conceptualized areas of training, evaluation, and system development in an understandable and practical manner. From this documentation, the actual work of implementing the new conceptualization of training can begin.

It does not appear that this application of SADT created new knowledge about specific aspects of the training system but rather that it integrated and communicated what was known about training in a useful and coherent way. The SADT diagrams and procedures provide a mechanism for documenting the best thinking in a client organization and interrelating important concepts in a clear and practical manner. It was concluded that further applications of SADT such as the one described in this report would be worthwhile.

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I. Project Overview *

This document describes the evaluation of a project supported jointly by the United States Army Training and Doctrine Command (TRADOC) and the Defense Advanced Research Projects Agency (ARPA) under the contract title "Demonstration and Evaluation of an Advanced Systems Analysis Technique in Modeling a DoD Training Environment" (ARPA Order No. 3230, Contract No.: MDA 903-76-C-0249).**

In this study SofTech, Inc., a Boston-based computer software firm, applied the Structured Analysis and Design Technique (SADT®) to the problems confronting a training command headquarters in managing rapidly occurring innovations in training methods. These changes include the self-pacing of a large number of Army courses, the initiation of a major project to evaluate training effectiveness both in terms of the individual soldier and the unit, and the development of management strategies to improve TRADOC's ability to allocate resources to training sites, establish better accountability of resources expended, improve the management of teaching quality, measure competence objectively and quantitatively, and to achieve a better match between training content and real world job objectives.

If this particular analysis and planning methodology signficantly

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*The authors would like to thank SofTech, Inc. for their cooperation and assistance in gathering data for this report, especially Reuben Jones, project manager; Steve Lipka, Stan Smith and Boyd Mathers, SADT authors; as well as many officers at TRADOC who freely gave of their valuable time for interviews and questionnaire responding. Without the cooperation of both agencies this report could not have been written.

**Evaluation reports were generated throughout this project. These interim reports were written for a limited audience and were not disseminated. Although not available, these reports are cited in the following text to provide background and clarity to ongoing discussions. The substantive results and conclusions of these smaller, sequential project summaries are contained in this report.

improved TRADOC's ability to accomplish these objectives, more wide-spread use of SADT throughout the DoD training establishment, and possibly other parts of DoD would be warranted. Because of the rapid pace with which training innovations are planned at TRADOC, this environment provided a good test bed in which to assess the applicability of SADT to analysis and planning problems encountered in other DoD training environments.

Thus, this project included an evaluation effort to assess the utility and effectiveness of the Structured Analysis and Design Technique (SADT) in a training environment and an evaluation of the impact of the project on TRADOC's ability to identify and understand the types of changes required in Army training and to develop a practical plan for carrying out those changes. This document constitutes the final report of this evaluation.

II. Overview of SADT

SADT is a systematic approach to understanding and solving complex system problems, including planning, requirements definition, functional analysis, and system design. Under development by SofTech since 1970, the technique grew out of earlier work on software engineering at the Massachusetts Institute of Technology. SofTech has applied the technique to a wide range of planning, analysis, and design problems, involving people, machines, software, hardware, databases, communications networks, procedures and finances.

The underlying philosophy of SADT is that the human mind is capable of understanding any amount of complexity, as long as it is presented in small, accessible chunks that are linked together to make a whole. This structured decomposition orientation to understanding complex problems has become a standard tool of computer software development specialists but would appear to be applicable to any field where there is a need to elucidate the relationships between parts and wholes in complex systems or programs.

SADT analyzes a problem through building a model or representation of the problem on paper which is top-down, modular, hierarchic, and structured. SADT consists of two major components, the graphic notation of this particular modeling methodology and a disciplined process which specifies how individuals in clearly defined roles are to interact to produce the model. Thus, SADT consists of both a graphic language and a well-defined discipline or process which spells out the procedures to be followed in obtaining a structured decomposition of the problem at hand. These will be discussed in turn below.

Graphic Conventions. The SADT graphic language provides a limited set of constructs from which analysts and designers can compose orderly structures of any required size. The notation is composed of boxes and arrows. Boxes represent parts of a whole, arrows represent interfaces between parts. Diagrams represent wholes and are composed of boxes, arrows, natural language names, and certain other notation. The same graphics are applicable to both activities and data.

An SADT model is an organized sequence of diagrams, each with concise supporting text. A high-level overview diagram represents the whole subject. Each lower-level diagram connects exactly into higher-level portions of the model, thus preserving the logical relationship of each component to the total system. Thus, program detail is introduced gradually so that substantive detail is integrated into the whole without obscuring the overall intent or "big picture". Figure 1 provides a conceptual illustration of the modeling process. Figure 2 contains an actual SADT diagram produced during this project.

An SADT model is a graphic representation of the hierarchic structure of a system, decomposed with a definite purpose in mind. A model is structured so that it gradually exposes detail, but its depth is bounded by the restriction of its vantage point; and its content is bounded by its viewpoint. The priorities dictated by its purpose determine the layering of the top-down decomposition. Parallel models can accomodate both multiple viewpoints and various stages of system implementation.

The arrow structure on an SADT diagram represents a constraint relationship among the boxes. It does not necessarily represent flow of control or sequence, as for example, on a flowchart for a computer program.

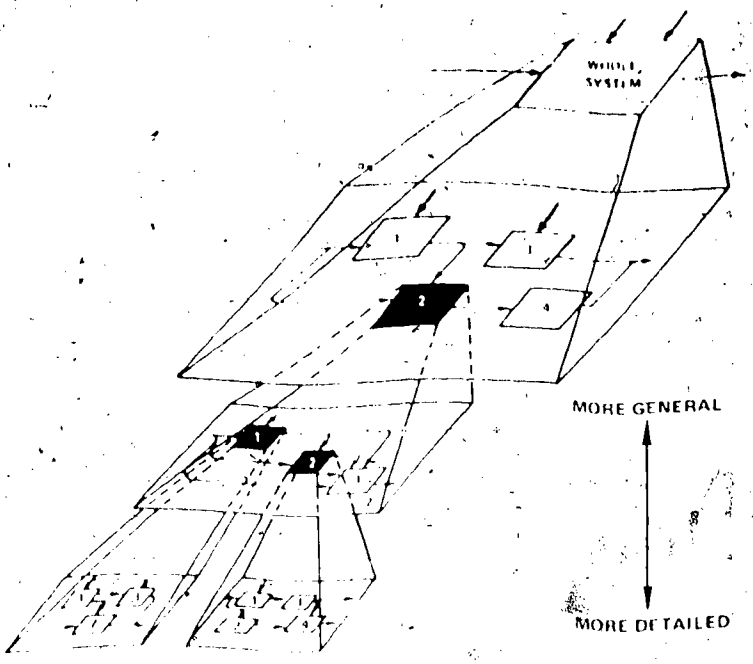

Figure 1. Conceptual illustration of the modeling process.

Constraint arrows show necessary conditions imposed on an activity.

Most arrows represent interfaces between boxes, whether in the same or different models. Some arrows represent non-interface interlocking between models. The interface structure, particularly, passes through several levels of diagrams, creating a web that integrates all parts of the decomposition and shows the whole system's environmental interfaces with the topmost box. Further documentation of the mechanics of the technique can be found in An Introduction to SADT (TM) (Publication number 9022-78R, SofTech, Inc., 460 Totten Pond Road, Waltham, Massachusetts, 02154).

The SADT Process. Complex problem analysis requires cooperative teamwork from many individuals. SADT attempts to provide a clear definition

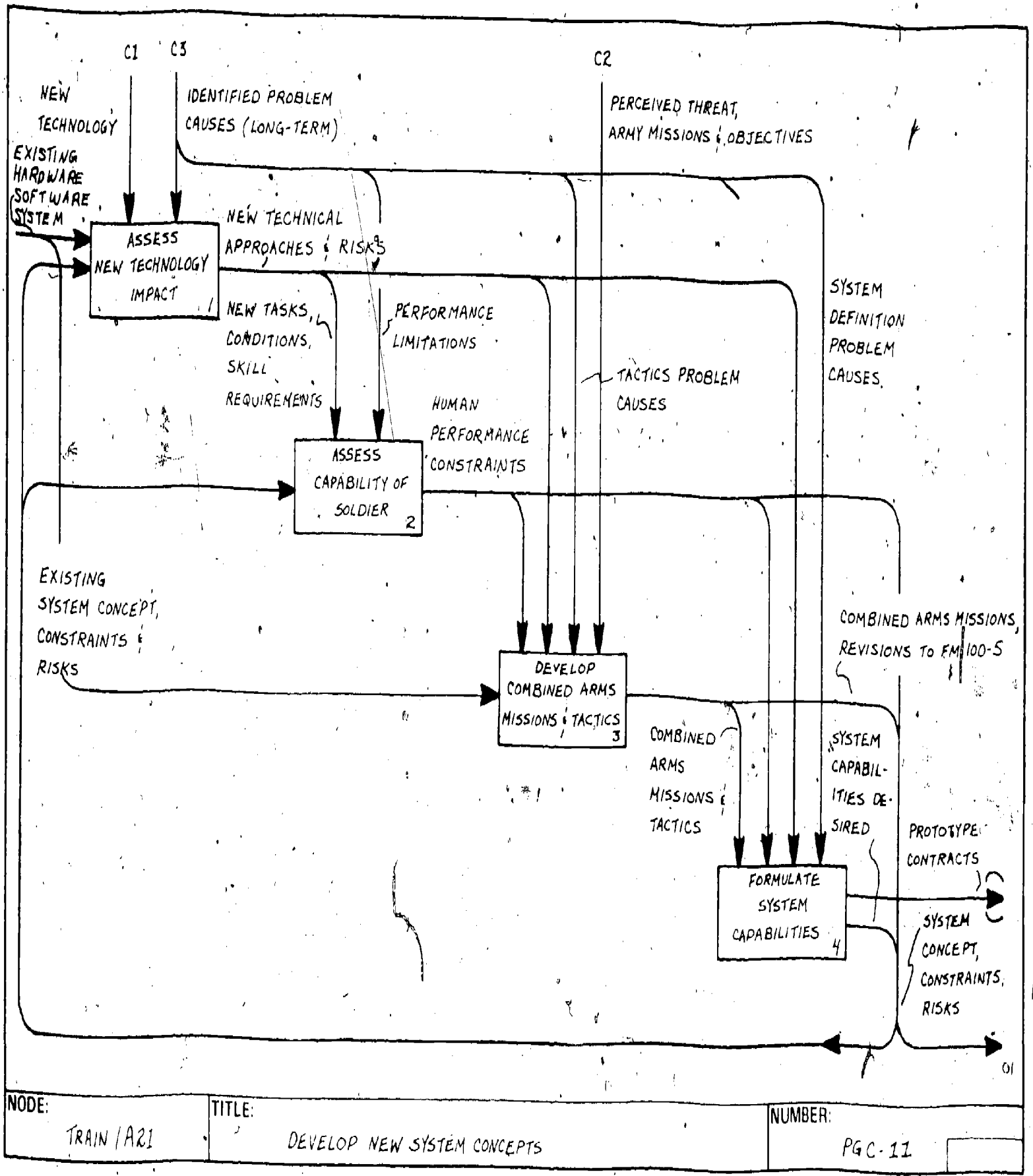

Figure 2. SADT diagram produced during this project.

of the kinds of interactions which should occur between the personnel involved by establishing titles and functions of appropriate roles. These appear in Table 1. The SADT process, in which these roles interact, provides continuous documentation, and regular critical review of the work produced. In this way decisions can be seen in context and can be challenged while alternatives are still viable.

Throughout a project, draft versions of diagrams in evolving models are distributed to project members for review. Commenters make their suggestions in writing directly on copies of the diagrams. Written records of decisions and alternatives are retained as they unfold. As changes and corrections are made, all versions are entered in the project files. A project librarian provides filing, distribution, and record keeping support. This process documents all decisions and the reasons why decisions are made. When commenters and authors reach an understanding, the work is reviewed by a committee of senior technical and management personnel. During the process, incorrect or unacceptable results may be identified early, so that oversights or errors can be detected before they cause major disruptions. Since everything is on record, future enhancement and system maintenance can reference previous analysis and design decisions. A list of roles and functions used in the SADT process appears in Table 1.

Because documentation is produced as the model evolves, the status of the project is visible to all interested parties. Management can study the requirements (or the design) in a "top-down" manner, beginning with an overview and continuing to any relevant level of detail. Although presentations to upper management usually follow standard summary and walk-through methods, even senior executives can become readers of the SADT language.

Table 1

Titles and Functions in the SADT Process

Title	Function
Authors	Personnel who study requirements and constraints, analyze the system functions and represent them by a model based on SADT diagrams.
Commenters	Individuals who must review and comment in writing on the SADT diagrams produced by the authors.
Technical Committee	A group of senior technical personnel assigned to review the analysis at every major level of decomposition. They resolve technical questions or disagreements or recommend a decision to the project management.
Experts	Persons from whom authors obtain specialized information about functional requirements and certain constraints by means of interviews.
Readers	Personnel who read SADT diagrams for information but are not expected to make written comments.
Monitor	A person fluent in SADT who assists and advises project personnel in the use and application of SADT.
Project Librarian	A person assigned the responsibility of maintaining a centralized file of all project diagrams and associated documents, making copies, distributing reader kits, keeping reader kits, keeping records, etc.
Project Manager	The member of the project who has the final technical responsibility for carrying out the system analysis and design.
Instructor	A person fluent in SADT who trains Authors and Commenters who are using SADT for the first time.

Implementing the Approach. How SADT is implemented varies according to organization needs and the kinds of systems under consideration. There is no set pattern among different organizations for the contents of a problem analysis. In each case, the needs of the client organization must be accomodated. Because local needs are diverse, implementation of SADT is a "learn by doing" experience in which project personnel acquire ways of understanding the generic nature of systems.

While little previous evaluative data exists on SADT, users report that it is a communications vehicle which focuses attention on well-defined topics, that it increases management control through visibility and standardization, that it creates a systematic work breakdown structure for project teams, and that it minimizes errors through disciplined flexibility (see Ross, D.T. and Schoman, K.E. Structured analysis for requirements definition. IEEE Transactions on Software Engineering, Vol. SE-3 (1), January, 1977, pp. 6-15).

III. Overview of the U.S. Army Training and Doctrine Command (TRADOC)*

The U.S. Army Training and Doctrine Command (TRADOC) was created in 1973. With an annual budget approaching one billion dollars and a total program that includes the employment of approximately 12,000 officers, 50,000 enlisted men and 40,000 civilians, TRADOC is charged with the responsibility of establishing and maintaining Army concepts, principles, and policies (doctrine) and for the conduct of all Army training.

TRADOC consists essentially of two major components for meeting these responsibilities: a combat developments program and a training program. The combat developments program consists of three major activities (1) the determination of requirements and capabilities of weapon systems and equipment (including non-combat equipment); (2) the development of optimal organizational policy (e.g., determining the formal organization of tank battalions and the integration of those forces with mechanized rifle companies, maintenance crews, etc.); and (3) the development of tactics and techniques by which the acquired weapons and equipment will be deployed by the various organizational groupings of troops on the modern battlefield.

The training branch of TRADOC consists of the traditional Army training structure described below, and a training development component which has achieved visibility only within the last two years. Each will be discussed below.

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*This description of TRADOC is based on the proceedings of various Commander's Conferences and Technology Symposiums sponsored by TRADOC in 1975 and 1976. While this overview may now be slightly dated, it illustrates considerations which ultimately led to TRADOC's participation in this project.

While the training developments component of TRADOC represents a new concept, the training structure within the Army is well established. For enlisted men, the program consists of the well-known basic training and advanced individual training (AIT) which is conducted at several installations across the country. There are 21 training schools such as the U.S. Army Infantry School at Ft. Benning, Georgia, the U.S. Army Armory School at Ft. Knox, Kentucky, the U.S. Army Field Artillery School at Ft. Sill, Oklahoma, the U.S. Army Transportation School at Ft. Eustis, Virginia, and the U.S. Army Engineer Training Center at Ft. Leonard Wood, Missouri. There is a continuing education program for noncommissioned officers (which, like AIT, is usually conducted through the training school) to keep soldiers current on developments in equipment and doctrine.

There is also basic training, intensive advanced individual training and continuing education programs for officers which contain special emphasis on such areas as leadership, management, and tactics. For higher ranking officers (usually majors) there is the Command and General Staff College at Ft. Levenworth, Kansas, and at a still higher level, there is the Army War College. Additionally, the entire ROTC structure and Officer Candidate School fall within TRADOC's responsibilities.

In addition to these training facilities, TRADOC contains many subagencies such as the Combat Arms Training Board (CATB), the Training Aid Development and Requirements Agency (TRADER), the Combat Development Experimentation Command (CDEC), the TRADOC Combined Arms Test Agency (TCATA) and the TRADOC Systems Analysis Agency (TRASANA). Thus, management responsibility for the various aspects of training and evaluation has traditionally been diffused throughout the training system.

While this brief survey of training commands and agencies is not exhaustive, it indicates the breadth of TRADOC's educational management responsibility. Thus, TRADOC represents perhaps the world's largest training agency, responsible for teaching a comprehensive range of skills and competencies across a wide range of geographic locales under the control of a wide range of subagencies within TRADOC.

Innovations in Army Training

Until recently, innovation had not been a high priority in Army training and evaluation. Traditionally, job training had been conducted in the Army schools using a platform lecture format. Performance usually was evaluated by paper and pencil tests. For each military occupation specialty (MOS) there was an AIT course and progressive supplementary training courses. There was an associated test for each skill level of each MOS, usually consisting of about 100 multiple choice questions.

Initial analyses of training effectiveness in the early 1970's suggested that the actual performance of soldiers in the field did not meet criteria established by outside contractors and the combat developments branch of TRADOC. A brief example illustrates this point. While the example presented is hypothetical, it is based on the results of several actual analyses of specific weapons systems.

Figure 3 indicates the probability of hitting a moving target with a particular weapon as a function of the distance from the target in meters. Line A indicates the actual performance of a group of soldiers using this weapon. Line B indicates the capability of the weapon as determined by the Army Materiel Systems Analysis Agency (AMSAA). Line C represents what a group of combat officers believed was the capability of their soldiers of using the weapon.

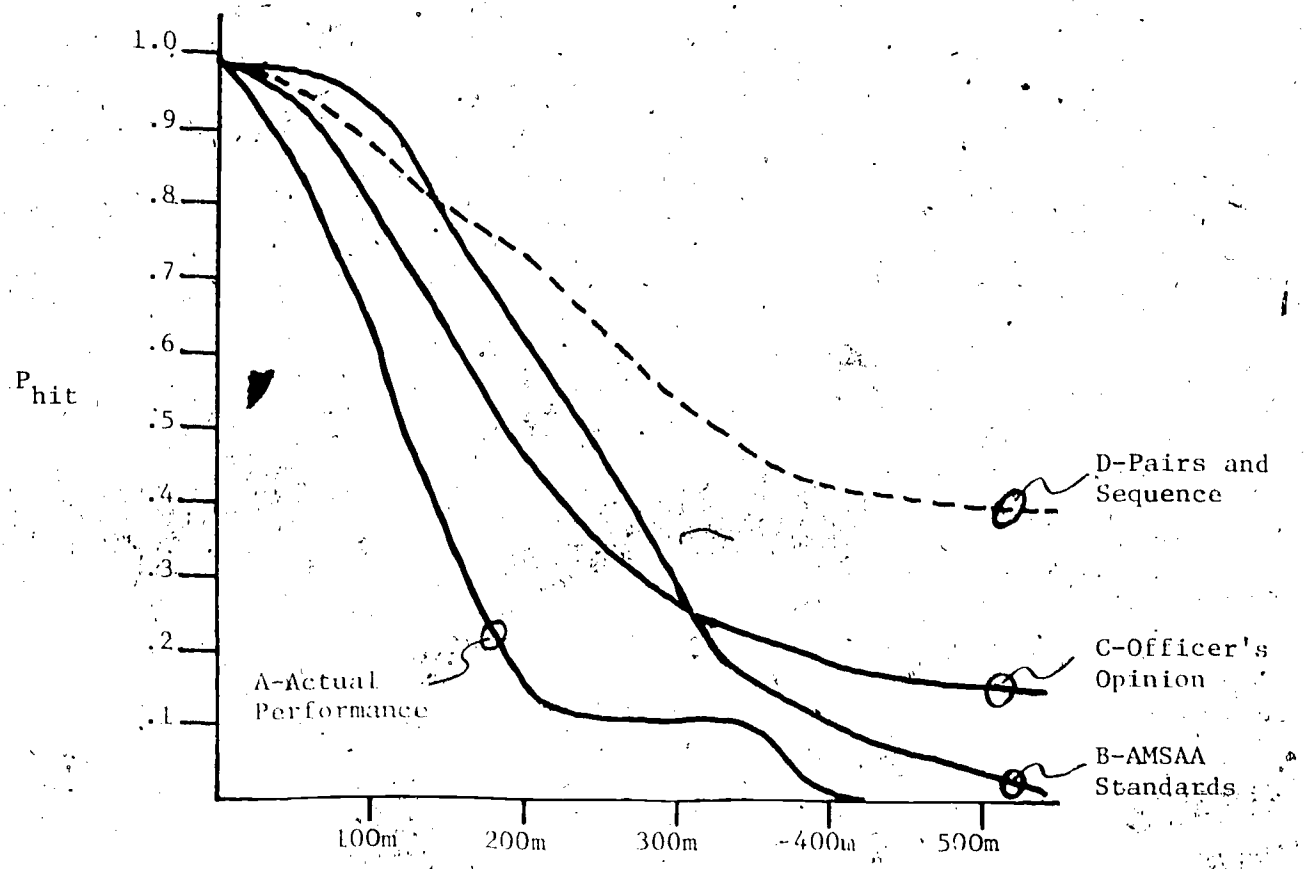

Figure 3. Probability of hitting a moving target (P_{hit}) as a function of the distance from the target in meters.

Figure 3 data suggest that the ability of the soldier to use the weapon in the field did not match the weapon's capability (discrepancy between lines A and B). Further, what commanding officers believed to be the capability of the weapon was not veridical with actual performance (discrepancy between lines A and C). Thus, the decisions an officer made on the battlefield relative to this weapon would not match his troops' ability to deploy it nor the weapon's actual capability.

Based on these results, the length of training for this weapon was doubled and a simulator developed to provide more practice opportunities. This increased proficiency considerably. In experimenting with the training for this weapon it was found that soldiers had difficulty estimating the range of the target through the weapon's complex sight. To remedy this it was decided to use the weapons in pairs and firing in sequence. Thus, one soldier would estimate range, aim, and fire. A second soldier would then use the first soldier's range estimate and his observation of where the first round hit to obtain a better range estimate for a second firing on the target. The performance of pairs of soldiers using this procedure is indicated by Line D on Figure 2. This level of performance exceeds what was originally considered to be the capability of the weapon. Training analysis studies such as this were seminal in bringing about a concern for training developments within TRADOC.

Another factor motivating the search for improved training methods was budgetary constraints. As TRADOC was becoming aware of some inadequacies in training, they were faced with the task of improving the quality of training with a decreased training budget. This forced the realization that the traditional labor intensive methods of training employed by TRADOC

(platform lecturers, low instructor/student ratios, etc.) were not a cost efficient approach for future Army training. Furthermore, most soldiers spend only 2 or 3 months out of a three-year tour of duty at a training school. The man-hours lost while a soldier is away from his unit of assignment attending school and the associated costs contribute to the cost of traditional Army training. These considerations have led TRADOC to make training available to the soldier in his unit of assignment. This was seen as no small task in that almost all training resources were located at the schools and training centers.

Given these considerations, TRADOC formed an instructional technology study group whose membership included representatives of industry, government, academia, and the military. After studying the Army training system this group presented its findings and recommendations to the leadership of TRADOC. While these findings are too lengthy to present here several key issues that emerged are summarized below to convey the flavor of what was reported by this group.

1. The Army's instructional strategies were not as cost-efficient as some more modern instructional technologies.
2. School personnel lacked the understanding, motivation, and skills to employ modern instructional technologies.
3. Effective training program evaluation was not occurring in the Army training system.
4. Criterion-referenced training and evaluation was not evident in the Army training system.
5. Very little self pacing was being employed in the training system.

6. Disincentives for the introduction of training innovations abounded in the training system.

7. There was no proponency within TRADOC devoted to the management of training effectiveness.

8. The organizational and management processes of TRADOC were fractionalized or diffused to the extent that training program development, implementation, and evaluation were impeded.

From their study, this consulting group recommended that TRADOC consolidate their training resource management processes, form a training management institute to orient and educate the various managers of training in modern educational technology, consider adopting a systems approach to training based on job performance data and criterion-referenced evaluation, and provide incentives to school and unit commanders for incorporating advanced instructional techniques and establishing pilot projects towards these goals as soon as possible.*

Since its inception in 1973, TRADOC has been active in its attempts to modernize Army training, primarily through its training developments branch. Major projects have included the development of packaged training extension courses (TECs) which can be sent to the units thus making it easier for the soldier to learn on the job. Most of these courses utilize an audio-visual cassette machine that presents a lesson both verbally and through visual aids, and allows for testing and feedback throughout the lesson. Some machines even allow simulations

*The aforementioned activities are not intended to be exhaustive of the influences leading to an increased concern for the status of training in the Army but rather exemplary of the considerations which led to change.

of the task being taught. Evidence indicates that the self-paced TEC courses are at least as effective as traditional Army training methods. At the end of FY 77, 1044 of the 5000 courses which had been proposed had been developed. By 1979 the Army expects to have 5 million copies of the TEC lessons available for active and reserve troops.

Primarily through the efforts of the recently formed Training Management Institute, Skill Qualification Tests (SQTs) have been developed to replace the old pencil and paper MOS tests. These are criterion-referenced performance tests based on job task analysis for each MOS. TRADOC is well on its way toward developing SQTs for each skill level of each MOS and towards the development of a prototype task description data base.

Another major effort has been devoted to the development of training and evaluation of collectives (groups). The Army Training and Evaluation Program (ARTEP) is an initial effort in this direction. ARTEPs are manuals containing "how to" instructions for unit commanders on conducting collective training and evaluation. They describe the cues and conditions under which a particular task may occur as part of some large defined mission (e.g., "deliberate daylight attack" or "night withdrawal" of a rifle company). The ARTEP manual also specifies the training and evaluation standards for judging the performance of a group.

Another major TRADOC effort has been the development of simulators to better train soldiers in the use of various weapons and equipment. One example is the LASER simulator for the M16 rifle, which emits an eye-safe laser beam when fired, rather than a live round. Sensors on targets provide immediate feedback on performance. It has been found that training with LASER simulators is at least as effective as traditional training

with live ammunition at a fraction of the cost.

In collective training, two-sided free play battlefield engagement simulators have been developed. One such simulation, REALTRAIN, requires that each soldier of two opposing forces wear specially treated numbers on their person. Each soldier's rifle is equipped with a special sighting lens. Upon sighting an opponent, a soldier shouts the opponent's number to a referee who records a "kill" and makes sure the victim retires from the game. The Multiple Integrated Laser Engagement System (MILES) incorporates the LASER simulator in a collective two-sided free play exercise. Each soldier wears a belt with laser sensors. A loud tone indicates to the soldier that he is the victim of a hit. If hit, the soldier must go to a referee who can turn off the tone with a key. A softer tone indicates to the soldier that he was the subject of a near miss. MILES and REALTRAIN simulators have also been developed for tank versus tank and soldier versus tank simulators. Further developments have been aimed towards integrating ARTEPs with REALTRAIN and/or MILES to obtain the specificity of the SQT evaluation of individuals at the collective training level.

This survey of the TRADOC efforts to modernize Army training is far from complete but is indicative of the actions being taken to meet this goal.

Constraints on TRADOC

TRADOC has been actively pursuing these activities despite shortages of personnel and resources. Another major constraint encountered initially by TRADOC was the varying degree of resistance to change in the training environment. Thus, TRADOC is in the position of not only managing a very large and complex training system, but also is actively attempting to modernize, even revolutionize, Army training in the face of

limited resources and resistance to change. Further, because there is a strong sense of time urgency in accomplishing these tasks, the management of TRADOC's planned activities is even more arduous.

It is within this context that TRADOC has contracted SofTech, Inc. to apply its Structured Analysis and Design Technique (SADT) to the problems of managing rapidly occurring innovations in training methods. SADT was to be used in this study to identify changes in Army training required to significantly increase combat effectiveness, describe how Army training, testing and evaluation programs would operate after the proposed changes are accomplished, and to plan how the changes in Army training would be undertaken and how progress would be monitored and evaluated.

Traditionally, Army training has not been viewed as a large system problem, but rather as a composite of many smaller problems. These smaller problems usually have been solved by a particular organization within the training command. A "good" solution often optimized the particular organization's objectives at some expense to the goal of achieving overall improvements in Army training. The major hypothesis of this study was that defining military training as a large system will provide the basis for more effectively solving small problems within the context of overall military objectives.

More specifically, TRADOC participated in this study to improve their analysis and planning of the training system. Special emphasis is given by TRADOC to the problem of describing the interrelationships between the many training innovations being envisioned and in planning how those changes should be accomplished. Once developed, it is hoped that the model of the Army training system can be used to guide and control system

development from its current status and capability to the status and capability desired. After the training system is fully implemented, the model could potentially be used to control and manage the system. Finally, the model produced could become the "standard" against which to compare current system functioning. Faced with the problems cited earlier, and in hopes of achieving the goals described here, TRADOC entered into the joint project with SofTech and ARPA, which is the subject of this evaluation report.

IV. Description of Project Tasks and the Evaluation Time Frame

Prior to actually applying SADT to Army training and testing programs, "lead time" was allowed for establishing a point-of-contact or liason officer within TRADOC to function as an interface between TRADOC and SofTech. This person was to be responsible for setting up facilities, establishing appointment schedules, and coordinating SofTech and TRADOC efforts. A major portion of this preparatory activity was devoted to training selected TRADOC personnel in reading and authoring SADT diagrams. These individuals were scheduled to play an active role in most project tasks, particularly as commenters.

Project Tasks

The plan for applying SADT in the TRADOC environment consisted of five project tasks. A description of these tasks as originally proposed appears below. As the project proceeded, it became necessary to alter Tasks 4 and 5. These changes will be discussed in a subsequent section of this report.

Task 1. In this task, SofTech analysts were to produce a model describing, at the overview level, how the Army training program would function after the training innovations envisioned by TRADOC were actually incorporated into Army practice. The principal purpose of this initial effort was to define the types of changes being planned by TRADOC and to determine how these changes were related to existing training methods. This initial description was to provide a focus for Task 2 work and serve as the basis for Task 3.

Task 2. In this task SofTech analysts and TRADOC officers

trained in SADT were to develop jointly a description of a total weapons system. The objective of this task was the derivation of the training requirements necessary for that weapon system to be maximally effective on the battlefield. It was believed that only by looking at a particular weapons system as a total system could that system's training requirements be fully understood.

The Army's major weapons systems, such as attack helicopters, field artillery and tanks, are necessarily conceptualized as dependent components within a larger integrated combined arms force. Because the tank force is a relatively independent system requiring an increasing amount of technical training for its crew and support elements, it was chosen as the focus of Task 2. The results of a thorough analysis of the training support necessary for this weapon system was expected to be representative of what would be found in analyses of other systems. The insights gained in working through an SADT model of this particular system were expected to be of value in determining the optimum structure of the entire Army training and evaluation program, which was the focus of Task 3.

Task 3. In Task 3 SADT and TRADOC personnel were to develop jointly an SADT model of the new Army training and evaluation system as it should function after training innovations envisioned by TRADOC were actually incorporated into the Army's standard operating procedures. The major input to this effort was to be the general overview model of the Army training system developed in Task 1, and the SADT model and associated reports of the analysis of the tank system as a total weapon system developed in Task 2.

The result of Task 3 was to be a model showing in increasing levels of detail all of the activities that comprise the training system of the future. These activities were to include such tasks as course development, budgeting for the Army schools, measuring training effectiveness, determining avenues of information flow and feedback between the various organizational components of the training system, evaluating the impact of information and feedback on the training activities that actually occur, measuring cost effectiveness, and evaluating the new conceptualization of training itself.

It was expected that this model would facilitate a better understanding of what the Army was to achieve and reduce the amount of time spent planning, managing, and accomplishing these achievements. Additionally, it was believed that the model would provide a format which would facilitate communication to and from the various proponent schools and upper echelons of the Department of the Army.

Task 4. The objective of this task was to be the development of an innovation plan describing how changes in Army training would be undertaken and how their progress would be monitored and evaluated. This plan was to be prepared in two complementary forms: an SADT planning model which shows precisely the interactions between the various elements of the plan and an implementation schedule prepared by the Critial Path Method (CPM).

SofTech was to assist TRADOC staff members in developing a model of the innovation plan and was to produce the CPM schedule. The SofTech deliverable was to be a report presenting the model, the resulting CPM schedule, and a summary of the algorithms used to perform the model

to CPM conversion.

Task 5. This task was to consist of two distinct parts, the overall evaluation of this project (which is represented by this report) and a plan for wider Department of Defense (DoD) use of SADT which was to be prepared by SofTech with the assistance of the project evaluator. The overall evaluation was to focus on whether changes in Army training actually occurred as a result of the project and whether these changes could increase the combat readiness and battlefield effectiveness of the Army. This evaluation was to include an SADT model, produced by the evaluators, of the overall evaluation effort.

If the final evaluation indicated that the project goals were met, SofTech was to prepare a plan for wider DoD use of SADT, addressing four key issues:

> the types of applications where the DoD could realize the greatest benefits and an estimate of the magnitude of the benefits;
>
> the types of documentation and courses required if a significant number of people were to learn the technique;
>
> areas where the methodology should be enhanced to improve the quality of the results or its transferability to a wider audience;
>
> the types of automated tools required for the exploitation of the methodology on large projects.

SofTech expected that the evaluation process would indicate areas in which there were problems in applying SADT methodology at TRADOC, areas where the technique must be further refined, and areas where alternative methods might be preferable. The plan was to indicate how any deficiencies in the methodology might be corrected prior to wider DoD use.

Evaluation Time Frame

The evaluation of this project was divided into three phases, with the results of each phase presented in an evaluation report. These phases are:

Phase 1. This phase covered Tasks 1 and 2, and concentrated on determining the usefulness of SADT in modeling Army training. A major portion of this effort was the identification and development of evaluative dimensions on which the effectiveness of SADT and the usefulness of the models produced were to be assessed. The evaluation report, submitted six weeks after the conclusion of Task 2 was to serve as input in determining whether or not to continue the project as planned.

Phase 2. This evaluative phase was concerned primarily with determining the impact of the Task 3 model. Because the model produced in Task 3 was to represent the bulk of SofTech's work for TRADOC, an evaluation of the perceived usefulness and impact of this particular model seemed appropriate prior to beginning the final (Phase 3) evaluation effort. Further, an interim evaluation deliverable at the conclusion of Task 3 would provide an opportunity to reconsider and update the findings and conclusions of the Phase 1 evaluation.

Phase 3. This evaluative phase was to: (1) re-examine the results and conclusions of the first two evaluative deliverables, and (2) focus upon the intermediate and long range effects of having developed the models produced in Tasks 1, 2, 3, and 4. Primary emphasis was given in this phase to whether the models had brought about a better understanding of what needed to be done to improve Army training, whether TRADOC personnel considered SADT a viable approach to their problems and a determination of whether the work produced during this project would ultimately make a difference in Army training and evaluation procedures. This paper constitutes the final evaluation report of this project and summarizes the procedures and results of all three evaluation phases.

Figure 4 indicates the relationship between project tasks and evaluation phases.

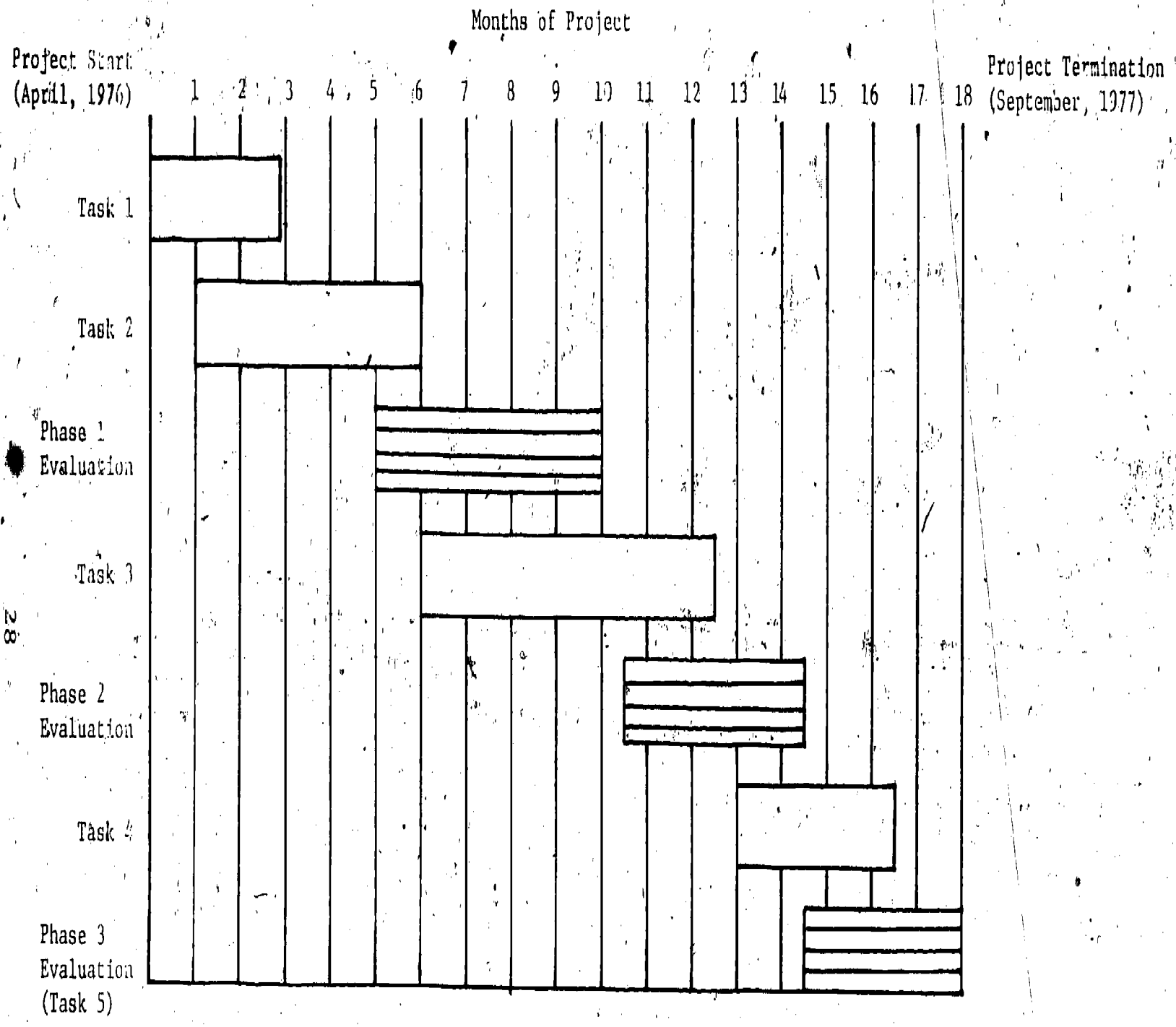

Figure 4. Temporal relationship between project tasks and evaluation phases.

The following sections will report the approach, specific procedures, results and conclusions for each of the three evaluation phases.

V. Phase 1 Evaluation Procedures and Results

General Approach

The proposal submitted to ARPA by SofTech specified an evaluation effort which would provide ARPA with:

(1) an assessment of the utility and effectiveness of the Structured Analysis and Design Technique (SADT) in the training command environment; and

(2) an evaluation of the impact of the project on TRADOC's ability to identify the types of changes required in Army training and to develop a practical plan for carrying out those changes.

The general goals of the evaluation effort (1 and 2 above) and the experience accrued by the evaluators during an orientation visit to TRADOC Headquarters suggested two major areas of inquiry for the Phase 1 evaluation. The first addressed the utility and effectiveness of the technique itself and encompassed such questions as: Are SADT diagrams accurate? Does the SADT process promote communication between diverse personnel in the project? Does SADT help achieve clearer understanding of the problems at hand?

The second major area of inquiry focused on the interface between the technique and the particular environment in which it is applied, in this case, TRADOC. The value of the technique itself is inconsequential if the technique is not successfully implemented. Because SADT is dependent on the cooperation and support of personnel in the client organization, marginal implementation in an unreceptive environment or a lack of uniform support could affect the utility and effectiveness of the technique itself.

Thus, two evaluation questions emerged. The first addressed the value of SADT; the second addressed the value of the technique as applied

in an environment like TRADOC. This second question was dependent on the degree of implementation and the amount of support the technique received from the client organization, TRADOC. Degree of implementation could be measured by various behavioral indices of participation in the project by members of TRADOC. The value question was not so easily answered. Given the available resources and time frame for the present evaluation effort, the perceived effectiveness of the technique by participating TRADOC officers was given primary consideration in determining the value of SADT.

The remainder of this section attempts to answer these questions by specifying the evaluation methods and procedures followed, reporting and discussing the results obtained, presenting conclusions based on the results, and providing a summary of critical issues which affected the implementation of SADT in the TRADOC environment.

Methods and Procedures

A. Site visits. The evaluation team (Dr. Gary D. Borich and Mr. Ron Jemelka) visited SofTech's Waltham, Massachusetts facility and TRADOC Headquarters at Ft. Monroe, Virginia in August, 1976. These visits provided inital contact with SofTech and TRADOC, and provided a realistic framework from which to plan subsequent evaluation efforts. Additionally, the evaluation staff was provided training in reading and authoring SADT diagrams during these site visits.

B. The development of evaluative dimensions. The next major evaluation effort was the development of evaluative dimensions to provide a framework for the assessment of SADT. The rationale for developing the evaluative dimensions was taken from the technical proposal submitted to ARPA by SofTech.

The approach used in developing these dimensions was to analyze the benefits claimed by SofTech to occur at TRADOC as a result of this contract. Because the selection of the evaluative dimensions was critical to subsequent evaluation efforts, these dimensions were derived directly from the contractor's claims, to protect the evaluation from being biased by criteria which were either unfair to the contractor or insensitive to Army needs and expectations. Deriving dimensions from claims made by the contractor in the technical proposal seemed ultimately fair to both SofTech and TRADOC, because SofTech wrote the proposal (made the claims) and TRADOC accepted the proposal as documentation of what was to be delivered. The only constraint imposed by the evaluator in selecting evaluative criteria was that each dimension chosen had to be measurable, given the resources and time frame allotted to the evaluation effort.

The technical proposal was analyzed and each claim was noted. The process of deriving evaluative dimensions began by clustering similar claims together. After this first clustering, each cluster was scrutinized further to determine if (a) there were significant overlap between clusters, (b) there were only a few claims in any one cluster, and (c) there were radically different claims in any one cluster. In some cases, clusters were combined and, in other cases, clusters were broken into related subclusters. The overriding criterion for the composition of clusters was that each be as independent of the others as possible.

Each cluster was then analyzed and a generic title chosen to cover all claims in that cluster. In this manner, each cluster evolved into an evaluative dimension. These evaluative dimensions appear in Appendix A.

C. Data gathering strategies. Given the time and resource limitations of the evaluation effort, the most direct manner in which to evaluate SADT in Tasks 1 and 2 was via the perceived effectiveness of the technique by TRADOC personnel involved in the project. The most straightforward strategy would be to ask these individuals about various aspects of the technique relevant to the evaluative dimensions and what benefits they believe have accrued or could accrue to the Army as a result of its participation in the project. Therefore, a questionnaire was developed and administered to TRADOC personnel and then followed with a structured interview focusing on specific responses to the questionnaire. The interview also provided the opportunity to pose general questions about the value of the technique and the use of the technique in the TRADOC environment. A copy of the questionnaire appears in Appendix B.

According to SofTech's descriptive literature, one of the necessary "subsystems" of an SADT project is a file system and library service which organizes and centralizes record-keeping and support functions and which allows the complete project history to be reviewed. This clerical function ensures that documentation of the development of an SADT model is maintained concurrent with that development. A copy of each diagram produced is retained on file, and all interactions between individuals in the project are documented.

This project file makes it possible to determine the subject area of a kit (a series of related SADT diagrams), number of diagrams in the kit, who the kit was sent to for comments, how many times kits were commented on and returned, and how often the author returned the kit to

the reader. From these data, one can determine whether the activities described in the proposal actually occurred. While designed to enhance the review of project decisions and development, these data were important in determining if the technique had been successfully implemented at TRADOC headquarters.

The project file at Ft. Monroe was examined to determine if this library function had been maintained as claimed. The number of diagrams produced and general content of the diagrams were noted. These data then were used to prepare frequency tables for all relevant process behaviors. TRADOC participants were queried at random to determine the degree of agreement between perceived level of participation and degree of participation documented in the project file.

D. Summary of procedures. The Phase 1 evaluation procedures yielded three types of data:

(1) process data - obtained from examination of the project file;

(2) quantitative data - obtained from the quantifiable questionnaire responses (see Appendix B, Items 1 through 38);

(3) qualitative data - obtained from responses to open-ended questionnaire items (Items 39 through 44) and from responses to interview probes.

After the results of each type of data were prepared they were combined where appropriate to answer the two basic questions which were the focus of the Phase 1 evaluation effort. The first question concerned the value or merit of SADT itself. The second question addressed the implementation of SADT, particularly in an environment such as TRADOC.

The data from all three sources were interrelated prior to drawing conclusions about the value of SADT. The interaction of these three groups of data illuminated both the technique itself and the effect of variables which moderate the effectiveness of the technique.

Results

This section presents results of the Phase 1 evaluation. Data on the implementation of SADT during this phase will be presented first followed by results from the questionnaire and structured interviews.

A. Process data. The first step in this phase of the evaluation was to determine whether the roles of the TRADOC and SofTech personnel specified in the contract proposal had actually been performed. Examination of what had occurred up to this point in the project revealed that the processes and role functions specified in the proposal did occur with some exceptions. One notable ommission, however, was that no Senior Review Committee was reported in the Task 1 report. SofTech explained the absence of the Senior Review Committee by noting:

> As fewer changes were indicated by comments received, the diagrams would normally have been sent to a selected group of commenters referred to as the Senior Review Committee. This committee would be requested to review these diagrams and approve them. Since the commenters included the members of the review committee, and since this model will be revised in Task 3, the formal senior review was omitted. (SofTech, Inc., Task 1 Report, p. 3-5)

A second discrepancy between contractor intents and conditions observed by the evaluators was that some individuals performed multiple roles. For example, the technical proposal specified that the individual assigned as the TRADOC interface was to be responsible for time commitments,

selection of staff for training and participation, and for ensuring completion of TRADOC deliverables. Although these functions were performed initially the role was modified early on in the project and ultimately became nonexistent. This individual was given other assignments unrelated to his responsibilities as the TRADOC interface and was asked to perform other duties within the project that limited the amount of time that could be devoted to the interface task.*

Another point concerns the sources of information for SADT authors. Although the number of experts interviewed was at least ten (as specified in the proposal), discussion with SADT authors indicated that early in the modeling process, significant information was gained by reading technical and progress reports on training and the proceedings of several conferences on training sponsored by TRADOC. Thus, the SADT process was not implemented initially; but rather following a schedule of background reading which undoubtedly made the subsequent author-TRADOC interviews more meaningful. This seems to be a desirable and natural activity prior to modeling but no mention is made of it in the SADT authoring procedures.

Examination of the events surrounding Task 2 of this project revealed several discrepancies from those specified in the technical proposal. The most notable involves the full time assignment to Task 2 of two TRADOC personnel as SADT authors. The SADT training provided these individuals was not timely, or necessarily complete relative to the Task 2

*Another individual with several functions was the on-site project manager for SofTech. In addition to management responsibilities, he was one of the two authors provided by SofTech for Task 1. He also assumed some of the functions of the TRADOC interface when necessary.

effort. Only one TRADOC author received formal author training, this occurring during the second half of Task 2. Although the second individual received some on-the-job training to prepare him to author diagrams, this training was reported by the two SofTech authors on site to be minimal.

Other than those noted above, the prescribed roles listed for Tasks 1 and 2 in the technical proposal were carried out as specified.

Examination of SofTech's descriptive literature reveals that several related classes of behavior constitute the SADT process or discipline. Two of these are the iterative author-commenter cycle, which is the vehicle for communication between SADT authors and commenters in the client organization, and maintenance of the SADT project library, which provides complete documentation of the project history.

The claims made by SofTech imply benefits such as enhanced communication, understanding, and involvement by personnel in the client organization, and casts SADT as a heuristic device which will aid in the solution of problems. The most central element of the SADT process is commenting on a kit. Because commenting on diagrams is the only official contact between SofTech personnel and individuals in the client organization, this activity must logically occur before any of the above-mentioned benefits accrue.

Table 2 presents data on kit issuance and return by rank of commenter for Tasks 1 and 2. All the data presented were obtained from the Task 1 and Task 2 reader kit coversheets in the project library file. Column II represents the number of kits each reader was expected to comment on. Column III indicates the number of times the reader actually commented on and returned the kit to the author by the time prescribed.

Column IV represents those instances in which a kit was returned but late. Column V indicates the number of times a kit was sent to a reader for comments but never returned to the author. Column VI indicates the humber of times it was unclear as to what actually transpired with any one kit, i.e., it was not possible to discern whether the kit had been commented on or not. This is clearly a failure of the librarian function to document precisely what had transpired.

Totals at the bottom of Table 2 indicate that 104 or 54% of the kits issued to readers for comments were not returned to the author. This level of participation by TRADOC personnel in the iterative author-commenter cycle of SADT was considerably less than SofTech had originally anticipated.

The large number of kits not returned led the evaluators to ask a SofTech project member about these discrepancies. It was indicated that in the later stages of the modeling, the interaction between SADT authors and the Senior Review Committee was often verbal and final approval of diagrams was obtained in a conference setting. According to SofTech descriptions, however, a conference between commenter and author is reserved for the case in which differences cannot be resolved on paper and all interactions, for whatever purpose, are to be recorded. The procedure used appears to be at variance with SofTech's descriptive literature.

In attempting to explain this discrepancy from standard procedure, a SofTech project member explained that working in this environment was at times too hectic for him to perform clerical duties. Another SADT author stated that to his knowledge, he logged all required data on kits

Table 2

Commenters by Selected Process Behaviors for Tasks 1 and 2

TRADOC Commenters	I Number of Kits Received	II Number of Kits--Response Requested	III Number of Kits Returned to Author on Time	IV Number of Kits Returned Late	V Number of Kits not Returned	VI Number of Inconsistencies*
Generals	6	4	2	0	1	1
Colonels	93	76	12	5	57	2
Lt. Colonels	30	27	11	4	11	1
Majors	18	18	10	0	7	1
Captains	59	49	15	9	24	1
Civilians	19	17	5	7	4	1
TRADOC Totals	225	191	55-29%	25-13%	104-54%	7-4%

*This column represents the number of times it was unclear from the coversheet information whether the kit was returned to the author by the commenter and appears to be the result of poor bookkeeping. The total of columns 3, 4, 5 and 6 should equal column 2.

he authored and issued, but added that performing these functions detracted from his authoring activities. When asked specifically about two individuals for whom records indicated they had returned less than 10% of the kits issued to them, the evaluators received verification that the figure seemed valid. Despite the tendency of SofTech authors not to record final stage approvals of their diagrams, it seems reasonable to accept the reader kit cover sheets as estimates of the interactions that went on during the project.

Another area where SofTech's original expectations of TRADOC participation was not met was in the assignment of two TRADOC personnel who were to become authors for Task 2. This assignment seemed critical to TRADOC's "internalizing" the SADT procedures. The fact that the individuals were not provided in a way that they could both be fully trained and assigned to the SofTech project full-time as expected raises two issues.

The first pertains to the productivity of project personnel during Task 2. Given that one of the individuals assigned was never formally trained and the other was trained three months after the Task 2 effort was begun, it would be unreasonable to expect the same results and degree of internalization of the technique had initial expectations been met. To quote the program manager of this project, "SofTech certainly would have been much more guarded in predicting the impact of the work at TRADOC if the actual level of Army author participation could have been predicted at the time the proposal was written."

The second issue arising from TRADOC's failure to provide the manpower originally agreed upon concerns the evaluation of the transfer of this technology from SofTech to TRADOC. Determining the extent to

which Army personnel can be trained in SADT methodology seems critical to determining the applicability of the technique to other environments within the Department of Defense. Unfortunately, only one author was trained. While this individual was considered a good SADT author by SofTech personnel, he was viewed by his superiors at TRADOC as a unique individual with considerable talent and potential, especially in the area of operations research. One officer stated during an interview that this individual "is not representative of the population at TRADOC." Certainly there are competent individuals who can learn the technique, but their productivity in using SADT to model program functions and the range of individuals capable of learning the technique in DoD environments cannot be determined from the present data.

In summary, the process data collected indicates that the SADT process was not always implemented as specified at TRADOC through Task 2. Participation by TRADOC personnel in the iterative author-commenter cycle was approximately half that expected. This reduced availability of TRADOC personnel for training and authoring of SADT diagrams limited the potential to institutionalize the technique at TRADOC. Thus, final and definitive conclusions about the success of transfering this technology to a DoD environment cannot be made from these data.

B. Quantitative data. This section reports responses to multiple choice and Likert type questionnaire items given to TRADOC officers working with the project. The questionnaire was completed by 13 of 16 Task 1 and 2 commenters. Statistical calculations indicate that the questionnaire reliably measured some characteristic of the respondents and that the individual items were producing similar

patterns of responding in different individuals (α = .95).* The same was true for evaluative dimensions II_A (α = .86), III_A (α = .96) and III_B (α = .96) and to a lesser extent for dimension II_C (α = .71). The pattern of responses for dimensions I_A, I_B, and II_B were more heterogeneous and of questionable reliablity (α = .35, .45, and .51 respectively).

Table 3 presents the number of respondents, the mean ($\bar{X}$) and the standard deviation (SD) of each quantitative item on the questionnaire. The major intent of each item is included and items are clustered by evaluative dimensions for easy reference.

Two conclusions can be made from examination of questionnaire data. The first concerns the value of SADT as an "engineering drawing system for systems description." This view of SADT, presented by SofTech in the technical proposal, stresses standardized graphics, controlled document revision through the provision of procedural mechanisms for audit purposes, and effective communication between the originator and user of descriptive models.

The results of Subscales I_A, II_A, and II_B, indicate that as an engineering drawing system, SADT is viewed positively by TRADOC personnel. The general consensus is that the SADT discipline, which specifies the format of all communications, controls the routing of diagrams and establishes the time frame in which these behaviors occur, generally results in accurate, highly readable diagrams that communicate the substantive components of complex problems.

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*Alpha (α) reliabilities calculated with the standard Kuder-Richardson formula (see Guilford, J.P. Fundamental statistics in psychology and education. New York: McGraw-Hill, 1965, 458-460.)

Item Means and Standard Deviations for TRADOC Headquarters Commenters

Items	N	Mean	Standard Deviation
I. COMMUNICATIVE QUALITY			
A. of Diagrams			
1. Respondent adequately trained to read diagrams?	13	4.08	0.95
2. Respondent adequately trained to comment on diagrams?	13	3.92	0.86
3a. First drafts of diagrams clear and unambiguous?	12	3.75	0.87
3b. Revised versions of diagrams clear and unambiguous?	13	4.31	0.48
3c. Final versions of diagrams clear and unambiguous?	12	4.58	0.51
4. Would written text explaining diagrams be helpful?**	12	3.00	1.21
5. Should discussion be a part of the SADT process?***	13	4.38	0.75
6. Are diagrams an effective way of communicating?*	13	4.23	0.60
10. Project benefits attributable to diagrams or to processes stimulated?*	9	3.44	0.53
Mean and standard deviation for Subscale I_A		3.97	0.75
B. of Process			
7. Have diagrams generated communication among individuals involved (i.e., asked to be commenters) in project?	13	3.38	1.45
8. Have diagrams generated communication among individuals not involved (i.e., not asked to be commenters) in project?	13	1.85	0.99
9. Have diagrams helped focus attention on variables not considered previously?*	13	3.38	1.26
10. Project benefits attributable to diagrams or to processes stimulated?*	9	3.44	0.53

Table 3 (continued)

Items	N	Mean	Standard Deviation
30. Were others consulted before commenting on a diagram? ††	12	1.00	0.00
Mean and standard deviation for Subscale I_B		3.01	0.85
II. QUALITY			
A. Accuracy			
6. Are diagrams an effective way of communicating?*	13	4.23	0.60
11. Have diagrams accurately represented content modeled in Task 1?	11	4.09	0.54
12. Have diagrams accurately represented content modeled in Task 2?	9	4.00	0.87
14. Confident that author-commenter cycle guarantees accuracy and completeness?*	13	4.08	0.76
Mean and standard deviation for Subscale II_A		4.10	0.67
B. Quality Control			
13. Does author-commenter cycle ensure quality of diagrams?	13	4.31	0.75
14. Confident that author-commenter cycle guarantees accuracy and completeness?*	13	4.08	0.76
15. Confident that comments were taken into account?	13	4.77	0.44
28. Confident in comments made on diagrams?	13	4.00	0.58
29. Respondent lacked sufficient experience to make meaningful comments?**	12	3.42	1.38
Mean and standard deviation for Subscale II_B		4.12	0.85
C. Efficiency			
16. Has communicating via author-commenter cycle saved time?	13	3.69	1.03
17. Has SADT saved time relative to other available approaches to the problem?	11	3.36	1.50

Table 3 (continued)

Items	N	Mean	Standard Deviation
18. Is SADT cost-efficient relative to other techniques having same purpose?	6	3.67	1.21
19. Percentage of time saved using SADT on design and analysis task?†	7	0.26	0.24
37. Has the progress made been worth the time spent?*	12	3.50	1.38
Mean and standard deviation for Subscale II_C		3.56	1.28
III. USEFULNESS			
A. In Tasks 1 and 2			
9. Have diagrams helped focus attention on variables not considered previously?*	13	3.38	1.26
20. Did Task 1 model provide clearer understanding of Army training?	11	3.09	0.83
21. Will models produced thus far actually be used in planning changes?	12	2.92	1.00
22. Will models produced thus far actually help to derive training requirements?	12	3.17	1.11
24a. Will SADT increase TRADOC's analysis capability?*	10	3.60	1.51
24b. Will SADT increase TRADOC's planning capability?*	10	3.40	1.26
24c. Will SADT increase TRADOC's management capability?*	10	3.00	1.05
25. Can SADT help identify training requirements affecting combat effectiveness?*	13	3.77	1.09
27. Is it practical for TRADOC to use SADT for design and analysis problems?*	13	3.62	1.12
32. Will SADT models provide impetus for changes in Army training?*	12	3.17	0.94
33. Will SADT be useful in identifying existing organizational inefficiencies?*	12	3.75	0.62

Table 3 (continued)

Items	N	Mean	Standard Deviation
34. Will SADT lead to conceptual insights about conducting Army training?*	13	3.46	0.88
36. Would it be useful to train some Army personnel to be SADT authors?*	13	3.69	1.49
37. Has the progress made been worth the time spent?*	12	3.50	1.38
38. Did Task 2 model provide clearer understanding of Army training?	11	3.64	1.03
Mean and standard deviation for Subscale III_A		3.41	1.10
B. In Subsequent Tasks			
23. Will SADT be effectively used to elaborate Task 1 model in Task 3?	13	4.31	0.63
24a. Will SADT increase TRADOC's analysis capability?*	10	3.60	1.51
24b. Will SADT increase TRADOC's planning capability?*	10	3.40	1.26
24c. Will SADT increase TRADOC's management capability?*	10	3.00	1.05
25. Can SADT help identify training requirements affecting combat effectiveness?*	13	3.77	1.09
27. Is it practical for TRADOC to use SADT for design and analysis problems?*	13	3.62	1.12
32. Will SADT models provide impetus for changes in Army training?*	12	3.17	0.94
33. Will SADT be useful in identifying existing organizational inefficiencies?*	12	3.75	0.62
34. Will SADT lead to conceptual insights about conducting Army training?*	13	3.46	0.88
35. Will use of SADT ultimately affect training concepts held by TRADOC?	13	3.15	0.80
36. Would it be useful to train some Army personnel to be SADT authors?*	13	3.69	1.49
Mean and standard deviation for Subscale III_B		3.54	1.04

Table 3 (continued)

Items	N	Mean	Standard Deviation
SPECIAL SCALES			
Value of SADT Model as a Reference			
26. Would an SADT model of Army training be of value as a reference document?	13	3.85	1.14
Mean and standard deviation for this subscale		3.85	1.14
Information Grasp			
28. Confident in comments made on diagrams?*	13	4.00	0.58
29. Respondent lacked sufficient experience to make meaningful comments?**	12	3.42	1.38
30. Were others consulted before commenting on a diagram? ††	12	1.00	0.00
Mean and standard deviation for this subscale		3.71	0.62
Desire for Change			
31. Presently, how critical is it to implement changes in Army training?	13	4.62	0.65
Mean and standard deviation for this subscale		4.62	0.65
Questionnaire Total		3.58	0.93

* Item also represented by another evaluative dimension.

** Scoring reversed for this item.

*** This item had only four alternatives, scored in the following manner: 1 = 4, 2 = 5, 3 = 2, 4 = 1.

† This item was not in multiple choice format. The mean and S.D. for this item were not included in the calculation of the per item mean and S.D. for Subscale II_C.

†† This item covers a communication aspect discouraged by the methodology. The mean and S.D. for this item were not included in the calculation of the per item mean and S.D. for this subscale.

Scores were lower for the evaluative dimensions that inquired into SADT's impact or usefulness at TRADOC (I_B, III_A, III_B). When queried about SADT diagrams and the SADT process per se, responses were quite positive (The item means for evaluative dimensions I_A, II_A, and II_B were 3.97, 4.10. and 4.12 respectively on a 1 to 5 point scale). When questions addressed the application of SADT within the TRADOC context, resulting scores were noticeably lower (2.61, 3.41, and 3.54 for evaluative dimensions I_B, III_A, and III_B, respectively). This difference between the context-free and context specific views of SADT suggests that there are characteristics of either the technique, the environment, or both, which have limited the applicability and usefulness of SADT in the TRADOC context. Data from other sources will be employed in other parts of this report to further illustrate the distinction between SADT's generic qualities as exhibited by the diagrams themselves and the technique's capacity to become integrated in the TRADOC environment.

C. Qualitative Data. Discussion questions from the questionnaire and a follow-up interview with respondents shortly after the administration of the questionnaire provided the raw data for the following interpretive comments. Despite differences in the format in which these two types of data were collected, considerable consistency among verbal and written comments emerged. The discussion of interpretive data begins with a presentation of the most general conclusions that emerged from analysis of the subjective comments of TRADOC members.

The most general conclusion shared by all but a few respondents at the end of Task 2 was that it was too early to say whether the

technique had any practical value for TRADOC. While almost all respondents indicated that they thought the technique was useful at a general context-free level, they were unsure about its applicability and usefulness within TRADOC. In response to the first discussion item on the questionnaire (Could you identify any specific benefits which may have accrued to the Army as a result of its participation in this project thus far?), the following comment was representative:

> Not yet. This has been some concern to me since the project started. The potential for using SADT as a tool to improve Army training is real. Perhaps I am not involved enough.

And, in a follow-up interview, this comment was expressed:

> We went into this project to get someone to provide a logical layout of the training system so we could get a handle on it. Dumb grunts like myself haven't gotten that out of it yet. I don't know if SofTech's work will be of any use at this time....I'll wait before saying yes or no.

All commenters could readily enumerate strengths of SADT, especially when asked about the technique in a general, context-free sense. While many strengths were mentioned, the following occurred with some consistency:

(1) SADT requires a graphic presentation of the problem which simplifies the problem and communicates it succinctly, i.e, a picture is worth a thousand words;

(2) Commenting forces an individuals to think critically about a problem before he can disagree with a particular diagram;

(3) SADT promotes a consensus of opinion about a previously ill-defined concept;

(4) SADT saves time over verbal communications because it's hard to "get off the subject" in commenting on an SADT diagram;

(5) SADT illuminates the real causes of problems.

Generally speaking, commenters provided positive accounts of SADT; all but one individual expressed that they believed the technique was a good one.

When asked about weaknesses of the technique, most commenters mentioned aspects of the application of SADT and not generic qualities of the diagrams themselves. The most consistently mentioned weaknesses were that the SADT process was too time-consuming and that commenting on a kit occasionally interferred with an individual's ongoing work. It can be seen that these comments mildly contradict those made about the strengths of the technique (for example, #4 above). This paradox was evident in many of the comments made and indicated that TRADOC personnel considered the technique during this p[illegible] of the evaluation as a good one generally, but were unsure of the value of its application within the TRADOC context.

Several consistent themes and comments emerged from examination of the interpretive data which help illuminate the ambiguity on the part of TRADOC personnel about the value and usefulness of SADT as applied to the complex problems of providing Army training. One of the most consistent themes was that insufficient resources had been expended on the project

thus far. Item 43 of the questionnaire inquired about obstacles which may have hindered SofTech's productivity at TRADOC. The following response to that question was typical:

> The normal workload at DCST (Office of the Deputy Chief of Staff for Training) is so heavy that numerous key personnel were not able to get involved at the level desired. This resulted in reduced visibility of the project. As the project grows to Task 3, there should be greater involvement, particularly after the Commander Conferences (in December). TDY (temporary duty involving travel away from usual assignment) and inaccessibility of key TRADOC staff -- this may have hindered them in getting the job done.

Several other individuals mentioned that they had not devoted as much time to the project as they should have. This may be one reason why individuals valued the technique generally but were unsure of its use and applicability.

Another consistent theme in the interprative data concerned the command emphasis for the project. Several commenters were critical of the Army's support of SofTech's work. Much of this criticism was aimed at "upper level Army management" as evidenced by the following comments from interviewees (all below the rank of Colonel):

> There has been a lack of command emphasis. I've had no pressure from my boss. It (participation in SADT project) has had no bearing on my job as far as he is concerned.

> There has been little enthusiasm for this project (SADT) by upper level management.

> Whether it will be used here is strictly dependent on management....If managers use it everyone will use it; emphasis has got to come from the top. If this happens it will be successful here.

Anecdotal comments written in the margins of mulitple-choice questions indicated that usage and value were "entirely dependent upon command influence," and that the amount of time devoted to this project "had been insufficient." One individual indicated that all questions pertaining to usage were dependent on management and he doubted that they would give this project a high priority. To summarize, there was some skepticism on the part of lower-ranking officers that upper level Army management was actually concerned about the SADT project.

A third factor contributing to skepticism about the value and usage of SADT at TRADOC was ambiguity and uncertainty shared by most commenters of what the project results should be. This impression became evident during inital contact and interviews with the TRADOC organization. This confusion still existed at the conclusion of Task 2 as indicated by ths following comment from a TRADOC colonel:

> We don't know what our (training) system is. We don't know how we will use it (the SADT model of training). I'm unclear in my own mind about how I'm going to use it....There's no clear perception of how it will be used by me or anyone I know.

A fourth consistency evidenced in the respondent's comments concerned the timeliness of the SADT project. The project closely paralleled the Total Tank System Study (T^2S^2) whose goals were much the same as those of Task 1 and Task 2. Several respondents pointed out that SADT was implemented after the T^2S^2 study was well under way. Because T^2S^2 and the

SADT project overlapped, both in terms of time, course, and general goals, the relative contributions of each to what was ultimately learned about tank training is unclear.

The chief officer at the T^2S^2 group had the most to say on this issue. He stated that the T^2S^2 results contained the "meat" of what was learned about training, but that the work done using SADT gave clearer definition of those results. He felt that if SADT had been introduced prior to the beginning of the T^2S^2 study, it would have contributed to the results. He addressed the timing issue in the following manner:

> I was immersed in real problems; we didn't have time to learn new techniques. It was initially a hindrance time-wise and procedurally...After the bulk of T^2S^2 was finished we had time for SofTech and the value of the technique became obvious. It communicates the "big picture" of the T^2S^2 results.

Because the SADT process was instituted when it was, and given that its goals and objectives closely paralleled those of T^2S^2, the value of SADT is confounded in the minds of most TRADOC officers. To paraphrase the comments of two TRADOC officers, SADT should have been applied to a new problem that had never been studied before with everyone working on the problem well-trained in SADT.

Concerning the relative contributions of each study to the achievement of insights into tank training, the consensus was that SADT had done little to isolate training requirements having a bearing on combat effectiveness and battlefield readiness. The opinion of those TRADOC personnel polled was that the T^2S^2 group actually did the work that led to conceptual insights with differing opinions about the relative contribution of SADT.

Another theme which emerged from the qualitative data that could account for the skepticism concerning subsequent usage of SADT was that of personnel turbulence. Several respondents mentioned this factor as a variable moderating the acceptance, usefulness and ultimate success of a project such as this one. One officer said that by next summer perhaps as many as five of the top-ranking officers who were responsible for or participated in the SADT project may be gone.

It is apparent that personnel turbulence in the Army will effect most any project. If the project is one that involves cooperation and time commitments from particular Army personnel, the efforts of the contractor are particularly dependent on personnel changes within the Army. The longer the length of the contract, the greater the probability of disruption to the ongoing work. The problem is not only one of trained Army personnel being lost to the contractor because of assignment changes but also one of acquiring the time of new officers for training and obtaining the needed commitment from a commanding officer who may also be new.

A final theme that emerges as a possible obstacle to the successful implementation and usage of SADT was the relative difficulty in institutionalizing the technique. Most individuals polled believed that for SADT to be used effectively it would have to be internalized. With few exceptions, the view expressed was that SADT could be a valuable problem-solving technique "brought to fruition within the Army." Opinions differed on how to internalize the technique but some general consistencies that emerged were:

(1) it takes bright individuals to learn how to author SADT diagrams, not everyone could be trained;

(2) if used by operations research people, then management would have to learn and accept it in order to communicate with their problem-solvers;

(3) if accepted and used by management, it would filter its way throughout the organization;

(4) some abridged, simplified form that did not require such extensive training would have a better chance of being accepted and used;

(5) if the technique clearly solves problems and/or saves time and manpower, and if individuals are sufficiently trained, the technique definitely will be used;

(6) complete dependence on an outside contractor will hinder the acceptance of any technique.

To summarize, although most respondents (13 out of 14) indicated that SADT was a valuable technique at a general, context-free level, there was considerable skepticism about its subsequent applicability and usefulness at TRADOC. Several consistent themes that emerged from the qualitative data were presented as potential explanations for the discrepancy between the context-free and context-specific views of SADT. Among these were:

(1) insufficient resources being expended on the project;

(2) lack of command emphasis on the project;

(3) lack of clarity about project goals;

(4) overlap between the SADT project and the T^2S^2 group study;

(5) personnel turbulence in the Army;

(6) difficulties in institutionalizing a technique such as SADT.

Discussion

The data collected in the Phase 1 evaluation indicated that officers within the TRADOC organization considered SADT a powerful and sophisticated approach to systems analysis, design, and management. Questionnaire items relevant to the context-free value of the technique were generally rated higher than other items. Comments obtained in response to discussion questions and interview probes reinforced the conclusion that the generic qualities of the diagrams themselves, such as communicative quality, efficiency, accuracy, consistency, and completeness, were present as claimed in the SofTech proposal.

The same is true about SADT's heuristic properties. When questioned about the technique per se, most individuals indicated a belief in SADT's ability to promote conceptual insights into problems. It should be mentioned that individuals were somewhat less sure of SADT's heuristic qualities than they were about the generic qualities of the diagrams themselves. It can be concluded that the sample for this evaluation study valued the SADT methodology and generally believed the claims made by SofTech in the technical proposal.

Queries about the value of SADT to the TRADOC organization did not yield the same positive responses as did questions about the technique itself. It appears that some characteristics of the SADT/TRADOC interface moderated individual's opinions of SADT. Both quantitative and qualitative responses about SADT's applicability and usefulness within the TRADOC context ranged from mild optimism to open skepticism. The discrepancy between context-free and context-specific valuations of SADT led the evaluators to examine more closely the interface between the technique and the environment. The process data collected provided a starting point

for this examination.

The available process data indicated that SADT had not been implemented during the Phase 1 evaluation to the degree prescribed in the technical proposal. The conclusion drawn from these data is that participation by TRADOC personnel in the iterative author-commenter cycle had been approximately half that expected in the usual application of SADT. The limited availability of TRADOC personnel for authoring SADT diagrams and the fragmentation of the TRADOC interface role during Task 2 further limited the implementation of SADT at TRADOC.

The open-ended probes built into the evaluation design provided respondents with a "free-hand" in expressing their views about the SADT project, and from these interpretive data, potential explanations of the marginal implementation of the technique emerged. The most consistently reported of these were that insufficient resources had been expended on the project and that there had been a lack of command emphasis for the project. Possible explanations for these project weaknesses included a lack of clarity about project goals (which could be a function of the nature of the problems addressed by this project) and personnel turbulence within the Army, which contributes to a lack of continuity in management perspective.

Another point that emerged which could be closely related to a lack of command emphasis was the difficulty encountered in attempting to institutionalize a technique such as SADT. If the project is not considered a particularly high priority by Army management, this is probably communicated to subordinates in many ways, e.g., officially and/or unofficially; purposefully or unintentionally. If communicated to subordinates, difficulties will probably be encountered in establishing the procedural mechanics of the project. The comment of one officer that his participation in the SADT

project had no bearing on his job as far as his superior was concerned illustrates this point.

The views of Army management did not actually refute what has been presented thus far. These individuals admitted that SofTech had not received the support expected and offered the rationalization that resource demands always exceed resource supply in the TRADOC environment. One officer stated that this resulted in TRADOC being an unfair test bed for SADT. Another officer stated that such a hectic, complex environment was an excellent arena in which to assess SADT's applicability to complex military problems.

The appropriateness of the testing site not withstanding, two conclusions are clear from examination of all available sources of Phase 1 evaluation data: (1) the implementation of the SADT methodology had been marginal, and (2) eight months into the contract most TRADOC personnel involved in the project were unsure of the technique's applicability and usefulness in the TRADOC environment.

In answer to the primary questions posed for the Phase 1 evaluation effort, the SADT methodology was considered to be a highly effective one generally, but its applicability and usefulness within the TRADOC environment was moderated by several factors. Not the least of these factors were the organizational characteristics of the military, which predispose individuals to view a problem one way, and the underlying philosophy of SADT, which prescribes a set of behaviors for attacking a problem in a different way.

VI. Phase 2 Evaluation Procedures and Results

This section describes the procedures and results of the Phase 2 evaluation. Using the Phase 1 evaluation procedures and results as guidelines, the Phase 2 evaluation effort was concerned primarily with determining whether the attitudes of TRADOC personnel towards SofTech's work had changed as a result of the production of the Task 3 model.* Emphasis was given in the Phase 2 evaluation to the perceived effectiveness and usefulness of the Task 3 model, how this model was being used and what impact the model was having on Army training and evaluation concepts.

This phase served as a follow-up to the Phase 1 evaluation, updating and documenting project activities and describing attitudes of TRADOC concerning the perceived effectiveness and usefulness of SADT. Examination of current project activities was conducted to validate solicited opinions about SADT and to suggest potential indicators of the ways in which the SADT project may impact Army training and evaluation programs.

Methods and Procedures

Nine individuals having close contact with the SADT project were interviewed approximately one month after the completion of the Task 3 model or approximately fourteen months after the start of the project. This group consisted of five colonels, one lt. colonel, two majors, and one captain. The conclusions drawn from the interview data are presented below in order of their consistency across the nine respondents. Special weight was given to the comments of those having major responsibility for

*Task 3 resulted in the generation of three models in the areas of evaluation, system development, and training. These will be referred to in this report as the Task 3 model.

this project. Appendix D contains representative stimulus questions used to promote discussion during the interview.

The interviewer also completed a structured questionnaire based upon each respondent's interview responses. The items for this structured questionnaire (which appears in Appendix C) were selected from among the relevant items on the Phase 1 questionnaire completed by these respondents at the conclusion of Task 2. This permitted the comparison of attitudes before and after the completion of the Task 3 model for a number of respondents.

Results and Discussion

The most consistent theme evident from the comments of respondents was that the Task 3 model had made a definite contribution in bringing about needed changes in Army training and evaluation programs. While respondents varied in how significant they thought the SofTech contribution was, it was clear that the TRADOC officers polled valued the Task 3 model and considered it an improvement over where TRADOC would have been at this point without it.

Most respondents considered the major value of SofTech's work to be in documenting the interrelationships between evaluation, system development, and training. For example, the Task 3 model depicts "informative feedback" as the interface between the heretofore individually conceptualized evaluation, system development, and training components, thus linking these functions in a systematic manner. Respondents indicated that individuals within TRADOC may have had a clear conceptualization of how parts of the system for which they were responsible operated, but the Task 3 model provided an integrated picture of the total Army training and evaluation system and how that system must interact with

combat developments. This insight apparently had not been achieved, or at least so vividly portrayed, previously, and is cited here as the probable basis for considerable enthusiasm by TRADOC personnel for actually beginning the work of implementing the new training and evaluation programs.

The following comments from interviewees are representative of this newly achieved integrated conception of evaluation, system design, and training:

> The SofTech project has been useful. The Army bureaucracy is filled with bright fellows working in various places but until SofTech came these ideas had not been put together. SADT was a mechanism for bringing about interaction. The ideas were there all along but had not been integrated.

> Nothing new appeared in the models but they caused me to think of them (training issues) in a different light. The further delineation of what evaluation is has changed our concept of evaluation and how it interrelates with the training system...This year has seen the realization of what we've been (talking) about for three years.

> The discussion with SofTech and examination of diagrams was one of several intellectual activities that defined and described where we were heading in TRADOC. The Army hasn't taken the process but the products of that process are valuable in where we're heading.

> SofTech's work has made people think. It ties things together. SofTech's work at TRADOC has provided organization to TRADOC itself; it has provided a sense of direction to the whole concept of TRADOC. It has forced TRADOC to a clear conceptualization of what they're doing, what they intend and what they want for the future.

In addition, a colonel having significant responsibility for the SofTech project indicated:

> For some time we thought we understood different aspects of the system, but for the first time we have a clear

picture of the interrelationships of different functions and organizations of the Army as they relate to training. The model systematized and coalesced our knowledge.

Between the Phase 1 evaluation report and the present follow-up conducted four months later, a marked shift in TRADOC's attitude toward SADT and its products was noted. This shift was traced to the emergence of the Task 3 model and/or the activity which surrounded its development. Most of the skepticism reported by TRADOC personnel in the Phase 1 report pertained to the usefulness of SofTech's work and the ultimate impact it would have on Army training and evaluation procedures. At the end of Task 3, this skepticism had been replaced by enthusiasm about the usefulness of SofTech's efforts. The Task 3 model seemed to have brought together and solidified many of the ideas generated by TRADOC, but that heretofore were seen as disjointed and insufficiently articulated to be of practical use.

The conclusions are supported by results from the structured questionnaire. Several items had higher (more positive) mean responses after Task 3 than they did at the conclusion of Task 2. These comparisons are presented in Figure 5.

Five items evidenced relatively large changes in mean response across the two samplings. The largest change (of about 1.5 scale units) occurred with respect to the respondent's understanding of Army training and evaluation programs (item 5). Other changes on the order of 1 scale unit can be noted for item 9, indicating that respondents were now more confident that SADT diagrams could increase TRADOC's planning, design and management capabilities and for items 6, 7, and 15 indicating that respondents now saw more uses for the models produced, saw the diagrams as more instrumental in establishing training requirements, and perceived greater impact of SADT on the training

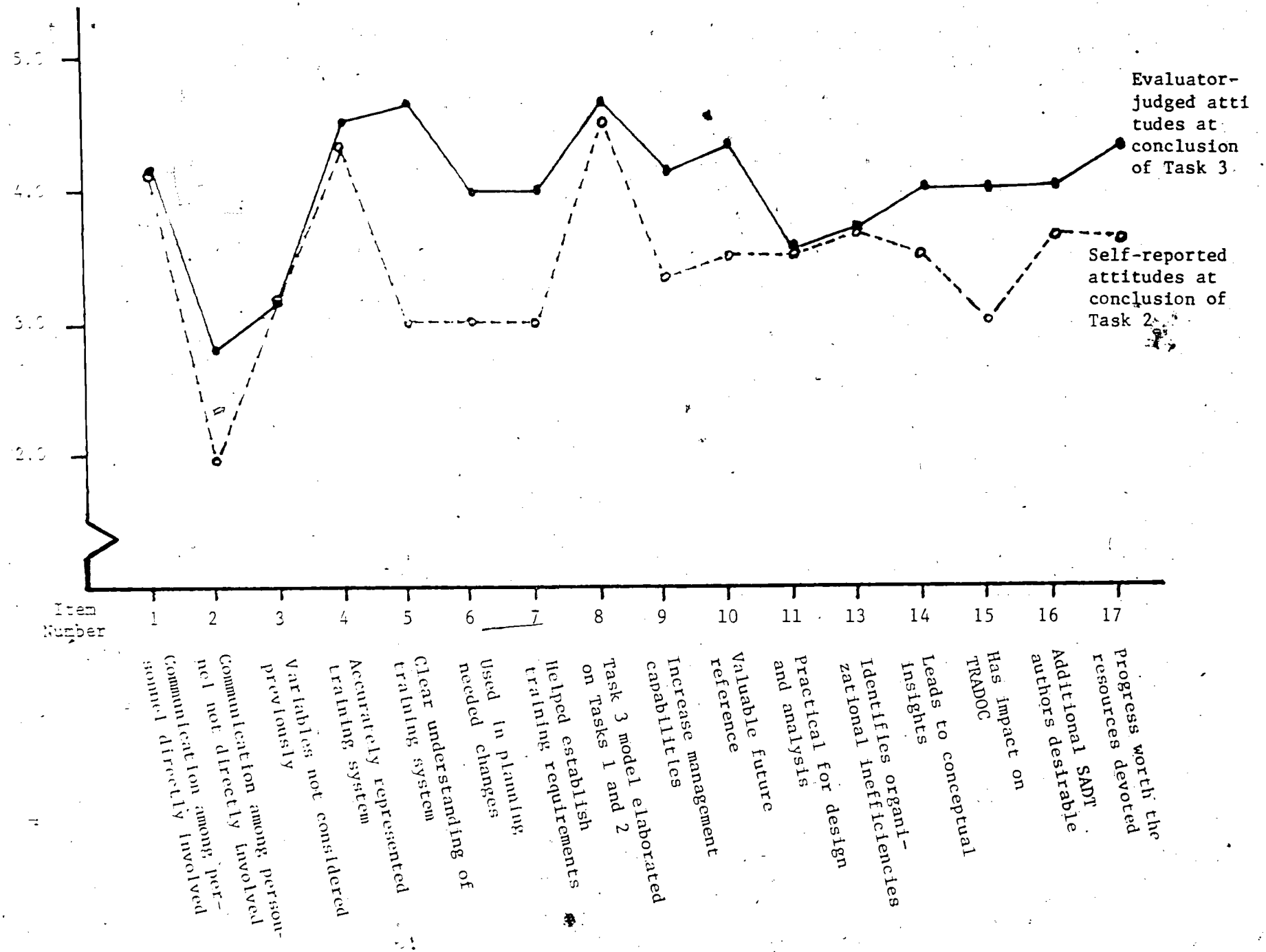


Figure 5. Mean responses to selected items at the conclusion of Task 2 (dotted) and at the conclusion of Task 3 (solid)

concepts currently held by TRADOC. Changes between .75 and 1 unit occurred on items 2, 10, and 17, suggesting that the production of the Task 3 model had stimulated more communication among individuals not directly involved in the project, that TRADOC personnel now considered the SADT models produced more valuable as reference documents than they did at the conclusion of Task 2 and that TRADOC personnel were now more convinced that the resources devoted to this project had been well-spent.

The Phase 1 evaluation indicated that the degree of implementation of the SADT methodology had been marginal, particularly the training of SADT authors, and suggested that lack of implementation might limit the utility and impact of SofTech's work. The skepticism about the value of the work produced through Task 2 was attributed earlier to this lack of implementation. It may be, however, that the content of the Task 1 and Task 2 models limited the statements that could have been made about ultimate usage and impact. Thus, the actual production of the elaborated model of Army training and evaluation resulting from Task 3 may have been a necessary prerequisite to TRADOC officers verbalizing any specific benefits of the SADT project. Further, positive valuations of SofTech's work at the end of Task 3 suggested that the degree of participation by TRADOC in the SADT process had been sufficient, although less than originally expected.

Tasks 1 and 2 represented necessary but preliminary steps that prepared the SADT analysts for the Task 3 effort. One officer stated that SofTech "cut their teeth" on Tasks 1 and 2. During this time, officers had a difficult time seeing the value of SofTech's work. Because no one could articulate what a model of the Army training system should look like before actual production of that model, TRADOC officers may have been uncertain as to how the Task 1 and 2 results would provide a better

understanding of Army training and evaluation programs. This also suggests that project benefits to TRADOC are directly attributable to the tangible outputs of the SADT process.

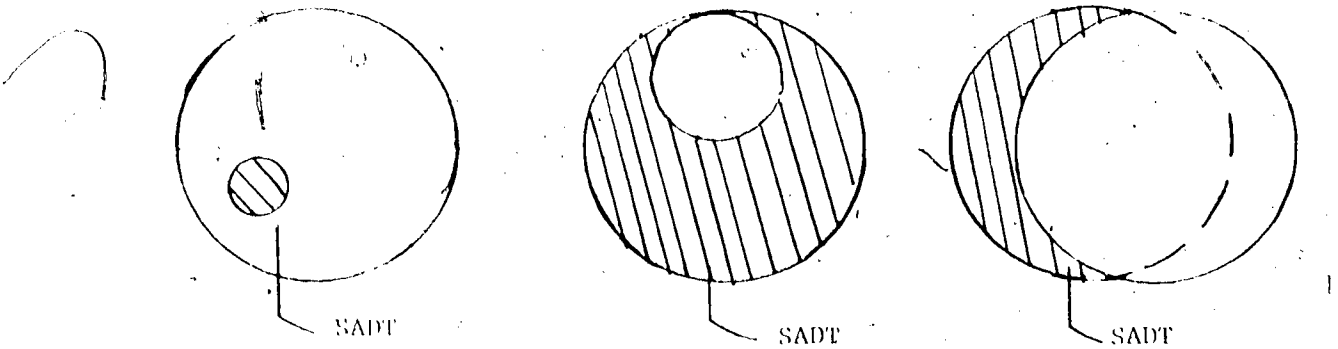
In summary, attitudes toward SofTech's efforts at the conclusion of Task 3 were positive. This represents a shift from generally neutral or skeptical attitudes expressed by TRADOC personnel interviewed at the end of Task 2. The relationship between training, evaluation, and system development was perceived by TRADOC personnel to be especially clear at the completion of the Task 3 model, while the limited focus of Tasks 1 and 2 may have contributed to the skepticism and ambiguity noted in the Phase 1 evaluation.

Although there was a high degree of enthusiasm at TRADOC about the new conceptualization of Army training and evaluation, it would be premature to conclude that this result was solely attributable to the production of the Task 3 model. Other factors contributing to this outcome may have included the particular insights (and foresights) of key TRADOC officers, the activities of other projects at TRADOC, subtle organizational characteristics which may have evolved at TRADOC, and the zeitgeist currently present in TRADOC and in the Army. While this list is speculative and far from inclusive, it is offered to indicate that TRADOC's current understanding of training and evaluation may be the result of the confluence of a large number of variables, many of which could not be measured given the time and resources allotted to this study. Furthermore, these potential influences may interact with each other in complex ways resulting in unique combinatorial effects.

Thus, a potentially large array of influences may have interacted to produce the attitudes measured in the Phase 2 evaluation. The opinion expressed by most TRADOC personnel was that SofTech's input was a part of this larger confluence. Two officers, however, expressed that SADT brought organization to TRADOC, that it created a different climate at TRADOC, influenced other projects, etc. This would suggest that this combine of influences falls within the influence of SADT itself. The representations in Figure 6 portray several of the conditions that may have existed at TRADOC to produce the attitudes measured during the Phase 2 evaluation.

Figure 6

Combination of all influences
affecting TRADOC's perception of Army training



SADT is among many factors influencing TRADOC's perception of Army training

SADT is the only factor influencing TRADOC's perception of Army training

SADT is the primary factor influencing TRADOC's perception of Army training.

Which of these relationships most accurately portrays the role of SADT in fostering change at TRADOC Headquarters cannot be determined by the present data. This discussion, then, is presented as a caution to those

who would interpret the Phase 2 evaluation as indicating that the production of the Task 3 model was the sole causal agent in bringing about changes in Army training and evaluation.

That TRADOC was pleased with the product of the project at the conclusion of Task 3 was evident. The following comment from a TRADOC colonel summarizes what TRADOC received from this contract through Task 3:

> The principle value (of this project) has been the identification of sources of information relative to how the system is working and feeding that information back into the front end (system development). (This) will increase our ability to better target resources we put into training and hardware development.

The contract proposal listed three specific benefits that would be derived from the Task 3 model:

(1) better understanding in TRADOC of what it is trying to achieve;

(2) ease of telling others, the schools, and Department of the Army what is going to happen; and

(3) reduction of time in planning, managing, and accomplishing the changes. (Contract proposal p. 3-10).

At the conclusion of the Phase 2 evaluation these benefits had occurred.

VII. Phase 3 Evaluation Procedures and Results

General Approach

This section describes the procedures and results of the Phase 3 evaluation. Building on the results of the Phase 1 and Phase 2 evaluations, Phase 3 determined post-project opinions of TRADOC personnel towards SADT.

The focus of Phase 3 differed somewhat from that which was originally planned. Because this change necessitated a shift in evaluation strategy, a discussion of the rationale for this change follows.

Although the Task 3 report was well-accepted at TRADOC Headquarters, the Task 3 models had received little exposure at the 21 TRADOC schools at the conclusion of Task 3. The models were considered reasonably specific by personnel at TRADOC Headquarters but the viewpoint of individuals at the TRADOC schools was that the models were abstract and of questionable practical value. Further, the models emphasized new roles for the schools involving heavy usage of exportable training, assigning various schools the responsibility for weapon system performance and requiring schools to use performance-oriented, criterion-referenced measures of training effectiveness. The traditional role of TRADOC schools (training resident students) was deemphasized in the Task 3 model. Following dissemination of the Task 3 report it did not appear likely that TRADOC school personnel would readily adopt the new model of training because of its lack of specifics about each school's weapon system and MOSs and the emphasis on newer rather than more traditional roles for TRADOC schools.

It was evident to SofTech and TRADOC personnel at the conclusion of Task 3 that acceptance of the new conceptualization of Army training

and evaluation at the various proponent schools was critical to the successful implementation of the model. Further, because of the extensiveness of the Task 3 model, it was believed that emphasis should be concentrated on TRADOC's most immediate critical needs rather than the broad focus of developing an implementation plan for the entire Task 3 model.

For these reasons, the decision was made to drop the implementation plan which was the original focus of Task 4. Instead, effort was to be devoted in Task 4 to several activities, including dissemination of the new model of Army training to the proponent schools of TRADOC to foster acceptance of the model, development of a plan for implementing some specific evaluation feedback loops into the existing training structure, and beginning a plan for a system architecture for the data processing support requirements of the new model of training.

Because the new focus of Task 4 did not emphasize the use of SADT, the Task 4 activities were not as directly relevant to the purpose of the overall evaluation--the evaluation of SADT in modeling a military training environment. Further, these and other project activities subsequent to Task 3 did not occur early enough to allow for an analysis prior to the preparation of this report. For these reasons the Phase 3 evaluation focused on a finer determination of TRADOC's perceptions of the effectiveness and usefulness of the SADT project, particularly the Task 3 model and specifically the factors which may have been responsible for the positive shift in attitude which occurred between the Phase 1 and Phase 2 evaluations.

Methods and Procedures

The data collection period for the Phase 3 evaluation occurred during July and early August 1977. The personal vacation schedules

and professional obligations of TRADOC personnel during this time period made it impractical to attempt to interview relevant TRADOC officers in depth about their perceptions of the SADT project and the Task 3 model. For these reasons a mail-out questionnaire, similar to the one used in the Phase 1 evaluation, was selected as the primary data source for Phase 3. This questionnaire appears in Appendix D.

Fifteen TRADOC officers having management responsibility for or participating in the SADT project were selected as the target population for the questionnaire. Two weeks after the questionnaire was mailed, an evaluation staff member went to Ft. Monroe to stimulate the return rate of questionnaires and to interview as many of the target population as possible about their overall impressions of the project. Questionnaire and interview results are presented and discussed below.

Results and Discussion

Twelve of the fifteen questionnaires were returned, a return rate of 80%. Further, four individuals were interviewed during a final visit to TRADOC Headquarters by an evaluation staff member. The results of these data gathering activities yielded two types of data, quantitative (from Questions 1 through 21 of the questionnaire, Appendix E) and qualitative (from questions 22 through 27 of the questionnaire and the interviews).

Quantitative Data. A reliability coefficient was calculated for the 21 quantitative items on the questionnaire. An alpha coefficient of .93 was obtained indicating that questionnaire items were homogeneous. That is, they produced similar patterns of responding in different individuals, indicating the questionnaire was reliable.

The mean ($\bar{X}$) and standard deviation (SD) for each item are presented in Table 4.

Inspection of the general intent of each item suggests that items can be clustered into relatively homogeneous groups. For example, Items 3, 4, 7, 9, 13, and 14 inquire about various heuristic aspects of SADT diagrams and the modeling process. Inspection of the results of these questions suggests most notably that the SADT models produced were helpful in elucidating the interrelationships between the various components of training (Table 4, Item 4) and that the Task 3 model provided a clearer understanding of the Army's training and evaluation programs (Item 7). Responses to Items 13 and 14 suggested that the technique was somewhat less effective in identifying organizational inefficiencies in the current training system or in providing conceptual insights about alternative methods of conducting Army training. None of the questions addressing heuristic properties of the technique received unfavorable ratings (i.e., a mean less than 3.00 on the five-point scale).

Items 8, 12, and 15 address the ultimate usage and impact of the models produced. While respondents believed the models would be used to a considerable extent in planning needed changes in Army training (Item 8), they were relatively less sure that the models would actually provide the impetus for change (Item 12) or that the project would ultimately affect the training concepts held by TRADOC. As with the previous grouping of items, none of these questions received unfavorable ratings.

Several items on the questionnaire (10, 11, 16, 17, 19, 20 and 21) asked the respondent for his summary judgments about various aspects of the SADT project. The most notable of these was that Item 11 received the highest ratings of any item on the questionnaire (4.55), indicating

Table 4

Item Means and Standard Deviations for Phase 3 Evaluation Respondents

Item	N	Mean	Standard Deviation
1. Are SADT diagrams an effective way of communicating?	12	4.33	0.65
2. Has SADT project generated communication among TRADOC personnel?	12	3.75	0.87
3. Have diagrams helped focus attention on variables not considered previously?	12	3.67	1.23
4. Did models elucidate inter-relationships between the components of training?	12	4.25	0.75
5. Project benefits attributable to diagrams or process?	11	3.00	0.89
6. Has SADT saved time relative to other approaches?	10	2.80	1.32
7. Did Task 3 model provide clearer understanding of Army training?	11	4.00	0.89
8. Will the models produced be used in planning changes?	12	3.50	0.80
9. Has SADT helped identify changes affecting combat readiness?	12	3.50	1.45
10. Would an SADT model of Army training be of value as a reference document?	12	4.33	0.89
11. Is SADT an effective approach to design and analysis problems?	11	4.55	0.69
12. Will SADT models provide impetus for changes in Army training?	12	3.17	1.03
13. Were SADT models useful in identifying existing organizational inefficiencies?	12	3.17	0.94

Table 4 (continued)

Item	N	Mean	Standard Deviation
14. Had SADT led to conceptual insights about conducting Army training?	11	3.45	1.21
15. Will use of SADT ultimately affect training concepts held by TRADOC?	12	3.25	0.75
16. Would it be useful to train some Army personnel to be SADT authors?	12	3.67	1.15
17. Has the project increased TRADOC's analytic and planning capabilities?	12	3.17	0.83
19. Has the progress made been worth the time spent?	12	4.42	0.79
20. Estimate of SofTech's contribution to the progress made by TRADOC.	12	3.08	0.79
21. Task 3 model an improvement over previous conceptualizations of training?	11	4.36	1.12
Overall		3.67	0.55

a strong belief among TRADOC personnel that SADT is an effective and appropriate approach to the design and analysis problems faced by TRADOC. These individuals considered the Task 3 model an improvement over previous conceptualizations of training (Item 21) and were of the opinion that the progress made was worth the resources devoted to the project (Item 19). Further, these individuals considered the model to be a valuable future reference document for TRADOC personnel (Item 10).

Despite the high ratings given to most items, Question 17 was marked relatively lower ($\bar{X}$ = 3.17) suggesting that a limited degree of technology transfer had occurred. This is congruent with conclusions drawn from the process data in the Phase 1 evaluation where it was reported that fewer than expected TRADOC personnel were trained in SADT and less than full participation among TRADOC personnel was recorded for the author/commenter review cycle. Item 20 also received relatively low ratings ($\bar{X}$ = 3.08), suggesting that while SofTech made a moderate contribution to the progress achieved by TRADOC, it was not a major contributor. This might be expected from the interaction of SADT and other influences on Army progress discussed at the conclusion of the Phase 2 evaluation results (pp. 63-64 of this report).

Qualitative Data. The questionnaire contained six open-ended questions (Appendix D, Questions 22, 23, 24, 25, 26, and 27). One of these (26) will be discussed in a subsequent section of this report. Questions 22, 23, 24, and 25 addressed specific issues that were either left unclear or emerged from the Phase 1 and 2 evaluations.

A conclusion drawn from the Phase 2 evaluation was that attitudes at TRADOC toward SADT had shifted positively following

dissemination of the Task 3 report. Several tentative explanations for this shift were offered at the conclusion of the Phase 2 evaluation report. The opinions of TRADOC personnel were solicited to further specify why this shift had occurred (Question 22). The most consistent response to this question was that Tasks 1 and 2 were necessary preliminary activities of limited scope while the Task 3 model constituted the "meat" of the project. The following comments by four officers are representative:

> Since Task 2 dealt with a specific weapons system (the tank), many officers were either unfamiliar or uninterested in the Task 2 report. The general subject of the training system is more widely understood and generated a greater degree of interest. The meat of the contract was in Task 3 and Tasks 1 and 2 were merely preliminaries.

> Task 3 seemed to come to grips better with the key issues. After all, it represented a high point in the learning curve. Simultaneously it occurred as we were trying to deal with (other agencies) on total system developments. Hence, its insights were of benefit in the daily battle.

> The Task 2 report was not promulgated as a solution. It was a means to an end. The Task 3 report, on the other hand, was more general and intended for wider distribution. Thus, improvement in opinion should occur.

> Task 3 showed the "big picture" for the first time. People could see how their piece fit in and where the gaps were.

Question 24 attempted to assess whether the SADT project had had an impact on TRADOC's ability to solve large and/or complex problems. While this was one of the major benefits implied in the contract proposal,

the issue had not been addressed directly in the Phase 1 and Phase 2 evaluations. The general response to this question was that the individual officers directly involved in the project had probably honed their personal problem-solving abilities but that SADT had not had an organization-wide impact on analysis and planning skills. It should be mentioned that several respondents believed that a lack of command emphasis during the project may have limited the impact the project could be expected to have on these skills.

A major conclusion of the Phase 2 evaluation report was that following dissemination of the Task 3 report, individuals were more confident of the usefulness of the SADT project and were more positive that this work would ultimately be of benefit to TRADOC. However, it was unclear from the Phase 2 data just how the Task 3 model would be used or what specific benefits have or were expected to accrue at TRADOC.

Question 23 inquired directly about ways the Task 3 model would be used by TRADOC. Emphasis was given to the responses of higher ranking officers with training management responsibility. Responses to this question fall into three general categories.

The most consistently mentioned usage of the model was as a communications tool. One officer stated that the model would be used to "clarify the DA (Department of the Army) staff's understanding of the training system." Another officer stated that a major use of the model was "to explain the pervasiveness of TRADOC's functions and missions to DA, DoD, and other major commands." Other responses suggested Task 3's usefulness as a communications tool within TRADOC, stressing that the

model can be used to explain to TRADOC personnel the interrelationships between TRADOC and other commands and agencies within the Army and the DoD. It is clear that a major usage of Task 3 is as "a way to explain the training system."

Another consistently noted usage of the Task 3 model was as an aid in the systematization and coordination of combat development and training development activities. This was discussed as a major conclusion of the Phase 2 evaluation and will not be elaborated here. It should suffice to say that the role of the Task 3 model as a blueprint for the coordination of combat development efforts (primarily the development of specific weapons systems) and training developments efforts continues as one of the most valued of the potential uses of the Task 3 model.

A third category of uses centers around the value of the Task 3 model as an analytical tool in such areas as the planning of management information requirements for the training system and determining the system architecture necessary to support future data processing needs. Additional usages within this area include providing management a perspective for assigning responsibility for various aspects of the training and evaluation system and establishing criteria for the allocation of training resources.

At the conclusion of Task 3, most respondents interviewed for the Phase 2 evaluation report expressed that it was too early to specify benefits that might accrue to TRADOC as a result of carrying out this project. The Phase 3 evaluation questionnaire followed these interviews by approximately three months, allowing time for the model to "sink in"

and for potential benefits of the model to evidence themselves. As with the uses of the Task 3 model discussed above, several specific benefits were articulated by respondents in response to Question 25.

A primary benefit listed by almost all respondents was that the SofTech project had resulted in the articulation of the Army training and evaluation system for the first time. This documentation was seen as very valuable by TRADOC personnel and is related to their perceived usage of the Task 3 model as a valuable communications tool. Another often cited benefit was the elucidation of the relationship between combat developments and training developments. A third consistently occurring response to Question 25 was that "the role of evaluation and feedback in the training system had been clearly identified and raised to the desired level of prominence."

Other, more idiosyncratic benefits listed in response to Item 25, were that because SADT highlights system constraints, required "fixes" to present training system problems could now be more easily identified. And, because the Task 3 model "highlighted areas where automation was needed," a starting point for planning future hardware/software needs could be determined.

A different perspective was offered by one officer who listed the only project benefit as the "crossfertilization of ideas." He explained his response this way:

> (The project) forced TRADOC to explain the system used to outside agents. This is a remarkably useful exercise for smug persons who think they understand what they do.

Given the evaluator's experience with SADT and TRADOC, this comment seems insightful and nondefensive, and appears to underscore the mechanics of how SADT accomplishes its results.

The idiosyncratic comments of another TRADOC officer deserve mention. While acknowledging the potential benefits of SADT, he had reservations about whether any benefits would actually be realized. His response to Item 25 follows:

> As a minimum, TRADOC has been exposed to an enlightened form of analysis. The results now exist in a highly usable form. I am concerned about TRADOC's ability to apply the Task 3 model. This concern is based upon our lack of experience in conducting such a massive project--the type of project a policy-oriented staff is not equipped to handle.

Thus, the benefits of the model as documentation of what TRADOC is trying to achieve is clear in the minds of most TRADOC officers. Even the process of working through the models was considered to be of benefit to the organization in and of itself. Further, the model appears to have considerable potential value as TRADOC Headquarters moves to make needed changes in the current Army training and evaluation system. There is some skepticism, however, that TRADOC will be able to use the model optimally. As stated by one officer "the value of SADT is still more 'potential' than realized."

Summary and discussion. The most notable trend from the Phase 3 evaluation is that the attitudes of TRADOC personnel towards the Task 3 model remain positive. No deterioration of the positive valuation of the SADT work was evident three months after dissemination of the Task 3 report. Further, it appears that this three month interval provided an "incubation period" in which the results of the Task 3 work

had a chance to "sink in" in the minds of TRADOC personnel. Phase 3 evaluation results indicated the model had not been put on a shelf and forgotten but rather had become a central document in TRADOC's thinking about training and evaluation. The high return rate for the Phase 3 questionnaires and the thoroughness with which most respondents answered items on the questionnaire seems to support this conclusion.

The conclusions drawn from the Phase 3 evaluation data were similar to those in Phase 2, namely that TRADOC is satisfied with the results and considered its investment in the project worthwhile. The general opinion expressed was that the groundwork had been laid to convert the Army training system from what it is to what it should be. Whether the potential benefits of the SofTech project are realized is dependent on two factors in the minds of most TRADOC personnel. The first concerns the emphasis given to the model as a planning tool by upper level management at TRADOC. Throughout all three evaluation phases, this has been an expressed concern of officers involved in the project. The ultimate use (and derived benefit) of the model is dependent on the priority given it by senior level managers in TRADOC. The second factor concerns reservations about the ability of TRADOC (more specifically ODCST) to use the results of the Task 3 model in working toward the state of training and evaluation desired by TRADOC.

The interrelationships between the results of the three evaluation phases and a final project-wide evaluation summary follows.

VIII. Project Results and Discussion

In this section trends across the three evaluation phases are integrated and discussed.

Process Data

Considerable emphasis during the Phase 1 evaluation was placed on the SADT process. With the exception of one TRADOC officer trained as an SADT author, commenting on and approving SADT kits represented TRADOC's only official contact with SADT. Thus, any benefits derived by the client organization would seem dependent on completion of these process behaviors. It was for this reason that the process data from the project file was examined during Tasks 1 and 2.

The Phase 1 evaluation report indicated that TRADOC's participation in the process of diagram review and revision was about 50% of that originally expected by SofTech. Despite this result, none of the project personnel polled at the conclusion of Task 2 believed that deficiencies perceived in the project at that time were attributable to this reduced degree of participation in the iterative author-commenter cycle. Most respondents indicated that ample communication had occurred between SADT authors and TRADOC commenters and that, if anything, the formality of the SADT process had hindered TRADOC's participation in the project to some extent.

Prior to completion of Task 2, SofTech altered the SADT process slightly to achieve a better match between the process and work procedures in the TRADOC organization. Primarily, communication within the SADT

process was expanded to include conferences and open discussion of the status of various aspects of the model. Because both SofTech and TRADOC expressed satisfaction with the level of communication between authors and commenters and because the procedural aspects of SADT had been altered to meet the needs of this particular application of the technique, the issue of process data and implementation was not pursued in subsequent evaluative phases. It appears that the traditional procedural mechanisms of SADT need not be strictly adhered to if appropriate alterations can be made to facilitate participation in the process by personnel in the client organization. The fact that positive project benefits were derived despite less than strict adherence to traditional procedures supports this contention.

Perceived Effectiveness and Usefulness of SADT

Examination of the results of the three evaluation phases indicated that a favorable change in attitudes towards SADT by TRADOC personnel had occurred. The Phase 1 evaluation concluded that the effectiveness and usefulness of SADT had not been clearly demonstrated at the conclusion of Task 2 and that the respondents indicated they believed the technique was a good one, generally, but had reservations about the ultimate impact of its application at TRADOC.

The Phase 2 evaluation, which followed Task 3, concluded that attitudes towards the SADT project and its results were positive and had changed considerably from what was found during Phase 1. The most consistently cited reason for the more positive sentiments found in the Phase 2 evaluation was that the Task 3 model had provided an integrated

picture of the total Army training and evaluation system, particularly the interrelationships between evaluation, system development, and training. This integration had not been as vividly portrayed previously and generated considerable enthusiasm for beginning the actual work of implementing the new training and evaluation system.

Phase 3 evaluation results were similar to those found in Phase 2. Attitudes towards the SADT project remained positive. Despite the obstacles encountered in beginning the actual implementation of the new training and evaluation system, the Task 3 model was still considered valuable documentation of TRADOC's best thinking on how the Army's new training and evaluation system should operate. Most respondents were of the opinion that the project has been a worthwhile experience for TRADOC and expressed that the groundwork had been laid for beginning actual implementation of the new system.

Thus, TRADOC personnel were originally unsure or even skeptical about the value of SADT but attitudes towards the technique shifted as the project progressed. Only two TRADOC officers questioned during the Phase 3 evaluation stated that they were unaware of such shifts in attitude across the project, while another indicated that the opinions of SofTech personnel had changed during the project but the same was not true for TRADOC personnel.

To validate whether shifts in attitude toward SADT had occurred at TRADOC, two strategies, one quantitative and one qualitative, were employed. Qualitative data were gathered (interview protocols and

responses to discussion questions from questionnaires) to determine if the subjective responses of specific individuals changed across evaluation phases.

A colonel having considerable management responsibility for the project believed that at the end of Task 2 the scope of the project was "far too global to be of any practical value" and favored redirecting the Task 3 effort to concentrate on particularly "thorny" here-and-now problems.

His attitude was expressed in the following comment made prior to completion of the Task 3 effort:

> I can't afford to spend a lot of my time working on these broad general goals. I have my own problems. If they will work towards my particular problems at this time, fine, but I can't spend my time and the time of my men if it's not going to solve my problems.

However, following dissemination of the Task 3 model the officer's opinion was noted to have changed considerably as exemplified by this later comment:

> For some time we thought we understood different aspects of the system, but for the first time we have a clear picture of the interrelationships of different functions and organizations of the Army as they relate to training. The model systematized and coalesced our knowledge.

When questioned during the Phase 3 evaluation about ways the TRADOC organization had benefitted from the project, this individual stressed that the work completed had provided TRADOC with "a better framework within which to accomplish its mission."

Another colonel made these comments following the conclusion of

Task 2:

> We went into this project to get someone to provide a logical layout of the training system so we could get a handle on it. (Individuals) like myself haven't gotten that out of it yet. (Individuals) like myself haven't work will be of any use at this time....I'll wait before saying yes or no.

Six months later and after dissemination of the Task 3 report, this same individual made this comment:

> Nothing new appeared in the models but they caused me to think of them (training issues) in a different light. The further delineation of what evaluation is has changed our concept of evaluation and how it interrelates with the training system....This year has seen the realization of what we've been (talking) about for three years.

The above comments are typical of the way people described the SADT project before and following dissemination of the Task 3 model.

The second strategy employed to determine if attitudes had changed during the course of the project was to compare the responses to specific quantitative questions from the Phase 1 and Phase 3 questionnaires. Examination of these instruments (see Appendices B and D) indicated that 10 questions were common to both instruments. Figure 7 presents the intent of these questions and the mean response to each item across evaluation Phases 1 and 3.

Figure [illegible] indicates that the mean responses to items common to the Phase 1 and Phase 3 questionnaires were, with one exception, higher for Phase 3 respondents than for Phase 1 respondents. Six of the respondents to the Phase 3 questionnaire (n = 12) were also respondents during

FIGURE 7

Mean Responses for Selected Items of Phase 1 and Phase 3 Evaluation Questionnaire

Phase 1 (n = 13). Relatively large shifts (of approximately one unit magnitude) occurred for items inquiring whether SADT had saved time, whether SADT was an effective design and analysis method and whether the progress achieved had been worth resources devoted to the project. Moderate shifts (of approximately .5) occurred for items inquiring about SADT's facility for promoting clearer understanding and focusing attention. These results further serve to illuminate the nature of changes in attitude before and after production of the Task 3 model.

To further specify why attitudes towards SADT became more positive as the project progressed, TRADOC officers were questioned in the Phase 3 evaluation questionniare (Appendix D, Item 22) as to why their impressions of the SADT project had changed. The general response given was that at the conclusion of Task 2, only the necessary preliminary activities had been completed while production of the Task 3 model was the goal of the Army's participation in this project. The following responses are representative:

> More people were able to identify with and use the general model described in the Task 3 report.
>
> Since Task 2 dealt with a specific weapons system (the tank), many officers were either unfamiliar or uninterested in the Task 2 report. The general subject of the training system is more widely understood and generated a greater degree of interest. Those who understood the entire project knew that the meat of the contract was in Task 3 and that Tasks 1 and 2 were merely preliminaries.
>
> The Task 1 and 2 reports were not promulgated as solutions. They were a means to an end. The Task 3 report, on the other hand, was intended for wider distribution. Thus improvement in opinion should occur.

TRADOC personnel were unsure of the value of the SADT project during the preliminary tasks of the project. The Task 3 work integrated these previous efforts and produced a model of the training and evaluation system as it should be, which was the TRADOC goal for the project. The complexity of the problem created initial confusion among TRADOC personnel as to the goals and objectives of the project, and because the primary project goal was articulation of the new training system, it was not until the production of the Task 3 model that individuals could see that this goal was attainable.

This conclusion should not imply that evaluation efforts at the conclusion of Task 2 came too early. Rather, the Phase 1 evaluation results were critical data for understanding the initial ambiguity and skepticism inherent in projects such as this one which feature the novel application of a specific technique to a highly complex system problem.

Factors Influencing Interpretation of Project-wide Results

The following discussion presents several aspects of the TRADOC organization which should be considered in drawing conclusions from this study. It is believed that these factors have had sufficient impact on these results to warrant discussion.

A. Lack of command emphasis. Throughout the project TRADOC officers have stated that the value and usefulness of the SADT project was dependent on command emphasis and that the project has had less than full support from the upper level management of TRADOC. This lack of command emphasis may have affected some individual's opinions of and participation in the project, thus hindering the accomplishment of project goals. Although not measurable, the subtle influence this variable may have had on the conclusions drawn can not be discounted.

B. Acknowledgement of contribution. This factor concerns a tendency on the part of some TRADOC officers to discount the contributions of outside contractors. Although not measured in this study, the impression of the evaluators is that some officers would have little good to say about the work of any outside contractor, regardless of performance. This relates to what one TRADOC officer called "the not invented here syndrome." This refers to the belief that officers will tend to emphasize the work done in their own shop and dismiss the work done by others.

C. Influences on the status of training. It was concluded at the end of the Phase 2 evaluation that a potentially large number of influences may have interacted to produce current attitudes at TRADOC. The SADT project represents only one of these potential influences. The most direct response from an officer bearing on this issue was from a colonel who offered the following comment:

> The discussions with SofTech and examination of diagrams was one of several intellectual activities that defined and described where we were heading in TRADOC.

It is not possible to "tease out" the amount of influence the SofTech project has had in bringing about the Army's current conceptualization of training from the contribution of other potential influences. Thus, the data gathered for this evaluation must necessarily be interpreted in light of the fact that this project was one of several activities engaged in by TRADOC to achieve a better understanding of their training system.

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Summary and Conclusions

In summary, the articulation of the Army training and evaluation system as it should be represents the most tangible direct benefit gained by TRADOC in this project. The Task 3 model integrated the previously independently conceptualized areas of training, system developments, and evaluation in an understandable and practical manner. Now that documentation of the system structure has been accomplished the actual work of implementing the new conceptualization of training can begin.

At a minimum, the Task 3 model has provided a way of communicating to agencies and individuals both within and outside TRADOC the future directions planned for Army training and evaluation. Prior to the production of the Task 3 model the training developments component of TRADOC had not been able to fully articulate its goals and intents. The Task 3 model provided this much needed documentation.

Perhaps the most disappointing result of this project was that only a limited amount of technology transfer occurred between TRADOC and SofTech. Given that the level of Army participation in the project was less than originally anticipated, the fact that the project has had minimal impact on TRADOC's general analysis and planning capabilities is not surprising. More specifically, the failure of TRADOC to provide additional personnel as SADT authors limited the amount of expertise SofTech could pass on to the client organization.

In spite of the decreased level of participation, a small degree of technology transfer did occur. One TRADOC officer (a captain) trained in authoring SADT diagrams, became proficient in this skill. Additionally, two colonels having management responsibility in the

training development branch of TRADOC were exposed to the general SADT approach to complex system problems. From discussions with these individuals during the project, it is believed that they now have a better perspective from which to manage complex analysis and design problems.

The original project goals were that SADT would be used in conjunction with TRADOC to:

(1) identify changes in Army training that would significantly increase combat effectiveness;

(2) describe how Army training, testing, and evaluation programs will operate after the proposed changes are accomplished; and

(3) plan how the changes in Army training will be undertaken and how progress will be monitored and evaluated.

The conclusion drawn from all evaluation data collected from the study is that goals 1 and 2 have been accomplished to the satisfaction of relevant TRADOC personnel.

Goal 3, however, was only minimally realized, although this was not due to shortcomings in the SADT technique or in the efforts of SofTech or TRADOC. The actual implementation plan was deferred by mutual consent and replaced by a more pragmatic intermediate step. It was not until the Task 3 model had been produced that the task of implementing the new system could be fully appreciated. It was then decided that Task 4 could better be spent attacking more specific problems that stood as obstacles to subsequent implementation of the full system. Given this redirection, the failure to develop a plan for implementing changes and monitoring progress can not be seen as a limitation of SADT but rather as a reflection of the complexity of the context in which the project occurred.

Thus, it is concluded that further applications of SADT such as the one described in this report would be worthwhile. The basis for this conclusion is not that there is any "magic" in the SADT diagrams or procedures but rather that they provide a mechanism for documenting the best thinking of bright individuals in the client organization and interrelating important concepts in a clear and practical manner.

It does not appear that the project created any new knowledge about specific aspects of the training system but rather that it integrated and communicated what was known about training in a coherent and useful way. This conclusion is best summarized by an officer when he said, "(The project) forced TRADOC to explain the system used to outside agents. This is a remarkably useful exercise for smug persons who think they understand what they do."

Appendix A

Evaluative Dimensions Derived from the SofTech Proposal

I. Communicative Qualities

While explicit claims were made about the communicative qualities of the technique, almost all claims at least implied communication. Communication appeared to be one of the underlying goals of the SADT process. There are three subdimensions relevant to evaluation of the communicative qualities of SADT: (a) Does the author communicate effectively with the reader through SADT diagrams?; (b) Is communication enhanced among relevant personnel in the project by following the SADT discipline?; and (c) Does the usefulness of the technique derive largely from the technique itself, i.e. from blueprint-like drawings, or from the communication between individuals engendered by the process of using the technique?

A. Communicative Quality of the Diagrams. Are SADT diagrams readable by Army personnel after training provided by SofTech? Is the message of a diagram clear and unambiguous to the reader? Disregarding the accuracy of the diagram, does the Army reader feel that he understands what the author is trying to say? Are the diagrams more communicative than standard verbal text? Do TRADOC personnel believe they would have understood the author's message as easily through written text or dialog?

B. Communicative Quality of the SADT Discipline. Has the SADT discipline (the iterative author-commenter cycle) facilitated communication between the diverse personnel participating in the project? Is the commenter cycle more effective than written communication or conversation? Has the SADT discipline facilitated communication between Army personnel about the problems of rapidly changing training procedures? Has the discipline helped focus attention on the relevant factors so that meaningful dialog could occur within TRADOC? To

what extent has the application of SADT at TRADOC led to a common conceptualization of the problem? Do Army personnel believe they are more able to communicate among themselves about their tasks, goals, and problems as a result of the application of SADT?

C. Impact of Improved Communication. If communication about the problems at hand has improved at TRADOC (A and B above), has this improved communication helped focus attention on critical variables impacting the effectiveness of Army training? Has this improved communication led to a keener understanding of the problems facing the training command . . . to a grasp of possible solutions to those problems? To what extent are the benefits of the SADT project attributable to the impact of SADT on communications within TRADOC?

II. Quality

The proposal made several claims to the effect that SADT will improve the quality of the work at TRADOC. While these quality claims were sometimes too vague to measure, several claims did cluster into three groups that are logically related to quality: accuracy, quality control, and efficiency (time savings). These three subdimensions form the Quality dimension.

A. Accuracy. Do Army personnel consider the SADT models to be accurate representations of the content modeled? Is the overview model developed in Task 1 a credible representation of the new training programs to those who are responsible for the conceptualization and design of these new programs? Similarly, is the model of the tank weapon system developed in Task 2 sufficiently isomorphic with that system for Army users to develop confidence in the model and to use it to deepen their understanding of the weapon system?

B. Quality Control. Built into the SADT discipline is an iterative review process that supposedly ensures the quality (accuracy, consistency, and

completeness) of the ongoing work. Do Army personnel perceive this method of quality control as effective? Do they believe that this process actually ensures the quality of the final draft of a diagram? If they do not see the process as effective, is it because of the author's insensitivity to comments by commenters . . . lack of interest and/or input by commenters . . . inconsistent feedback to author . . . poor information grasp by experts of the content modeled . . . and/or limitations on the way feedback is given?

C. Efficiency. Several claims were made about the reduction in time resulting from application of SADT in completing a structured analysis and design problem. Do the Army's perceptions support these claims? Does the iterative review cycle of the SADT discipline save time? Is it a more efficient way (in terms of time) to communicate ideas? Does the discipline seem more time efficient early in the modeling (A-Ø and AØ) or later in the modeling, i.e., at more detailed levels?

At the end of Task 2, do Army personnel consider the amount of progress made on the problem as a result of SofTech's input worth the time devoted to the project? Do they consider this amount of time a savings or deficit relative to the time it would have taken to reach the same level of output by more traditional methods?

III. Usefulness

This dimension, reflecting the largest single cluster, represents claims about the utility or usefulness of the technique. Taken together, these claims explicitly state that SADT is more than a decomposition technology or engineering drawing system, i.e., that it will facilitate the planning, implementation, management, and evaluation capabilities of TRADOC personnel by providing conceptual insights into the problems being modeled.

The evaluation of this dimension will be conducted at two different stages: (a) an evaluation of SADT's usefulness in Tasks 1 and 2 (incorporated in this evaluation report), and (b) given the Army personnel's experience with SADT in Tasks 1 and 2, their perception of the usefulness of SADT when applied in Tasks 3 and 4 (not scheduled for completion prior to the preparation of this report).

A. Usefulness in Tasks 1 and 2. Did the models produced in Task 1 lead to a clearer understanding of the problems being modeled? Will these diagrams be helpful in planning changes in Army training? Did the model define what types of changes are being planned?

In Task 2, did the training innovations having the greatest impact on combat readiness and battlefield effectiveness become sufficiently visible as claimed? By the end of Task 2, did SADT contribute to the isolation of innovations which are critical to Army training?

B. Usefulness in Subsequent Tasks. Do Army personnel believe SADT will be effective in elaborating the Task 1 model? Given their experience with SADT in Tasks 1 and 2, do they believe the more thorough model produced in Task 3 and the innovation plan (Task 4) will increase TRADOC's analysis, planning, and management capabilities? In addition to their utility for the present evaluation effort questions such as these ultimately will be used to determine whether the consensus of opinion at TRADOC supports the continuation of the project and/or the use of SADT in expanded contexts.

IV. Specificity

This dimension reflects the Army's perception of SADT's ability to produce models that meet a specific need, such as describing what functions a system must perform, specifying how a system should be designed, or how a system should be managed or maintained. Answers to these types of questions provided some initial information bearing on a decision about expanded usage of SADT in

the DoD environment.

A second area of Specificity is whether Army personnel can obtain specific information from the models. If an Army officer needs to know something specific about a system, can he look at the SADT model of that system and find what he needs? Could, for example, a microfiche SADT model file serve as a valuable reference for Army training personnel?

These evaluative dimensions and their respective claims are summarized in the following table.

Appendix A (cont.)

Factor Structure of Claims by Evaluative Dimensions

Claims about SADT	I Communicative Qualities: Diagrams I_A	I Communicative Qualities: Discipline I_B	I Communicative Qualities: Impact I_C	II Quality: Accuracy II_A	II Quality: Quality Control II_B	II Quality: Efficiency II_C	III Usefulness: Tasks 1 and 2 III_A	III Usefulness: Subsequent Tasks III_B	IV Specificity IV
1. Identify changes increasing combat effectiveness							X		
2. Accurately describe how Army training will operate				X					
3. Help plan how changes will be monitered								X	
4. Plan how progress will be monitered								X	
5. Improve TRADOC's analytic and planning ability								X	
6. Plan how training changes should be accomplished								X	
7. Understand complex interrelationships								X	
8. Focus attention on innovations with greatest potential for increasing combat effectiveness			X				X		
9. Plan and schedule how innovations will be incorporated								X	
10. Plan how effectiveness of innovations will be evaluated								X	

	I_A	I_B	I_C	II_A	II_B	II_C	III_A	III_B	IV
11. Understand major changes in Army training			X				X	X	
12. Plan major changes in Army training								X	
13. Describe new Army training and testing programs				X			X		
14. Derive training requirements							X		X
15. Understand aspects of training that impact combat effectiveness							X		
16. Evaluate approaches to meeting training requirements							X		
17. Improve quality of resulting work				X	X	X			
18. Identify changes that increase effectiveness of weapons systems							X		
19. Show how changes are related to existing training methods							X		
20. Improve quality of work on the 5 tasks				X	X	X			
21. Communicates results among analysts, designers, users, and managers		X	X						
22. Integrated approach to managing large complex systems		X	X				X	X	
23. Communicates results among people with different interests and backgrounds		X	X						

	I_A	I_B	I_C	II_A	II_B	II_C	III_A	III_B	IV
24. Documents logical relationship of components to total system	X								
25. Consistent decomposition of a system				X	X				
26. Effective communication between originator and user of descriptive models	X								
28. Will yield unusually clear description of problem	X						X		
29. Complete decomposition of a system				X	X				
30. Highly readable decomposition of a system	X								
31. Highlights interfaces between components	X						X	X	
32. Defines changes being planned							X		
33. Will describe training system operation after changes are incorporated				X					
34. Will be effective in training command							X	X	
35. Will have utility in training command							X	X	
36. Describes interrelationships between innovations	X						X	X	
37. Highlights complex interactions	X								

	I_A	I_B	I_C	II_A	II_B	II_C	III_A	III_B	IV
38. Integrated approach to planning, analysis and design		X	X				X	X	
39. Ensures quality and configuration control					X				
40. Ensures consistency and completeness					X				
41. Interviewing standardizes means of capturing information					X				
42. Interviewing organizes process of gathering facts					X				
43. Defines requirements									X
44. Describes what functions a system must perform									X
45. Specifies how a system's use or construction is to be managed									X
46. Explains a system's use or maintenance									X
47. Specifies a system's design									X
48. Allows a complex system to be understood		X							
49. Critical management and technical review built into overall process		X	X		X				

	I_A	I_B	I_C	II_A	II_B	II_C	III_A	III_B	IV
50. Constant attention given to quality of work in progress					X				
51. Simplifies testing of all interfaces for consistency and completeness					X				
52. Allows analysis and description from several viewpoints		X	X						
53. Will reduce elapsed time to complete 5 tasks						X			
54. Will save time on this project						X			
55. Is expected to reduce elapsed time to complete 5 tasks						X			
56. Is particularly powerful for planning								X	
57. Involves more than a decomposition technology		X	X		X				
58. Is a systematic methodology for performing planning								X	X

NOTE: Claims 8, 11, 13, 14, 22, 28, 31, 38, 49, 57, and 58 are equally applicable to two dimensions.

Appendix B

Phase 1 Evaluation Questionnaire

Current Position_____

Months in Current Position_____

Total length of experience with Army training and testing programs_____

Have you taken the SofTech Reader Course? yes /__/ no /__/

Have you taken the SofTech Commenter Course? yes /__/ no /__/

1. To what extent do you feel you were adequately trained to read SADT diagrams?

   1.____not trained at all

   2.____poorly trained

   3.____trained to a working knowledge

   4.____fairly well trained

   5.____expertly trained

2. To what extent do you feel you were adequately trained to comment on SADT diagrams?

1. ____ not trained at all

2. ____ poorly trained

3. ____ trained to a working knowledge

4. ____ fairly well trained

5. ____ expertly trained

3. In general, to what extent were the SADT diagrams clear and unambiguous? (Complete each column separately.)

	first drafts	revised versions	final versions
1. Diagrams were always ambiguous			
2. Diagrams were mostly ambiguous			
3. Diagrams were occasionally clear			
4. Diagrams were mostly clear			
5. Diagrams were always clear			

4. To what extent do you think it is necessary that written text containing a more complete explanation of the content modeled accompany SADT diagrams contained in reader kits?

1. ____ not necessary

2. ____ might be slightly helpful

3. ____ probably of some help

4. ____ would be fairly helpful

5. ____ would be very helpful

5. In your opinion, do SADT reader kits allow adequate communication between author and commenter or should discussion between author and reader be a required part of the SADT process?

1. ___ SADT diagrams are an adequate means of communication; no discussion is necessary

2. ___ discussion between author and reader at the request of either party (the present procedure) is adequate

3. ___ inclusion of required discussion between author and reader would be helpful

4. ___ inclusion of required discussion between author and reader is essential

6. To what degree do you believe SADT diagrams are an effective way of communicating to trained readers the substance of providing Army training, testing, and evaluation programs?

1. ___ not effective

2. ___ rarely effective

3. ___ sometimes effective

4. ___ fairly effective

5. ___ very effective

7. To your knowledge, to what extent have SADT diagrams generated either formal or informal communication about Army training procedures among TRADOC personnel directly involved with the SADT project?

1. ___ none at all

2. ___ a little

3. ___ some

4. ___ fair amount

5. ___ very significant amount

8. To your knowledge, to what extent have SADT diagrams generated either formal or informal communication about Army training procedures among TRADOC personnel not directly involved with the SADT project?

1.____none at all

2.____a little

3.____some

4.____fair amount

5.____very significant amount

9. To what extent have SADT diagrams helped focus your attention on training and testing variables which you had not considered previously?

1.____not at all

2.____very little

3.____somewhat

4.____to a fair extent

5.____very much

10. To what extent do you believe the benefits of the SADT project at TRADOC, if any, are due to the diagrams or models themselves, i.e., the tangible products or drawings, as opposed to the process of communication between TRADOC staff members which may have been stimulated by the modeling process? If you feel no benefits accrued at all relevant to this question, check only the following:

/_/ no benefits at all

1.____benefits entirely product-diagram related

2.____benefits mostly product-diagram related

3.____benefits split about evenly between products produced and processes stimulated

4.____benefits mostly process related

5.____benefits entirely process related

11. To what extent do the revised diagrams that you have seen of the new Army training and testing programs accurately represent the content modeled?

/ / not enough information to judge

1. ___ not accurate

2. ___ rough approximations

3. ___ variable in accuracy, depending on content modeled

4. ___ fairly accurate

5. ___ extremely accurate

12. To what extent do the revised diagrams that you have seen of the tank weapon system accurately represent that system?

/ / not enough information to judge

1. ___ not accurate

2. ___ rough approximations

3. ___ variable in accuracy, depending on content modeled

4. ___ fairly accurate

5. ___ extremely accurate

13. Is the author-commenter review cycle used by SofTech in the production of SADT diagrams an effective means of ensuring the quality of SADT models?

1. ___ not at all effective

2. ___ not very effective

3. ___ somewhat effective

4. ___ fairly effective

5. ___ very effective

14. How confident are you that this method of quality control guarantees that the final diagram will be as complete and accurate as possible?

1. ___ not at all confident
2. ___ very little confidence
3. ___ some confidence
4. ___ fairly confident
5. ___ very confident

15. What degree of confidence do you have that your written comments on SADT diagrams were actually taken into account in producing final draft models?

1. ___ no confidence at all
2. ___ low confidence
3. ___ some confidence
4. ___ fairly high degree of confidence
5. ___ very high degree of confidence

16. In your opinion, to what extent has communicating to SofTech authors by way of the author-commenter cycle, rather than by discussion and written text, resulted in a time savings?

1. ___ no time was saved
2. ___ a little time was saved
3. ___ some time was saved
4. ___ a fair amount of time was saved
5. ___ a great deal of time was saved

17. To what extent has the application of SADT at TRADOC saved time relative to other approaches (e.g., in-house TRADOC committees, outside consultants) that might have been employed to communicate Army training procedures?

1.____has not saved time

2.____has saved very little time

3.____has saved some time

4.____has saved a fair amount of time

5.____has saved considerable time

18. How cost-efficient do you believe SADT is compared to other techniques having the same general purpose with which you are familiar?

/_/ unfamiliar with other techniques

1.____all others are superior to SADT

2.____many others are superior to SADT

3.____others and SADT are about the same

4.____a few others are superior to SADT

5.____SADT is superior to all others

19. In your opinion, approximately what percentage of actual time could be saved, if any, by using SADT on a design and analysis task instead of traditional procedures? _____%

20. To what extent did the Task 1 model of Army training provide you with a clearer understanding of the Army's training, testing, and evaluation programs?

/__/ unfamiliar with Task 1 model

1. ____less understanding than before project

2. ____same understanding as before project

3. ____a slightly better understanding

4. ____a noticeably better understanding

5. ____a much better understanding

21. Do you believe the SADT models produced by SofTech thus far will actually be used in planning needed changes in Army training?

1. ____will not be used

2. ____will be used to a small extent

3. ____will be used some, depending on content modeled

4. ____will be used to a fair extent

5. ____will be used extensively

22. To what extent do you believe the SADT diagrams produced thus far will actually help in deriving training requirements?

1. ____will not help

2. ____will help to a small extent

3. ____will help some

4. ____will help noticeably

5. ____will help considerably

23. In your opinion, can SADT be effectively used to elaborate upon already completed diagrams and to accurately articulate an extended final model of Army training and testing during the next phase of the project (Task 3)?

1. ____definitely not

2. ____probably not

3. ____uncertain

4. ____probably yes

5. ____definitely yes

24. To what extent will SADT models actually increase TRADOC's analysis, planning and management capabilities? (Complete each column separately.)

	Analysis	Planning	Management
1. none	_____	_____	_____
2. a little	_____	_____	_____
3. some	_____	_____	_____
4. a fair amount	_____	_____	_____
5. very much	_____	_____	_____

25. Do you believe that SADT can help identify training requirements that have a significant effect on combat readiness and battlefield effectiveness?

1. ____definitely not

2. ____a little

3. ____somewhat

4. ____to a fair extent

5. ____to a significant extent

26. In your opinion, would a complete SADT model of Army training serve as a valuable future reference for Army personnel responsible for providing training?

1.____would not be of any value

2.____would be of little value

3.____would be of some value

4.____would be fairly valuable

5.____would be very valuable

27. How practical do you believe it is for TRADOC personnel to use SADT for most design and analysis problems facing the Training and Doctrine Command?

1.____very impractical

2.____fairly impractical

3.____marginally practical

4.____fairly practical

5.____very practical

28. How confident were you in the comments you made on SADT diagrams?

1.____not at all confident

2.____barely confident

3.____somewhat confident

4.____fairly confident

5.____very confident

29. Of the diagrams you read, approximately what percentage were in content areas in which you felt you did not have sufficient experience to make meaningful comments? If you would like to be more precise in your estimate, do so in the space provided: _____%.

1.____0-20%

2.____21-40%

3.____41-60%

4.____61-80%

5.____81-100%

30. About how often did you consult other TRADOC personnel before commenting on an SADT diagram? If you would like to be more precise in your estimate, do so in the space provided: _____%.

1.____0-20%

2.____21-40%

3.____41-60%

4.____61-80%

5.____81-100%

31. At this time, how critical do you believe it is to implement changes in Army training?

1.____no need presently exists

2.____needs to be done but not immediately (low priority)

3.____somewhat critical (medium priority)

4.____fairly critical (high priority)

5.____very critical (urgent priority)

32. To what extent do you believe SADT models will provide the impetus for changes in Army training and testing programs?

1.____will not provide any impetus for change

2.____will contribute to change to a small extent

3.____will provide some impetus for change

4.____will contribute to change to a fairly large extent

5.____will provide the major impetus for change

33. To what extent will SADT be useful in identifying existing organizational inefficiencies in the current training and testing procedures?

1.____no use

2.____not much use

3.____some use

4.____a fair amount of use

5.____a great use

34. In your opinion, will the application of SADT lead to conceptual insights about alternative methods of conducting Army training and testing programs?

1.____not at all

2.____very little

3.____some

4.____to a fair extent

5.____to a great extent

35. In your opinion, will the use of SADT ultimately affect the training concepts currently held by TRADOC?

1.____not at all

2.____very little

3.____to some extent

4.____to a considerable extent

5.____to a great extent

36. In your opinion, would it be useful to TRADOC's mission to train some Army personnel to be SADT authors?

1.____no use

2.____slightly useful

3.____of some use

4.____fairly useful

5.____very useful

37. In your opinion, has the amount of progress made by this project on the problems facing TRADOC been worth the amount of time Army personnel have devoted to it?

1.____definitely has not been worth the time

2.____generally has not been worth the time

3.____has varied with the content being modeled

4.____generally has been worth the time

5.____all time spent has been worthwhile

38. To what extent did the Task 2 model of the tank weapon system provide you with a clearer understanding of the Army's training, testing, and evaluation programs?

/7/ unfamiliar with Task 2 model

1.____less understanding than before project

2.____same understanding as before project

3.____a slightly better understanding

4.____a noticeably better understanding

5.____a much better understanding

Please respond to the following questions by writing your answers in the space provided. If you need more space, continue on the extra pages at the end of this booklet or attach an additional sheet. While some of the questions could be responded to with a brief comment, I would like to ask that you elaborate on your responses whenever possible.

39. From your experience in revising SADT diagrams, can you recall if there were general content areas in which diagrams were particularly accurate and other areas where they were particularly inaccurate? What variables, in your opinion, might account for differences in the accuracy of SADT diagrams?

40. Could you identify any specific benefits which may have accrued to the Army as a result of its participation in this project thus far?

41. Drawing on your experience with SADT, what are a few of its major strengths and weaknesses?

42. Are there other personnel at TRADOC who were not included in the SADT project who may have had more experience or closer contact with the content being modeled than yourself? If so, why do you believe they were not participants in the project?

43. To your knowledge, have there been any obstacles which may have prevented SofTech from doing the best job possible at TRADOC?

44. Do you have any other thoughts or comments about SADT which you have not had the opportunity to express?

Appendix C

Phase 2 Structured Interview Form

1. (7)* To your knowledge, to what extent has the SofTech project facilitated either formal or informal communication about Army training procedures among TRADOC personnel directly involved with the SADT diagrams (commenting or authoring)?

   1. ___ none at all
   2. ___ a little
   3. ___ some
   4. ___ fair amount
   5. ___ very significant amount

2. (8) To your knowledge, to what extent has the SofTech project facilitated either formal or informal communication about Army training procedures among TRADOC personnel not directly involved with the SADT diagrams (commenting or authoring)?

   1. ___ none at all
   2. ___ a little
   3. ___ some
   4. ___ fair amount
   5. ___ very significant amount

3. (9) To what extent has the SofTech project helped focus your attention on training and testing variables which you had not considered previously?

   1. ___ not at all
   2. ___ very little
   3. ___ somewhat
   4. ___ to a fair extent
   5. ___ very much

*Question number on the Phase 1 questionnaire

4. (11) To what extent do the revised diagrams that you have seen of the new Army training and testing programs accurately represent what the Army training and evaluation system should be?

/___/ not enough information to judge

1. ___ not accurate

2. ___ rough approximations

3. ___ variable in accuracy, depending on content modeled

4. ___ fairly accurate

5. ___ extremely accurate

5. (20) To what extent will the Task 3 model lead to a clearer understanding of Army training, testing, and evaluation programs?

1. ___ less understanding than before project

2. ___ same understanding as before project

3. ___ a slightly better understanding

4. ___ a noticeably better understanding

5. ___ a much better understanding

6. (21) Do you believe the SADT models produced by SofTech thus far will actually be used in planning needed changes in Army training?

1. ___ will not be used

2. ___ will be used to a small extent

3. ___ will be used some, depending on content modeled

4. ___ will be used to a fair extent

5. ___ will be used extensively

7. (22) To what extent do you believe the SADT diagrams produced thus far will actually help to establish training requirements?

1. ___ will not help
2. ___ will help to a small extent
3. ___ will help some
4. ___ will help noticeably
5. ___ will help considerably

8. (23) Have the Task 3 models effectively elaborated those developed in Tasks 1 and 2?

1. ___ definitely not
2. ___ probably not
3. ___ uncertain
4. ___ probably yes
5. ___ definitely

9. (24) To what extent will SADT models actually increase TRADOC's analysis, planning, and management capabilities? (Complete each column separately.)

	Planning	Analysis	Management
1. none	___	___	___
2. a little	___	___	___
3. some	___	___	___
4. a fair amount	___	___	___
5. very much	___		

10. (26) In your opinion, would a complete SADT model of Army training serve as a valuable future reference for Army personnel responsible for providing training?

1. ___ would not be of any value
2. ___ would be of little value
3. ___ would be of some value
4. ___ would be fairly valuable
5. 1 would be very valuable

11. (27) How practical do you believe it is for TRADOC personnel to use SADT for most design and analysis problems facing the Training and Doctrine Command?

1. ___ very impractical
2. ___ fairly impractical
3. ___ marginally practical
4. ___ fairly practical
5. ___ very practical

12. To what extent to you believe SADT models will be useful in bringing about changes in Army training and testing programs? (Not included in original questionnaire.)

1. ___ will not provide any impetus for change
2. ___ will contribute to change to a small extent
3. ___ will provide some impetus for change
4. ___ will contribute to change to a fairly large extent
5. ___ will provide the major impetus for change

13. (33) Has SADT been useful in identifying existing organizational inefficiencies in the current training and testing procedures?

1. ___ no use
2. ___ not much use
3. ___ some use
4. ___ a fair amount of use
5. ___ a great use

14. (34) Has the application of SADT lead to conceptual insights about alternative methods of conducting Army training and evaluation programs?

1. ___ not at all
2. ___ very little
3. ___ some
4. ___ to a fair extent
5. ___ to a great extent

15. (35) Has the use of SADT had an impact on the training concepts currently held by TRADOC?

1. ___ not at all
2. ___ very little
3. ___ to some extent
4. ___ to a considerable extent
5. ___ to a great extent

16. (36) In your opinion, would it be useful to TRADOC's mission to train some Army personnel to be SADT authors?

1. ___ no use
2. ___ slightly useful
3. ___ of some use
4. ___ fairly useful
5. ___ very useful

17. (37) In your opinion, has the amount of progress made by this project on the problems facing TRADOC been worth the resources the Army has devoted to it?

1. ___ definitely has not been worth the time
2. ___ generally has not been worth the time
3. ___ has varied with the content being modeled
4. ___ generally has been worth the time
5. ___ all time spent has been worthwhile

Appendix D

Phase 3 Evaluation Questionnaire

Check the alternative most congruent with your sentiments to each question. Feel free to elaborate on your responses in the additional space provided.

1. To what degree do you believe SADT diagrams are an effective way of communicating to trained readers the substance of providing Army training, testing, and evaluation programs?

   1. _____ not effective
   2. _____ rarely effective
   3. _____ sometimes effective
   4. _____ fairly effective
   5. _____ very effective

2. To your knowledge, to what extent did the SADT project generate either formal or informal communication about Army training procedures among TRADOC personnel?

   1. _____ none at all
   2. _____ a little
   3. _____ some
   4. _____ fair amount
   5. _____ very significant amount

3. To what extent did SADT diagrams help focus attention on training and testing variables which had not been considered previously?

   1. _____ not at all
   2. _____ very little
   3. _____ somewhat
   4. _____ to a fair extent
   5. _____ very much

4. To what extent did SADT models elucidate the interrelationships between the various components of training?

1. _____ not at all
2. _____ very little
3. _____ somewhat
4. _____ to a fair extent
5. _____ very much

5. To what extent were the benefits of the SADT project at TRADOC, if any, due to the diagrams or models themselves, i.e., the tangible products or drawings, as opposed to the process of communication between ODCST staff members which may have been stimulated by the modeling process? If you feel no benefits accrued at all relevant to this question, check only the following:

_____ no benefits at all

1. _____ benefits were entirely product-diagram related
2. _____ benefits were mostly product-diagram related
3. _____ benefits were split about evenly between products produced and processes stimulated
4. _____ benefits were mostly process related
5. _____ benefits were entirely process related

6. To what extent has the application of SADT at TRADOC saved time relative to other approaches (e.g., in-house TRADOC committees, outside consultants) that might have been employed to develop an integrated system concept of training?

1. _____ has not saved time
2. _____ has saved very little time
3. _____ has saved some time
4. _____ has saved a fair amount of time
5. _____ has saved considerable time

7. To what extent did the Task 3 model of Army training provide a clearer understanding of the Army's training, testing, and evaluation programs?

_____ unfamiliar with Task 3 model

1. _____ less understanding than before project
2. _____ same understanding as before project
3. _____ a slightly better understanding
4. _____ a noticeably better understanding
5. _____ a much better understanding

8. Do you believe the SADT models produced by the SofTech project will actually be used in planning needed changes in Army training?

1. _____ will not be used
2. _____ will be used to a small extent
3. _____ will be used some
4. _____ will be used to a fair extent
5. _____ will be used extensively

9. Has SADT helped identify changes in training procedures that would have a significant effect on combat readiness and battlefield effectiveness if instituted?

1. _____ definitely not
2. _____ a little
3. _____ somewhat
4. _____ to a fair extent
5. _____ to a significant extent

10. In your opinion, would the complete SADT model of training serve as a valuable future reference for Army personnel responsible for providing training?

1. _____ would not be of any value
2. _____ would be of little value
3. _____ would be of some value
4. _____ would be fairly valuable
5. _____ would be very valuable

11. In your opinion, is SADT an effective approach to the design and analysis problems encountered by an agency such as TRADOC?

1. _____ not effective
2. _____ rarely effective
3. _____ marginally effective
4. _____ fairly effective
5. _____ very effective

12. To what extent do you believe SADT models will provide the impetus for changes in Army training and testing programs?

1. _____ will not provide any impetus for change
2. _____ will contribute to change to a small extent
3. _____ will provide some impetus for change
4. _____ will contribute to change to a fairly large extent
5. _____ will provide the major impetus for change

13. To what extent were the SADT models useful in identifying existing organizational inefficiencies in the current training and testing procedures?

1. _____ no use
2. _____ not much use
3. _____ some use
4. _____ a fair amount of use
5. _____ a great use

14. Has the application of SADT led to conceptual insights about alternative methods of conducting Army training and testing programs?

1. _____ not at all
2. _____ very little
3. _____ some
4. _____ to a fair extent
5. _____ to a great extent

15. In your opinion, will the SofTech project ultimately affect the training concepts held by TRADOC?

1. _____ not at all
2. _____ very little
3. _____ to some extent
4. _____ to a considerable extent
5. _____ to a great extent

16. In your opinion, would it be useful to TRADOC's mission to train additional personnel to be SADT authors?

1. _____ no use
2. _____ slightly useful
3. _____ of some use
4. _____ fairly useful
5. _____ very useful

17. Beyond the specific models produced, to what extent has the experience of participating in this project increased TRADOC's general analytic and planning capabilities?

1. _____ the experience has had no effect on these abilities
2. _____ the experience has had a minimal effect on these abilities
3. _____ the experience has had an effect only in the particular content areas modeled
4. _____ the experience has had a noticeable effect on these abilities
5. _____ the experience has greatly increased these abilities within TRADOC

18. In your opinion, is it realistic to expect that TRADOC's general analysis and planning capabilities would increase as a result of their participation in a project such as this one?

1. _____ not a realistic expectation
2. _____ definitely a realistic expectation
3. _____ insufficient information to judge

19. In your opinion, has the amount of progress made by this project on the problems facing TRADOC been worth the time Army personnel have devoted to it?

1. _____ definitely has not been worth the time
2. _____ generally has not been worth the time
3. _____ has varied with the content being modeled
4. _____ generally has been worth the time
5. _____ all time spent has been worthwhile

20. The new total system conceptualization of training developed by TRADOC is the result of several major intellectual activities occurring at TRADOC in the last few years. We are trying to determine how much influence the SofTech project has had on the emergence of this new system. Please indicate your estimate of SofTech's contribution to the progress made by TRADOC in developing an integrated systems approach to training.

1. _____ SofTech has not contributed
2. _____ SofTech's contribution has been minimal
3. _____ SofTech made a moderate contribution
4. _____ SofTech was a major contributor
5. _____ SofTech was the most important single contributor

21. Do you consider the total system concept of training as elucidated by the Task 3 model an improvement over previous conceptualizations of training held by the Army?

1. _____ previous conceptualizations of training were superior
2. _____ previous conceptualizations were slightly better
3. _____ previous conceptualizations and total system concept are about equal
4. _____ total system concept is slightly better
5. _____ total system concept is superior

Please respond to the following questions by writing your answers in the space provided. If you need more space, continue on the extra pages at the end of this booklet or attach an additional sheet. While some of the questions could be responded to with a brief comment, I would like to ask that you elaborate on your responses whenever possible.

22. Questionnaire and interview data showed that the opinions of TRADOC officers were more positive towards SADT at the end of Task 3 (May, 1977) than they were at the end of Task 2 (December, 1976). To what do you attribute this shift in attitude?

23. To your knowledge, in what ways will the Task 3 model be used by TRADOC?

24. It was anticipated that in addition to the SADT models produced, the TRADOC organization would improve their analytic and planning capabilities as a result of their participation in the project.

In you opinion, has this project had an impact on TRADOC's ability to solve large and/or complex problems? If so, how has TRADOC's analysis and planning capabilities improved? If you do not think the project has had an impact on these abilities within TRADOC, why do you think this transfer of technical skills failed to occur?

25. In what ways has TRADOC benefited from the SofTech project?

26. In what ways could the SofTech project have been altered to better meet TRADOC's needs?

27. Do you have any other thoughts or comments about SADT or the SofTech project which you have not had an opportunity to express but believe to be important to this evaluation?