THE AUTOMATED SYSTEMS APPROACH TO TRAINING (ASAT)

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ABSTRACT

This paper describes ASAT, the Automated Systems Approach to Training System, which has been designed to automate many of the procedures involved in the Army's Systems Approach to Training. It provides information on the background of the project, specifically addressing the problems that heretofore confronted the training development community within the TRADOC school system in accomplishing their training support mission. It describes the problems involved in analyzing units and the jobs of individual soldiers and designing, developing and producing training support materials (in both the collective and individual training arenas) for use by commanders, training managers, trainers and soldiers in Active and Reserve Component units throughout the Army. The functional design that emerged to resolve those problems is then discussed and the capabilities of the prototype system are explained. Specific issues such as hardware suites, use of commercial-off-the-shelf software, man-machine interface, and data base design are addressed. The paper then goes on to give the results of the economic analysis and the formative evaluation of the prototype system. Based on those empirical findings, the paper then presents suggestions for making ASAT even more responsive to the needs of those involved in collective and individual training analysis, design and development and how the mature ASAT can be integrated into the TRADOC TRAMOD system.

BACKGROUND

Importance of training support material

Perhaps no documents influence the quality of training throughout the Army more than the ARTEP Mission Training Plans, Programs of Instruction and Soldiers Manuals. These documents have been developed to describe the critical collective and individual tasks that units and individual soldiers throughout the Army are expected to be able to perform during combat. In addition, they prescribe the conditions under which the tasks are to be performed and the standards of performance that must be achieved. Suffice it to say that the quality of these documents plays a tremendously significant role in the quality of training that takes place throughout the Army's schools and units.

Current manual system

The US Army Training and Doctrine Command (TRADOC) has as one of its missions the publication of the ARTEP Mission Training Plans and Soldiers Manuals to support collective and individual training within units as well as Programs of Instruction to support training that takes place within the Army's schoolhouses. This involves the analysis of unit missions and the jobs of individual soldiers and the decomposition of those missions and duties into collective and individual tasks, a process generally known as Front-end Analysis. It also includes the design process, whereby training developers identify the tasks that are critical to mission or job accomplishment and develop, for each critical task, conditions, standards and subtasks. It is during this process that they also develop various other aids for trainers and training managers, such as: training matrices

that indicate the crosswalks between missions and tasks, collective and individual tasks, etc.; training and evaluation outlines; situational and field training exercises; and drills. The development process includes the actual formatting of the publications themselves. These three processes — analysis, design and development — form the heart of the Systems Approach to Training (SAT). (The other two processes are the implementation and feedback processes). Figure 1 below depicts, in simplified fashion, the work flow involved in generating collective training material (the production of individual training material is generally similar, albeit from a individual soldier perspective).

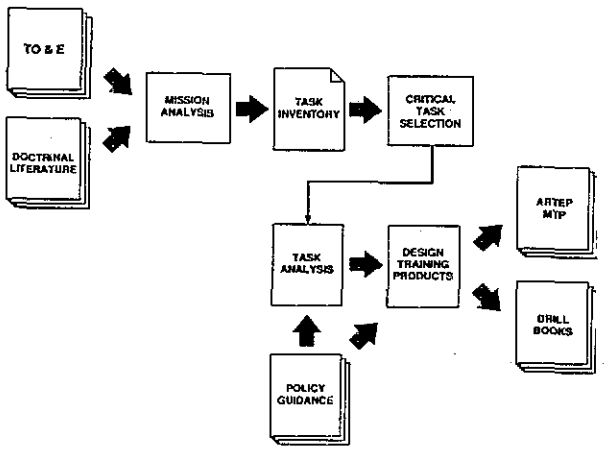

Figure 1. Work Flow for the Generation of Collective Training Materials

Based on an analysis of the unit's mission, as determined by a review of, among other sources, the unit Table of Organization and Equipment (TO&E) and appropriate doctrinal literature, the training analyst performs a mission analysis. Task candidates are then identified and recommendations made as to their criticality. A critical task selection board then selects those that are deemed mission critical. The training analyst performs a detailed task analysis of the critical tasks, identifying conditions, standards, etc., following which he or she designs the appropriate training support materials that will embody those tasks.

Currently, TRADOC fulfills its mission as follows. Every school within the TRADOC is assigned proponency for related TO&E units and individual Military Occupational Specialties (MOSs) as well as additional skill identifiers. As an example, the Infantry School at Fort Benning, GA, is responsible for the TO&Es of units such as the mechanized infantry battalion, airborne battalion, and light infantry battalion. The MOSs for which it is proponent include MOS 11B, Light Weapons Infantryman, MOS11C, Heavy Weapons Infantryman, etc. These schools enter into contracts with Headquarters TRADOC to produce a number of Mission Training Plans, drill books, Programs of Instruction (POIs), Soldiers Manuals, etc. for the TO&E units and MOSs for which they are proponent. Within each proponent agency, an element is designated as the agency responsible for conducting the various processes involved in the SAT model (except for the implementation of individual and collective training conducted in units).

Labor Intensive

Historically, the TRADOC schools and integrating centers have fulfilled their responsibilities by assigning teams of individuals (generally training developers and subject matter experts) and requiring them to conduct the various SAT processes. The procedures used by these teams of individuals has been extremely labor intensive. As a first step, the team members must conduct a thorough research of pertinent organizational, doctrinal, technical and training literature. The analysis process alone requires significant manpower, since the job of analyzing units and jobs requires thorough identification of all possible candidate missions, duties and tasks, a thorough analysis of all the candidates, and the identification of those that are considered critical to mission or job accomplishment. Since this has generally been accomplished using a 'stubby pencil' method, even the act of tailoring the results of an older analysis involved many tedious hours of labor.

Skill Requirements

Not only are the procedures for the development of training materials (mission training plans, drill books, POIs, soldiers manuals, etc.) labor intensive but they require specialized knowledge, subject matter expertise, and expertise in the SAT process itself. The need for these knowledges and skills will be exacerbated by the increasing complexity of unit missions, soldiers' jobs (a result of increasing weapon system complexity), reduction in force strength, and changes in the Army's mission (due to changing geopolitical factors). These factors will overburden those training developers with limited expertise in the SAT process; in addition, there will be fewer available subject

matter experts. Thus, ASAT must have the capability to provide guidance and training in the SAT process, as well as enable the Army to make optimal use of its limited subject matter experts.

Costly in terms of time/money

A labor intensive system is inherently costly in terms of time and money. Since the complexity of unit missions and soldier jobs varies greatly, no single set of numbers can be used to describe how much time or money is involved in the creation of new publications that support these varying units and MOSs. However, individuals within TRADOC have indicated that it is not atypical for the creation of a new publication to take several years from the initial determination of need to the publication of the document and it is not unlikely that when these publications do reach the field they are frequently outdated and inaccurate.. It is thus axiomatic that the production of a single document is a costly undertaking indeed.

CAPS

It was against this background that the Army several years ago decided to investigate the feasibility of automating many of the processes involved in the design, development and production of some of the training support materials for which TRADOC schools were proponent. The project designed to make such an investigation was called CAPS — the Computerized ARTEP (Army Training and Evaluation Program) Production System. As its name implies, CAPS was originally designed to be a system that addressed only ARTEPs (the term ARTEP now is used as an umbrella term to include ARTEP Mission Training Plans, the direct descendent of the ARTEP, and drill books). The CAPS effort was let competitively, and the contractor undertook a concept study to explore the feasibility of such a system and to recommend how the system should be designed.

PRECURSOR STUDIES

CAPS Concept Study

The CAPS Concept Study ([1]) concluded that an automated system was not only feasible, but extremely desirable for a variety of reasons. The most obvious was the savings in time and money that would be realized as a result of changing from a manual, paper-based system to an automated one. Moreover, by capitalizing on the storage, cut and paste, and search capabilities that the computer provides, great savings can be realized in the various SAT processes built into an automated system.

The study also made some specific recommendations as to the system architecture. For example, it was recommended that the man-machine interface be graphics-based and menu-driven, using a combination of keyboards and mouse-pointing devices as input devices in order to make the system as user friendly as possible, especially since many of the users are generally computer naive. It was also recommended that extensive use of tutorials and help routines be built into the system in light of the fact that members of the user community were frequently not thoroughly trained in the processes involved in the systems approach to training. The concept study also made some specific recommendations pertaining to the hardware and software that the system should involve. For example,

The ASAT Study

The Army accepted the conclusions of the CAPS Concept Study and decided to develop a prototype system to be installed at one of TRADOC's proponent agencies. The name of the system was changed from CAPS to the Automated Systems Approach to Training (ASAT), a change that was made to more accurately reflect the fact that the system must embody the front-end analysis and design processes as opposed to just the "production" of the ARTEP Mission Training Plans and drill books. The ASAT project's goal was to conduct a proof-of-concept of the concept of an automated system for the production of ARTEP Mission Training Plans and drill books, as detailed in the CAPS concept study. The specific objectives of the ASAT project were to design and develop a software system, install it at a TRADOC school or integrating center, evaluate it and perform an economic analysis, and finally develop a functional specification for the operational ASAT system. The contract called for the prototype to be designed in accordance with the recommendations of the CAPS Concept Study with the exception that hardware to be utilized for the work stations would be the Zenith 248s that were already in place within the TRADOC school system; these workstations would be linked to IBM main frames at the various installations. The change in hardware suite was made for two reasons. First, Zenith 248s were selected to enable the ASAT system to be compatible with the TRADOC's Training Module (TRAMOD) system.

Secondly, Zenith 248s were already available at all of the TRADOC schools and integrating centers. Consequently, an objective of the ASAT study was to determine the feasibility of the Zenith 248 PCs as a suitable hardware alternative for the ASAT system.

The US Army Logistics Center at Fort Lee, VA, was selected as the site for the installation of the prototype system. The contract required that the ASAT system design to embody the SAT development processes for the creation of collective training products. (A subsequent modification to the contract added individual training products.) In addition to the normal documentation involved in the development, the contract also called for training of the users, a formative evaluation and economic analysis of the prototype, and the preparation of a functional description of a full-scale ASAT.

REQUIREMENTS DEFINITION

Methodology

In defining the requirements for ASAT, the design team used the approach described in DeMarco's Structured Analysis and System Specification (2). DeMarco's model calls for the functional decomposition of the current system (the one being replaced) by generating current physical data flow diagrams and logical data flow diagrams. This is followed by the development of data flow diagrams for the proposed system alternatives.

Design

The architecture for ASAT, greatly simplified, is shown in Figure 2 below. Workstations for the training developers and their supervisors are linked by means of a local area network (LAN). A data server is also connected to the LAN for storage of work in progress. The LAN in turn is linked to the installation main frame, which provides the gateway to another LAN which contains the archives of the approved collective and individual task data for which the school or center is proponent. The installation main frame also provides the gateway to main frames at remote installations. This allows the training developers at one school to access, browse and copy (but not change) the approved task data bases of other TRADOC schools for use in their own training support materials.

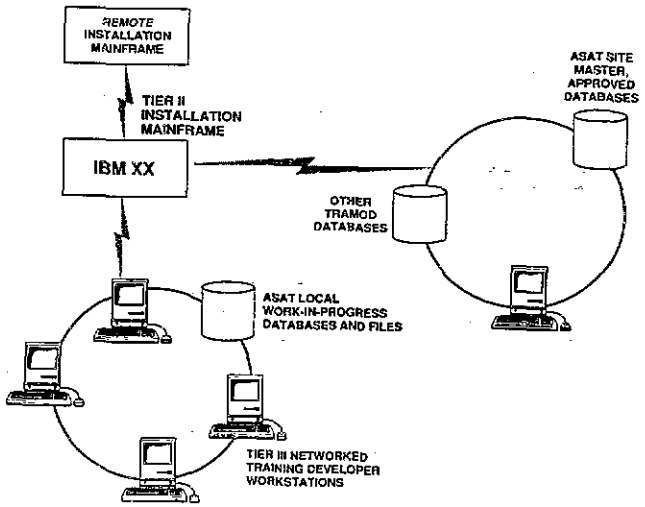

Figure 2. Simplified Architecture of the ASAT System

Figure 3 depicts how ASAT supports the generation of collective and individual training publications. Similar to the work flow shown in Figure 1, the analyst accesses the appropriate TO&E and doctrinal literature that pertains to the unit on which he/she is working. In addition, since it is germane to the development of individual training material, the analyst will also access occupational survey data from the Comprehensive Occupational Data Analysis Program (CODAP) data that are relevant. (Although not currently available in the prototype ASAT, it is envisioned that in the future the analyst will be able to call up the appropriate references on the ASAT workstation.). Through a combination of his/her analyses and the power of the computer, the production of the various training support materials becomes a far less tedious task.

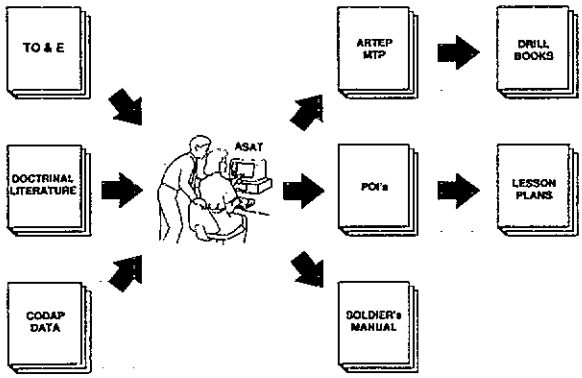

Figure 3. Inputs to and Outputs from ASAT

Hardware Constraints

In specifying the design of the ASAT prototype, the Army decided, as previously mentioned, to utilize existing Zenith 248 personal computers for the user workstations in lieu of the hardware suite recommended in the CAPS study. The Zeniths are linked together via an Ethernet LAN and to the installation IBM mainframe (at the prototype installation, Ft. Lee, this is an IBM 43xx computer). In accordance with Government specification, the use of commercial off-the-shelf (COTS) software was used to keep software development costs to a minimum. For the prototype, the COTS software selected were Microsoft Windows© (v. 2.11), Aldus PageMaker©, Paintbrush© by ZSOFT Corporation, WordPerfect Corporation's WordPerfect©, and Gupta's SQLBase© Relational Data Base Management System.

Interfaces

In accordance with the recommendations contained in the CAPS *Concept Study*, the ASAT was designed to be user-friendly. The interfaces are icon-based and menu-driven, allowing the operator to select processes and options by either pointing/clicking with the mouse or by utilizing the keyboard in the more traditional manner. According to their level of expertise and experience, operators may be required to follow the SAT process in a sequential fashion; at the option of their superiors, operators may be given the authority to move about freely within those processes.

Screens

Data entry screens were designed to provide a simplified view of the work environment of the training developer. In order to get to the data entry screens, the operator must first select the module he/she will be working on (collective, individual, or administrative), then make an appropriate selection as to what is to be accomplished, and then select the particular job to be conducted. In Figure 4, the operator has first selected the individual module and indicated individual task analysis as the specific job. He/she now clicks on the **<Conduct>** menu selection and, as shown in the figure, can choose from five menu options. Note that menu options that are not available to the operator at that particular place within the ASAT system are grayed out indicating that they cannot be accessed.

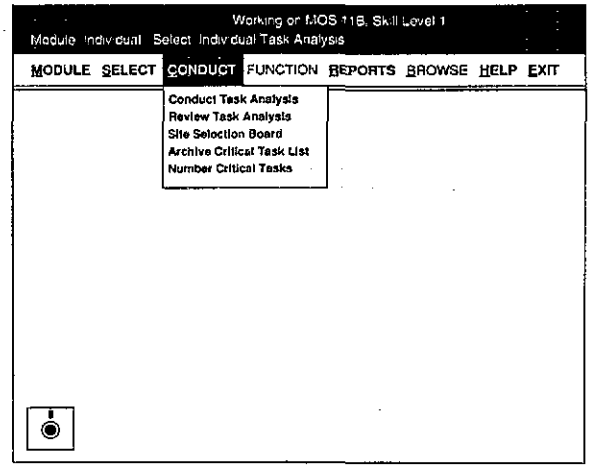

Figure 4. Sample ASAT Screen.

If the operator has elected to conduct a task analysis, he/she now has a number of options available. As shown in Figure 5, these include selection of a particular task, developing the conditions and standards, identifying hazards, required equipment, performance steps, etc.

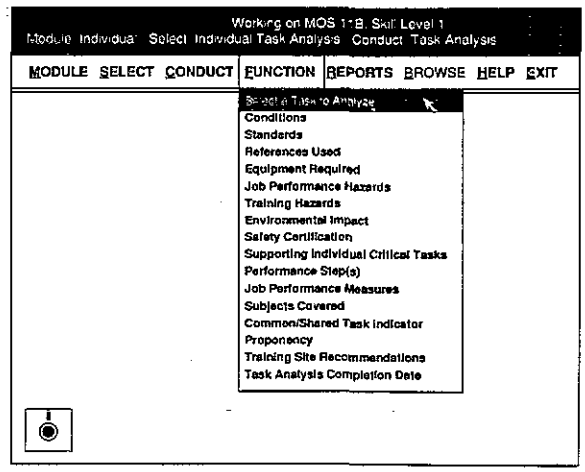

Figure 5. Individual Task Analysis Function Screen.

Input-Output

Input devices generally include the keyboard and mouse pointing devices. Future enhancements of the ASAT may incorporate electronic scanners as well in order to enter portions of supporting doctrinal literature and previous Mission Training Plans so that they may be incorporated into emerging training documents.

Output devices include screens and dot-matrix and laser printers. The laser printers are necessary to prepare camera-ready copy of material that will be printed and distributed as Department of the Army approved publications. In the future, if the Army adopts a centralized electronic publication system, the laser printer will probably be replaced by a modem allowing for electronic transmittal of an approved document to the printing facility.

Processes

For the sake of simplicity and ease of use, the number of top-level processes was kept to a bare minimum. The three selected were the System Management, Collective, and Individual Modules.

The System Management module permits the identification and assignment of individual system operators and allows for the designation of what specifically those operators are allowed to access and/or update with regard to the data bases available within the system. This translates into the designation of one or more "super-users" who are authorized to select individuals to work on specific projects and the degree to which they may change data in the data base.

The collective module is structured to allow authorized users to perform the various processes that are involved in collective training development. For example, users may be allowed to perform mission or task analysis, design various collective training programs (e.g., ARTEP Mission Training Plans and Drill Books) or develop the publications that incorporate those programs. The operators are also allowed to browse through various on-line services such as approved task lists, action verb lists, proponent agency codes, etc. It is envisaged that other on-line resources will be added in the future, allowing the operator to browse electronic copies of doctrinal and technical literature, Tables of Organization and Equipment (TO&Es) and results of task performance by units in the field.

The processes involved in the individual module are essentially the same as those in the collective module. Operators are able to perform job and individual task analyses, and design and develop programs of instruction, lesson plans, and individual training support materials such as soldier's manuals.

Storage

Each proponent agency has access to a variety of data bases. Work in process is stored in a data server on the local area network. The data contained in this data base have not been officially approved and there is considerable flexibility in changing the data. A second data base is maintained in a file server on another LAN. The task data archived in this file server have been approved by the local school commandant or integrating center commander and may not be changed except by an operator officially authorized to do so by the appropriate commander. The training developer also has access to the task data that reside at remote installations through gateways provided by the mainframe computers at his and at the remote installation. While no other school can alter those data, training analysts and developers throughout TRADOC can access the data, browse through them, and copy the data for use in their own training publications. In addition to those data bases, other data bases provide information on approved task action verbs, Battlefield Operating Systems (BOS), and reference publications.

DEVELOPMENT

Coding

Coding for ASAT was accomplished iteratively. This was due only in part to the contract modification which added individual training to ASAT. A second reason was an intentional decision to demonstrate top level features of the system, get feedback from the user community represented by the Project Advisory Group (PAG), and then modify the system before such modifications became too cumbersome and costly.

IPRs

Consequently, the project had numerous In-progress reviews (IPRs). These IPRs allowed for the demonstrations, followed by the receipt of comments from the PAG, and any additional guidance that was called for.

INSTALLATION

Incremental

Just as the software was coded iteratively, the installation of the prototype system was

accomplished incrementally. Again, this was due in part to the addition of the individual training module via the contract modification. It was also done so that early feedback could be generated in order to receive approval and/or guidance on minor changes that needed to be made, instead of more substantive, major changes.

TRAINING

Training was conducted on the system incrementally as the system was installed. The first week-long session provided an orientation to the ASAT system as well as the COTS software packages that had been incorporated into the system.

Once the collective module had been debugged and installed, a second session was conducted at the Logistics Center for those personnel who are involved in collective training support material development and production.

A third session was conducted on the individual training module for personnel at the Quartermaster School who are involved in the individual training development effort.

One relatively significant problem was encountered during the training sessions. This resulted from not having a homogeneous target population. Although the training was designed primarily with the actual users and administrators in mind, numerous observers from other schools and integrating centers throughout TRADOC also sat in on the sessions. Obviously, there concerns did not always track with the concerns of the users; thus the instructors were forced to in effect train two distinct groups of students during the same sessions. In retrospect, it would have been better to provide separate instruction to the two groups, but equipment availability and funds for additional travel did not permit this.

EVALUATION

In order to determine whether the ASAT prototype actually accomplished what was required contractually, a formative evaluation was planned and conducted. Although the small number of users trained to operate ASAT precluded very definitive results of the formative evaluation, it was concluded that the ASAT does provide the potential for significant improvements in the effectiveness of implementing an automated training development process. In other words, it proved the concept of ASAT as suggested in the original CAPS concept study.

In parallel with the formative evaluation, an economic analysis was conducted to determine if in fact ASAT provided a more efficient method for accomplishing the training support mission of TRADOC schools and integrating centers. Again, although the sample of respondents was necessarily small, sufficient data were generated to lead to the conclusion that, in fact, ASAT represents significant savings in funds and labor hours to justify the development and acquisition costs of a full-scale ASAT system.

PROBLEMS ENCOUNTERED

Hardware

As is generally typical of most studies of this type, the development of a prototype system includes some degree of risk in achieving the project's objectives on time and within budget. One such significant hardware problem encountered was associated with the use of Zeniths a a development and delivery platform. These problems did not manifest themselves until the loading of the software and database shells was complete. The Zeniths, when running the ASAT software, had a tendency to overheat and lock up. It took many man-hours of effort to trace system crashes and isolate the problem as a hardware rather than software problem. However, not all of the GFE Zenith 248s exhibited this problem. It appears that Zeniths purchased under the first buy of computers were the ones susceptible to the problems mentioned above. Although the new Zeniths purchase in the second buy did not manifest those problems, they were still too slow in running the software, suggesting that these machines, even with upgrades in memory, were being pushed to their limit. This leads us to the conclusion that although the Zeniths are adequate for running word processing, spreadsheet, and some database applications, they are not adequate to house the full-up ASAT system.

Evolving policy

One of the problems identified early on in the requirements definition effort, and indeed which continued throughout the contract period, stemmed from a lack of a uniform and stable policy concerning how the TRADOC schools are expected to accomplish their training support missions. TRADOC is currently in the process of revising training development policy and guidance with respect to the

analysis, design, development and production of collective and individual training support material. These revisions are, in part, an attempt to streamline the process and achieve much needed uniformity. However, in a project involving the development of software, it is extremely difficult to build an automated system around a set of documents that are themselves undergoing change at the same time the automated system is being designed and developed.

Variations among TRADOC proponents

Another problem encountered early on was the difficulty in identifying the requirements of the system that were common among all the TRADOC proponents and those that were unique with various schools or groups of schools (e.g., combat service support versus combat support versus combat arms). The challenge thus was to build a system that would be generic enough to be acceptable to all the TRADOC schools while providing enough flexibility so that they would be able to adapt the system to their own unique methods in implementing the Systems Approach to Training.

Expansion of effort to include individual training

Although not a problem at the outset of the effort, there was an expansion of the scope of the effort well into the contract period to include individual training and integrate it with the collective training aspects of the SAT process. From the contractor's standpoint this was not an unwelcome problem; it nevertheless meant that some of the early work had to be undone to accommodate the changes necessitated by the expansion of the effort. A corollary problem stemmed from the fact that there were different proponents for collective and individual training within TRADOC; while the initial collective version of ASAT was responsive to the needs of the collective side of the house, the individual proponents had different ideas on taxonomies, data entry screens, human-machine interfaces, etc.

THE FUTURE OF ASAT

Expansion to other proponent agencies

Based on the results of the formative evaluation and economic analysis, the Government's acceptance of the prototype system, as well as the availability of funds in an environment of significantly constrained budgets, the Army has made the decision to develop a full-scale ASAT. As the Army implements this decision to move forward, the ASAT prototype will serve as the baseline for the full-scale system which will be competitively procured. It is anticipated that the system will be developed and installed at all TRADOC integrating centers and schools with responsibilities for the development of collective and individual training materials.

The success of the full-scale system is dependent upon several considerations. The first and obviously most important consideration is the formation of consistent and uniform policy and procedures for the production of the training materials (both collective and individual). This would include the development of standard procedures for the SAT process (analysis, design and development). The real challenge will be to develop an automated system that provides a standard approach to the production of training materials and is generic enough to meet the needs of users across the different TRADOC schools and integrating centers.

Secondly, the success of the full-scale ASAT will depend on the willingness of the individual users to use all the capabilities that are built into the system. One of the disquieting observations made during the evaluation of the prototype system at Fort Lee was the tendency for users to revert to the old stubby pencil methodology, doing their analyses and designs on paper and then transferring their work to the automated system. Too often, the users commented that the data entry screens did not look like the paper forms with which they were familiar and reverted to filling out the paper forms and then transferring the information and data to the computer. This obviously negates the efficiencies of the automation aspects of ASAT and will represent an insignificant step forward.

CONCLUSION

ASAT represents the first step in the realization of the concepts originally made in CAPS. The concept has been proved with the development of the ASAT prototype. Its success as a more effective and efficient means of accomplishing TRADOC's training support mission, however, is heavily dependent upon user willingness to abandon the stubby pencil method of generating training support material and acknowledging and accepting the benefits that an automated system can provide. Success depends too on the willingness of the user