Increasing Speed and Flexibility of Feedback Systems for DIS Exercises

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The After Action Review (AAR) is an interactive discussion intended to help Army units decide what happened during an exercise, decide why it happened, and identify potential corrective actions. An AAR system may facilitate this process by providing aids that portray exercise events (ground truth) from a variety of perspectives. One of the major challenges of an AAR system is that of providing appropriate AAR aids within about ten minutes after exercises conducted in the distributed interactive simulation (DIS) environment. A second challenge is to provide the flexibility necessary to adapt the AAR aids to the results of a specific exercise. The Automated Training Analysis and Feedback System (ATAFS) was developed to help trainers prepare AAR aids as soon as possible after the end of an exercise, by, in part, the application of a knowledge database to support automatic generation of candidate AAR aids. This paper describes the AAR process, the workload of trainers, the ATAFS approach to assisting trainers, and the strengths and shortfalls of this approach.

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THE AFTER ACTION REVIEW PROCESS

The After Action Review (AAR) is the Army's approach for providing feedback to units after collective training exercises. It is an interactive process in which exercise participants discuss mission planning and execution under the guidance of a trainer (Scott, 1983). The starting point for the AAR is normally a description of the unit's plans for the mission followed by a discussion of what happened during the mission (Department of the Army, 1993). The goals of the AAR are to describe what happened during an exercise, decide why it happened, and identify potential corrective actions. The AAR in effect becomes the bridge between the completed training event and the next training event, providing post-exercise learning that will enable leaders to fix training weaknesses.

The major sources of information feeding the AAR process are displays showing what happened during an exercise (ground truth), memories of exercise participants, and displays illustrating candidate methods for improving performance. The ground truth displays must go beyond battle damage assessment (counting the number of weapon systems on each side that are damaged or destroyed) and provide data that can help diagnose the causes of gross outcomes. For example, a display showing that an armor platoon engaged an enemy force with direct fire for ten minutes before it reported enemy contact to the company commander helps to explain why a platoon was destroyed.

"Ground truth" displays are usually not sufficient to diagnose problems in unit performance. The group must draw upon the memory and knowledge of participants to gain information about situational awareness, thought processes and knowledge or understanding of tactics, techniques, and procedures to explain "ground truth" data. An important task for trainers is that of asking questions that lead a unit through the process of discovering the causes of outcomes.

Finally, displays may be required to help a unit identify potential fixes to the problems that have been diagnosed. These displays might take the form of statements from doctrinal manuals, figures illustrating tactical concepts, or descriptions of lessons learned from successful units.

THE TRAINER'S WORKLOAD

Trainers are overwhelmed with the duties they must perform to control exercises and prepare training feedback. They must review and understand the unit's concept of maneuver and fires, and they must review the Mission Training Plan (MTP) standards for the tasks the player unit will execute during the battle. Trainers must monitor the performance of the unit and collect and analyze information during the battle to assess which tasks were accomplished to standard and which tasks require additional training. The trainer may have control functions to accomplish as well, such as simulating an adjacent unit, playing the role of the higher headquarters, and constraining the activities of opposing forces (OPFOR) to provide the player unit an opportunity to accomplish its training objectives for the exercise. The Army employs a Take Home Package (THP) covering a series of exercises to reinforce and supplement the feedback provided in AARs, and at least part of the work in preparing THP is accomplished at the same time that a trainer is involved in an individual exercise.

During and after the battle trainers must identify the player unit's actions that had a major impact on the outcome of battle and decide which medium or combination of media to use in portraying the actions. Upon exercise termination, trainers must complete preparation of AAR training aids, arrange the aids in a logical sequence and, conduct a brief rehearsal prior to orchestrating player discussions during the AAR. The challenge that faces the trainer is how to present displays and ask questions that will lead a unit through the process of discovering what happened, why it happened, and potential corrective actions.

THE DIS ENVIRONMENT

The distributed interactive simulation (DIS) exercise environment, in which combat vehicle simulators are networked, presents certain unique benefits and challenges concerning the AAR process. The initial application of DIS, simulation networking (SIMNET), was developed by the Defense Advanced Research Projects Agency (DARPA) and included simulators for armor and mechanized infantry vehicles (Thorpe, 1988). Information produced by each simulator, such as its location on the terrain database and target location of each firing engagement, is

broadcast over a network and picked up by other simulators. Using broadcast data and data from a common terrain database, computer graphics generators with each simulator construct realtime "out the window" pictures of the battlefield for each gunsight and vision port in each vehicle simulator. DIS provides automated data on firing events and location with much greater precision than is practical to implement on instrumented ranges. Unlike instrumented ranges, DIS also provides automated data on such variables as fuel levels, ammunition levels, weapon system orientation, trigger pulling time, and engine speed throughout an exercise.

This electronic battlefield facilitates the AAR process by providing a data stream that can be used to create data displays showing ground truth, but it also has features that detract from the AAR process. Unlike the instrumented range environment where units have logistical and maintenance tasks to perform after an exercise while the trainer prepares to conduct an AAR, making efficient use of the time of soldiers requires initiating an AAR within a few minutes after soldiers step out of their simulators.

HISTORY OF AAR SYSTEMS

SIMNET was developed without an AAR system (Alluisi, 1991), but the capability to replay exercise data from a two dimensional plan view or three dimensional out-the-window view was soon added. Unfortunately, there was no capability to prepare graphs and data tables, and the number of independent exercises conducted at one time often exceeded the number of systems available to host exercise replays.

The Unit Performance Assessment System (UPAS) was an early attempt to provide a more complete AAR system inexpensive enough to support wide distribution (Meliza and Tan , 1991). The UPAS loaded data into a relational database to support preparation of data summary graphs and tables. The system also included the capability to provide a moment by moment replay of movement and firing events from a plan view, static plan view shots showing the positions and orientations of entities and line-of-sight data, traces of the movement of individual vehicles over time, a plan view aggregating shot lines and artillery impacts over time, and a timeline of movement, shooting, and communication events.

Researchers made substantial progress in identifying data display applications that could be used to analyze what happened during an exercise (Shlechter, Bessemer, Rowatt, and Nesselroade, 1994), but they also discovered three critical problems in applying

the UPAS to support AARs (Meliza, Bessemer, and Tan, 1994). First, the time required to prepare displays using the UPAS greatly exceeds the ten to twenty minutes available to trainers before starting the AAR, because AAR preparation could not begin until after the UPAS had completed data collection. Second, the UPAS did not help the user to select data displays and decide how to use these displays in guiding unit discussions. Third, the UPAS could not collect radio communications data synchronized with visual displays of exercise events. Another important lesson learned was that providing the user with the flexibility to adapt the system to specific training situations is crucial in ensuring utilization.

The Army's efforts to prepare for the future under the Warfighter XXI campaign includes a component concerned with the development of a Standard Army AAR System (STAARS). One of the important goals of STAARS is to define a three-tiered system that can meet the needs of a wide variety of users (National Simulation Center, 1996). Tier 1 would be for users wanting or needing specific AAR aids and discussion questions handed off to them. Tier 2 would be for trainers wanting menus of AAR aids from which they could select those appropriate for a specific exercise. Tier 3 would meet the needs of trainers wanting to design and create their own AAR aids.

THE ATAFS APPROACH

The Automated Training Analysis and Feedback System (ATAFS) was produced in the context of a Small Business Innovation Research (SBIR) effort. The Phase I SBIR produced the concept for an AAR system designed to help trainers prepare AAR aids quickly. The ATAFS concept included two methods for helping trainers to prepare AAR aids in a timely fashion. The first method involved giving trainers the capability to manually create AAR aids during and/or after exercises. Implementing this capability required the system to allow trainers to move back in exercise history and create displays while the system continues to collect exercise data. The second method involved using a knowledge database to guide the preparation of AAR aids automatically. An ATAFS Phase II SBIR project funded by the Simulation, Training and Instrumentation Command (STRICOM) demonstrated the capability to support automated AAR aid preparation and the capability to allow trainers to manually create AAR aids during exercises. The project then progressed through a Phase III project funded by the DARPA Simulation in Training for Advanced Readiness (SIMITAR) program involving complete system production, testing, and refinement in a mix of training

environments. This effort included supporting simulators that use the DIS protocol standards through the use of a DIS to SIMNET translator. The remainder of this paper provides a description of how the ATAFS works, focusing on speed and flexibility issues.

A key goal of the ATAFS was to provide a bin of automatically and manually created AAR aids at the end of an exercise. The top section of the bin contains all of the aids produced during an exercise, while the bottom part contains the aids selected and edited by the user for display during the AAR (see Figure 1). Aids moved to the bottom bin can be edited and sequenced for presentation during the AAR. The aids in the lower bin can also be transferred to VCR tape and given to units as an electronic THP.

The ATAFS employs the same variety of displays included in the UPAS. The ATAFS plan view and fire fight displays provide an improvement over the UPAS versions by including the synchronized replay of tactical radio communications.
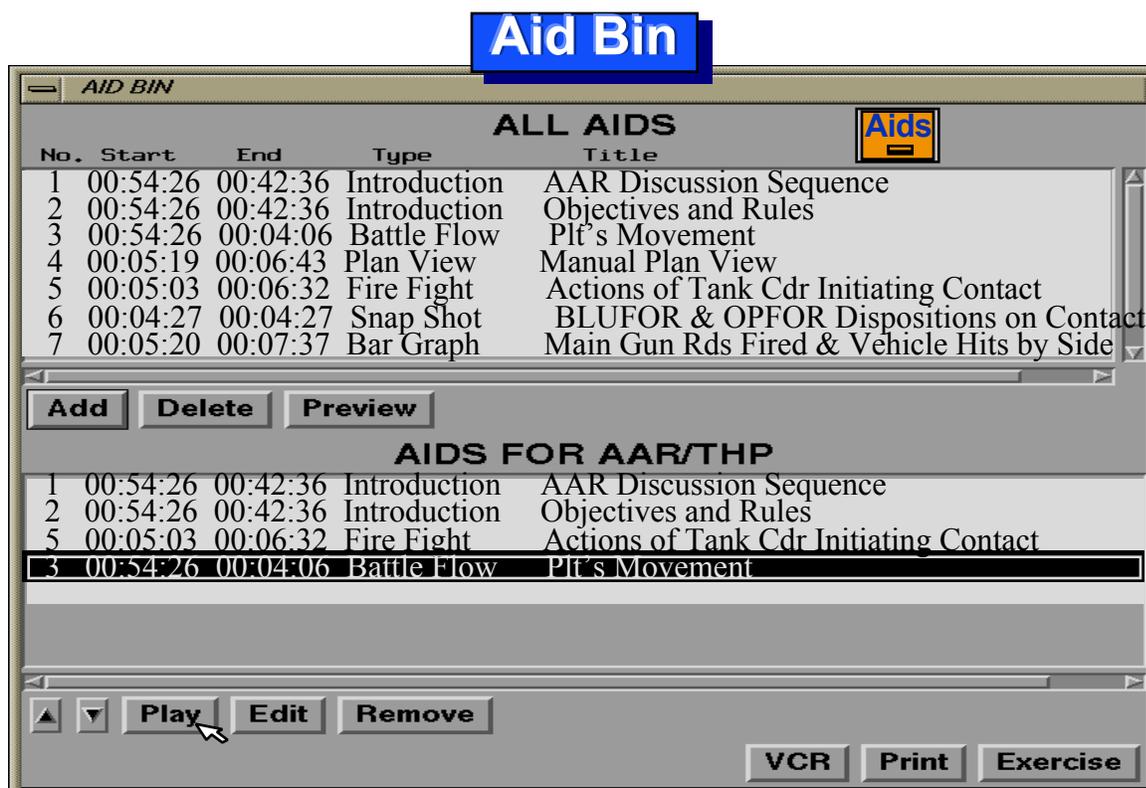

Figure 1. ATAFS AAR aid bin.

Figure 2 is an example of an automatically generated AAR aid. Each aid contains a title that describes the general topic to be addressed by the aid, identifies the tactical events defining the beginning and end of the time period addressed by the aid, and reports the beginning and end times (expressed as elapsed time). Each aid also contains a list of questions that can be used to guide discussions centering on the display. A manually produced aid would have the same format, but no title, no discussion questions, and no description of the tactical events that define the period covered unless these items are added by the trainer.

A trainer can edit one of these aids by changing the title, the discussion questions, the description of the tactical events, and/or the beginning and end times. The capability to change time is made possible by the fact that the ATAFS created definitions of aids rather than creating aids pre se. One of the benefits of this approach is that it allows a trainer to expand the time period covered by an aid if critical radio communications are cut off.

Automating the preparation of AAR aids involved identifying the type of aids that could be used to apply specific unit performance standards from the Mission Training Plan for Armor Platoons, identifying the tactical events that define the period of time to be covered by each aid, and developing a set of questions that a trainer can use to draw out

information during interactive discussions. The knowledge database that guides the automatic generation of AAR aids includes a specification of the type of aid to be produced, a description of the tactical events at the beginning and end of the period covered by the aid, discussion points tied to the beginning or end points, and the rules to be used by the system in deciding when tactical events have occurred.

Fire Fight AAR Aid

Actions on Initial Contact

Start Time: 00:05:45 Battle Drill Ordered

End Time: 00:06:40 Spot Report to Co/Tm Cdr

00:06:40

1st Plt, Co A, 3-70 AR
18 Nov 94
Exercise 012
Movement to Contact

Engaged and destroyed two T-72s.

Keys Points for AAR Discussion

What battle drill was ordered?

What did the plt ldr report to the Co/Tm Co?

Was the report complete and accurate?

Stop   Pause   FWD   Hyper (+)

Prev Aid   Aid Bin   Edit   Next Aid

LD
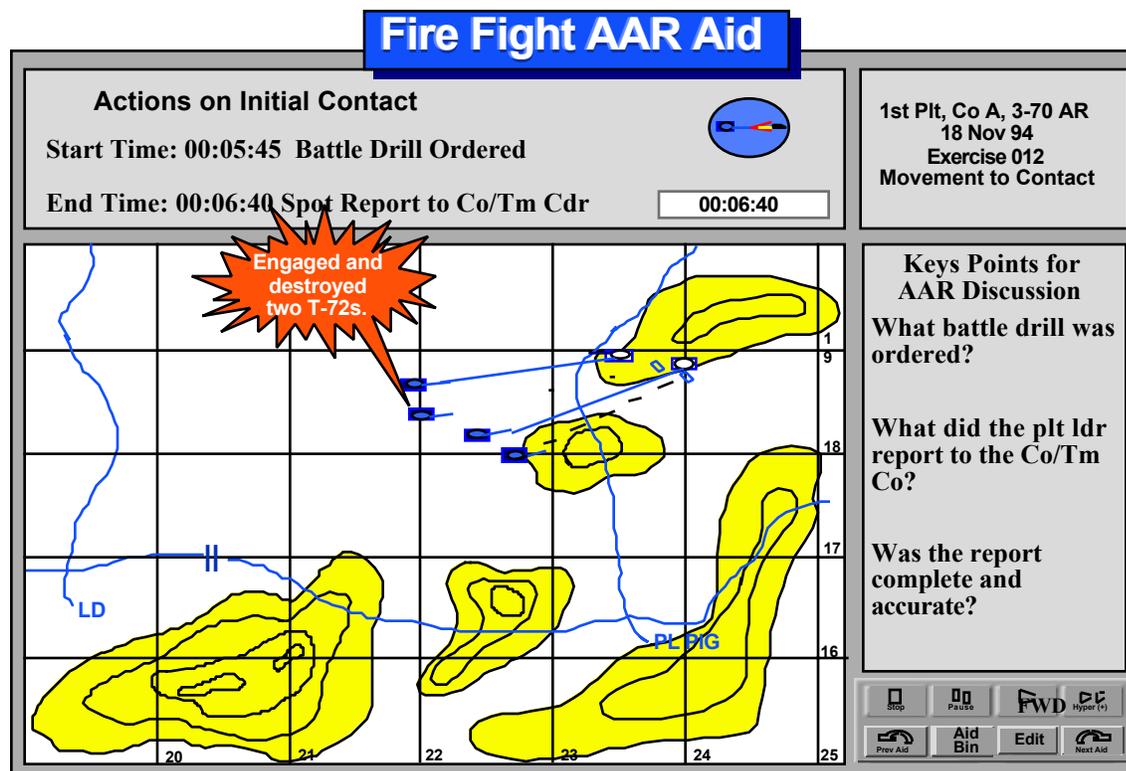
PL DIG

20   21   22   23   24   25

Figure 2. Example of an ATAFS AAR aid.

A tactical event may signal the end of the period covered by one or more aids, and it may signal the beginning of the period covered by one or more aids. For example, making contact with the enemy may end a Battle Flow and start a Plan View and a table showing when each vehicle first fired.

Rules for deciding when an event has occurred are of two types. First, certain rules can be applied through software analysis of the network data stream (deciding when a unit first fires). Second, the trainer can observe an event and convey this information by responding to screen prompts. To reduce the workload of the trainer, events that can be addressed by data stream analysis are measured by the system. Events that are better assessed by a subject matter expert (e.g., deciding a unit has issued a contact report) are left to these experts. As the Army moves towards digitized command and control systems to disseminate information within a unit, then more events can be assessed by software.

The ATAFS knowledge database is sensitive to the fact that operational definitions for deciding when a tactical event occurs may differ among exercises. For example, the tactical event of interest may be establishing contact with the enemy. Contact may first be made evident by a contact report, the delivery of friendly fire, the receipt of enemy direct fire, or the receipt of enemy indirect fire. These variations influence the operational definitions used to decide when contact is initiated, and they also influence the discussion questions to be asked. The ATAFS reflects this variability by, for example, using a rule that states whichever events occurs first determines when contact was established. ATAFS also reflects

variability by linking discussion questions with the events that trigger the beginning of period separate from the events that trigger the end of the aid so that the discussion questions shown on an AAR aid depend upon what happens during an exercise.

The screen with which a trainer interacts during exercises to prepare manual and automatic aids is shown in Figure 3. The right side of the screen shows prompts for events the trainer reports by using a mouse to highlight the item and clicking on the OK button at the bottom of the screen.
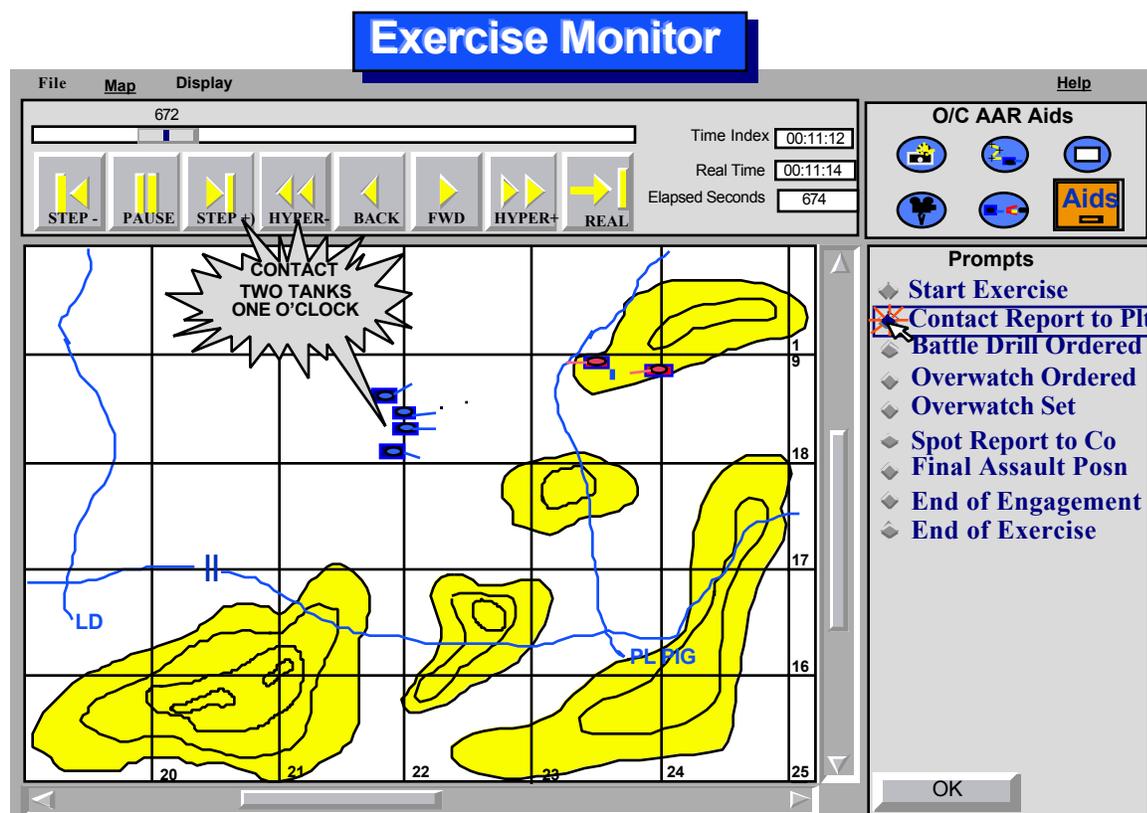

Figure 3. ATAFS exercise monitor screen.

The videocassette recorder-like controls at the top of the map display allow trainers to move around in exercise history as the system continues to collect exercise data. Trainers can pause the replay, move backwards at normal or twice real time speeds, move forward in one second increments, move back in one second increments, move forward at normal and two times normal speeds, and snap back to real time. The icons in the top right portion of the screen allow trainers to create aids manually by selecting the icon for a particular type of display to identify the start time and by selecting it again to identify the end time.

Based upon lessons learned from other AAR systems, we knew it was critical to give non-programmers the capability to change the knowledge data guiding the production of AAR aids, including the capability to add more collective tasks. We also found that the

Army's move toward libraries of structured scenarios at specific sites made it critical to give non-programmers the capability to modify automated AAR aid production to fit specific sets of scenarios. The ATAFS effort was expanded to include the development of an ATAFS Authoring Tool (ATAFS-AT) to meet these needs.

Figure 4 illustrates the operation of the ATAFS-AT currently under development. First, the user decides what to display on the aid. Next, the user begins to interact with ATAFS-AT by selecting and ordering a sequence of icons that identify the type of aid to be created, the methods to be used to trigger the beginning and ending of aid production (unit crossing of a line, unit entering or leaving an area, trainer response to prompts, firing events, and casualty events). In the example below, the operator wants a plan view to begin when a platoon crosses its Line of Departure (LD) and end when contact is

reported over the platoon net. The first event is to be identified by the ATAFS and the second through a trainer's response to a prompt.

After the operator has provided the information in Figure 4, he/she will be asked to provide additional information through the selection of menu items. For example, when the operator selects the line crossing trigger, the system will want to know the line type, whether the event is to be measured when the first vehicle crosses, the center of mass crosses, or the last vehicle crosses.
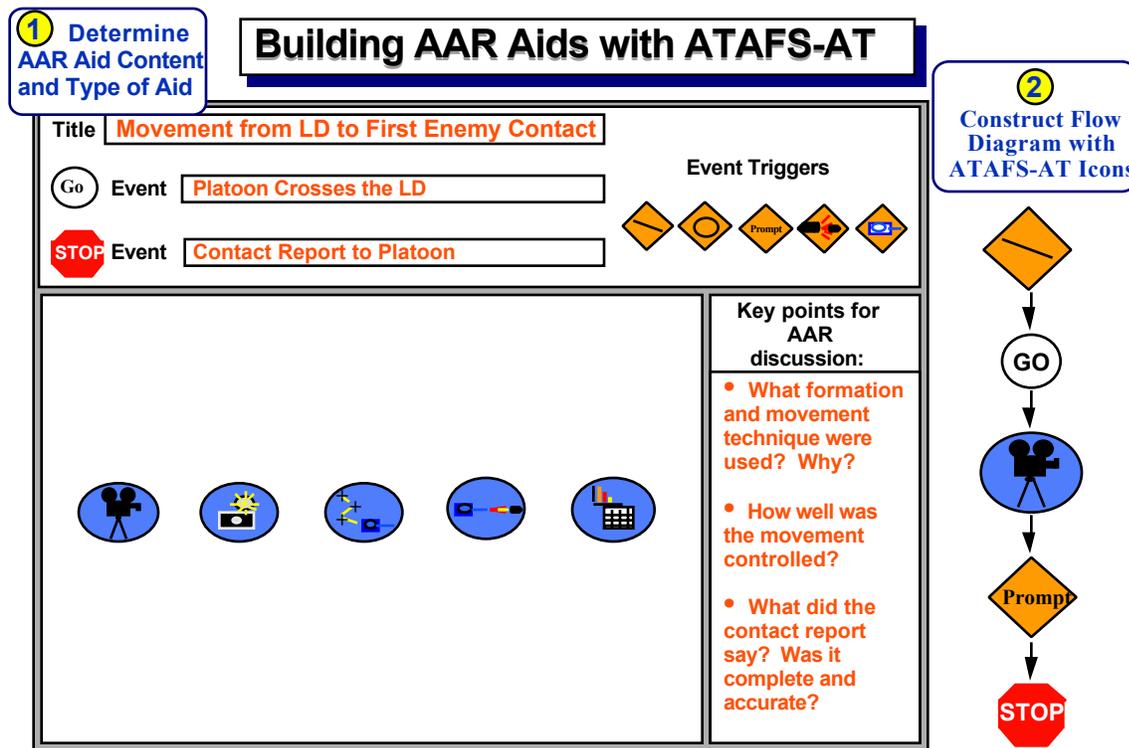

Figure 4. Using the ATAFS Authoring Tool (ATAFS-AT) to create automated AAR aids.

SPEED AND FLEXIBILITY ASSESSMENTS

The ATAFS has been installed at five Army National Guard (ARNG) training sites differing widely in terms of training resources and training management philosophies.   User feedback has resulted in important lessons learned about how well the ATAFS meets speed and flexibility requirements.

The ATAFS can insure that candidate AAR aids are available to support AARs as soon as an exercise ends, but the trainer is still faced with the need to decide which of the candidates to use. In most cases, a trainer might want to use five aids at most for an AAR, while ATAFS will generate fifteen to twenty aids. There is an obvious need to help trainers select among the candidate aids, or step back and create a system that makes greater use of artificial intelligence to provide fewer AAR aids for a specific exercise.

The ATAFS aids are currently limited to those describing "ground truth."   If a trainer wants to display a diagram from a "How to Fight" manual, he/she must display this diagram separate from the ATAFS displays (e.g., by using an overhead projector). This deficiency tends to create awkward situations where the trainer must move from one display system to another,   reducing the overall efficiency of the AAR.   Giving the trainer the capability to insert "how to" type data displays or select from libraries of such displays, would improve the efficiency of the AAR process. A greater gain in efficiency would be possible, if the system could select "how to" type displays that were appropriate to the outcome of a specific exercise.

The ATAFS-AT concept supports the ability of non-programmers to implement and modify the automatic preparation of AAR aids, but there are limits in terms of the flexibility of ATAFS-AT.   The limitations of

the ATAFS-AT are due to the availability of utilities to analyze the network data stream. For example, in moving from platoon to company level, there is not a utility written for deciding when the center of mass of a company passes a control measure. Further, there are types of trigger events not addressed by existing triggers, such as assessing when line-of-sight between enemy and friendly entities is established and then broken. Finally, the ATAFS-AT is limited by the fact that it addresses ground truth displays only.

The ATAFS system also lacks flexibility in terms of data summary tables and graph. To add new data summary tables and graphs, or to modify existing tables and graphs, users require the aid of programmers.

CONCLUSIONS

The ATAFS system supports the STAARS Tier 2 concept by providing a menu of AAR aids at the end of an exercise. It also supports the Tier 3 concept by enabling users to create their own aids; however, ATAFS would support the Tier 3 concept more effectively by giving users the capability to create their own data summary tables and graphs. The fact that the ATAFS does not provide a means for trainers to display "how to fight" displays is a weakness in terms of its ability to support Tier 2 and 3 concepts.

Due to a combination of speed and flexibility issues, the ATAFS approach is not yet able to support the STAARS Tier 1 concept of providing a turn-key AAR. The number of aids used by a trainer is much smaller than the number automatically generated. This means that inexperienced trainers are left with the substantial task of deciding which of the candidate AAR aids to employ. Further, the system does not link "how to fight" displays with "ground truth" displays, leaving busy and often inexperienced trainers with the task of selecting and integrating the "how to fight" displays.

An additional flexibility concern relative to Tier 1 applications concerns the tools available to the Army for use in automating the AAR process. The concept for the ATAFS-AT has been well received in terms of its simplicity and potential ease of use, but more thought must be given about the most efficient way to expand the network data analysis utilities to address the needs of higher echelons and a greater variety of unit types. Further, the ATAFS-AT concept does not address the integration of "how to fight" displays.

REFERENCES

Alluisi, E. A. (1991). The development of technology for collective training: SIMNET, a case history. Human Factors, 33(3), 343-362.

Department of the Army (1993). A Leader's Guide to After Action Reviews. TC 25-20. Author: Washington, D.C.

Meliza, L.L., Bessemer, D.W., & Tan, S.C.(1994). Unit Performance Assessment System (UPAS) Development (ARI Technical Report 1008). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Meliza, L.L. & Tan, S.C. (1991). Application of the SIMNET Unit Performance Assessment System to After Action Reviews. Proceedings of the 13th Interservice/Industry Training Systems Conference. 136-144, December.

National Simulation Center (1996). Operational Requirements Document for a Standard Army After Action Review System (STAARS).

Scott, T. D. (1983). Tactical engagement simulation after action review guidebook (ARI Research Product 83-13). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A143 014)

Shlechter, T.M., Bessemer, D.W., Rowatt, W.C., & Nesselroade Jr, K.P. (1994). Evaluating the unit performance assessment system's after action review displays. (ARI Technical Report 997). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.