Research Product 2008-02

After Action Review Tools for Dismounted Soldier Systems

Paul N. Blankenbeckler
Richard L. Wampler
Michael D. Dlubac
Northrop Grumman Corporation

Jean L. Dyer
U.S. Army Research Institute

June 2008

ARI-Fort Benning Research Unit

U.S. Army Research Institute
for the Behavioral and Social Sciences

U. S. Army Research Institute
for the Behavioral and Social Sciences

A Directorate of the Department of the Army
Deputy Chief of Staff, G1

Authorized and approved for distribution:

Barbara A. Black

BARBARA A. BLACK, Ph.D.
Research Program Manager
Training and Leader Development

Michelle Sams

MICHELLE SAMS, PhD.
Director

Technical review by

Donald R. Lampton, U.S. Army Research Institute
Robert Pleban U.S. Army Research Institute

NOTICES

DISTRIBUTION: Primary distribution of this Research Product has been made by ARI. Please address correspondence concerning distribution of reports to: U.S. Army Research Institute for the Behavioral and Social Sciences, Attn: DAPE-ARI-ZXM, 2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926.

FINAL DISPOSITION: This Research Product may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this Research Product are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

REPORT DOCUMENTATION PAGE

<table>
<tr><td colspan="3">1. REPORT DATE (dd-mm-yy)
June 2008</td><td colspan="2">2. REPORT TYPE
Final</td><td>3. DATES COVERED (from. . . to)
February 2007 to February 2008</td></tr>
<tr><td colspan="5" rowspan="2">4. TITLE AND SUBTITLE

After Action Review Tools for Dismounted Soldier Systems</td><td>5a. CONTRACT OR GRANT NUMBER
W74V8H-04-D-0045 (DO#16)</td></tr>
<tr><td>5b. PROGRAM ELEMENT NUMBER
622785</td></tr>
<tr><td colspan="5" rowspan="3">6. AUTHOR(S)

Paul N. Blankenbeckler, Richard L. Wampler, and Michael D. Dlubac (Northrop Grumman Corporation);and Jean L. Dyer (U.S. Army Research Institute)</td><td>5c. PROJECT NUMBER
A790</td></tr>
<tr><td>5d. TASK NUMBER
326</td></tr>
<tr><td>5e. WORK UNIT NUMBER</td></tr>
<tr><td colspan="5">7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Northrop Grumman Corp
3565 Macon Road
Columbus, GA 31907

U.S. Army Research Institute for the Behavioral and Social Sciences
ARI-Ft Benning Research Unit
PO Box 52086
Fort Benning, GA 31995-2086</td><td>8. PERFORMING ORGANIZATION REPORT NUMBER</td></tr>
<tr><td colspan="5" rowspan="2">9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U. S. Army Research Institute for the Behavioral & Social Sciences
ATTN: DAPE-ARI-IJ
2511 Jefferson Davis Highway
Arlington, VA 22202-3926</td><td>10. MONITOR ACRONYM
ARI</td></tr>
<tr><td>11. MONITOR REPORT NUMBER
Research Product 2008-02</td></tr>
<tr><td colspan="6">12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.</td></tr>
<tr><td colspan="6">13. SUPPLEMENTARY NOTES

Contracting Officer's Representative; Jean L. Dyer
Subject Matter POC: Paul Blankenbeckler</td></tr>
<tr><td colspan="6">14. ABSTRACT (Maximum 200 words): This research examined tools and capabilities required to implement an embedded training (ET) after action review (AAR) support system in future dismounted Soldier systems to enhance the training of squads and platoons (small combat units). Dismounted Soldier systems are being designed and developed to increase battle command, situational awareness and understanding, and provide embedded training for the small unit. The context of the research was tools to assist the leader/trainer in conducting small-unit AARs. The effort examined projected system design requirements; AAR systems and capabilities employed at combat training centers and in virtual simulations; and AAR concepts and solutions explored during the Future Force Warrior Advanced Technology Demonstration. The analytic findings provide concepts for interactive system controls integrated into menus to facilitate the AAR process. The findings also provide tools to facilitate the integration of realistic firing engagements and casualty play during training. A suite of flexible tools was recommended which addresses the AAR ET requirement for the Ground Soldier System.</td></tr>
<tr><td colspan="6">15. SUBJECT TERMS
After Action Review   AAR   Embedded Training   Digital AAR   Training Assessment
Training Feedback   Small Unit Evaluation   Ground Soldier System   Land Warrior   Future Force Warrior</td></tr>
<tr><td colspan="3">SECURITY CLASSIFICATION OF</td><td rowspan="2">19. LIMITATION OF ABSTRACT

Unlimited</td><td rowspan="2">20. NUMBER OF PAGES</td><td rowspan="2">21. RESPONSIBLE PERSON

Ellen Kinzer, Technical Publication Specialist
703-602-8047</td></tr>
<tr><td>16. REPORT
Unclassified</td><td>17. ABSTRACT
Unclassified</td><td>18. THIS PAGE
Unclassified</td></tr>
</table>

Research Product 2008-02

After Action Review Tools for Dismounted Soldier Systems

Paul N. Blankenbeckler
Richard L. Wampler
Michael D. Dlubac
Northrop Grumman Corporation

Jean L. Dyer
U.S. Army Research Institute

ARI-Fort Benning Research Unit
Scott E. Graham, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926

June 2008

Army Project Number
622785A790

Personnel Performance
and Training Technology

ACKNOWLEDGEMENT

The authors wish to express their appreciation to Mr. Gary Hall and Mr. Dale Thomas, General Dynamics Corporation, who provided information and insights into the capabilities of S2 Focus™ and other emerging technologies. We also thank the various personnel who participated in the training efforts for the Future Force Warrior (FFW) Advanced Technology Demonstration (ADT) who offered their ideas on conducting after action reviews.

AFTER ACTION REVIEW TOOLS FOR DISMOUNTED SOLDIER SYSTEMS

EXECUTIVE SUMMARY

Research Requirement:

The after action review (AAR) is a "Socratic" discussion facilitated by a leader or trainer to elicit feedback from unit personnel concerning what transpired during an event with a focus on determining how future events could benefit from sustaining or improving unit actions. Units in the U.S. Army employ the AAR process to improve Soldier, leader, and unit proficiency. The AAR facilitator frequently uses supporting aids such as maps, charts, and videos to focus the discussion. Identifying some common AAR tools that can be integrated into user interfaces in dismounted Soldier systems and linked to other training capabilities and data storage devices could benefit the conduct of an AAR for small combat units. These tools would also help address the embedded training (ET) requirement for the Ground Soldier System.

Procedure:

A front-end analysis of embedded AAR functions appropriate for small-unit leaders and trainers equipped with dismounted Soldier systems was conducted. Background information and Army projects on dismounted Soldier systems that related to embedding AAR training capabilities were reviewed. Specifically, the Army's training and doctrine literature on AARs and the AAR aids developed for Soldier simulations were examined. Also reviewed were Army development efforts with the Land Warrior (LW) and Future Force Warrior (FFW) dismounted Soldier systems, with emphasis on the AAR accomplishments during the FFW Advanced Technology Demonstration (ATD) from 2004 to 2007. Prior conceptual work on AAR tools for the LW system was examined. The major themes, findings, and approaches emerging from this front-end analysis, plus experience with the LW and FFW systems, were integrated and used to develop concepts for embedded AAR tools on future dismounted Soldier systems. A suite of graphic user interfaces was developed that would enable trainers to quickly generate AAR tools and information appropriate for feedback to small units in training and operational environments.

Findings:

The products generated from the front-end analysis were concepts for an embedded software system consisting of a series of basic interactive menus that would be displayed on a trainer's dismounted Soldier system. The menus address the necessary controls and functions for conducting an AAR with units equipped with these systems. The menus permit the small-unit trainer to organize unit member information and create a file for the training event, specify data to be captured, create alarms to enhance observation, tag events, review data, and support viewing or replay of information during the AAR. Two additional controls provide the capability to manage firing engagement systems and casualty data to enhance training realism. The requirement for a graphics tool to assist in the preparation of AAR aids was identified. The end result was a logical series of tools that will permit the trainer to assist the unit in determining what was supposed to happen during the event, to identify strengths and weaknesses by

determining what happened, both the good and bad, and to assist in determining why it happened and how to improve.

Utilization and Dissemination of Findings:

The findings and proposed concepts for embedded AAR capabilities can help guide the design and development of future dismounted Soldier systems that have a requirement for embedded training, such as the Ground Soldier System. In particular, the AAR tools are appropriate for small-unit leaders and trainers. The concepts and associated displays presented in the report can be used by Army training organizations to create tools that could be made available to support AARs at the installations, major training facilities, and in support of unit operations. The AAR concepts were briefed to the TRADOC Capabilities Manager-Soldier in March 2008.

AFTER ACTION REVIEW TOOLS FOR DISMOUNTED SOLDIER SYSTEMS

CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

Page

LIST OF FIGURES

After Action Review Tools for Dismounted Soldier Systems

Introduction

After action reviews (AARs) are a primary means trainers and leaders use to improve Soldier, leader, and unit proficiency. An AAR is "a professional discussion of an event, focused on performance standards, that enables Soldiers to discover for themselves what happened, why it happened, and how to sustain strengths and improve on weaknesses" (Department of the Army [DA], 1993a, Chapter 1, p. 1). In AARs the trainer will often use some aids, such as a map of the terrain with associated graphics. These aids help identify what happened and stimulate discussion of why events happened, and what should be changed as well as sustained in the future.

The AAR is not a critique of Soldier/unit performance, nor does an AAR grade success or failure. Instead it can be characterized as a "Socratic" discussion. The trainer is central to facilitating a candid discussion process and to eliciting full participation of the unit in reflecting on the training event. Supporting AAR aids can be used effectively, not at all, or ineffectively. However, as stated in Field Manual (FM) 7-1 (Battle Focused Training) (DA, 2003), a training aid should be used only if it makes the AAR better.

With the advent of training simulations and simulators, various automated AAR tools that facilitate the collection of AAR-related information and that generate AAR aids have been developed to assist the trainer. Morrison and Meliza (1999) described several phases of AAR development. Tactical engagement simulation systems (TESS) filled a previous void in force-on-force training. Use of TESS provided credible engagement results enabling a more accurate and credible form of objective feedback. This objective feedback helped foster the development and implementation of new methods that rapidly became recognizable as the AAR in use today. The advent of computer networked simulations provided data that could be automatically captured and used this information in an AAR. The primary training simulations/simulators that used these automated AAR tools were armor/mechanized, mounted force simulations, specifically Simulation Network (SIMNET) and the Close Combat Tactical Trainer (CCTT). More recently, work on AAR aids and tools that support dismounted Soldier simulations have emerged (Campbell, Knerr & Lampton, 2004; Gately, Watts, Jaxtheimer & Pleban, 2002; Knerr, Lampton, Martin, Washburn, & Cope, 2002). The computer capabilities associated with these training simulators/simulations make automated AAR tools possible. These tools were designed to help trainers, not to replace the central and critical role of the trainer in the AAR dialogue and discussion with Soldiers.

Throughout this report, the phrase "AAR tools" is intended as an overarching phrase to include a variety of items and information that contribute to the AAR process. These include such items as user interfaces in software systems, links to other training capabilities and data storage devices, display capabilities on the digital systems, as well as sample displays and recommended attributes of displays that could be used while conducting an AAR. Additionally, throughout the report the term "trainer" will be used. Trainers include unit leaders, observer/controllers (OCs), and facilitators who direct training events and lead AARs.

The AAR tools presented in this report differ in some important ways from those typically used in live-training and those that support computer simulations. The report is on embedded AAR tools for live-training that support future dismounted Soldier systems which incorporate body worn computers. As such it is important to recognize that the AAR ideas presented here are not suggested enhancements to the tools used with computer training simulations. The tools developed for this report focus on system interface designs that facilitate the collection and recording of information relevant to small-unit AARs. Some ways of displaying this information are also presented, but are not the primary focus.

Embedded AAR tools do not alter the purpose of AARs, but the context in which they are generated and the required supporting technologies do differ. With operational systems, the critical questions in identifying and developing AAR tools center on:

- What information is available on or passing through the Soldier systems?
- What available information is potentially useful to the trainer and unit and should be saved for an AAR?
- What trainer-friendly techniques are available or can be developed for identifying and saving this information during a training exercise?
- What are the best modes of presenting this information so it is easily understood and usable in AARs?

The AAR concepts and features described in this report are based on the following:

- The Army's training and doctrine literature on AARs
- AAR aids developed for Soldier simulations
- Dismounted Soldier Systems
  - Land Warrior (LW) system which has been fielded to a deployed Stryker Battalion (2006-2008)
  - Future Force Warrior (FFW) system developed during the FFW Advanced Technology Demonstration (ATD) (2004 to 2007) by the U.S. Army Natick Soldier Research, Development, and Engineering Center (NSRDEC) (http://nsrdec.natick.army.mil/wsit/index.htm)
- Capability Development Document (CDD) for the future Ground Soldier System (GSS) (TRADOC, 2006).
- Earlier conceptual work on embedded AAR tools for the LW system (Dyer, Wampler & Blankenbeckler, 2005)
- Embedded training technical memo developed during the FFW ATD (Hall et al., 2005)
- Technology developments that occurred during the FFW ATD, specifically the S2 Focus™ system developed by General Dynamics (General Dynamics C4 Systems, Battle Management Systems Division, 2007)

The AAR tools and concepts here could be considered during system development of the GSS. All concepts presented are technically achievable as they are based on existing technologies and demonstrated concepts.

The LW program, which started in 1993 with a Mission Need Statement, The Mission Needs Statement for the 21st Century Land Warrior System (DA, 1993b), was the Army's initial program to field a warfighting system for Soldiers that enhanced lethality, command and control, survivability, mobility, and sustainability in support of individual, dismounted Infantry Soldiers Both the FFW system and the GSS have roots in the operational requirements that were established for the LW system. Core operational components in both systems are wearable computers, local area networks, and global positioning systems. The FFW ATD was the Army's science and technology program designed to mature and transition technologies to the GSS. The GSS CDD (TRADOC, 2006) specifies embedded training as a key performance parameter, although embedded AAR aids are additional performance attributes.

There are at least two potential sources that can provide AAR aids for future Soldier dismounted systems. One is the Soldier's computer capability itself. The second is an embedded software infrastructure, management tool, and architecture. For example, S2 Focus™, developed by General Dynamics Corporation, demonstrated the ability to capture, sort, and store digital information from the Soldier's personal area network (PAN) and the unit's local area network (LAN). Both sources could be harnessed to provide similar capabilities in the GSS.

The Introduction of this report provides a historical perspective on AARs, as well as efforts specifically related to dismounted Soldier systems. The subsections of the Introduction are ordered chronologically from the past to the present time. The Results section presents AAR concepts that emerged from these prior efforts as well as from the authors' personal experiences with the LW and FFW dismounted Soldier systems and their experience as military trainers and leaders who frequently facilitated and participated in small-unit AARs.

AAR Origins – von Steuben's Training Legacy

The AAR is derived from the evolution of the U.S. Army's training culture. The seeds of this unique training culture were cultivated in adversity. Historians still argue about why the Army did not disintegrate that winter of 1777 to 1778. Even Washington feared that it would. Hunger and disease were common; disillusionment, death, illness, and desertion thinned the ranks. Fortunately, the spring of 1778 brought change. In February, the weather turned from brutal to merely miserable. In March, the revived Commissary Department began to improve both the quantity and quality of food supplies. However, the greatest change came in April with the arrival of Friedrich Wilhelm von Steuben. Von Steuben, a former captain with experience on the Prussian General Staff, began to train Soldiers. This training sparked the transformation of a band of threadbare rebel patriots into a disciplined, seasoned Army, capable of standing toe-to-toe against His Majesty's finest.

Figure 1. Baron von Steuben drilling troops at Valley Forge by Edwin A. Abbey.

These American Soldiers were unlike any that von Steuben had previously encountered. The ragtag troops of this new Army, this Continental Army, did not respond with fear and mindless obedience to his orders. These men were ornery, bold, with a strong streak of independence and individualism. They snickered at his tirade of profanity in mixed German, French, and broken English at their mistakes and missteps. Perhaps out of frustration, he adopted methods unlike those previously experienced by these Soldiers. The Prussian Drill Master found that they responded to his personal involvement, explanations, demonstrations, and examples, but there was more. Unlike the European troops that he had previously encountered, these men had a vested interest in their success. These American Soldiers wanted to know "why" and asked for explanations. A quote frequently attributed to the old Inspector General is, "The genius of the nation is not in the least to be compared with that of the Prussians, Austrians, or French. You say to your Soldiers, 'Do this' and he doeth it; but I am obliged to say 'This is the reason why you ought to do that,' and then he does it." (Gaines, 2007).

This enlightened approach to training departed from European traditions. Von Steuben streamlined commands, standardized drills, and simplified movements. He developed, implemented, and documented standards for skills and tactics and adopted progressive training to introduce, develop, and attain, then maintain standards. He developed a professional cadre of trainers and a training model that began with the School of the Soldier and progressed through the School of the Regiment.

The Soldiers responded with reasoned obedience to these techniques and methods. Progressive training developed their skills and their understanding of required performance and standards. When Soldiers understood the standard, the reason for the order or technique, or their errors, they not only improved, they began to perform superbly and with confidence. Discipline and pride grew quickly from their confidence. History tells how, in short order, this change was evident with their orderly retreat from Barren Hill in May and in June along the Monmouth Road; troops rallied and held against determined British assaults in the sweltering heat (Historic Valley Forge Web site, 2007).

While the U.S. Army was not born at Valley Forge, it began to become of age there in that spring of 1778. The seeds of many of the concepts that became the culture, the unique culture of the American Army, were sown on the training grounds in the valleys of Pennsylvania. While refinement, formalization, and institutionalization of concepts like the AAR process are relatively new, von Steuben's style of training - demonstrations, examples, corrections, and, above all, explanations - are the foundations for training methods and AAR concepts in use today. Some things do not change. The American Soldier still does his best when he knows the expected standard of performance, understands the reason behind the technique, tactic, or procedure (TTP), and is afforded the opportunity to improve his skills through coaching and realistic practice.

Out of this distinctive heritage has emerged an inimitable and vital element of unit training, the AAR. FM 7-1, *Battle Focused Training* (DA, 2003), credits the AAR as the training tool that makes the U.S. Army unique to all other armies of the world. Few other armies of the world open themselves to such potentially brutal internal scrutiny. Admitting mistakes, taking responsibility for actions, and determining ways to improve unit performance, are traditions from the days of von Steuben at Valley Forge. Few armies permit junior subordinates and private Soldiers to comment on, help determine progress toward, or chart the pathway to improvement of collective skills. This effective standards-based, mission-focused training feedback parallels and supports performance counseling and mentoring, the cornerstones of U.S. Army leader development. Additionally, the AAR contributes to the assessment of unit proficiency and to the formulation of unit training plans to improve and sustain skills. When properly conducted, AARs support both individual and professional development of all participants. The AAR makes Soldiers better warriors and leaders, and it directly contributes to building cohesion and esprit-de-corps in units.

The AAR Process as it Evolved to Support Live Training

The AAR - A Concept Refined to an Art Form

In von Steuben's day, trainers relied heavily on their personal observations, the observations and comments of officers and noncommissioned officers (NCOs), and questions or comments from the Soldiers involved to determine "what happened." These observations and comments, first-hand accounts, identified correct or incorrect performance of individuals or units. While observations and comments remain a staple for input to the AAR today, technology has drastically changed and is able to dramatically enhance training feedback. Today, the U.S. Army has evolved a wide-ranging training doctrine, refined an extensive training management system, and poured millions of dollars into training aids, devices, simulators and simulations (TADSS). However, the Army retains and heavily relies on the proven value of realistic, integrated live environment training. The crown jewels of this effort are the combat training centers (CTCs). Two noted examples of the CTCs are the National Training Center (NTC) at Fort Irwin, CA and the Joint Readiness Training Center (JRTC) at Fort Polk, LA. CTCs are equipped with extensive electronic instrumentation and data collection systems. Supporting staffs, networks of expert OCs, instrumentation, sophisticated camera networks, and automated analytical systems support information collection on training unit activities and actions. The dedicated training staff, a professional opposing force (OPFOR), role players, unique facilities, and training areas, immerse the unit in realistic, demanding, live environment training exercises. Detailed operations orders (OPORDs) require units to execute complex tactical missions and tasks. After missions, events, or at varied phases of a unit's training experience, the CTC training staff facilitates extensive AARs supported by sophisticated audio and visual display and playback capabilities (Herold, Sanzotta & Everitt, 2000).

At the CTCs, determining the details of events and actions taken (what happened) are enhanced with the aid of data collection systems and multimedia simulations and displays. Displays, electronic maps, and terrain models can show the precise movements of elements, vehicles, and can be focused on the actions of small units and an individual Soldier. Video and still pictures capture key events, entities, and individuals from varied angles and views. Sound recordings from radio nets, tactical operations centers, briefings, or oral orders and guidance are captured for review and replay. Resources and weapon systems, the full assets of the combined arms team, are fully integrated into scenarios or realistically simulated. Data are collected on ammunition expenditures, engagements, shooter-victim pairings, and the handling and treatment of simulated casualties. The full spectrum of unit operations is minutely examined: fire support operations, logistic operations, maintenance and recovery, employment of supporting units and resources are all placed under the microscope to determine what happened at all echelons. Practically every occurrence on the battlefield can be captured with fidelity and not only replayed, but with the assistance of an extensive professional training staff, events are dissected for detailed examination. Soldiers and leaders can see and hear what happened both at their locations and across the battlefield. Related and unrelated incidents occurring at different locations, sometimes simultaneously, are captured, replayed, and examined by all players and parties. Members of the OPFOR and neutral role players are available to present their actual and intended actions, discuss their impressions of situations, and respond to the questions from the training unit.

CTCs have elevated the formal AAR to an art form. While these multimedia presentations are useful in revealing and qualifying factual information, the act of compiling volumes of data, analyzing it, and crafting segments of it into sophisticated presentations should not be confused with the AAR process.

The AAR – Feedback to Promote Understanding

To the casual observer the replay of battlefield actions, the refined focus on specific events, and emphasis on finding faults, mistakes, or outstanding performance can easily be taken as the central theme for an AAR. However, as explained in the Introduction, the AAR is not a playback or a critique. To be effective it should be a Socratic discussion (DA, 2003). The AAR should be an open discussion of the events that transpired. It should examine the performance of individuals and the unit as a whole, which enables Soldiers to discover what happened and how it happened. The discussion should also address how to sustain strengths and improve on weaknesses. Leaders and units can use the process to get maximum benefit from every mission or task. If conducted properly, the AAR can provide candid insights into Soldier, leader, and unit strengths and weakness from various perspectives and give participants the feedback and insights critical to planning and conducting battle-focused training.

U.S. Army Field Manual (FM) 7-1 (DA, 2003), *Battle Focused Training*, states that the directed nature and climate of a critique - focusing only on what is wrong - prevents candid discussion of training events, stifles learning, and inhibits team building. It is the involvement of participants, the discussions and exchanges during the course of the AAR that permit Soldiers and leaders to actively discover and understand what happened and why. As participants, these Soldiers and leaders remember and learn far more than they would from a critique alone. It follows that training aids (displays, graphics, maps, etc.) which assist in the discussion, which serve to remind participants of facts and data surrounding key events, and which highlight the involvement from different perspectives can add to the success of the AAR. To be effective, however, these aids should directly support discussion and understanding of the training event and promote learning. A variety of considerations (displays, group size, availability of electrical power, etc.) must be included when selecting AAR aids. But while planning for, resourcing, and coordinating AAR aids are key, the bottom line is that a training aid should <u>only</u> be used if it makes the AAR better.

AARs fall into two types: formal and informal. Both types generally follow the same structure and format:

- Introduction and rules
- Review of training objectives (normally omitted for operational missions)
- Commander's (leader's) mission and intent (**what was supposed to happen**)
- OPFOR leader/commander mission and intent (when appropriate)
- Relevant doctrine, tasks and drills, and tactics, techniques, and procedures (TTP)
- Summary of recent events (**what happened – both the good and bad**)
- Discussion of key issues (**why it happened and how to improve**)
- Discussion of optional issues
- Discussion of force protection issues (discussed throughout), and
- Closing comments (summary).

A key difference between formal and informal AARs is the preparation time available to gather training aids and the length of time available to actually conduct the AAR. The formal AAR process, supported by instrumentation (when available), a staff of OCs, and potentially drawing together leaders (and/or Soldiers) from across the battle space requires time-consuming preparation. The events may take place over a wide geographic area. Planning, preparation, and execution of the mission may be spread over several hours or days. Combined arms coordination, a routine aspect of most operations, increases complexity of observation, data collection, and preparation. Formal AARs require not only extensive preparation but may last for two hours or more. For example, AAR preparation at the fully instrumented CTC for a battalion mission may require in excess of 24 to 36 hours of data review, analysis, and compilation by a dedicated staff. OCs may spend hours reviewing and selecting materials. Presentations are rehearsed and may involve several technicians, complex cueing, and the integration of multiple sources and databases. The CTC AAR may require a theater-like facility or room equipped with extensive audio-visual support systems. The presentation is often limited to key leaders, their staffs, and selected members of the unit.

Formal AARs for companies, battalions, and brigades at home station may be less elaborate. However, they normally require some audio-visual system support, a large classroom or tent, and screens, briefing maps, or charts to permit attendees to see data, graphics, and diagrams. Formal AARs are normally reserved for company or higher echelons.

Informal AARs are most commonly used by echelons at company level and below. At company level, these sessions normally consist of leaders and selected individuals, but at platoon and squad level, all Soldiers are frequently involved. These informal sessions are normally facilitated by unit leaders or OCs. While OCs at CTCs are a specific group of Soldiers assigned for that function. During home station training, OCs may be from a sister unit or from within the training unit. Unit leaders may serve simultaneously as the element leader, OC, and AAR facilitator. For example, some rifle squad training events may have another rifle squad leader (SL), weapons squad leader, platoon sergeant (PSG), or the platoon leader (PL) as the OC. However, most will find the small unit leader (squad leader or platoon leader) serving as the element leader, OC, and review facilitator. The informal AAR is normally conducted directly after a mission or tactical vignette or during a brief pause in training. While this provides immediate feedback to Soldiers, leaders, and units, there is very little or no time for extensive preparation. Ideas, recommendations, and solutions gathered during the AAR may immediately be integrated into training or the operation as it continues. An AAR may be an aspect of preparation for the next mission or phase of the operation. While the format will follow the structure previously indicated, the informal AAR process is often abbreviated to focus only on three of the ten elements cited:

- Evaluation of the performance of the unit against the Army task standard (**what was supposed to happen**)
- Identification of strengths and weaknesses (**what happened – both the good and bad**), and
- Determination of how to improve or sustain performance when training continues (**why it happened and how to improve**).

Trainers normally use informal AARs for on-the-spot coaching. AAR training aids may be elaborate or be nonexistent. Trainers may use sophisticated terrain mock ups (when available), simple terrain models (a clear spot, pinecones, and sticks), a chalk board or sketch pad, or the unit may conduct the AAR while walking or overlooking the terrain covered during the training event.

AAR Aids with Training Simulations

The technologies supporting simulations and virtual training environments have resulted in a wide variety of AAR aids and support systems (Knerr, Lampton, Crowell et al., 2002; Knerr, Lampton, Martin, et al., 2002; Knerr et al., 2003). Virtual environments are much like fish bowls. Their isolated electronic environment makes them accessible from multiple angles. Training and experimental support systems provide the capability to view into, capture, analyze, and playback data generated within the operating system and network support the virtual environment. An example of these systems is the Dismounted Infantry Virtual After Action

Review System (DIVAARS) as reported by Knerr and his colleagues. During an exercise, DIVAARS provides the trainer the ability to enhance his observation by:

- Flying about, zooming in, and zooming out from varied perspectives in a (non-interference) stealth mode.
- Looking through walls, floors, or roofs into rooms, buildings, and subterranean chambers (sewers, drainage systems, caves, etc.).
- Viewing actions from a detached third-person perspective.
- Viewing actions from the perspective of a "live" entity (training force, neutral, or OPFOR).
- Viewing actions from the perspective of a programmed semi-automated force (SAF) entity (friendly force, neutral, OPFOR, or robotic system).
- Listening to audio exchanges.

As an exercise progresses, DIVAARS records data for later review and replay. Far from merely recording data, the system permits tagging and marking of events and times for reference, review, and later replay. The system records, in real time, movements and routes for each entity; tracks shooter-victim pairings, indirect fires and weapons effects; records communication network usage; and monitors the consumption of munitions, fuel, and other expendables. The capabilities of DIVAARS provide for an expeditious review and identification of materials for rapid access during the AAR. During the AAR the system can present training aids and support materials that can enhance discussions and add clarity to situations. For example DIVAARS can provide:

- Real time, slow motion, stop-action or speed up replay of events and allow the participants to view the action from varied views and perspectives.
- Still images that can be viewed from the varied perspectives player entities (OPFOR, friendly, or neutral) or locations.
- Highlighted routes or enhanced "snail trails" that depict, by varied sizes, the movement, brief pauses, or dwell time of entities at locations.
- Replay of audio exchanges and depictions of radio usage by time, net, and player.
- Charts and timelines depicting unit strengths, ammunition expenditures, engagements, victim-shooter pairings, wounds, and treatment times for both the friendly force and the OPFOR.

The closed, artificial nature of the virtual environment permits the capture of details by systems like DIVAARS and close examination of all training events. But this artificial, electronic, virtual environment provides opportunities for collection of information not available in the real world. Standard topographic products provide fair but inexact models of the terrain in an area of operations. The terrain model of the closed virtual environment seldom replicates minute details - each tree and limb, rock, bush, and minor terrain irregularities. Logs, a minor depression, or section of thick undergrowth in the actual terrain may provide an undetectable, protected position for a sniper or a support by fire element. Stealth or first person perspective views in the virtual environment are not attainable in the real world. However, virtual environment AAR systems have provided some insight into the potential of exploiting and using data from the small unit networks and processors associated with a dismounted Soldier System.

Dismounted Soldier Systems

The Army has successfully fielded digital command, control, communications, computer, and intelligence (C^4I) systems for mounted forces and command centers. With technology decreasing weight requirements and improving capacities for electrical power storage, the Army is preparing to field C^4I systems for the dismounted units. Dismounted Soldier systems with C^4I capabilities make embedded AAR aids possible. Global positioning systems (GPS) increase the potential value of AAR aids. In addition, some of the inherent computer software features, such as graphics, orders, and messages can be used for both operational and training purposes. An overview of the LW and FFW systems is given to provide the necessary background for the embedded AAR concepts presented in the Results section.

The Land Warrior (LW) system, as a forerunner to the GSS, has been issued, on a limited basis, to one Stryker Brigade Combat Team (SBCT) and has successfully supported combat operations in Iraq. Major features include a wearable computer whose graphic interfaces and displays are shown via a helmet mounted display. Other major components include global positioning system, radio, and integrated weapon subsystem with integrated laser range finder and daylight video sight. Individual Soldier systems are interconnected via a local area network. Software capabilities include accessing digitized and satellite maps, sending and receiving combat messages with associated e-mail features (addressees), graphics (overlays and other simplified graphics), orders, capability to store images, and situation awareness (SA) features that allow Soldiers to see themselves and other members of the unit.

The FFW Increment 2 System developed for the final phase of the ATD conducted in FY07 had two Soldier systems: a basic system using a personal digital assistant (PDA) and a leader system employing a larger computer processor. Common to both were a processor, power source, Soldier wave form radio, display, and GPS capabilities. However, leader systems had a more powerful computer with increased processing and storage capacity, higher resolution head or goggle mounted displays, and more accurate GPS or precision navigation systems. The S2 Focus™ software suite described later could only be run on a leader computer.

In the later part of this decade, the GSS is projected to be introduced to the force. The more advanced GSS will be a system of systems, integrating and leveraging multiple technologies to provide overmatching operational capabilities to ground combat Soldiers and small units (squads and platoons). These capabilities will include increased battle command (BC), situational awareness and situational understanding (SA/SU), and embedded training (ET), as well as, enhance lethality, survivability/force protection, mobility, and sustainability. As with the LW and FFW, central components will be a wearable computer/processor, an embedded global positioning system, and a wearable radio terminal networking voice and data communications within units.

The Capability Development Document (CDD) (TRADOC, 2006) for GSS specifies ET as a Key Performance Parameter (KPP) for GSS. Under "Additional Performance Attributes", the CDD lists the AAR as a form of ET and specifies that the threshold GSS will, "Monitor, record, assess and playback training exercise and actual operations" (p. 16). A more complete statement of this requirement was also provided in the CDD:

ET: After Action Review (AAR). The GSS must contain an after action review (AAR) system to support individual and collective training. The AAR system will provide a means to monitor, record, assess and playback training exercise and actual operational events. The system must allow the trainer to flag events as they occur to facilitate locating specific events during playback. The system must be able to execute an operational pause during an exercise for the purpose of conducting an intermediate AAR. The system must be able to show effects of leadership decisions made during planning and execution. All AAR assessment and performance data must be recorded in an embedded learning management system. The same AAR system must capture lessons learned from actual combat operations. (p. 47).

In addition to the ET KPP, other capabilities and characteristics of the GSS CDD design specifications support the integration of an AAR support system. While the integrated display, voice radio, navigation and location system, data communication's capability, and computer all contribute to enhanced awareness and survival, they provide features that facilitate capture of information for an AAR. These features are illustrated in Figure 2, which shows a conceptual diagram of a FFW system.

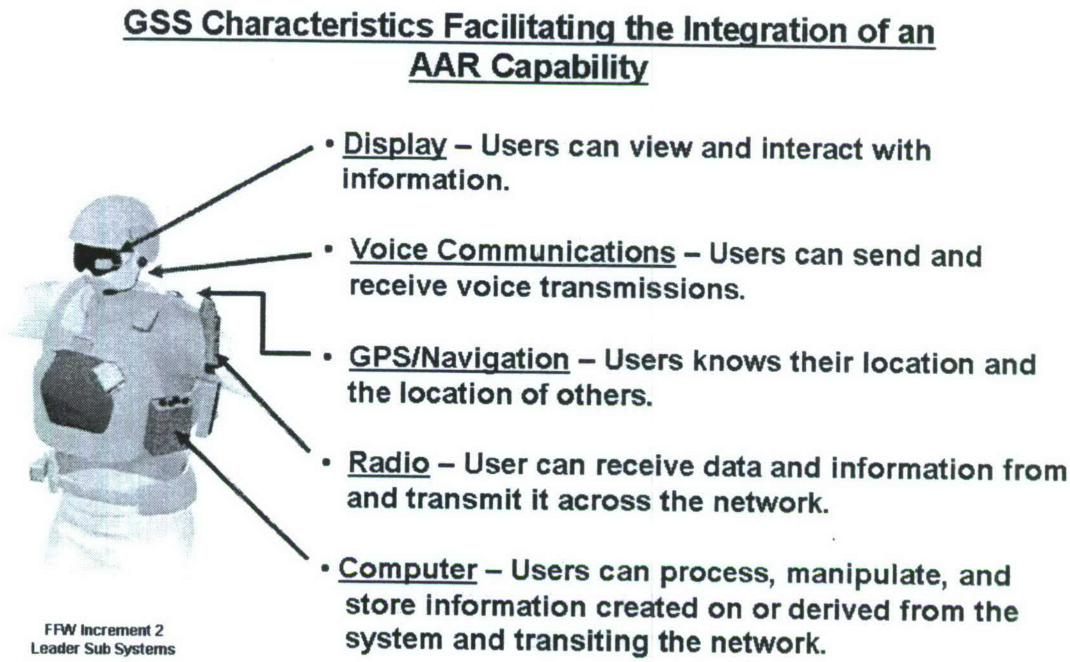


Figure 2. GSS characteristics facilitating the integration of an AAR capability.

Integrating an AAR system places a demand on subsystem capabilities and must be considered in their design (Hall et al., 2005). For example, the processing capability of the computer must include the capacity to capture system events and messages (e.g., orders, position updates, and overlays), consolidate data from varied sources, and drive display of the information and data. The computer/processor must provide memory and storage capacities for these captured events, data and messages. The software must provide a capability to identify and/or tag events during a training exercise and control the capture and replay of information to conduct AAR. Additionally, the software should provide for TESS integration, specifically the need for the data storage of target pairing and engagement resolutions.

Evolving Role of the Trainer as an Information Collector with ET AAR Tools

Clarifying Trainer Uses

The LW system was examined in the Joint Contingency Force Advanced Warfighting Experiment (JCF AWE) conducted in 2000 at the Joint Readiness Training Center (JRTC). The OCs who observed the LW platoon in that experiment were interviewed (Dyer et al., 2005) to gain their insights into how such a system could facilitate small-unit (squad/platoon) AARs. The OCs (n = 10) were also asked what they stressed in AARs, as the assumption was that AAR aids should reflect factors OCs view as important. Lastly, the OCs reacted to possible AAR graphic aids that might be generated from using LW capabilities.

The OCs were experienced small-unit leaders, as well as being veterans of unit CTC training rotations. They rank ordered six major topics of information they addressed in small-unit AARs. From high to low in importance this order was: communications (including planning), move, preparation, shoot, force protection, and fratricide. The topics of move and preparation were tied in this ranking.

With each topic, the OCs indicated which subtopics they usually addressed in a small-unit AAR. Table 1 summarizes this information, listing only the subtopics cited by at least 80% of the OCs Fratricide was not cited by at least 80%, but the OCs indicated that whenever fratricide occurred it was addressed in the AAR.

Table 1
Frequent Topics in JRTC Small-Unit AARs

Topic/Subtopic	% OCs Addressing Subtopic	Topic/Subtopic	% OCs Addressing Subtopic
1. Communications		3. Preparation for Operations	
Planning	100%	Precombat Inspections	100%
Synchronization	100%	Rehearse	100%
Coordination	100%	Maintain	100%
Information passing	90%	4. Shooting	
2. Movement		Enemy casualties	100%
Location of individuals, vehicles, units	100%	Friendly casualties	100%
Dispersion	100%	Weapon status	100%
Routes	80%	Sensors/Optics	100%
5. Force Protection			
Planned fires	100%		
Location of obstacles	80%		

Dyer et al. noted that operational capabilities within the LW and similar systems could be used to assist the OCs. The operational planning tools such as orders and graphics overlaid on maps best illustrate this point. AAR participants with dismounted systems could share such stored information without the need to create special embedded AAR tools.

The OCs indicated that some AAR data at JRTC were obtained through electronic sensing, photography, voice recording, and other data collection systems controlled and compiled at JRTC's Tactical Analysis Facility (TAF), but their preference for traditional observation methods was readily apparent. Most OCs indicated the value of video images (stills and movies). There was general agreement that images and video captured during engagements, obstacle breaching operations, and military operations in urban terrain were of value during the AARs. However, discussions indicated that their preferred and most reliable source of information was their own observations and the observations of other OCs.

It is doubtful that the value of the information listed in Table 1 during a small-unit AAR will change. These topics and subtopics are apt to remain constant for the future. The use of GSS capabilities and tools may impact aspects of these topics and subtopics but will not replace them.

Trainer Limitations

Dyer et al. (2005) also examined the new opportunities for the LW or GSS-equipped trainer to observe and monitor battlefield information during a training mission. They determined that the OCs or leaders using a LW-type system could monitor many actions and movements, in real-time, unconstrained by their location on the battlefield. The OCs could visually compare actual maneuvers, actions, and fires to the plan, and see the plan unfold and modify as leaders and units adapt to the situation. These individuals, assuming they are an addressee in the network, could read messages, receive overlays and orders. Additionally, they could monitor communications over voice radio networks.

With all of these potential added capabilities, there were also limitations. With the LW system or other systems that have a head-mounted or goggle-mounted display, the OC or leader is unable to directly observe how others use the system computer. The only indication of system use may be output such as digital or voice messages and the appearance of new or changed icons or symbols on the SA display. When observing others, it is difficult if not impossible to determine if Soldiers are looking at an overlay on the map, preparing to send a message, monitoring their leader's movements, reading a message or an order, checking battery status, participating in a cooperative engagement, or creating a call for fire. An external observer has no means of distinguishing among these different activities and could easily overlook or not be in position to observe any of them. Additionally, it is difficult to determine the impact that improved SA and information may have on a Soldier's or leader's decisions, individual actions, or initiative. It would also be difficult to determine if the lack of checking a digital system, misinterpretation of information, or poor use of the system capabilities contributed to bad judgment or a wrong action.

These limitations point to a need to be able to embed software that allows the recording and collection/integration of data from individual Soldier systems during the execution of a mission as well as allow a trainer to "tag" critical events. However, any tagging system should be fast and simple (Dyer et al., 2005) as discussed below.

Identifying What May be Important – Tagging Events

The value of event tagging has already been proven in AAR systems supporting virtual simulation environments as indicated by Knerr, Lampton, Crowell et al. (2002) and Knerr et al. (2003). Dyer, et al. (2005) concluded that to be of value in live training exercises, the tagging process had to be executed quickly. Tagging should not interfere with the trainer's ability to observe training and should only be a minor and short term diversion from system operation. For training events when the element (platoon and squad) leader is also the principal trainer, the leader cannot be distracted from primary leadership and C^2 responsibilities. Tagging must be simple and direct with minimal disruption and must contribute to organizing the data. For instance, pity the leader who begins the AAR preparation with a series of 25 time marks trying to recall the event or action that caused him to mark event number 16 at 12:07 hours.

While dedicated OCs are not as engaged in command and control (C^2), supervision, or mission execution decisions, their primary mission and focus is to observe. When not directly involved in observing an event, they are focused on moving toward and looking and listening for cues for the next critical event. Dyer et al. (2005) suggested that while tagging must be simple, some reference other than time is recommended. Categorized reference tags would serve to avoid this problem by:

- Assisting in rapid review, assessment, and assembly of information for the AAR
- Facilitating rapid display to the facilitator or group
- Providing a reminder to the trainer, should time lapse between the training event and the AAR.

Dyer et al. (2005) suggested that trainer's tags or markings for most operations could fall into seven general categories:

- Casualty(ies)/Fratricide
- Contact
- Action
- Reaction
- External Assets
- Change
- Tempo

This research also noted that the training observer (OC or leader) seldom perceives the need to capture information until after the event and that prediction of a coming event is seldom exact. Their observations and experience indicate that the time window identified by the tag should permit access of data transiting the network 90-seconds before the mark and for 90-seconds after the mark. This 3-minute window of time provides the OC or multitasked leader with the ability to access a manageable span of information for review and potential presentation or integration into an AAR.

Technology Approaches to AAR Aids in the FFW ATD

Technical Concepts

As indicated previously, specifications and requirements for the GSS include an AAR support capability. The FFW ATD was the Army's Science and Technology program designed to transition technologies to the GSS. This effort included focusing on exploration of those aspects of the GSS CDD that outlined the specifications for all aspects of ET. The FFW ATD included efforts to determine both the realm of possibilities for ET based on the current and projected state-of-the-art technologies, as well as realistic exploration of the means to address the CDD requirements.

The FFW ATD program directed examination of technologies to accomplish the requirements of the GSS CDD through technical memorandums and work products. The Embedded Training Technical Memo, Work Product #24, (Hall et al., 2005) examined the overall ET interoperatibility, interface issues, and integration of external Army training programs into the FFW Program. The FFW Training Team assisted this technical engineer effort providing information to outline requirements and provide a context for the design and implementation of all aspects of ET, specifically AAR tools that could be employed by a FFW-equipped small unit (platoon and squad). The Technical Memo focused on the technologies with sufficient maturity for integration into the FFW ATD. The review concluded that five types of ET demonstrated the requisite level of maturity for integration into the FFW ATD effort.

- Embedded Tactical Engagement Simulation System (TESS) capability.
- Course of Action (COA) analysis and mission planning/rehearsal leader training using OneSAF (One Semi-Automated Force), the Army's new constructive simulation.
- Embedded skill exercises with performance feedback for sustaining and practicing critical skills and tasks.
- Information and performance aids (memory joggers) and check lists.
- AAR aids on the FFW system for collective field exercises.

Additionally, the Technical Memo summarized system ET AAR requirements intended for the FFW ATD. The requirements outlined for an AAR aid system were:

- Computer processing capability to capture system events and messages (e.g., orders, position updates, overlays).
- System memory storage for captured events and messages. External events and messages can be captured on leader systems if necessary for a squad or fire team to reduce the processing and memory requirements for the individual Soldier system. Internal events (e.g., Soldier position relative to other Soldiers at various times during the operation for visual display during the AAR dialogue) that would normally not be transmitted during an operational event may need to be captured by each Soldier system.

- Ability in system software for leaders to control the capture and replay of information to conduct AARs and debriefs.
- Ability in system software for the leader to inject and tag events during a training exercise to better conduct AARs and debriefs.

The ET Technical Memo investigated both technology and employment applications. It determined that the FFW small combat unit would require the ability to provide AAR capabilities for both operational activities as well as training activities. These capabilities would need to support just the small combat unit (at home station for example) and support the larger AAR activities for company and above level exercises at the CTCs or when deployed. These capabilities would include the ability to capture and replay operational activities (such as sending position reports, orders, and overlays). The system should also have the ability for leaders to flag key events and messages during an exercise or operation for later review.

This Technical Memo assumed that an individual in the platoon headquarters (platoon leader and/or platoon sergeant) equipped with a computer designated to support the data collection requirements for an AAR. The primary purpose of the computer would be for C^2 and mission planning/mission rehearsal functions. However, processing and storage capability could be assumed to supplement or complement some ET functions including AAR support. Additionally, the document identified requirements for TESS integration with the AAR subsystem, specifically the need for the data storage of target pairing and engagements.

Technological Approaches - S2 Focus™

In order to leverage the capabilities of a dismounted Soldier system and support ET tools, additional software capabilities were required. Such software capabilities were developed by General Dynamics as part of its S2 Focus™ software.

To explore addressing the CDD requirements and to implement the findings of the Technical Memo, the FFW Program directed the development of an AAR support system that would complement the FFW system. The result was an AAR Data Manager (ADM) (General Dynamics C4 Systems, 2007). The ADM, developed as a component of the General Dynamics' S2Focus™ software, was designed to be embedded as a software subcomponent on a leader system processor. S2Focus™ ran on a variant of the FFW leader system. S2Focus™ (Hall, 2005) is a distributed simulation management tool and architecture that provides simulation management, monitoring, and analysis. The tool is customizable and extendable, making it adaptable for the development of specialized tools like the ADM.

The S2Focus™ software with the ADM component was designed to run in the background on one of the FFW leader systems. The design permitted the software to be turned on to run only during selected training exercises. This leader system would be worn by an element leader or a designated OC and acted as the controller on the network. When activated, the S2Focus™ ADM would communicate with the other systems and run as a low demand software subsystem. It would support collection of TESS and medical information for the AAR. On other FFW systems within the unit network, a small segment or kernel of the software ran as an Engagement Data Logger (EDL) in the background.

This section provides more information on these software functions. As detailed below, most of the developmental work related to TESS and casualty assessment via the TESS process and the Physiological Status Monitor (PSM), which was a separate subsystem in the FFW systems. The PSM is the integrated physiological and medical sensor subsystem that monitors and collects information regarding vital signs such as body temperature, heart rate, and blood pressure. Future systems may also monitor hydration, stress levels, sleep status, body positioning and workload capacity of the Soldier. The PSM can notify medics and leaders of irregularities or abrupt changes in the Soldiers physical condition or if the Soldier sustains wounds or becomes a casualty.

The ADM permits the controller system to define a training event and create a discrete file for a mission, vignette, or selected period. This action permits the "registration" of systems (participants) active in the network during the training event. Once the system begins logging, all participating systems capture and store selected data from the wireless (Bluetooth) personal area network (PAN). Within the PAN, each system captures data from the ICON™ wireless TESS receivers and small arms transmitters (SATs) to record TESS offensive engagements (the Soldier firing his weapon). The PAN also receives the "electronic bullet" information and captures the engagement and resolves the TESS "electronic bullet" as a near-miss, casualty, or kill data (the Soldier being engaged or hit by a specific weapon). Figure 3 provides a schematic of the data flow and processing for a TESS engagement.

Additionally, when a Soldier is struck by the "electronic bullet" from a SAT or other weapon effects generator and is resolved as a TESS casualty, an audible alert is emitted from the Soldier's TESS subsystem. The subsystem also stimulates the PSM to generate a message indicating that the Soldier is a casualty. Based on the assessed training wounds, this message automatically updates and alters the appearance of the Soldier's icon in SA displays (a circle with a rifle weapon system symbol in the center) across the network. This icon is supplemented with a quickly identifiable medical status marker and the appropriate medical triage category based on the changes in vital signs normally associated with the system-assessed simulated wound (see Figure 4).

In Figure 4, the triage category of "delay" for "delayed" means treatment is required but there is a high chance of survival. "Immed" for "immediate" means emergency treatment is required with a high chance of survival with therapy. "Expect" for "expectant" means immediate highly specialized treatment is required with a low chance of survival. Lastly, the "**T**" to the upper right of the symbol indicates a training or simulated casualty to differentiate the Soldier from an actual casualty.

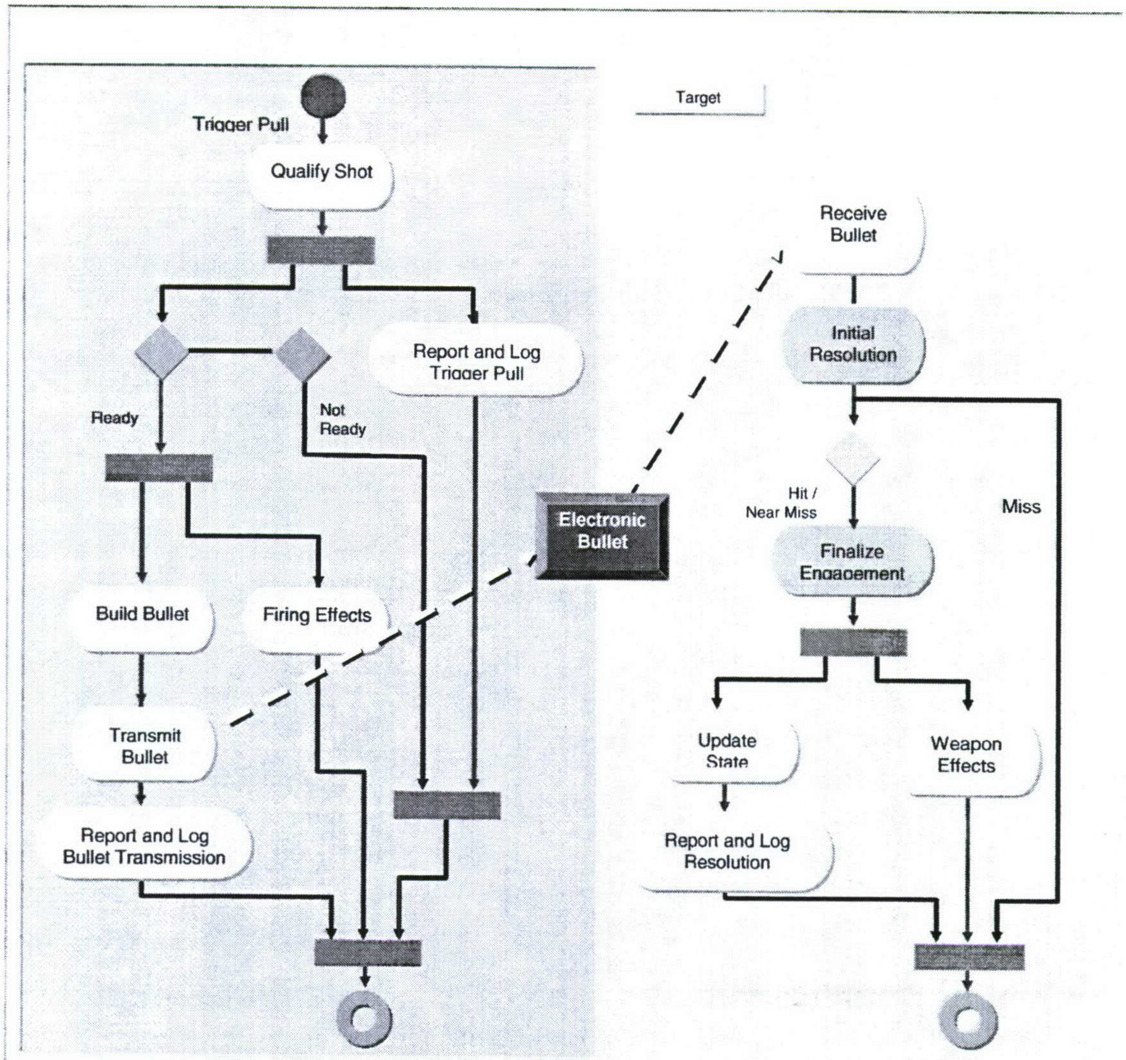


Figure 3. Schematic for a TESS small arms engagement.

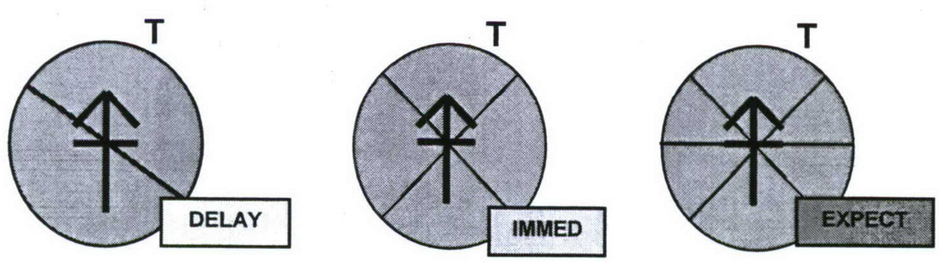


Figure 4. Icons displayed on a Soldier's system for TESS-generated training casualties.

The functions of the PSM are not degraded during training. Actual casualty data would be generated and displayed without the "**T**". For example if a Soldier were to break a limb or sustain a puncture wound during training and manifest the associated physiological changes (respiratory or pulse deviations from normal), the system would generate a message and the Soldier's symbol would change in the SA display to reflect the actual assessed medical condition. The displays on the unit medic, combat life saver (CLS), and/or selected leader systems would highlight the condition (see Figure 5 where the icons are within a square). The EDL stores the TESS engagements and casualty resolutions as discrete events for later retrieval and transmission.

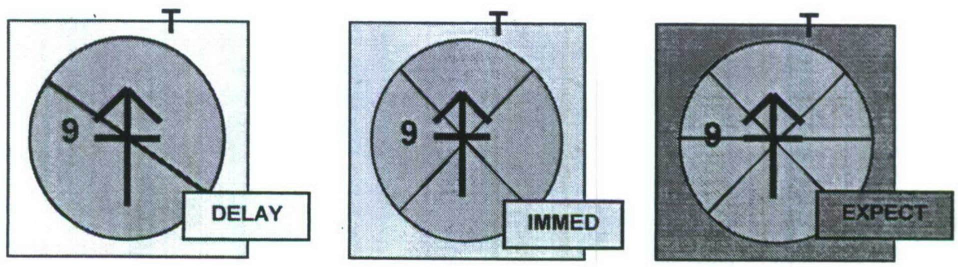
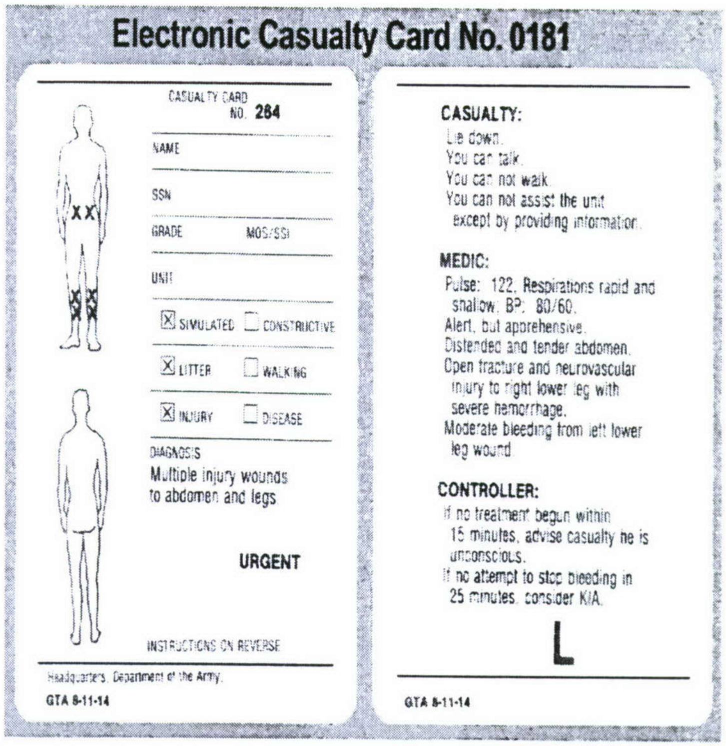


Figure 5. Icons for TESS-generated training casualties on the system displays of the unit medic, CLS, and/or selected leaders.

The FFW system also stimulates the insertion of a randomly generated Casualty Card (DA, 1993c) on the SA display of the victim. One side of this Casualty Card tells the victim his medical condition and the outward symptoms of his injury (see Figure 6). It also tells the Soldier if he is capable of communicating (anything beyond his medical status) to those who respond to him or to his buddies nearby. The other side of the Casualty Card provides additional information to the Medic, CLS, leader, or buddy responding to the casualty.

The Casualty Card was integrated in the FFW system (see Figure 7 for an example). The left display shows wound information and option buttons: BACK, FRONT, and TREAT. The right display shows a casualty display after treatment. Once the Medic or CLS has treated the casualty, the TREAT button can be selected by an OC or the treating buddy, Medic, or CLS. The WOUND TREATED indicator will display. However, if treatment is delayed, the condition of the casualty will continue to degrade in the system. Electronically the condition of the casualty will incrementally become more serious. The victim icon status would be progressively updated. For example, in a training exercise, a superficial gunshot wound in an extremity, if not treated, would eventually result in the patient expiring due to blood loss and/or shock. The intent of the system design is to provide this realistic degradation of untreated wounded Soldiers.



Electronic Casualty Card No. 0181

CASUALTY CARD
NO. 264

NAME

SSN

GRADE MOS/SSI

UNIT

[X] SIMULATED [ ] CONSTRUCTIVE

[X] LITTER [ ] WALKING

[X] INJURY [ ] DISEASE

DIAGNOSIS
Multiple injury wounds to abdomen and legs

URGENT

INSTRUCTIONS ON REVERSE

Headquarters, Department of the Army.
GTA 8-11-14

CASUALTY:
Lie down.
You can talk.
You can not walk.
You can not assist the unit except by providing information.

MEDIC:
Pulse: 122. Respirations rapid and shallow. BP: 80/60.
Alert, but apprehensive.
Distended and tender abdomen.
Open fracture and neurovascular injury to right lower leg with severe hemorrhage.
Moderate bleeding from left lower leg wound.

CONTROLLER:
If no treatment begun within 15 minutes, advise casualty he is unconscious.
If no attempt to stop bleeding in 25 minutes, consider KIA.

L

GTA 8-11-14

Figure 6. An example of a two-page casualty card.

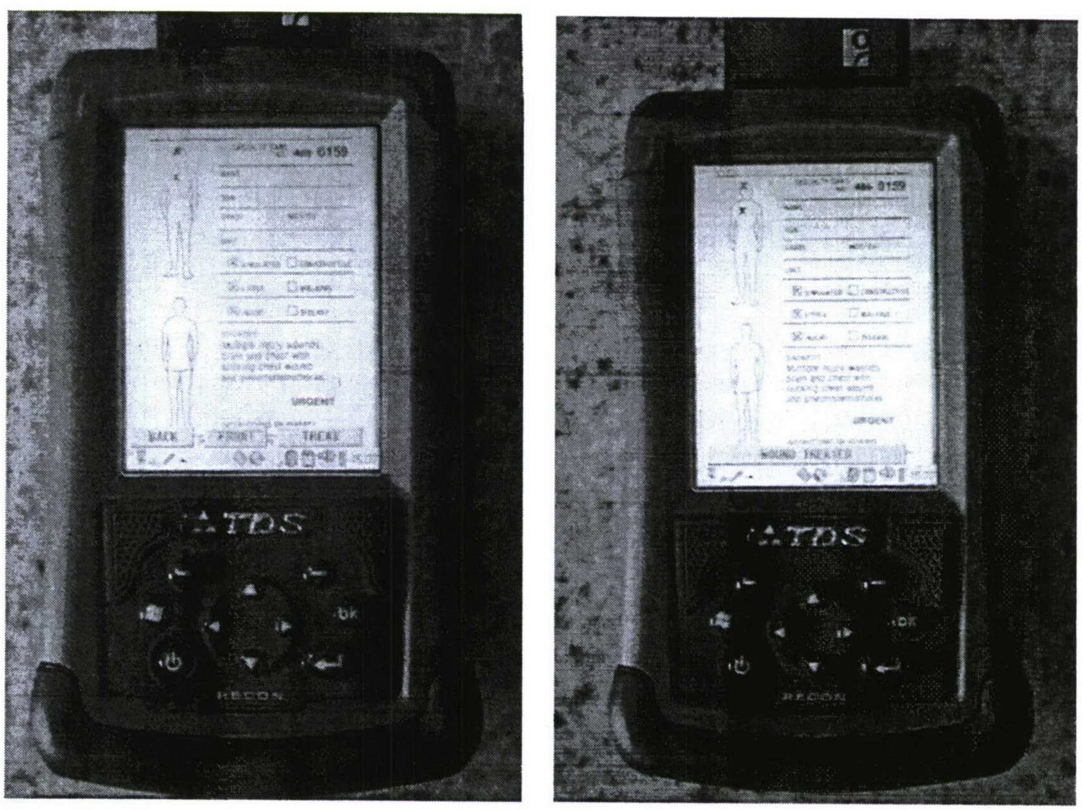


Figure 7. An example of a casualty card displayed on the FFW basic system.

An additional feature of this subsystem was the ability to generate a specific type of wound on an individual or designate a specific individual as a casualty. During a training exercise, the trainer may cause a specific type of simulated training wound using casualty codes generated through the **Remote Casualty Handling** option of the ADM. This capability currently does not exist through the "god gun" or control device fielded for Multiple Integrated Laser Engagement System (MILES). In most exercises Soldiers are issued a Casualty Card prior to the exercise or OCs distribute the Cards. Soldiers then become casualties during the exercise. This insertion of a specific type of wound can assist in training unit medical personnel and leaders to deal with or treat particular types of injuries and casualties. Moreover, the designation of a selected individual (e.g., a leader, primary operator of a weapon system, or an individual at a specific location) can greatly contribute to the evaluation of unit capabilities, reactions, and flexibility during a training event. The "god gun" or the **Send Reset** function of the ADM can also be used to clear or "resurrect" a casualty. These features provide the trainer an option to intervene in an exercise to mitigate the negative training impact of a simulated injury. Excessive casualties or loss of a key leader could degrade or negate the intended training objectives. For example, extensive unit casualties could work against the value of the training exercise or event.

In addition to promoting realism through engagements, casualty play, and medical treatment during a training exercise, at the end of the exercise, mission, or vignette, the ADM may be cued to end logging and retrieve files across the network from all participants. This retrieval of TESS engagement data after the mission precludes interference or competition on the network with operational information such as SA updates and operational messages and requests. The exchange of training information occurs after the exercise. The TESS engagement and casualty data from these EDLs may be retrieved and merged on the ADM operating on the leader system. Additionally, during the event or exercise the trainer can use the ADM to tag or identify specific events. This permits retrieval and time association of an event for AAR preparation.

Three other components of S2Focus™ can be used to generate AAR aids. These are the Analyzer, the Viewer, and the Recorder.

The **Analyzer** component of S2Focus™ can collect, analyze/process, and create displays of captured data. The **Analyzer** is customizable as indicated in the interface shown in Figure 8. The interface, **Timelines and Event Generators**, permits the creation of custom plug-ins. These plug-ins capture, process, and display information in a preconfigured form and format. For example, a selection of basic timeline and event charts have been developed that could be used or customized into a standard package for small unit leaders. Fire events/engagements, casualties and treatments, messages transmit or receipt, or other events can be viewed on a timeline or other customized display. Figure 9 provides an example of possible displays that could be used in an AAR to show different fires and effects over time and by weapon system.

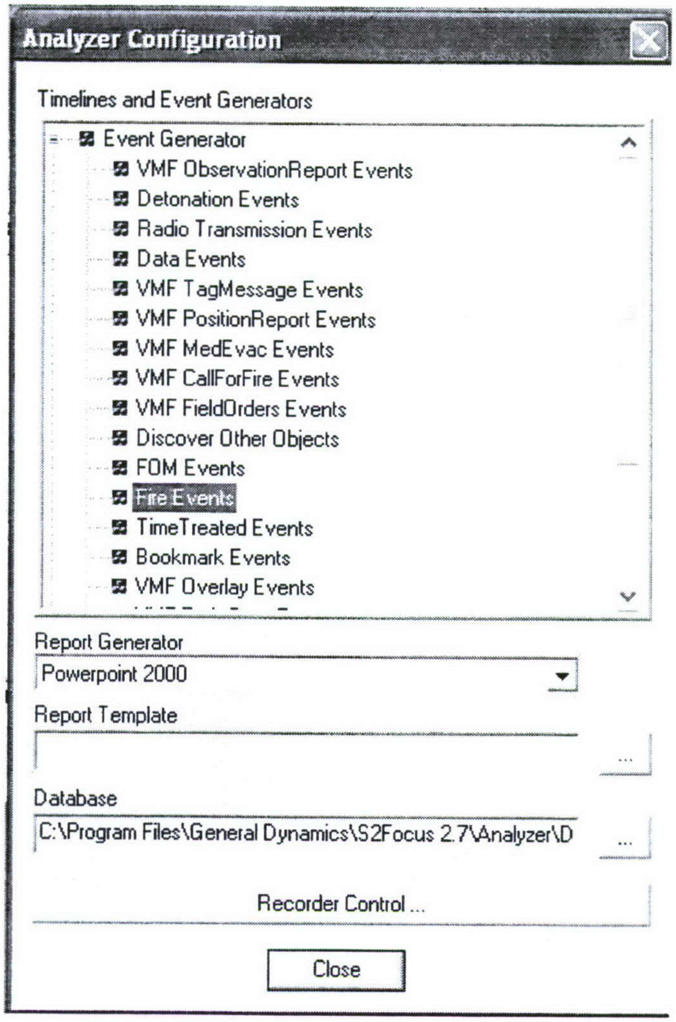


Figure 8. Examples of timelines and events that can be created as displays for view by the S2Focus™ Analyzer.

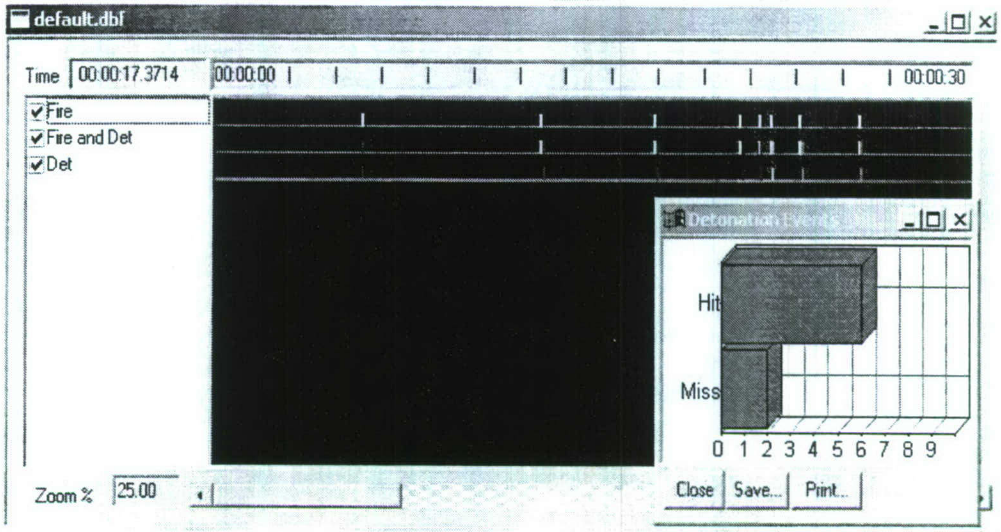


Figure 9. Possible AAR displays: Fires, fires and detonations, and detonations on a timeline and a separate overlay display of hits / misses for a weapon system.

The **Viewer** component of S2Focus™ provides a visualization tool that can present a 2D or 3D view of the battlefield on topographic maps, photographic maps, or overhead photos (see an example in Figure 10). This **Viewer** could provide a snapshot of the SA picture for a specific tagged event (for example, the breach of an obstacle, occupation of a support-by-fire position, or actual positions at the time of initial contact with the enemy). The **Viewer** would permit a comparison with planned positions vs. actual positions. Phased snapshots taken over time could be used to demonstrate how a situation developed or deteriorated. This snapshot capability parallels the capabilities discussed in simulation systems like DIVAARS. It should be noted that images on ground Soldier systems can be saved and transferred as a form of a message to others, including the trainer, who are in the network. This includes images transmitted from unmanned ground or aerial vehicles as well as situation awareness displays and overlays on 2D and 3D maps, which the trainer may create or receive from others in the network. Figure 10 illustrates an SA display.

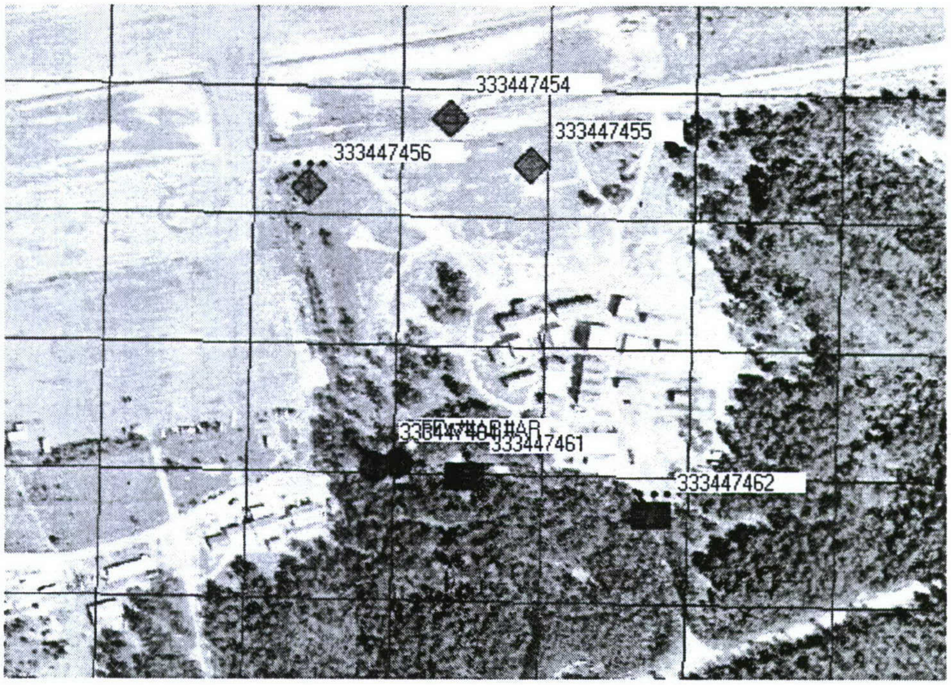


Figure 10. Example of an SA snapshot with identification tags (diamonds (red) indicate enemy single entities, rectangles (blue) indicate friendly units, and circles (blue) indicate friendly Soldiers).

The **Recorder** component of S2Focus™ provides the ability to record and playback data captured from the network. These data could be short clips from SA displays played in real or fast time or stepped forward by time increments. Voice data from radio networks passing through a computer subsystem could also be captured and replayed through the **Recorder**.

Demonstrated Proof of Concept for the FFW AAR Support System

During the FFW ATD, integration issues prevented full, interactive demonstration of the ICON™ wireless TESS and S2Focus™ ADM capabilities. However, laboratory testing, experiments, and demonstrations confirmed the function and validity of the ADM concepts and capabilities, as well as the functions of the TESS and PSM interfaces. The S2Focus™ has, in support of FFW and other simulations and programs, proven a valuable tool to collect, analyze, and display information. The notion for use of these or similar ET tools to support the small unit AAR process has advanced beyond concept and prototype. While much information can be captured and accessed for an AAR, the issue remains that training aids – charts, images, diagrams - should only be used when they make the AAR better. The implication is that training aids should promote learning and understanding and help Soldiers and leaders more quickly discern what happened, what was done well, and what requires improvement.

Purpose and Scope

This report identifies embedded AAR tools viewed as important for future dismounted Soldier systems, specifically the GSS. They represent a further step forward to achieving the ET requirement stated in the GSS CDD.

The tools involve using the existing operational capabilities of Soldier systems as well as additional software subsystems to support more AAR elements. The tools facilitate two key elements of the AAR process: examination of **what was supposed to happen** and of **what actually happened**.

Also presented are design proposals for user-friendly software interfaces by which critical events can be collected by a trainer during a small-unit training exercises. Many of these concepts focus on direct and indirect fires, and the interaction with TESS technologies. All concepts presented are technologically feasible, leveraging the prior work and concepts cited in the Introduction.

These tools would permit GSS-equipped dismounted platoons and squads at home station to draw organic equipment and training ammunition, enter a nearby training area, conduct leader-directed live-environment tactical training, and after a quick water break and equipment check, conduct an informal AAR. Additionally, these embedded tools would be available during deployments at intermediate staging bases or after deployments at secured areas within a forward operating base to support sustainment, refinement, and improvement of essential tactical skills. These tools, less those associated directly with TESS, would have the potential for use following actual combat operations to determine what happened and why to improve unit performance.

Method

The analyses and concepts presented in this report were based on the Army literature, research, and system experimentation cited in the Introduction, as well as personal work by the authors with dismounted Soldier systems. In summary, these were:

- The Army's training and doctrine literature on AARs, and tenets in that literature.
- AAR aids developed to support training simulations.
- The impact of the Army's digital system modernization on the AAR process.
- Information on the capabilities of the current LW and FFW systems.
- Research on applicable embedded AAR concepts for the LW system.
- Technologies developed during the FFW ATD to support embedded AAR capabilities.
- The requirement for embedded AAR tools presented in the GSS requirement document (the CDD).
- Prior military experience by the authors in facilitating and participating in AARs within small-units.
- Personal experience in developing training materials for and in training Soldiers on the LW and FFW systems, and interactions with system engineers on the FFW ATD.

The analysis and proposed concepts leveraged the evolution of AAR tools, in general and their potential for Soldier systems in particular, described in the Introduction. The overall framework was to insure that any proposed tools reflected the intent in the GSS CDD and doctrinal tenets underlying the AAR process, as well as be responsive to the demands and limitations of a small combat unit executing an AAR.

Given the information available from the sources cited previously, we examined more systematically the impact that Army digital system modernization has had on the AAR process. With the advent and wider distribution of digital systems, the possibility for capturing more detailed information from training events is increasing. This increased information could be beneficial in understanding what was planned and happened during training and, hence, could contribute to the AAR process.

We capitalized on ongoing science and technology programs to gain further insights into potential AAR tools, in particular the FFW ADM developed during the ATD effort. The authors of this report were directly involved in developing training for the FFW program and, thus, used this in-depth knowledge coupled with military expertise to garner salient points for consideration in this report. The proposed AAR tools assume that a software capability similar to S2 Focus™ is available for the GSS. Many of the ideas for the collection of battlefield information in the FFW via S2 Focus™ were incorporated in the analyses and the proposed tools.

A front-end analysis was performed. The first step involved determining the software capabilities assumed to exist within the GSS, based on the predecessor LW and FFW systems, which could be used to assist a trainer. In particular, we identified system information/features could be used to clarify **what was supposed to happen**. During the receive, plan and preparation phase of a mission, small unit leaders follow Troop Leading Procedure (TLP)[1]. The front-end analysis identified which GSS capabilities were associated with each TLP step. For example, planning actions that require messaging, orders development and dissemination, and graphics development and dissemination will transit the network data or voice networks and messages, orders, and graphics will be stored on processors. Many actions associated with movements, leader reconnaissance, and supervision of preparations such as rehearsals can be viewed over and captured through SA features. These TLP steps, process, and the resulting OPORD address the AAR element of "**what was supposed to happen**."

The second step of the front-end analysis was similar, but focused on **what actually happened.** Again, system features that could assist a trainer in presenting this topic during an AAR were identified. The second phase involved identifying the required controls and developing prototype interfaces and some functional descriptions of tools that would facilitate the trainer in collecting performance related information, both with regard to **what was supposed to happen** and **what actually happened**. Most of this analysis focused on mission execution and tools to aid the trainer. In addition, given the importance of integrating TESS engagements into the AAR process, several AAR tools directly related to weapon system integration and casualty handling were included. The proposed interfaces were based on the authors' prior experience with current TESS and with the predecessor LW and FFW systems.

[1] See FM 3-21.71, Mechanized Infantry Platoon and Squad (Bradley), Chapter 2, Section III, dated Aug 2002, for a detailed discussion on the TLP process and steps.

The third step involved focusing on preparing for and presenting data in a form to support a small unit AAR. It is the AAR process that identifies to the participants **why it happened and how to improve**. The purpose was to identify the tools required to expedite the review data, select and prepare data, then display or disseminate data to support the conduct of a small unit AAR. While a portion of this effort was devoted to identifying displays, the primary focus remained on developing prototype interfaces and determining the functional descriptions of tools that would facilitate the very necessary review, selection, and presentation of data. The proposed interfaces were based on experiences with and the constraints and limitations of the small unit AAR process.

The primary outputs of the analysis were proposed interactive, user-friendly, easy-to-use interfaces that could be integrated into the ground Soldier systems carried by small-unit leaders. The tools embedded in these displays focused on what the small-unit leader typically needs when conducting an AAR.

Results

The results section presents the results of the front-end analysis. This is followed by examples of the tools developed under this effort to support small-unit AARs.

Defining What a Digital System Could Contribute to an AAR

Having examined the informal AAR structure and make up, it is important to look at the aspects of the operation that could potentially pass through and be captured by a digital Soldier system, such as the GSS. Like all military operations, small-unit operations follow a predictable cycle. While the actual capabilities of the GSS to support this cycle are still evolving, it is possible to examine how the process could be supported or facilitated by a digital C^4I system at the small combat unit level. Units receive a mission, plan and prepare; execute the mission; and then consolidate and reorganize. While the cycle of activity is generally standard, trainers normally plan a training exercise or vignette with goals and objectives in mind. They focus the effort and scenario to evaluate performance of a task, train a new task, improve, or sustain performance of a task. The order and tasks used, selection of terrain, time allocated, and planned encounters or engagements are shaped by the training goals and objectives. The exercise begins with the training concept, and "**what was supposed to happen**" is both a function of the tactical order or plan and the unit's actions and reactions to the emerging situation.

The "**what was supposed to happen**" aspect of a mission is generally derived during the "receive a mission, plan, and prepare" phase of the cycle. In squads and platoons, this phase follows TLP. TLP has eight identifiable steps or tasks, but it is only a guide to the planning and preparation process. Some steps or tasks of TLP have subtasks or steps, some may be abbreviated, some omitted, and some may be performed out of sequence. Table 2 reflects the potential interface of the tasks and subtasks of TLP within GSS, based on the operational capabilities of the LW and FFW systems and the GSS CDD. Just because a capability exists, it may not be used. Leaders may employ a variety of techniques during TLP. For example, leaders may disseminate the order verbally or use a terrain model hastily drawn in the dirt to communicate the mission, the concept of maneuver, or subordinate unit missions and tasks. Table 2 depicts actions or steps of the TLP process that may be supported or facilitated by capabilities of a dismounted Soldier digital system. Some actions would create messages, orders, overlays, or other graphics that may be stored on the system and/or distributed digitally or by some other means. Additionally, some actions would trigger the transmission of messages, directives, or requests over the data or voice networks. Some actions would cause individual or unit movements, detectable as changes to the SA. Other actions would cause the employment of system capabilities. When the leader employs his digital system during TLP, most actions could be captured. These data would contribute to a pool of potential information available for an AAR. This information could be used to create or contribute to aids to support an AAR.

Table 2.
Potential Interface of the TLP Steps with the GSS

TLP Actions	Potential Interface with GSS
Step 1 - Receive the mission.	
Receive the mission from higher headquarters.	-The higher headquarters' order may be transmitted as a free text or formatted digital message with graphic overlays or transmitted as a voice message.
Begin an analysis of the mission using the factors of METT-TC (mission, enemy, terrain, time, troops available, and civilian considerations) (with SA).	-This analysis may require the leader to reference or access other documents, messages, maps, photos, or graphics archived on his computer.
Receive attachments or directives for detachment of elements.	-This process may require reconfiguration of networks, address groups, and voice radio talk groups.
Step 2 - Issue a warning order.	
Provide initial planning and/or preparation guidance to subordinates.	-The warning order may be transmitted as a free text or formatted digital message with graphic overlays or transmitted as a voice message to subordinate leaders or to the entire unit.
Step 3 - Make a tentative plan.	
Conduct a mission analysis.	-This analysis may require the leader to reference other documents, messages, maps, photos, imagery or graphics archived on his computer.
Develop a course or courses of action.	-This process may require use of other documents, messages, maps, photos, or graphics archived on the computer. -This process may require use of a graphics capability and embedded planning tools on the leader's computer.
Compare course(s) of action.	-This comparative analysis process may require use of a graphics capability and embedded planning tools on the leader's computer.
Make a decision based on the current estimate	-Selection of a course of action may require use of a graphics capability and embedded planning tools on the leader's computer.
Step 4 - Initiate necessary movement.	
(*Note*: Early movement or repositioning of the force may be required in preparation for a mission. However, the unit may be in position to execute without adjustments and this step may be omitted.)	-Preparation for or execution of movements or repositioning may require use of other documents, messages, maps, photos, imagery or graphics archived on the computer. -Movements may be aided by the graphics capability and embedded planning tools on the leader's computer.

TLP Actions	Potential Interface with GSS
	-Movement or adjustment may require use of navigation tools and SA displays. -Movement or repositioning may require use of voice or digital message communications.
Step 5 - Conduct a reconnaissance.	
Done by leader(s), possibly using a map, or with unmanned aerial vehicle (UAV) or an unmanned ground vehicle (UGV).	-Reconnaissance may require use of other documents, messages, maps, photos, imagery or graphics archived on the computer. -Employment of a UAV, UGV, or other robotic system may require interface with robotics mission planning tools or direct interface with robotic system controls. -Receipt of robotic reconnaissance results may require receipt of imagery or graphics. May require use of navigation tools and SA displays. -May require use of voice or digital message communications.
Step 6 - Complete the plan.	
Create / complete required graphics, fire planning, and movement / maneuver planning.	-Completing the order or plan may require the leader to reference other documents, messages, maps, photos, imagery or graphics archived on the computer. -Completing the operations overlay or graphic may require use of a graphics capability and embedded planning tools.
Step 7 – Issue the order to subordinates.	
Voice radio, digital message, and/or graphics.	-Disseminating the plan or order may require transmitting a free text or formatted digital message with graphic overlays or transmitted as a voice message to subordinate leaders or to the entire unit.
Step 8 - Supervise preparations for the mission.	
Conduct rehearsals. (*Note:* Mission rehearsals may be done in a variety of ways. It may be a simple table top or terrain model walk through/talk through with leaders or a dry run	-Movement to or execution of rehearsals may require use of other documents, messages, maps, photos, imagery or graphics archived on the leader's computer. -Rehearsals may require use of navigation tools and SA displays. -Preparation for or execution of rehearsals may require use of other documents, messages, maps, photos, imagery or graphics archived on the leader's computer. -Rehearsals may require the use of a graphics capability and embedded planning tools on the leader's computer.
Conduct inspections / re-inspections.	-Conducting pre-combat pre-missions may require the leader to reference other documents, messages, maps, photos, imagery or graphics archived on the computer. -Pre-combat/mission checks and inspections may require verifications of settings, maps, photos, imagery and scales on subordinate Soldier and leader computer subsystems. -Pre-combat/mission checks and inspections may require verification of networks, address groups, and voice radio talk groups. -Pre-combat/mission checks and inspections may require verification of battery life or power supply/support plans.

During TLP leaders of small units should receive a mission from their higher headquarters, complete and disseminate their own, and supervise the activities of their subordinates in preparation for mission execution. The TLP process may also provide contributions to the "**what happened – good and bad**" aspect of the AAR. For example, a poor plan/order, one that does not address all specified or implied tasks of a mission, or poor preparations may cause **bad** things to happen.

Significant contributions to the determination of "**what happened – good and bad**" will occur during the "execution" and the "consolidation and reorganization" phases of the operation. Every tactical situation and mission differs. However, Tables 3 and 4 provide examples of activities and tasks common to most unit tactical missions. However, the tasks and activities in these tables are not all inclusive for every mission. Furthermore for each activity and task identified, there are potentially additional supporting individual and collective tasks or steps. While the actual capabilities of GSS are not known, each of these common activities and tasks could potentially require interface with, be stored on, or be supported by functions and capabilities on the GSS.

Table 3

Common Activities and Tasks During Execution of Tactical Missions Requiring Potential Interface with GSS

Common Activities and Tasks During the Execution Phase of Tactical Missions
• Initiate mission, movement, or action at the required time. • Keep self and/or subordinates informed – voice communications and posting of graphics and entities to the SA displays. • Anticipate the need to modify unit formation or rate of movement due to orders, reports from subordinates/peers, terrain changes, and/or changes in enemy situation. • Modify and control the unit's formation and movement rates based on the situation. • Maintain control of unit during movement/maneuver. • Cross a danger area. • Understand the nature and location of enemy contact. (React to contact.) • Control fires and maneuver during and after contact. • Adjust to changes after contact with the enemy. • Control/coordinate the execution of actions on the objective. • Control and adjust direct and indirect fires. • Employ, control, and adjust indirect fires. • Act according to the plan or adjust/modify actions based on the situation. • React to casualties. • React to Prisoners of War (POWs)

Table 4

Common Activities and Tasks During the Consolidation and Reorganization Phase of Tactical Missions Requiring Potential Interface with GSS

Common Activities and Tasks During the Consolidation and Reorganization Phase of Tactical Missions
• Keep self, higher, and/or subordinates informed – voice and digital communications and posting of graphics and entities to the SA displays.
• Recover and redistribute key equipment and capabilities.
• Consolidate at the appropriate location, adjust for losses, and prepare to change, adjust, or continue the mission.
• Treat and evacuate casualties.
• Evacuate POWs.
• Identify shortages and request replacement/resupply.
• Resupply or cross level and refit for the next mission.

Exploiting Digital System Capabilities to Support the AAR

Tools of the embedded AAR support system should be designed to capture data passing through the Soldier's system. The data could include messages, reports, voice transmissions, situational events, or locations of individuals or units. The data could assist in the determination of "**what happened.**" Many leader and Soldier tasks are cognitive; they require a decision of when to engage a target and which target in an array should be engaged first. Leader and individual Soldier reports, decisions or actions may be based on their perceptions of the information available and their awareness or understanding of the situation from both the digital system SA, communications monitored over radio nets or by voice, digital messages received, battlefield sounds, and their own observations. Capture of related information available on or through the GSS and available for review during the AAR process can contribute to individual and unit understanding of "**why it happened and how to improve**" on poor performance and decisions, as well as, how to sustain good performance. AAR tools could be focused to consolidate, analyze/process, harvest, and display data pertaining to these activities of the unit.

To capture the information, a list of desired controls was developed. Some of these functions and controls were derived from lessons learned from the FFW ADM and requirements stated in the FFW CDD. Others were derived from controls and tools in AAR systems developed for virtual environments. Still others were recommended by OCs at JRTC and the authors' experiences in conducting or observing small unit AARs. These controls included:

- Create a mission file
- Start and stop (or pause) logging of data
- Edit or adjust participants and their status
- Select and tag events
- Select specific data to be collected
- Review the collected and/or analyzed data
- View or disseminate data

In addition to the controls listed, it was determined that alerts and displays could enhance the trainer's ability to observe critical actions during the mission, exercise, or vignette. Additional controls could permit the trainer to set time or location related alarms to alert him to observe, either on system SA or from a vantage point on the terrain.

Engagement simulation and casualty management features of FFW ADM, previously only assessable through the TESS "god gun," demonstrated promise in facilitating or exercising training objectives. They also showed the feasibility of integrated tools to enhance training and realism. For example in a current TESS supported training exercise, if a crew served weapon gunner becomes a casualty that weapon is taken out of operation for the duration of the mission or training vignette. During actual operations, leaders would not permit a major casualty producing weapons systems to remain idle. In actual situations, a new gunner is quickly designated or a nearby warrior takes up the weapon to keep it in the fight. The current TESS systems require time consuming reaffiliation of the weapon to an individual by an on-site controller equipped with a control device/"god gun". With integrated TESS, this reaffiliation could be performed remotely, over the network, keeping the weapon in operation.

While this analysis did not focus on displays to support the AAR process, it was determined that at small combat unit level time is not available to develop customized displays for the AAR. Instead a series of standardized displays should be determined. However, to make these displays meaningful, supplemental graphics tool should be available to highlight pertinent information, insert supplemental text, and enhance existing operational symbols and graphics.

Identification of AAR Tools

The ADM developed for the FFW program is an excellent baseline for the GSS AAR support system. It provides an operational model for AAR capabilities and a model for interface with TESS, a PSM type capability, the ensemble's processor subsystem, and the communications subsystem. Continuation of similar interface capabilities is assumed in the tools and controls identified by the analysis reported here. Building on the FFW ADM concepts, the AAR tools available in the GSS must be simple to operate. These tools must support easy set up, operation, and rapid retrieval and assembly of information pertinent to the small combat unit AAR process. To meet this requirement some captured information should be processed automatically and all information should be easy to access, retrieve, and review for pertinence and presentation. The data, the potential training aid, must be in a form or format that is easy for leaders and Soldiers to understand. Overshadowing these requirements is the need to effectively convey the information to the leaders and Soldiers participating in the AAR process. As stated earlier, a training aid should <u>only</u> be used if it makes the AAR better.

The manner of display of the information, the training aid, must support the discussion format of effective AARs. The context for the use of tools is a platoon or squad informal AAR. As discussed earlier, the review most likely would be conducted immediately at the conclusion of an event or a phase of the training. The site for the review would, most likely, be an unprepared training site. Little preparation time would be available for the OC or unit leader facilitating the review. To address these needs and challenges the recommended tools and their characteristics are discussed below.

The identified controls of the proposed AAR support system are depicted in Figure 11. The controls are grouped by menus or graphic user interfaces (GUIs) on the trainer's system.

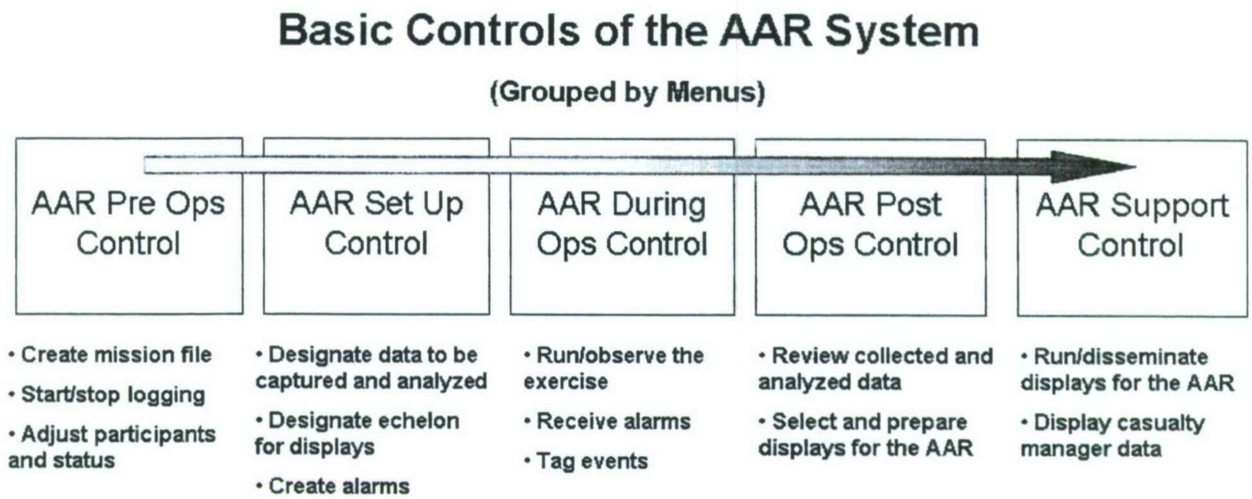


Figure 11. Basic controls of the AAR system.

These controls provide the essential capabilities to collect information during missions, to review and organize the resulting information and displays, and to disseminate/display the information to participants. Additionally, these controls provide features to assist the trainer as an observer. Supplemental controls (Figure 12) provide interface to TESS features and controls, and provide the trainer the capability to monitor casualty treatment and modify, reset, or inflect wounds to enhance training. An additional capability is provided through graphics tools. These tools provide a capability to insert graphics, highlight, and insert supplemental text on displays and charts to focus attention during an AAR.

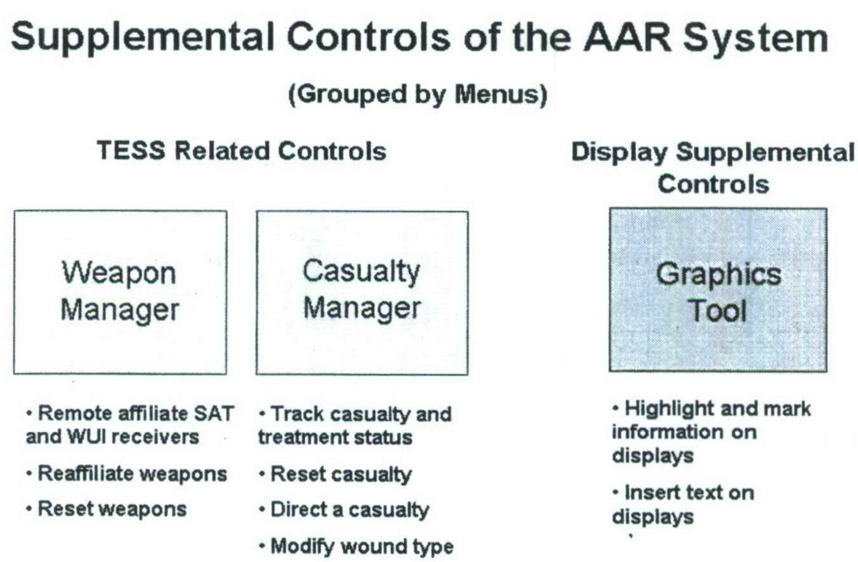


Figure 12. Supplemental controls of the AAR system.

AAR ET Pre-Operations and Set-Up Functions and Controls for the Trainer

As indicated, all menus and controls embedded in the trainer's AAR software must be simple and easy to operate. For pre-operations, the set-up, configuration, and customization of data capture and anticipated feedback should be done in advance. For example, unit personnel data could be preloaded from other databases. Additionally, association of weapons (TESS weapon type and identity codes) with duty positions or individuals could be preloaded and/or standardized to simplify training exercise preparations. Identities of participants in the system should be in standard Army language and not machine language. For example the rifleman for Alpha Fire Team of 3rd Squad, 2nd Platoon, Alpha Company, 1st Battalion 15th Infantry Regiment should be R/A/3/2/A/1-15IN and the trainer should have the option to abbreviate the identities to simplify their appearance on displays when training with only the squad or platoon. Unit organization listings should be prestructured in the system – a platoon headquarters, three rifle squads, and a weapons squad. However, preloaded data should be easily editable to permit adjustments immediately prior to a training exercise. Trainers should be able to modify the database for absences (sick call, appointments, etc.), assignment of additional personnel, attachments, detachments, and position substitutions. Additionally, the Pre-Operations menu for the trainer must:

- Initialize TESS and data logging processor
- Initiate logging of the data
- Preload events and alarms (time and location)
- Designate any display formats intended for use during the AAR. (This should trigger any associated collection and processing/analysis required for the format as training occurs.)

The ADM in S2 Focus ™ described earlier provides an excellent foundation for these tools. Figures 13 and 14 provide examples of trainer displays for these tools. Figure 13 is the AAR Pre-Operations Control. This GUI provides for naming the training event or mission. It provides for the selection of elements to be logged during the training event (3rd Squad). Note that the organization for combat of the squad in training has been adjusted for a Soldier who is absent (R/A/3/2/A/1-15 IN), an assigned over-strength (R2/B/3/2/A/1-15IN), and the Attachment of a machine gun team from the platoon's weapons squad (WPNS SQD). The menu provides for navigation to other menus and screens. For example, the user can rapidly navigate to the Set Up or During Operations menus.

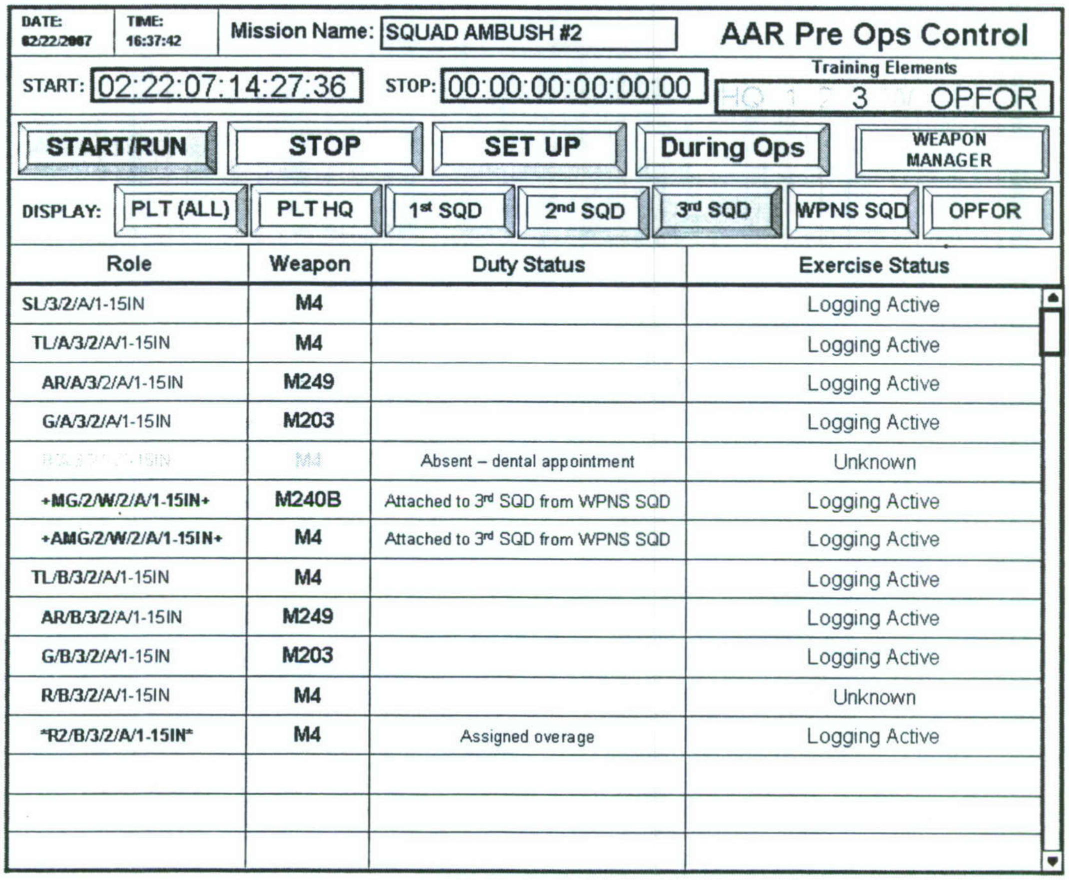


Figure 13. AAR pre-operations control.

The Set-Up menu (Figure 14) permits the selection of data to be captured and processed for events tagged by the trainer. The trainer may also select the level of focus or echelon for the data to be displayed. The selections (twelve [12] buttons) indicated under **Data to be Captured/Processed/Analyzed by Tagged Events** are designed to be descriptive and provide examples, instead of being proscriptive or directive. These fields and data could be altered, after additional research, in a final system or they could be designed as editable categories. Their intent is to provide examples of standardized data that should be available for selection by the platoon leader or squad leader. For example, selection of **Victim – Shooter Pairing** would build a chart of friendly and OPFOR TESS engagements for the selected period. Selection of **Record Voice Transmissions** would provide for the recording of voice transmissions for a selected period while the selection of **Voice Traffic Graph** could show the use of voice networks by individual for a selected period. The **Current SA** button allows a screen capture of the leader's map display which will typically show friendly and enemy icons and critical graphics.

The menu also provides for the programming of time and location alarms to alert the trainer to the approach of a mission time or a location where a critical event in the exercise should occur. This initial set-up would be accomplished prior to the initiation of information logging on the Pre-Operations Control. The integration of the TESS data with operational information is an essential characteristic for future AAR tools.

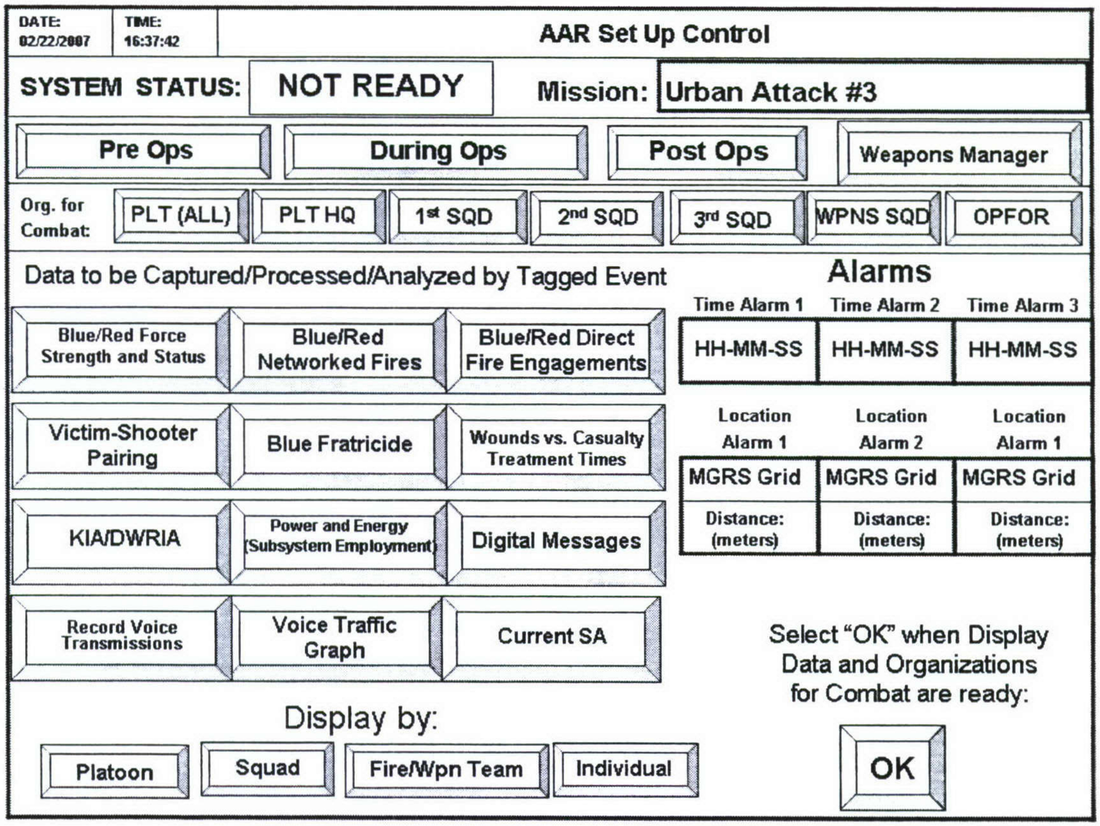


Figure 14. AAR set-up control.

AAR ET During Operations Menu and Controls for the Trainer

The purpose of the During Operation Control is to facilitate both the trainer's ability to observe and tagging of key events. During all phases of the operation, AAR-related menus and controls must be simple and easy to operate. However, unlike other phases of AAR system use, this menu is used during the operation or training event. The menu should incorporate a Windows-type feature with the ability to minimize or maximize at a single touch. It should also be designed to display over the SA screen as a transparent layer. This would allow a semi-unhindered view of the situation as well as system alerts while immediately available to the user. Figure 15 provides a prototype display for this menu.

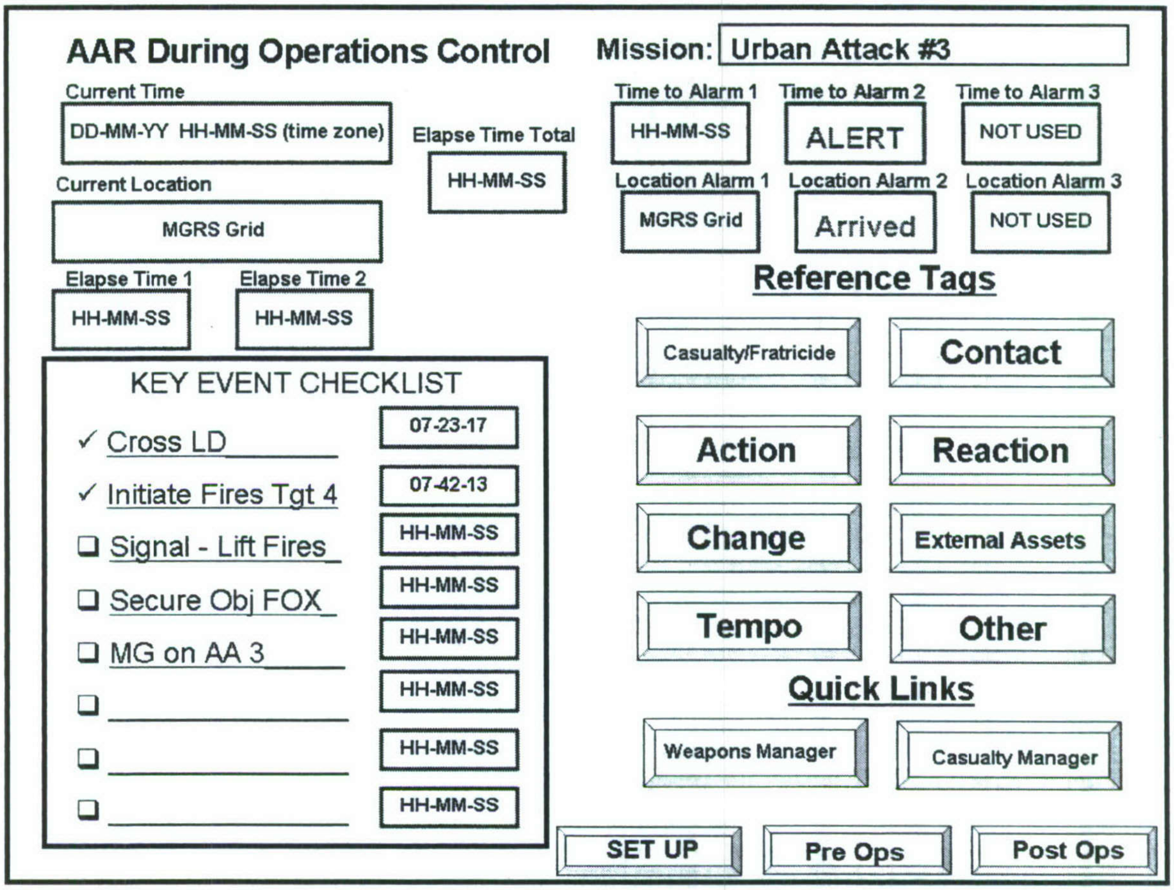


Figure 15. AAR during operations control.

To facilitate the duties of the trainer (a busy OC or multitasked leader), the during operations menu in Figure 15 has the following features:

- In the upper left of the display is the current mission time, the location of the user, and the elapsed time since logging was initiated; basic information to keep the trainer oriented.

- Below the current grid location are two stop watch type windows. These permit capture of elapsed time for two events.

- The Key Event sub-window permits entry of selected operational and scenario events. These events can be checked when they occur or are accomplished. The time is displayed when the events are checked as completed. This feature is primarily for the trainer but could also be of value during the AAR to assist the unit in recalling the sequence of events or key tasks, essential elements of specified or implied tasks, or identifying tasks omitted or not performed during the mission.

- On the upper right of the menu are the preprogrammed time alarms. These time alarms would alert the trainer to the approach or arrival of a critical operation time. For example, if the unit is to cross the line of departure, execute a raid, or trigger a target at a specific time, the alert would remind him to be watching or listening for this key event. Similarly, a pre-coordinated, preplanned target executed by the higher headquarters or adjacent element may be central to the unit's operation.

- Programmable location alarms, below time alarms, would alert the trainer of the unit's approach to a key location – an objective, attack position, etc. or to a scenario related location unknown to the unit – a sniper's hide, an enemy ambush site, etc. The distance or range from the location can be preprogrammed in 20-meter increments to trigger these alerts. Time and location alarms would flash in red or an attention grabbing color until acknowledged by the operator.

- Reference Tags are available to quickly mark data for later reference. These tags labels were derived from the recommendations of veteran JRTC OCs (Dyer, et al, 2005). These Tags would trigger recording of other data previously selected from the twelve buttons on the Set-Up menu (Figure 14); for example voice data from radio nets, if previously selected. This recording would capture 90 seconds of voice data already in a pass-through buffer and capture the next 90 seconds. This 3-minute capture would be available, if selected, for transmission on demand, in total or in a truncated segment, over designated voice networks. Additionally, the system could capture location and icon data currently on the network (via the Current SA button, see Figure 14). This snapshot would capture locations of all Soldiers and leaders in the unit, graphics, targets, and icons displayed at the time of the mark. The captured data are held in memory for trainer to review.

- Note that access to the Weapon Manager and Casualty Manager is provided from this control. These features are discussed later.

With this simplified menu, the trainer is a maximum of two clicks away from capturing or marking information. If he uses the system with the menu as a transparent layer, he is only one click away from data capture. There are no fields to fill-in and no date or other information to select or type in. Typically, squad and platoon missions are of a short duration. The trainer must dedicate his time to his primary task of observing the unit during the event. Figure 16 shows this menu displayed as a transparent layer over the SA display of an FFW Leader System.

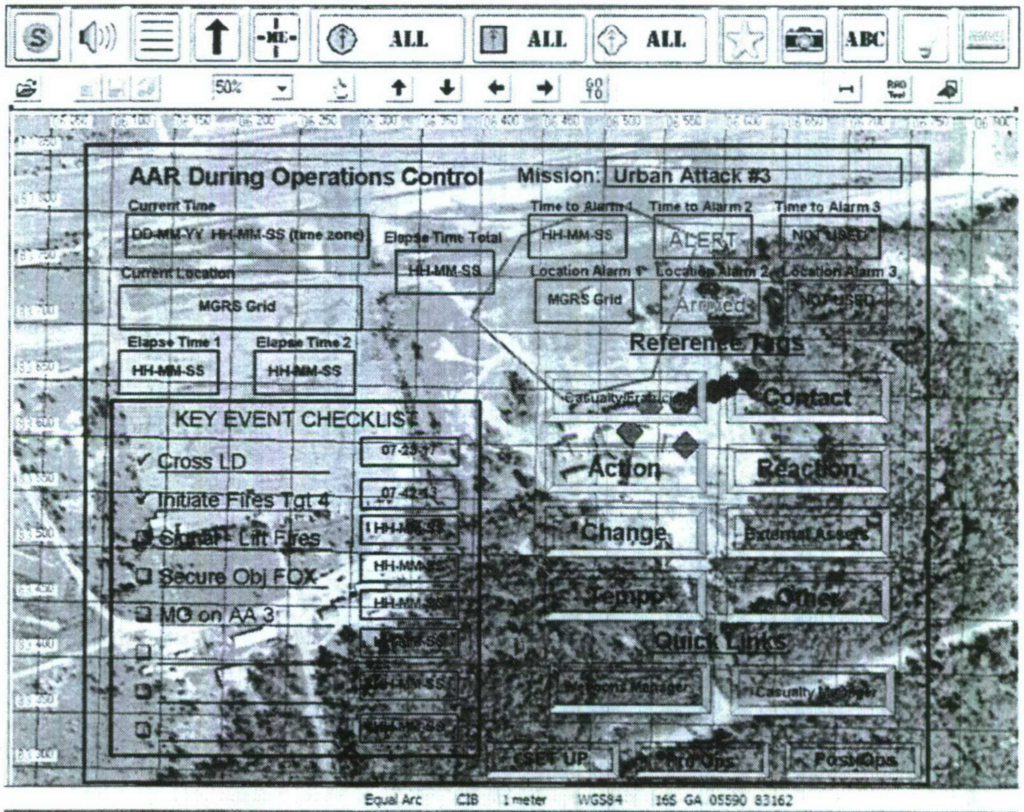


Figure 16. Display of a transparent AAR during operations menu over a photo map on the FFW Leader System.

Supplemental tools for use during operations contribute to exercise realism. One of these tools would permit interface with the TESS for modification of weapon's affiliations. The other tool would permit interface with the casualty management subsystem. Figure 17 provides an example of a TESS Weapon Manager menu.

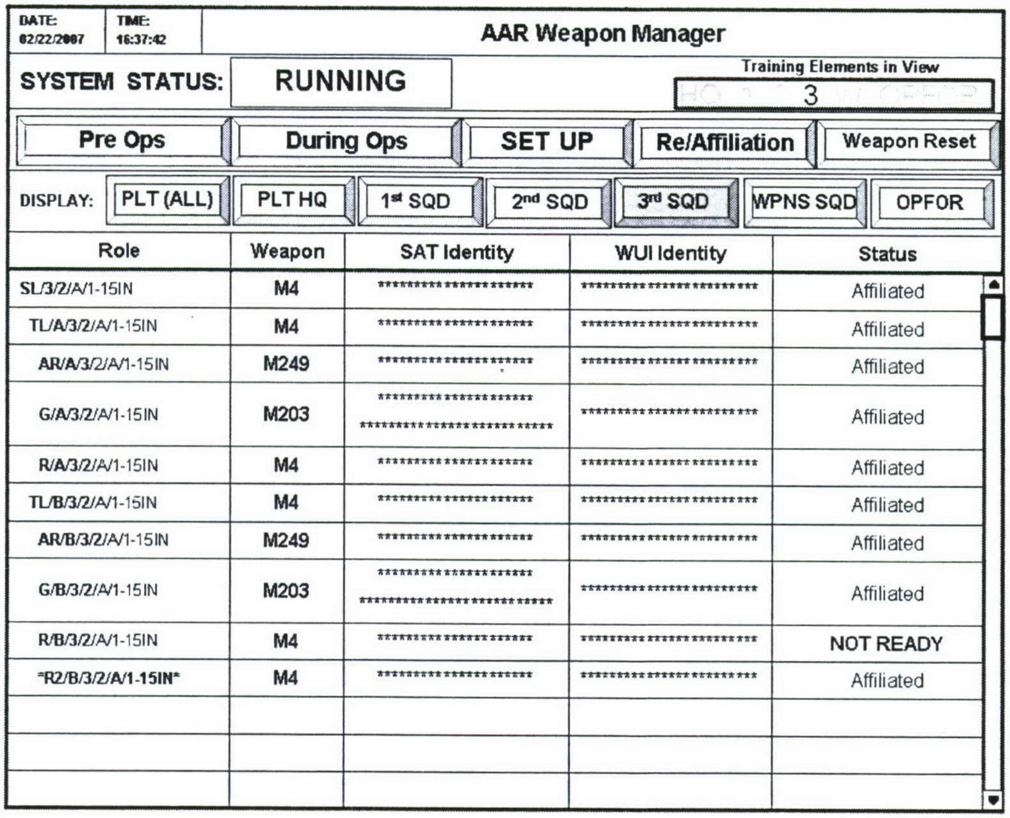


Figure 17. Sample AAR weapon manager menu.

In current training operations TESS subsystems are affiliated with an individual and the assigned weapon. This method permits a weapon, along with its associated characteristics and kill codes, to be linked to a Soldier. While this assists in determining **who fired a shot** or **shot at whom**, it is a limitation to realism. With this system design, when a Soldier becomes a casualty, the weapon can not be used. In addition, if another Soldier, an unwounded healthy Soldier, retrieves the weapon, the healthy Soldier cannot use it. The body-worn TESS control on the Soldier retrieving the weapon must be reset by a TESS "god gun" equipped, on-site OC. The Soldier must then affiliate the weapon SAT with the body-worn TESS control. During a fast moving training exercise, this process is seldom accomplished; if a Soldier is wounded, the weapon is out of play. Figure 18 provides a sample menu that provides a solution to this problem by providing for the rapid re-affiliation of a weapon to another Soldier (reference reaffiliation of the M240B machine gunner highlighted in Figure 18).

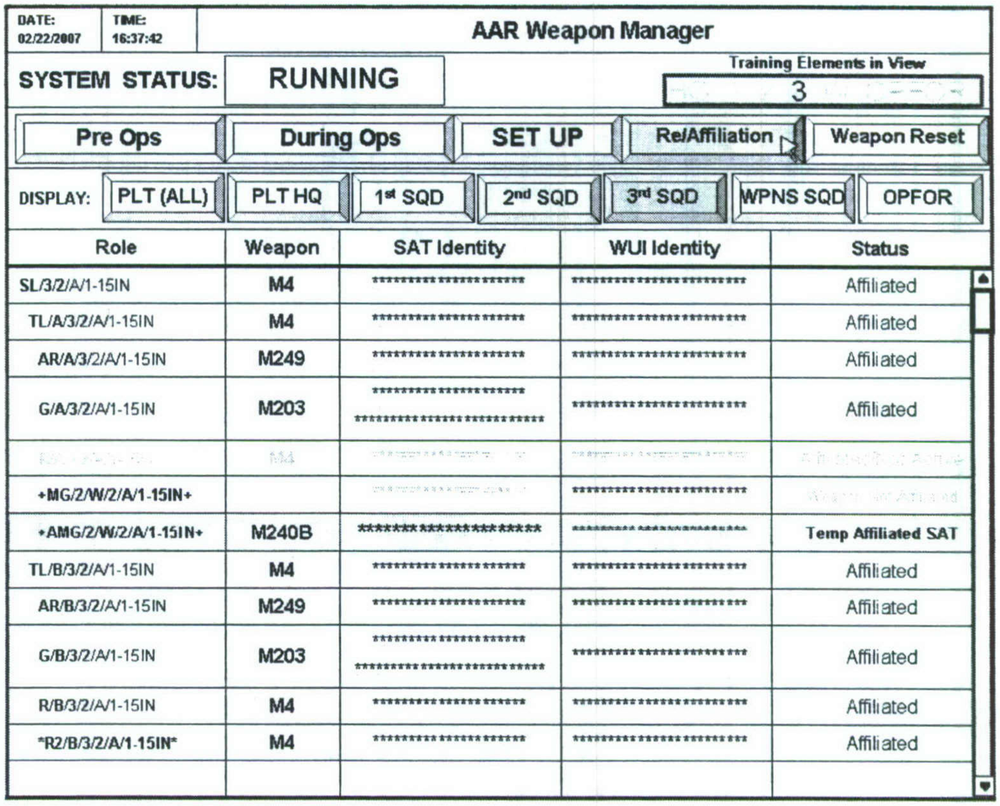


Figure 18. Using the AAR weapon manager to re-affiliate a weapon from a wounded Soldier.

In actual operations, major casualty producing weapons (e.g., machine guns, automatic rifles, and grenade launchers) are quickly retrieved and placed back into the fight if their primary operator becomes immobile or incapacitated. In the example above the Machine Gunner (MG) manning an M240B machine gun has become a casualty. The Assistant Machine Gunner (AMG) has secured the weapon. The trainer has employed the control to re-affiliate the weapon using a drag and drop function from the wounded machine gunner (MG) to the healthy assistant machine gunner (AMG) and selected the **Re/Affiliate** button. Not having this capability with TESS is potentially negative training. Much like the function of the **Send / Reset** function of the ADM described earlier, the trainer has been able to rapidly affiliate a weapon system to a new user. This supplemental tool would assure realism and provide positive training as leaders direct or Soldiers take the initiative to keep more lethal weapon systems in the fight.

A similar capability is required to manage casualties and keep the focus on unit training objectives. Figure 19 provides a prototype menu for Casualty Management during training.

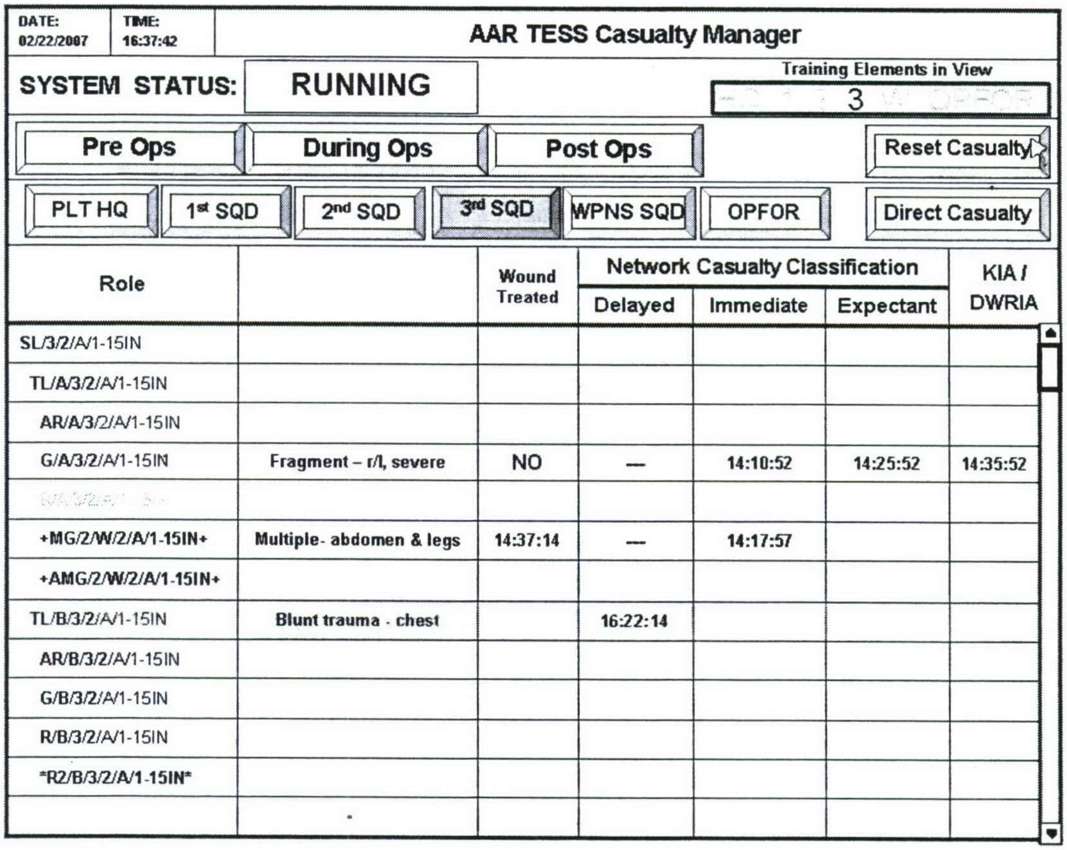


Figure 19. Sample AAR casualty manager menu.

While some casualties will be exercised for their full training value, the trainer may choose to reset a casualty and keep the Soldier in the fight. For example, the squad is consolidating on an objective. The Bravo Team Leader (TL) has become a casualty, but the training value of this event and the fire team's experience is more critical than exercising the TL as a casualty. The trainer can select the TL, then the **Reset Casualty** function. While this clears the TL as a casualty and permits the TL to control the team, it would not prevent discussions during the AAR of how the TL became a casualty or the impact that this loss could have had on the operation.

Likewise, there is value to directing or causing casualties even though the OPFOR might not be immediately available to initiate an engagement. Figure 20 demonstrates how inclusion of this menu and capability could facilitate and enhance casualty training.

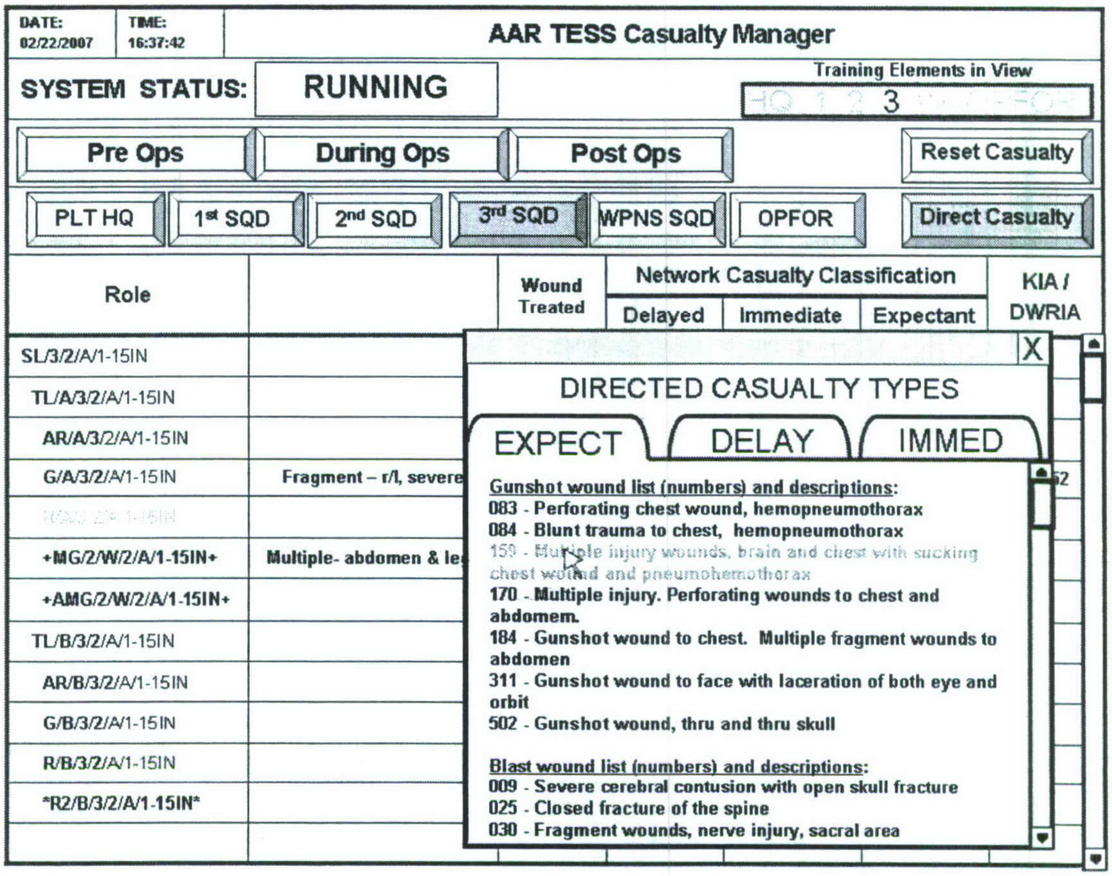


Figure 20. Casualty assessment with the casualty manager menu.

With the GUI in Figure 20, the trainer can select an actual TESS casualty and modify the wound code, or for training purposes designate a specific type of casualty to evaluate casualty handling procedures. The trainer selects an individual and presses the Direct Casualty button (button is shaded in Figure 20). The Directed Casualty Types menu is then displayed and the trainer can select a triage category and type of wound from the menu. The use of standard categories – expectant (requiring immediate highly specialized treatment with a low chance of survival), immediate (requiring emergency treatment but a high chance of survival with therapy), and delayed (requiring treatment by trained personnel but with high chance of survival) – permits latitude for training focus and situation development. The menu would close and the trainer could navigate back to the **During Ops** menu and continue observing.

AAR Post Operations Controls and Sample Displays for the Trainer

The Post Ops Control menu facilitates the rapid review, selection, and preparation of data collected and analyzed during a training mission or vignette. These controls must provide quick access to data that has been identified and captured through the tagging process. The trainer has a short time to review what has been captured, consider and select items, and prepare to facilitate the AAR. As with the CTC AARs discussed earlier, far more data are collected than can or would be used. Trainers must review the data to determine if it provides supporting information or examples. Ideally they should be ready to begin the AAR within 15 to 20 minutes from the exercise pause or the end of the exercise (ENDEX). Experienced military trainers using a ground Soldier system will generally have determined the key training points and where they want to lead the discussion prior ENDEX. They will have observed performance and made some assessments of correct or incorrect actions and determined valid or poor perceptions of participants. While several events may have been tagged, trainers will have insight to the timeframes of particular interest, messages, or data displays that could prove useful during discussions. Much more information will have been developed or be available and archived on their own systems. Based on an initial assessment, trainers may choose to limit the AAR to a limited set of available data. The focus may be on a single or few key or pivotal events, a significant error or departure from accepted tactics or techniques, an exemplar execution, or training objectives pre-selected for the event. The trainer could stop logging and navigate to the Post Operations Control. The Post Operations Control menu shown in Figure 21 provides a trainer with the flexibility to determine the scope and depth of tools to support the AAR.

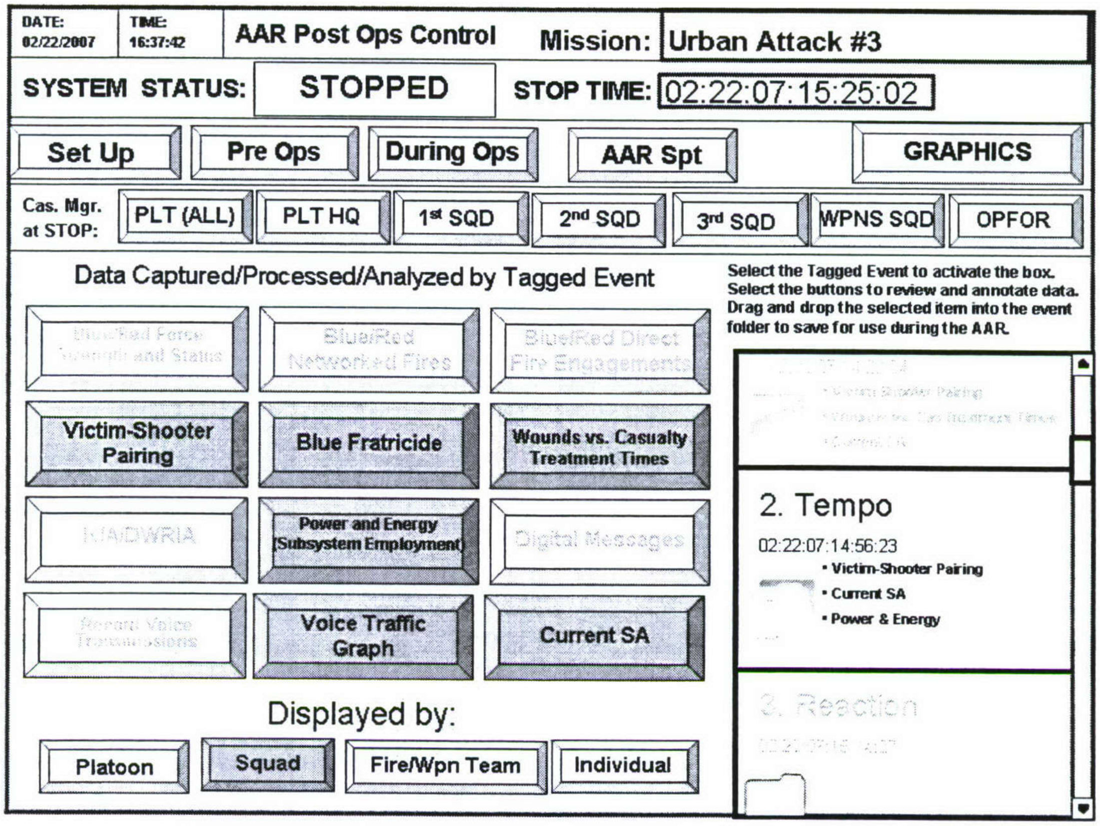


Figure 21. AAR post operations control.

The tool should enable the trainer as the AAR facilitator to pull up messages, orders, overlays or graphics, charts, voice radio recordings, and SA snapshots captured during tagging. The tools should enable a quick review of these items. The supplemental graphics may be used to highlight, mark, and annotate these charts, images, and documents. Some may be discarded, but those of value can be identified and dropped into the folder for reference or future use. This process enables the trainer to segregate or identify selected items for rapid retrieval and display, for transmission for distributed viewing, or for later review. In the example shown in Figure 21, the trainer selects a marked event (corresponding to a Reference Tag in the During Operations Control, Figure 15), and the system displays the data captured for this event that had been selected via the Set-up Display (Figure 14).

Some data may be retained by the trainer as reminders only and some may be retained for backup or detailed discussions beyond the AAR. Figures 22, 23, 24, and 25 provide examples of images and charts that could be prepared for and used during an AAR.

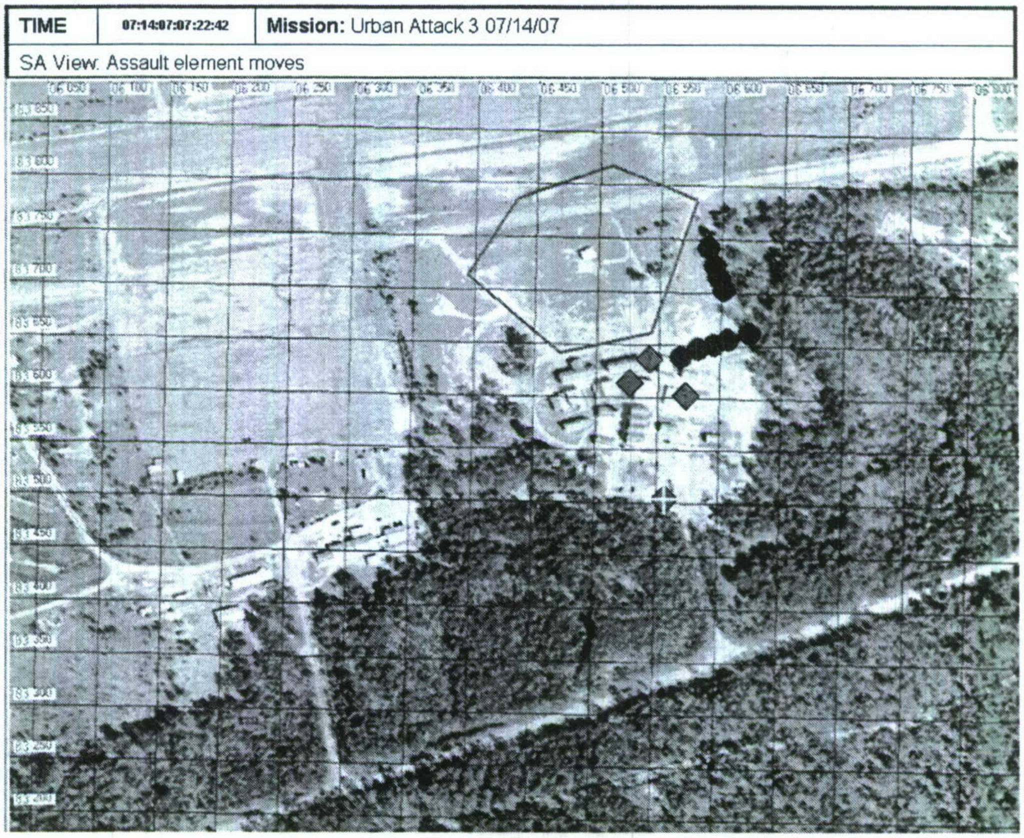


Figure 22. Image capture of an SA snapshot.

An SA snapshot (generated by selecting the "Current SA" button, see Figure 14) captures the locations of the participants at a point in time. The snapshot could support a discussion about what was happening at this point in time, or what was planned to happen. Images like this could be used to determine what went wrong. For example in the image in Figure 22, one fire team is the support by fire element (upper right dark circles). They are situated in the wood line engaging the building as the assault element (the other fire team and the squad leader) rush the building to begin clearing operations. The SA depicts a known enemy element or Soldier to their flank. This may be an error or it may be a deliberate action with suppressive fires being delivered on the enemy position. This SA snapshot would permit discussion of the situation by the squad during the AAR. Unit actions or reactions can be compared to the plan using SA snapshots to refresh the recollections or confirm or refute perceptions of the participants.

Figure 23. Image capture of an SA snapshot comparing the plan to unit actions.

This snapshot in Figure 23 provides an example of comparing what happened to the unit's plan. The squad leader planned a route using waypoints. In this example, the unit's actual route (white circles on top of dark circles in Figure 23) departed by some 75 meters from their planned route (the straight line). This visual depiction of the plan vs. actions could be used to enhance discussions on the reasons for the change, determine who was aware of the change, coordination or permission required to change (if any), and advantages/disadvantages of the actual route used.

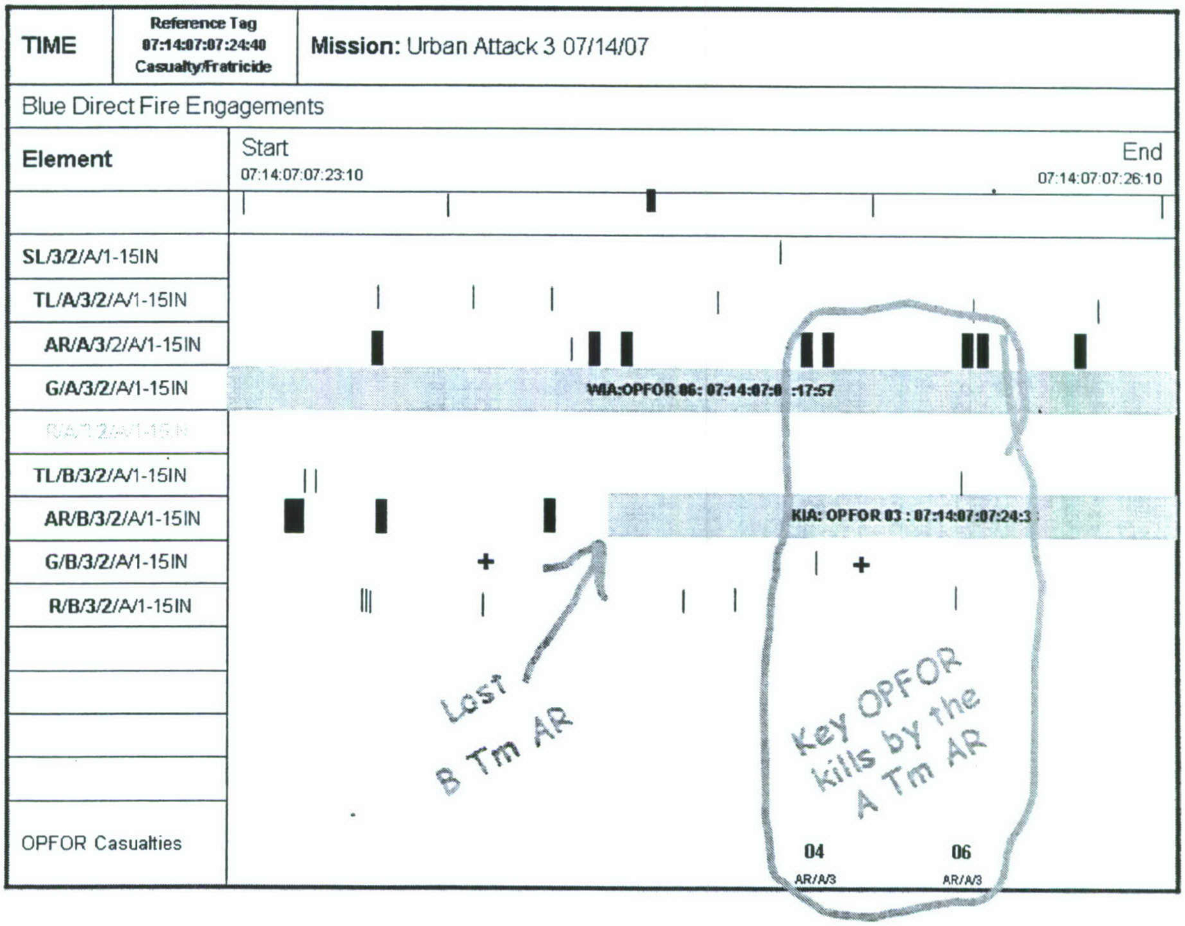


Figure 24. TESS engagement data for Blue direct fire engagements annotated to highlight friendly and OPFOR casualties.

The chart in Figure 24 depicts friendly force engagements and friendly and OPFOR casualties on a timeline. In this example, lone marks indicate single shots fired by Soldiers, bars indicate bursts of machine gun or automatic rifle fire, and plus symbols (+) indicate grenades fired from the M203 grenade launchers. The A Team Grenadier (G) was wounded earlier in the engagement and the B Team Automatic Rifleman (AR) was killed. Of note, the B Team AR Soldier becoming a casualty may have been what triggered the tagging of this event by the trainer or the trainer may have observed the A Team AR move to a location permitting engagement of the position occupied by the two OPFOR aggressors. The trainer could have used but chose not to display other aids to confirm that the A Team AR produced the OPFOR casualties during this engagement. For the display chosen for presentation, supplemental graphics and text, added by the trainer greatly aid in highlighting key discussion points.

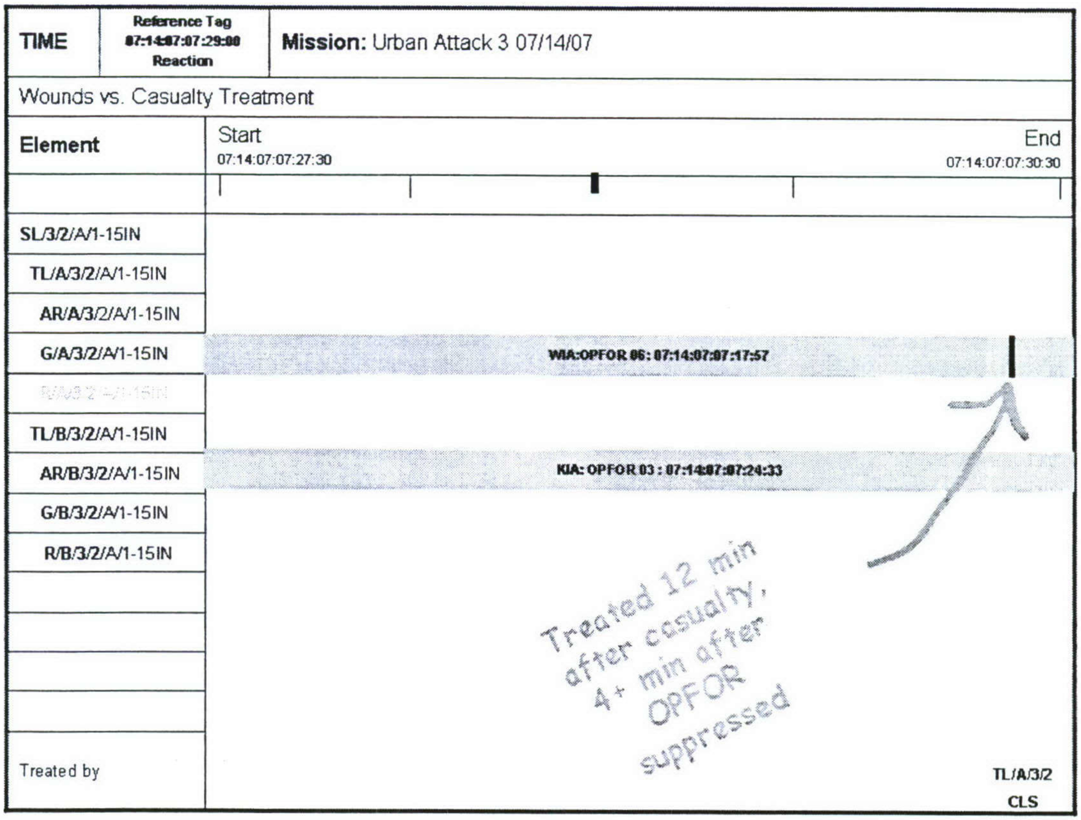


Figure 25. Wound vs. casualty treatment data annotated to show time from wounding and OPFOR suppression to treatment.

The chart in Figure 25 depicts wounds versus casualty treatment for the tagged event. While a different type of display, this chart shows a continuation of the situation depicted in the previous figure and demonstrates value of varied products and multiple event tags. A key training point for the AAR discussion could be that it took the unit 12 minutes to treat the wounded A Team Grenadier. This slow response is mitigated by the indication that the squad was in heavy contact with the OPFOR. Just 4 minutes after the OPFOR was effectively suppressed the Team Leader was able to assess and complete initial treatment of his wounded Grenadier.

During AAR Controls for the Trainer

During the AAR, controls must facilitate rapid retrieval and dissemination of information. Soldier discussions tend to take abrupt turns. Since much of what is stated is based on perceptions, the information coming from the AAR system would be factual and assist in reinforcing correct perceptions or correcting misperceptions. Detailed information available from snapshots and charts may reinforce a statement or help others to understand what happened. Similarly, data from the GSS may be a means of refuting or changing, with images and factual information, a misconception. The trainer should have a menu such as the one in Figure 26 available to allow quick access to various data and displays.

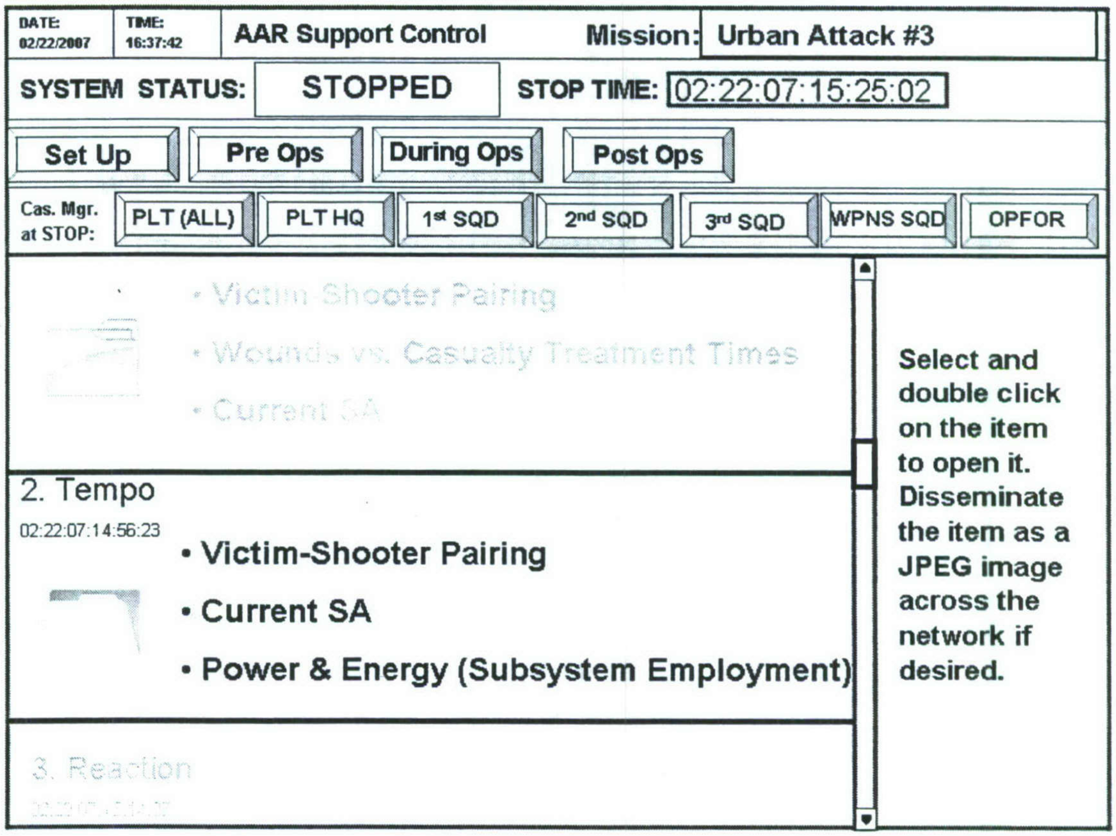


Figure 26. AAR support control.

Items selected can be rapidly distributed, displayed, or played over the network, when the capability exists. However, care needs to be exercised with AAR support and training aids. There may be a tendency to want to use or introduce a document, chart, or image because it has been selected and annotated. However, Soldiers may learn more from listening to peers, hearing leaders, or viewing the actual terrain. An AAR support system merely provides additional tools and aids; it is not a magic solution. The aids should only be used **<u>if</u>** they improve the AAR. Collective performance of a squad relies heavily on individual Soldier task performance. As the old saying indicates, a picture or chart may "be worth 1000 words." AAR aids produced from the digital system have the potential to greatly enhance the discussion, improve understanding, and produce a force better trained to deal with the situations that they may encounter on future battlefields.

Display Devices for AARs

How AAR information can be displayed by the trainer during an AAR should also be considered in system design. Although the design for the GSS is undetermined, system design directly impacts potential AAR tools. While some information and data can be effectively introduced through discussion, much of the information drawn from the GSS can best contribute if it can be observed or viewed by the unit participants. While system design may provide for a projector or screen hook-up for external display, it is doubtful that large display or projection systems would be available in most training areas, particularly for informal AARs at remote locations. Experience indicates that viewing by a nine-man squad would require a 26-inch diagonal screen or larger to view details. However, the basic capabilities of the GSS should provide the needed dissemination and viewing capabilities for training aids.

The CDD implies that Soldiers and leaders will have a wearable processor. Access to the information on the processor may be viewed by way of a helmet mounted display (HMD), a protective eyewear/goggle-mounted display (GMD), or, as in the case of the PDA used by the FFW Basic System, a built-in screen on the processor or wearable display device. If all participants are equipped with a viewing capability, only minor accommodation would be required to transmit training aids over the network in an image format. Soldiers and leaders could then review AAR training aids on their own system. The facilitator/trainer could use supplemental, John Madden-type, graphics or simple highlights to focus the viewers' attention to key information on messages and orders, overlays, charts, and images. With networked voice communications, the AAR could be conducted with troops being dispersed at varied locations across the training area. While it is most likely that rifle squads would still huddle for their AAR, a platoon AAR could be conducted with subordinate squads at or near mission locations. This would save training time, facilitate incremental pauses, and permit quick resumption of training after the AAR. It could also facilitate other training or retraining with Soldiers and units being able to see, first hand during a brief pause, an error in a technique or reinforce a technique or tactic that was well executed.

Should final designs not include a processor and viewing device on all Soldiers, the AAR support system could provide enhanced electronic note cards and reminders for the AAR facilitator on his body-worn system. It would then fall to the facilitator to introduce these details through group discussions. Without broad dissemination or viewing by all participants, it is doubtful that an embedded review support system would alter the AARs currently conducted by squads and platoons. The value that the AAR provides would be based on the experience of the facilitator as a leader and trainer.

Summary

AARs are a means of enhancing small combat unit training to improve, sustain, or enhance the proficiency of individual and collective tasks and skills, teamwork, and develop leaders. TESS, the dedicated instrumentation capabilities at the CTCs, and systems associated with virtual simulations have demonstrated the ability to view, capture, analyze, and playback data generated during training exercises. When appropriately integrated into the AAR process, these data enhance the process, focus follow on training, and have demonstrated the ability to improve unit performance.

The fielding of a future digital system such as the GSS to the dismounted Soldier provides the capability to enhance battle command, situational awareness and understanding, and embedded training capabilities, as well as lethality, survivability/force protection, mobility, and sustainability. A potential aspect of ET is that with minimal modifications or accommodations to body-worn computer software, processing, and storage, engagement and operational data can be effectively captured and displayed or replayed to support the AAR process in GSS-equipped units. The GSS CDD provides requirements for this capability but does not stipulate the details of how this capability can be recognized or implemented.

The analysis and the resulting products were based on a relatively extensive body of previous work and Army training doctrine. This included work with AAR aids and tools used in face-to-face AARs and with simulations; work with dismounted Soldier systems; technical advances in capturing, storing, and displaying information via body-worn computers; Army training doctrine on AARs; the expertise of experienced OCs; and personal experience of the authors with dismounted Soldier systems and in conducting small-unit AARs. A point of special emphasis in this approach was to consider tools from the perspective of the small combat unit leader or trainer. Specifically, the tools needed to provide a system that is easy to operate, support the task of the trainer as an observer, provide the means to quickly review and prepare data for the review, and permit rapid dissemination or display of training/discussion aids.

Experimentation during the FFW ADT demonstrated the feasibility of implementing the GSS CDD requirements into a surrogate system and provided insights to enhancements that positively impact on realism in training. With this success, a need existed to move beyond the proof of concept and recommend a suite of tools that could be used to fully implement GSS CDD requirements. This concept of defining tools in the form of controls and menus departed from the frequently used method of writing detailed hardware or software specifications. Providing specifications have sometimes resulted in systems that perform to the letter of the detailed specification but fall short of providing an integrated, easy to use product.

The product of this analysis was a concept for an embedded software system that addressed the necessary AAR functions with a series five basic interactive control menus to be used by the small-unit trainer. These menus permit the trainer to organize information on unit members and create a file for the training event, specify the data to be captured, create alarms to enhance observation, tag events, review data, and support viewing or replay of information during the AAR. Two additional controls provide the capability to manage TESS systems and casualty data to enhance exercise realism. A graphics tool was identified to assist in the preparation of AAR aids. Only one of the five control menus was designed to be used during mission execution, thus reducing the load on the trainer to log or key-in data during the mission itself. The other control menus were designed to specify the data required prior to the mission and to enable quick summaries after the mission. All proposed concepts are technically feasible. While AAR displays were not the primary focus of the effort, some exemplar displays were developed to assist in determining display attributes that support the small combat unit AAR process.

The end result was a logical series of tools that could be embedded in a ground Soldier system to assist the trainer in leading an AAR; not to replace the trainer. They enable the trainer to assist the unit in determining **what was supposed to happen**, in identifying strengths and weaknesses by determining **what happened,** and in determining **why it happened and how to improve**. They can assist the unit and the unit leadership in identifying ways to improve substandard performance and in sustaining acceptable performance.

References

Campbell, C. H., Knerr, B. W., & Lampton, D. R. (2004). *Virtual environments for Infantry Soldiers* (ARI Special Report 59). Alexandria, VA: U. S. Army Research Institute for the Social and Behavioral Sciences. (DTIC No. AD-A425 082)

Department of the Army. (1993a). *A leader's guide to after-action reviews* (TC 25-20). Washington, DC: Author.

Department of the Army. (1993b). *LW Mission Need Statement*. Ft. Benning, GA: Author.

Department of the Army. (1993c). *Multiple Integrated Laser Engagement System (MILES) Casualty Cards* (GTA 8-11-014). Washington, DC: Author.

Department of the Army. (2003). *Battle focused training* (FM 7-1). Washington, DC: Author.

Dyer, J.L., Wampler, R.L., Blankenbeckler, P.N. (2005). *After-action reviews with the Ground Soldier System*. (ARI Research Report 1840). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A438 040)

Gaines, J. R. (2007). Washington & Lafayette: Almost inseparable in wartime, the two generals split over a virtual question: Should revolutionary ideals be imposed on others?. *Smithsonian Magazine*. Retrieved December 11, 2007, from http://www.smithsonianmag.com/history-archaeology/washington_main.html?c=y&page=2

Gately, M. T., Watts, S. M., Jaxtheimer, J. W., & Pleban, R. J. (2005). *Dismounted Infantry decision skills assessment for virtual dismounted infantry simulations.* (ARI Technical Report 1155). Alexandria, VA: U. S. Army Research Institute for the Social and Behavioral Sciences. (DTIC No. AD-A432 164)

General Dynamics C4 Systems, Battle Management Systems Division. (2007). *After action review (AAR) data manager (ADM) user's guide for Future Force Warrior (Increment 2) Embedded Training Application*. Scottsdale, AZ: Author.

Hall, G. (2005). *S2Focus™*. Orlando, FL: General Dynamics C4 Systems, Advanced Distributed Simulation Systems (ADSS).

Hall, G., Dyer, J.L., Wampler, R.L., Blankenbeckler, P.N., Bloomquest, R., & Cheves, R. (2005). *Embedded training technical memo* (Future Force Warrior Work Product 24). Scottsdale, AZ: General Dynamics C4 Systems, Battle Management Systems Division.

Herold, E. J., Sanzotta, M. A., & Everitt, T. W. (2000). Fire support training in the CCTT. *Field Artillery Magazine*. Retrieved December 11, 2007 from http://sill-www.army.mil/FAMAG/2000/SEP_OCT_2000/SEP_OCT_2000_PAGES_42_45.pdf

Historic Valley Forge Web site. (2007). Who served here?. Retrieved December 11, 2007 from http://www.ushistory.org/valleyforge/served/steuben.html

Knerr, B.W., Lampton, D.R., Crowell, H.P., Thomas, M., Comer, B.D., Grosse, J.R., et al. . (2002). *Virtual environments for dismounted Soldier simulation, training, and mission rehearsal: Results of the FY 2001 culminating event* (ARI Technical Report 1129). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A403 147)

Knerr. B. W., Lampton, D. R., Martin, G. A., Washburn, D. A., & Cope, D. (2002). *Developing an after action review system for virtual dismounted infantry simulations.* Proceedings of the 2002 Interservice/Industry Training, Simulation and Education Conference. Orlando, FL.

Knerr, B.W., Lampton, D.R., Thomas, M., Comer, B.D., Grosse, J.R., Centric, J.H., et al. (2003). *Virtual environments for dismounted Soldier simulation, training, and mission rehearsal: Results of the FY 2002 culminating event* (ARI Technical Report 1138). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A417 360)

Morrison, J. E., & Meliza, L. L. (1999). *Foundations of the action after review process* (Special Report 42). Alexandria, VA: U. S. Army Research Institute for the Social and Behavioral Sciences. (DTIC No. AD-A250 699)

U.S. Army Training and Doctrine Command (TRADOC). (25 September 2006). *Capability Development Document (CDD) for the Ground Soldier System (GSS), Version 1.1.* Ft. Monroe, VA.

APPENDIX A

LIST OF ACRONYMS

AAR	After Action Review
ADM	AAR Data Manager
AMG	Assistant machine gunner
AR	Automatic rifleman
ATD	Advanced Technology Demonstration
BC	Battle command
C^2	Command and control
C^4I	Command, control, communications, computer, and intelligence
CCTT	Close Combat Tactical Trainer
CDD	Capability Development Document
CLS	Combat lifesaver
COA	Course of action
CTC	Combat Training Center
DA	Department of the Army
DIVAARS	Dismounted Virtual AAR System
EDL	Engagement Data Logger
ENDEX	End of exercise
ET	Embedded training
FFW	Future Force Warrior
FM	Field Manual
G	Grenadier
GMD	Goggle-mounted display
GPS	Global positioning system
GSS	Ground Soldier System
GUI	Graphic user interface
HMD	Helmet-mounted display
JCF AWE	Joint Contingency Force Advanced Warfighting Experiment
JRTC	Joint Readiness Training Center
KPP	Key Performance Parameter
LAN	Local area network
LW	Land Warrior

METT-TC	Mission, enemy, terrain, troops, time available, and civilian considerations
MG	Machine gunner
MILES	Multiple Integrated Laser Engagement System
NCO	Noncommissioned Officer
NTC	National Training Center
OC	Observer/Controller
OneSAF	One semi-automated force
OPFOR	Opposing Force
OPORD	Operations order
PAN	Personal area network
PDA	Personal digital assistant
PL	Platoon Leader
POW	Prisoner of War
PSG	Platoon Sergeant
PSM	Physiological Status Monitor
SA	Situational Awareness
SAF	Semi-automatic forces
SAT	Small arms transmitter
SBCT	Stryker Brigade Combat Team
SIMNET	Simulation Network
SL	Squad Leader
TADSS	Training aids, devices, simulators, and simulations
TAF	Tactical Analysis Facility
TESS	Tactical Engagement Simulation System
TL	Team leader
TLP	Troop leading procedure
TTP	Tactics, techniques, and procedures
TRADOC	U.S. Army Training and Doctrine Command
UAV	Unmanned aerial vehicle
UGV	Unmanned Ground Vehicle
WPNS SQD	Weapons squad