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Platoon-Level After Action Review Aids in the SIMNET Unit Performance Assessment System

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U.S. Army Research Institute

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The networking of simulators provides a means of conducting collective training that supplements field exercises. The effectiveness of this training depends, in part, on the quality of feedback units receive during After Action Reviews (AARs). ARI developed a prototype PC-based Unit Performance Assessment System (UPAS); its object was to support the conduct of AARs and provide a tool for training effectiveness research by collecting and analyzing data broadcast over the simulation network. The UPAS loads network data into a relational database patterned after the National Training Center database, and it provides menus of data summary table and graph options for examining these data. In addition, the prototype UPAS replayed exercises from a bird's-eye view over a grid map.

This report describes the effort to improve the UPAS to support training feedback and research more effectively, with emphasis on training at the armor platoon level. A threefold increase in the number of Mission Training Plan standards addressed by UPAS was gained by the design and software implementation of UPAS AAR aids that integrate network data with data on terrain features and unit mission

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plans. The addition of tactical communications to one of these AAR aids, the Exercise Timeline, will further increase the number of standards addressed by the UPAS.

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FOREWORD

The networking of combat vehicle simulators, as illustrated by SIMNET, provides a method for collective training that supplements field exercises. To realize the training potential of this "electronic battlefield," trainers must be provided with tools to use in identifying and illustrating key events during postexercise After Action Reviews (AARs). As a first step in meeting this need, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) developed a PC-based Unit Performance Assessment System (UPAS) to collect data on vehicle status and firing events broadcast over the simulation network. This report describes the procedures and outcome of an effort to design graphic UPAS AAR aids that integrate network data with other sources of information to provide a more complete picture of unit performance than is possible with network data alone.

This research has been used as input to develop a joint service standard for distributed interactive simulation that addresses unit performance measurement and feedback systems. The software implementation of the UPAS AAR aids designed under this project are undergoing user testing by trainers at the Combined Arms Tactical Training Center, Fort Knox, Kentucky.

The work described in this report is a portion of the research task, Training Requirements for Combined Arms Simulators. This task supports a memorandum of agreement entitled "The Effects of Simulators and Other Resources on Training Readiness," signed 16 January 1989. Parties to this agreement are the U.S. Army Training and Doctrine Command, the U.S. Army Center at Fort Knox, the U.S. Army Materiel Command, and ARI.

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Technical Director

PLATOON-LEVEL AFTER ACTION REVIEW AIDS IN THE SIMNET UNIT PERFORMANCE ASSESSMENT SYSTEM

EXECUTIVE SUMMARY

Requirement:

The networking of simulators provides a means of conducting collective training that supplements field exercises. To take advantage of the training potential of networked simulators, the Army just ensure that units receive prompt quality feedback during postexercise After Action Reviews (AARs).

A previous effort by the U.S. Army Research Institute for the Behavioral and Social Sciences produced a prototype PC-based Unit Performance Assessment System (UPAS) that collects data on firing events and vehicle status from simulation networking (SIMNET) exercises, loads these data into a relational database, and provides tools for analyzing these data using original or predefined graphs and tables. The prototype UPAS includes a plan view display that replays an exercise from a bird's-eye view. The goal of the work described in this report was to modify and expand the prototype UPAS to support platoon-level AAR more effectively.

Procedure:

The prototype UPAS was assessed in terms of its ability to meet four criteria for a performance feedback system in the SIMNET environment: capability to integrate data from diverse sources; capability to help a trainer identify and illustrate key exercise events quickly; capability to support multiechelon AARs; and flexibility. Concepts for improving the plan view and creating additional AAR aids were designed and implemented in software.

Findings:

Roughly 36% of the Armor Platoon Mission Training Plan standards supported by SIMNET require integrating the network data collected by the UPAS with data on the terrain situation, unit plans, tactical communications, and observable behaviors of soldiers. We identified the need to develop AAR aids that support the integration of network data with other data sources. In addition, the prototype plan view failed to meet the criterion of supporting rapid identification and illustration of key exercise

events because moving from one point in time of the exercise to another was a slow process.

Concepts were designed to improve the plan view and implement three new types of AAR aid formats: a battle flow chart to trace a unit's movement over the course of an exercise, battle snapshots to provide static bird's-eye views of the battlefield at discrete points in time, and an exercise timeline to provide information about temporal relationships among the application of control measures, movement, and firing events.

The new plan view, battle flow chart, and snapshot were used to integrate terrain and planning data with network data. The grid map display for these aids includes major terrain features and unit control measures from the unit's operations order. A quick search capability was added to these aids to allow the user to move quickly to points of interest within the exercise.

The exercise timeline is a separate display that indicates when a unit crosses a control measure, halts, starts moving, receives indirect fire, first receives enemy direct fire, sustains a casualty, first fires on the enemy, and destroys an enemy vehicle. Friendly firing events cued by enemy firing events, compliance of movement with control measures, and movement rate are performance aspects that can be assessed with the timeline.

The exercise timeline and the battle flow provide means of identifying key exercise events and the time of their occurrence. Additional information about these events can be gained from the plan view or battle snapshots, as appropriate, once the time and nature of key events have been identified.

Utilization of Findings:

These findings will be used to ensure that the UPAS supports timely and effective AARs at the end of SIMNET exercises. They are applicable to future generations of networked simulators, such as the Close Combat Tactical Trainer, and they are applicable to the design of a feedback system for collective embedded training. Finally, these findings will support the conduct of training research in the simulation networking environment, including the development of improved tools for controlling the behavior of Semi-Automated Forces (SAFOR).

PLATOON-LEVEL AFTER ACTION REVIEW AIDS IN THE SIMNET UNIT PERFORMANCE ASSESSMENT SYSTEM

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Introduction

Simulation Networking (SIMNET)

The networking of combat vehicle simulators provides a method for training crews to work together as part of a unit and training units to work together as part of a larger organization (U.S. Army Armor School, 1989a; Thorpe, 1988). Information produced by each simulator, such as its location on the terrain database and the target location of each firing engagement, is broadcast over a network and picked up by other simulators. A computer graphics generator with each simulator is able to reconstruct a realtime "out the window" picture of the battlefield using broadcast data and data from a common terrain database. The initial application of networked simulators, SIMNET, was developed by the Defense Advanced Research Projects Agency and included simulators for armor and mechanized infantry vehicles (Thorpe, 1988). Rotary wing aircraft were subsequently added to the SIMNET family in a project referred to as Airnet.

The goal of networking simulators is to support collective training rather than individual skills or gunnery training. This restricted goal allows SIMNET to avoid certain costly options, such as a high-resolution graphics generator. For example, while SIMNET may lack the fidelity required to use it to train individual gunnery skills (Drucker and Campshure, 1990), it appears to be capable of supporting certain collective training requirements such as training a unit how to use a volume of fire to cover the movement of another friendly unit (Burnside, 1990).

The cost of using SIMNET is also kept low, relative to that of field-based exercises, by employing Semi-Automated Forces (SAFOR). SAFOR can be used in the roles of threat forces or friendly forces (Mullally, Petty, and Smith, 1991). The SAFOR function allows an operator to control a large number of simulated vehicles. This feature offers the benefit of reducing the training support personnel costs associated with collective training and adds further to the overall cost-effectiveness of SIMNET.

Purpose of Report

This report describes a project designed to develop a SIMNET Unit Performance Assessment System (UPAS) to help trainers provide units with feedback during platoon-level After Action Reviews (AARs). This report describes

- the AAR concept;

- training device innovations such as SIMNET, that facilitate application of the AAR concept;

- the need for a product like UPAS to support AARs in the SIMNET environment;

- the initial prototype UPAS;

- the process and outcome of an effort to define requirements for improving the UPAS to address training requirements more effectively;

- UPAS improvements made in response to these requirements;

- potential applications of the improved UPAS to tasks other than supporting SIMNET AARs.

The After Action Review (AAR) Concept

The AAR is an interactive process in which exercise participants discuss mission planning and execution under the guidance of an AAR leader (Scott, 1983; Scott and Fobes, 1982; Meliza, Sulzen, Atwood, and Zimmerman, 1987; Downs, Johnson, and Fallesen, 1987). During AARs, exercise participants acquire information about how to improve their performance through the process of "discovery learning."

The AAR focuses on critical events having a direct influence on mission outcome (Scott, 1983; Scott and Fobes, 1982; Meliza et al., 1987), rather than addressing all possible measures of performance that apply to an exercise. For example, a platoon's mission might be to provide covering fire for a unit conducting an assault. If the platoon does not provide adequate covering fire during the assault, then it has failed its mission. Identifying the critical events that led to this failure serves to define specific corrective actions. Further, linking critical events and corrective actions to mission outcome serves to increase their credibility in the eyes of exercise participants.

The AAR should result in concrete suggestions for correcting performance (Downs et al., 1987). During an AAR, a platoon might find that it was late in providing covering fire for an assault. Further discussion may lead to the conclusion that tardiness in firing was due to the fact that the platoon was not in a position to observe the start of the assault and the unit's plan did not provide a mechanism for coordinating the timing of suppressive fires with the start of the assault. The AAR, in this case, points the way to specific corrective actions. In comparison, if the platoon is told merely that it failed to provide covering fire, then corrective actions are not clearly defined.

In preparing for an AAR, the leader identifies critical events that made substantial contributions to mission outcome and diagnoses unit strengths and weaknesses that led to these events.

During the AAR, the AAR leader guides the discussion to ensure that key events and their causes are discussed. Ideally, the AAR leader will have AAR aids to illustrate exercise events and their causes. In the example of a platoon providing covering fire for an assault element, these AAR aids might include a graph showing the volume of fire delivered by the platoon as a function of time and a figure showing intervisibility between the platoon and the assault force.

Training Device Innovations That Facilitate Application of the AAR Concept

Three major innovations in training devices have facilitated application of the AAR concept; realistic simulation of weapon effects, instrumented ranges, and the networking of simulators. These innovations combine to facilitate the AAR concept by

- providing a credible mission outcome around which an AAR can be developed;
- employing electronic data that can be used to prepare AAR aids; and
- increasing the opportunity for units to train by reducing the cost of training.

Each of these innovations is discussed below.

The Army's move towards realistic simulation of weapon effects in force-on-force exercises began with REALTRAIN (or Scopes) and continued with the Multiple Integrated Laser Engagement Simulation (MILES). REALTRAIN employed a procedure whereby numbers on the helmets of enemy soldiers or vehicles had to be identified (using scopes affixed to weapons) and called out by the firing element in order for a casualty to be assessed. MILES replaced this cumbersome system with eye-safe lasers and detector belts, but REALTRAIN was used to test the training effectiveness of engagement simulation per se. Units trained with REALTRAIN and the AAR technique performed better than conventionally trained units in terms of mission accomplishment, casualty exchange ratios, and process-oriented measures of team performance (Meliza, Scott, and Epstein, 1979; Scott, Meliza, Banks, and Hardy, 1979). The use of engagement simulation helps to ensure that there are credible outcomes of training exercises on which to base an AAR.

The development of instrumented ranges was the second innovation to support the AAR concept. Instrumented ranges collect time-tagged position location, firing event, and casualty data from vehicles on a near continuous basis. The U.S. Army's National Training Center (NTC) at Fort Irwin, California, is an instrumented range used to train units up to brigade slice level.

The Precision Range and Integrated Maneuver Exercise (PRIME) is an instrumented range used to train platoons at Fort Hood, Texas. The position location, firing event, and casualty data collected automatically within these ranges are used in preparing AAR aids after NTC (Meliza et al., 1987) and PRIME exercises (Witmer, 1990). The benefits of these ranges can be better appreciated when one considers the cost of trying to collect these time-tagged data using trained data collectors. Collecting these data during the REALTRAIN validation for Armor/Anti-Armor units required a data collector on each vehicle in the exercise and a mapper to follow each unit (Scott, Meliza, Hardy, Banks, and Word, 1979). Such a large commitment of personnel to data collection is not cost-effective.

The networking of simulators was the third innovation to support the application of the AAR concept. SIMNET offers the greatest potential for instrumented data collection, because the training exercise takes place in an electronic environment. SIMNET incorporates the first two innovations supporting AARS described above, and goes beyond these innovations to provide data that are not currently collected on instrumented ranges in an automated fashion. For example, SIMNET makes it possible to monitor fuel levels, ammunition levels, weapon system orientation, and engine speed throughout an exercise.

In order to make use of more realistic weapons' effects and electronic data to facilitate AARs, units must be first given the opportunity to train. The high cost of training using operational equipment, combined with severe limitations in the availability of training resources, acts to reduce opportunities for unit tactical training. In addition to providing realistic weapons' effects and electronic data to prepare AAR aids, SIMNET offers the advantage of addressing problems in training costs and resource availability. Since SIMNET does not employ operational equipment, it provides a savings in terms of fuel expenditures and reduced wear and tear on operational equipment. Further, SIMNET requires fewer personnel to support training exercises, because SAFOR can be used to play the role of both threat forces and friendly forces. Finally, the capability of SIMNET to employ terrain databases from a wide variety of training areas addresses the need for more varied terrain and larger training areas that face units when conducting unit tactical training at their home station.

The Prototype Unit Performance Assessment System

SIMNET has powerful tools for observing replays of unit performance during AARs (Thorpe, 1988). These tools include a "Stealth Vehicle" that provides an "out the window view" of the action from any point on the battlefield and a Plan View Display that allows the action to be observed from a bird's-eye view. However, use of these tools requires knowing when critical events occurred in order to navigate through the replays effectively.

In addition, problems arise in using a single Plan View and Stealth to host AARs when multiple exercises are conducted at the same time, or when exercises are conducted at company level and above. The latter situation creates a problem in that AARs should be conducted for each echelon participating in the exercise, one at the highest unit level and one for each subordinate unit.

ARI recognized the need for low cost, personal computer-based (PC-based) methods for analyzing data from SIMNET exercises and initiated development of the UPAS (White, McMeel, and Gross, 1990). Figure 1 provides a graphic summary of the components of the prototype UPAS. The system collects data packets from the simulation network and uses these packets to drive a replay of the exercise from a bird's-eye view. The system also extracts a copy of the data in the packets and loads these data into a relational database management system. Once these data are in the database, they can be analyzed using Structured Query Language or SQL (XDB Systems, Inc., 1990). Graph and table editors within the UPAS can be used to create a menu of graph options and a menu of table options. Each of the major components of the UPAS are described below.

Network Data Packets and Their Collection by the UPAS

UPAS collects virtually all of the data packets broadcast over the simulation network regarding vehicle status and firing events and loads these packets into a raw data file. The types of time-tagged packets are described below.

- The Vehicle Appearance Packet provides the information needed to simulate continually the position and appearance of each vehicle in SIMNET. The information contained in this packet includes the vehicle ID, bumper number, a force identifier (1 for BLUFOR and 2 for REDFOR), the elevation of the vehicle, the turret azimuth, the gun elevation, the appearance (live or burning), the type of vehicle, the location of the vehicle, the speed of the vehicle, the speed of the engine, and the direction of the vehicle. Figure 2 illustrates what one of these packets looks like when viewed through the UPAS Packet Display feature.

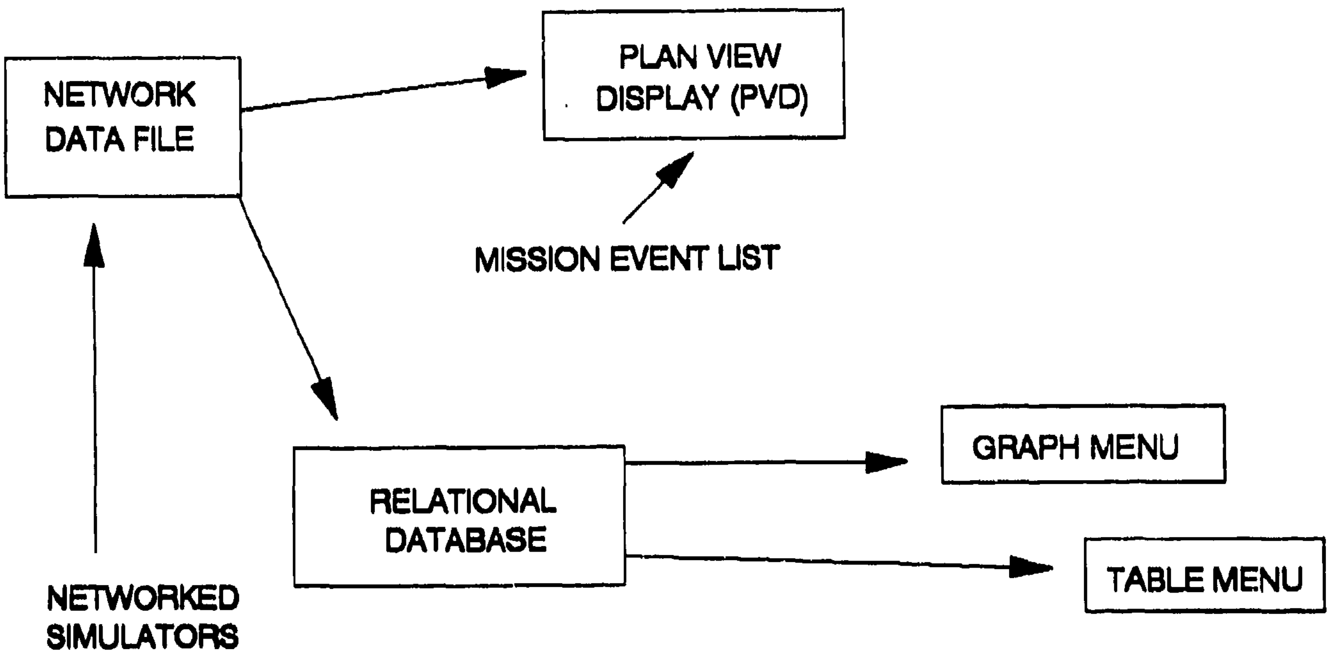


Figure 1. Overview of major components of the prototype UPAS.

- The Vehicle Status Packet contains information about a vehicle other than that required to simulate the outward appearance of the vehicle. This information includes: the volume of fuel in each of the vehicle's tanks; the total number of ammo rounds available; the odometer reading; the type of vehicle; a rating of the mobility, fire power, and communications status of the vehicle as operational or non-operational.

- The Fire Packet identifies the target (if known), the type of ammunition used, the firing vehicle ID, the location of the gun muzzle, the type of fire, the number of rounds fired, and the rounds fired per second.

- The Indirect Fire Packet identifies the location of an indirect fire mission impact, the result of the impact, the type of ammunition employed, and the number of rounds fired.

- Impact Packets describe the ground impact or vehicle impact resulting from a firing event. These packets indicate the location of the impact, the distance from the muzzle to impact, the number of rounds, and the number of rounds per second, the ID of the firing vehicle, and the type of ammunition used. If the packet describes a vehicle impact, it also includes the ID of the target vehicle.

- The Status Change Packet describes changes in the status of a vehicle resulting from damage by a direct or indirect firing event. This packet identifies the vehicle whose status if changed, the vehicle causing the change, and the nature of the change.

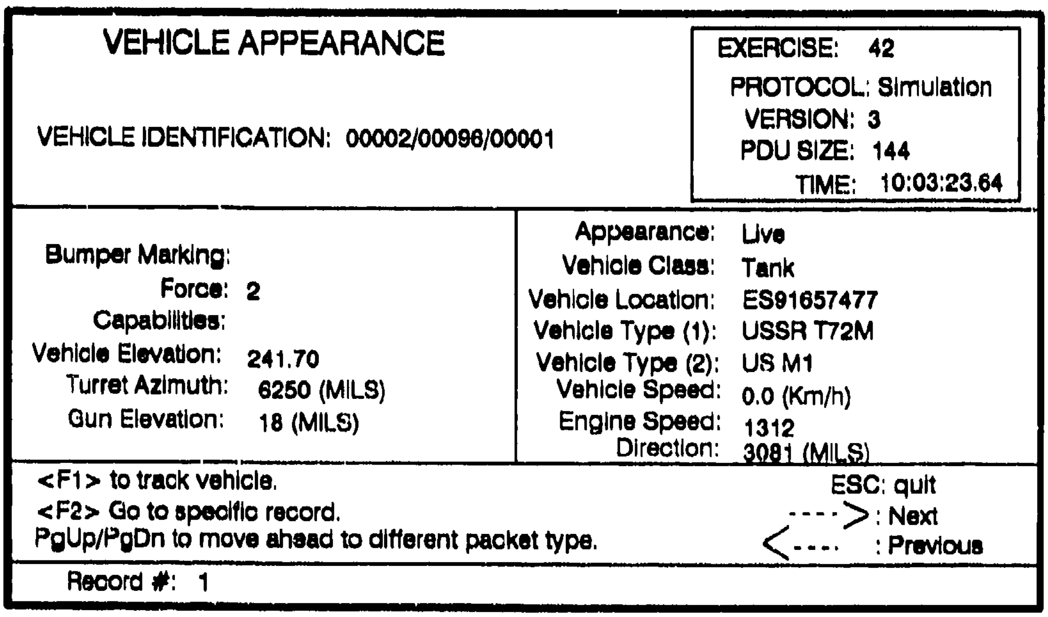


Figure 2. Sample Vehicle Appearance Packet from a SIMNET exercise.

A SIMNET exercise is capable of generating a large number of packets. For example, a short ten minute exercise with firing events may generate thirty thousand or more packets. Most of these packets are Vehicle Appearance Packets, because one of these packets is generated by each vehicle at one second intervals.

Plan View Display

The raw data file can be used to replay the mission or critical segments of the mission from a bird's-eye view using a Plan View Display as illustrated in Figure 3. Tactical vehicles are represented by rectangular icons for which weapon system orientation is indicated by a line representing the gun tube. Friendly blue force (BLUFOR) vehicles are represented by blue rectangles, and enemy red force (REDFOR) vehicles are represented by red rectangles. Each time a vehicle fires, it brightens in color briefly. Vehicles that become casualties change color permanently (blue to cyan and red to white). The exercise is replayed over a grid map lacking terrain features.

The prototype Plan View allows the user to magnify the battlefield. The first screen displayed after initiating the Plan View covers an area 16 kilometers by 8 kilometers. The user has the option of limiting the area covered by the display to an area 1 kilometer square, so that the area is magnified by a factor of 128. Intermediate levels of magnification may also be used.

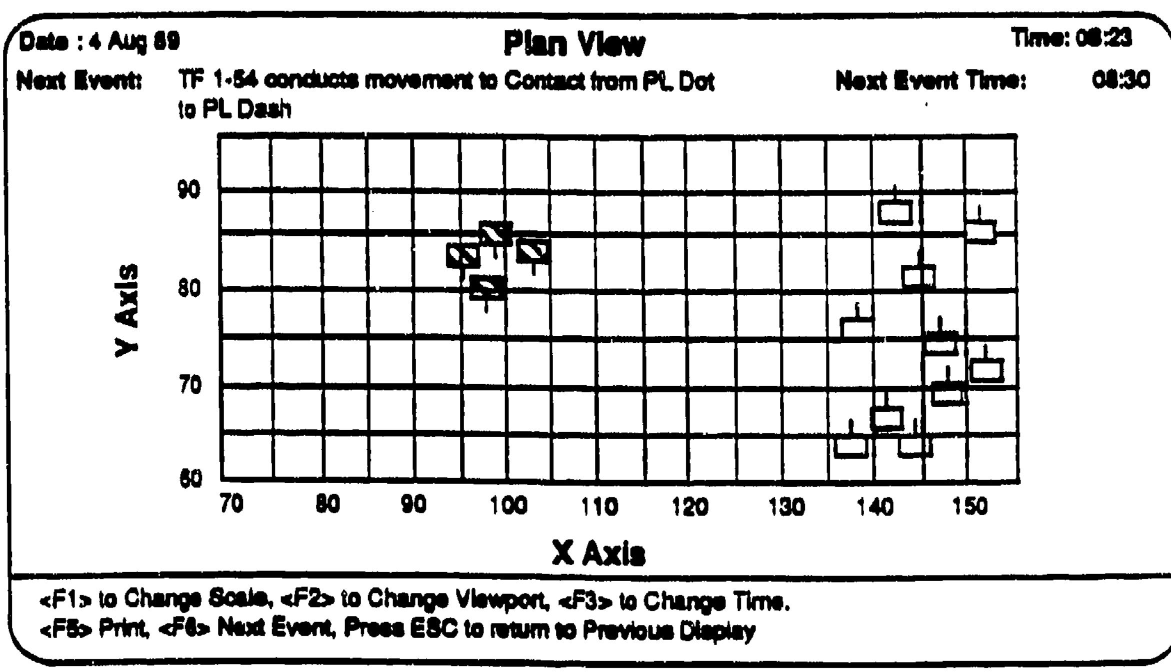


Figure 3. Prototype Plan View Display.

The Plan View is linked to a feature called a Mission Event List that helps the user to navigate through the replay of an exercise. A Mission Event List screen allows the user to type in key time-tagged events from the unit's operations order, as illustrated in Figure 4. During the replay of the exercise using the Plan View, the user can press the <F6> key to move to the next time-tagged event in sequence. In addition, the user can move to a particular point in time in an exercise by pressing the <F3> key and typing in the new time to which the user wants to move.

Master Event List

Event	Time
Move out of assembly area	06:30
Cross Line of Departure	06:45
Cross Phase Line Dog	07:10
Reach Assault Position Falcon	07:30

<F1> Save Change and Exit <F4> Append
<F2> Edit <F9> Delete
<F3> Insert <ESC> Exit Without Change

Figure 4. Mission Event List screen for loading data on time-tagged events from the unit's operations order.

<u>Data Conversion to a Relational Database</u>

The UPAS contains an utility that converts the raw data and loads them into a relational database. Once the data are in this database, they can be analyzed by non-programmers using Structured Query Language (SQL).

The design of this database is patterned after the NTC Archive database, and thus it is referred to as the SIMNET/NTC database. In terms of the number of data tables, the SIMNET/NTC database is a subset of the NTC Archive database. For example, the NTC database contains a Minefield Casualty Assessment Table that is not included in UPAS, because minefields are not played in SIMNET. On the other hand, certain of the SIMNET/NTC Tables in UPAS contain information that is unique to SIMNET. Tables 1 and 2 indicate the information contained in two tables common to the two databases, Ground Position Location Table and Paired Event Table. Items with an asterisk are unique to SIMNET. Other SIMNET/NTC tables are described in White et al. (1990).

TABLE 1. CONTENTS OF THE SIMNET/NTC GROUND PLAYER POSITION LOCATION TABLE

- TIME OF VEHICLE STATUS UPDATE
- PLAYER BUMPER NUMBER
- LOGICAL PLAYER NUMBER
- POSITION OF VEHICLE EXPRESSED IN TERMS OF X-Y-Z COORDINATES
- POSITION OF VEHICLE EXPRESSED IN X-Y COORDINATES RELATIVE TO THE ORIGIN OF THE TERRAIN DATA BASE *
- VEHICLE SPEED *
- VEHICLE DIRECTION *
- GUN ELEVATION *
- TURRET AZIMUTH *
- ENGINE SPEED *
- ODOMETER READING *
- TOTAL AMOUNT OF AMMUNITION *
- AMOUNT OF FUEL LEFT IN VEHICLE *

TABLE 2. CONTENTS OF THE SIMNET/NTC PAIRED EVENT TABLE

- TIME OF FIRING EVENT
- TARGET PLAYER BUMPER NUMBER
- TARGET LOGICAL PLAYER NUMBER
- RESULT OF FIRING EVENT (MISS, HIT, OR KILL)
- FIRING PLAYER BUMPER NUMBER
- FIRING PLAYER LOGICAL PLAYER NUMBER
- TYPE OF WEAPON SYSTEM FIRED
- TYPE OF AMMO USED
- AN INDICATION OF WHETHER THE EVENT IS A FRATRICIDE *
- POSITION OF TARGET VEHICLE EXPRESSED IN X,Y COORDINATES
- POSITION OF FIRING VEHICLE EXPRESSED IN X,Y COORDINATES
- RANGE OF THE ENGAGEMENT

There are at least two benefits to employing a common database design. First, this commonality supports efforts to validate SIMNET training against NTC training, and it makes it possible to develop software tools for analyzing unit performance in one environment and transfer these tools to the other environment. Second, the NTC database is designed to include all of the combined arms elements. As more elements are added to SIMNET or future generations of Army networked simulators, the UPAS database will readily accommodate these additions.

Summary Tables and Graphs

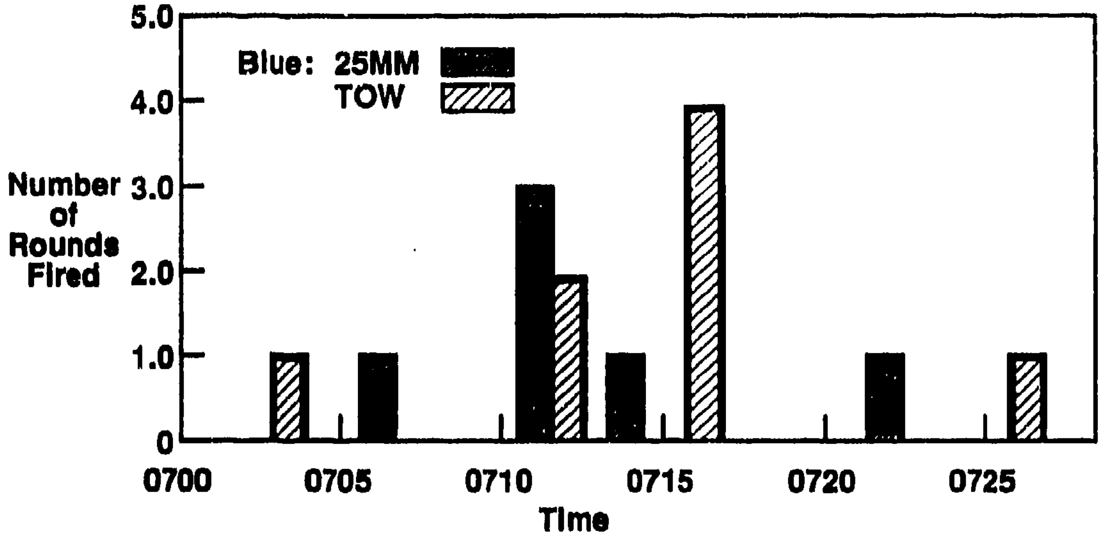
To facilitate the analysis of data in the SIMNET/NTC database, UPAS also contains menu-based table and graph editors. These editors are used in combination with SQL to create menus of tabular and graphics options for use in examining unit performance. Once a new table or graph has been "defined" using these editors, its name is added to the menu of tables or graphs available to all users of the UPAS. When a specific graph or table option is selected, the UPAS automatically prepares the table or graph using the exercise files currently being examined. Using these menus does not require knowledge of SQL.

The graph and table options can be used by trainers or researchers to analyze unit performance, and they can by used as audiovisual aids in providing feedback to exercise participants during AARs. Table 3 shows a data summary table that can be produced using UPAS, and Figure 5 illustrates one of the graphs produced from the menu of graph options. Note that the graph display gives the user the option of changing the scale of the graph. This feature is important, for example, when the user wants to focus attention on the volume of fires during a specific period of time during the exercise (e.g., during the first five minutes after initial contact with the threat).

TABLE 3. FIRING EVENTS DURING SIMNET EXERCISE AS A FUNCTION OF UNIT SIDE, TIME, RESULT, AND RANGE

TIME	FIRING SIDE	RESULT	RANGE
06:45:00	Red	Near Miss	1430
07:03:00	Blue	Hit	1860
07:04:00	Blue	Hit	1781
		Near Miss	1612
	Red	Near Miss	2263
		Hit	1856
07:05:00	Blue	Near Miss	1563
		Near Miss	1836
		Kill	1132
		Hit	1894
	Red	Near Miss	1900
		Hit	1918

ROUNDS OVER TIME BY WEAPON



<F> to change scale, <F> to print,
<ESC> to exit.

Figure 5. Example of a UPAS graph showing volume of fires as a function of time and weapon type.

The Need to Expand UPAS Capabilities

SIMNET is the first example of what is now known more broadly as Distributed Interactive Simulation (DIS). The importance of unit collective performance measurement in the DIS environment is illustrated by the inclusion of a Performance Measures Subgroup in an ongoing series of workshops sponsored by DARPA and the U.S. Army Project Manager for Training Devices (PM-TRADE) to develop joint service standards for DIS.

In the Fourth Workshop for Interoperability of Defense Simulations, Meliza (1991) described four requirements for a unit performance feedback or measurement system in the DIS environment. First, the system must be capable of integrating data from multiple sources. Second, the system must help a trainer to identify and illustrate key exercise events quickly. Third, the system must be flexible to allow for differences in information requirements across exercises as a function of such variables as the echelon being trained, the specific collective tasks to be trained, and lessons learned about which types of information displays are most useful to trainers. Fourth, the system must provide decentralized data analysis to support multiple AARs. Each of these requirements is described in detail below with a critique of the capability of the prototype UPAS to meet the requirement.

Integration of Data Sources

It is necessary to integrate network data with non-network data to provide a complete description of unit performance. Information about the specific mission, enemy, friendly troops, terrain, and time (METT-T) situation under which an exercise is performed is needed to interpret the casualty and position location data collected during a simulated engagement (Kerrins, Atwood, and Root,1990; Hiller, 1987).

The need to integrate network data with other data sources can be demonstrated by examining performance standards from the Army Training and Evaluation Program (ARTEP) Mission Training Plan (MTP) document for Armor Platoons (Department of the Army, 1988a). The frequency with which various data sources and combinations of data sources are used in applying Armor Platoon MTP standards are shown in Table 4. This table provides a summary of the categorization of those data sources which account for at least two percent of the standards from the armor platoon MTP document. These data were prepared using the Simulation Networking/Training Requirements database (Meliza, in preparation). They include only those standards supported by SIMNET (Burnside, 1990). Roughly 36% of the standards require integration of network data with another data source, while only 10% of the standards can be applied using network data alone.

TABLE 4. DATA SOURCES USED IN APPLYING ARMOR PLATOON MISSION TRAINING PLAN STANDARDS SUPPORTED BY SIMNET.

DATA SOURCES	PERCENTAGE OF STANDARDS USING DATA SOURCE
Observations	16%
Network	10%
Network + Communications	10%
Network + Terrain	9%
Communications + Observation	8%
Communications + Observation + Planning	7%
Observation + Planning	7%
Communications	6%
Network + Planning	5%
Network + Planning + Terrain	5%
Network + Observation	3%
Network + Communications + Planning	2%
Network + Communications + Terrain	2%

It is important to note that the "observations" data source referred to in Table 4 means direct observation of the behavior of individual soldiers. Such observations can be made by a trainer in the SIMNET environment only when soldiers are outside of the simulators. There have been discussions of using videotaping or other means to monitor the behavioral events inside a simulator, but this approach appears to be too costly to implement on a regular basis. Therefore, the memory of exercise participants is the major source of information about what would otherwise be events observed by a trainer. Information about these events will tend to surface during AARs to the extent that they are relevant to key exercise events.

The UPAS is concerned primarily with applying measures of performance that make use of the data collected from the network. Therefore, we are interested particularly in the subset of standards that can be trained in SIMNET and can be assessed using network data alone or network data in combination with planning, communications, and terrain data. Focusing on these standards, we identified twelve categories of standards that appear to cover virtually all of the MTP standards that meet those criteria. The categories define, at a broad level, the aspects of collective performance that need to be addressed by the UPAS. These categories are listed below with more specific examples of the aspects of performance to be addressed within each category and a list of the range of data sources that support the application of the standards in each category.

Friendly movement cued by enemy or friendly firing events. These standards are used to assess whether a unit takes appropriate movement actions when fired upon. The initial and subsequent movement responses to enemy fires are a function of the overall METT-T situation. This category of standards also addresses the coordination of friendly movement with friendly covering fires across a wide range of tactical situations.

Data Requirements: terrain features; vehicle location (enemy and friendly); time, volume, and results of enemy and friendly firing events; time and location of enemy indirect fire missions.

Friendly firing events cued by enemy firing events. The standards within this category assess how well a unit controls its volume and distribution of fires in response to enemy firing events. Do units promptly return fire? Do units adjust volume and distribution of fires in response to changes in volume of enemy fires?

Data Requirements: time, volume, and results of enemy and friendly firing events; friendly gun tube orientation; vehicle location (enemy and friendly).

Compliance of movement with control measures. These standards are used to assess how well a unit's movement techniques, routes, and movement rates match the unit's operations order. Do units initiate movement and cross control measures as designated in the operations order? Do units employ appropriate movement techniques or formations as a function of control measures designated in the unit operations order?

Data Requirements: Location, purpose, and time data relevant to each control measure; position location data.

Appropriateness of movement techniques as a function of the METT-T situation. These standards are used to assess whether the movement techniques employed by the unit are appropriate to the METT-T situation throughout the exercise.

Data Requirements: terrain data; vehicle location (enemy and friendly); tactical scenario; enemy and friendly firing events.

Use of cover and concealment during movement. This category of standards addresses the cover and concealment offered by the overall route of advance of a unit. It also addresses the cover and concealment afforded by short movements, such as the route from a battle position to an alternate firing position.

Data Requirements: terrain data; enemy and friendly positions.

Orientation of weapon systems as a function of the METT-T situation. This category covers two subcategories. The first assesses whether the orientation of the gun tube of each vehicle is appropriate given the METT-T. This second addresses the issue of whether each crew continually scans its assigned sectors or areas of responsibility as indicated by gun tube movement.

Data Requirements: turret azimuth; vehicle orientation; enemy and friendly vehicle positions; terrain data.

Halts and cover/concealment. These standards are used to assess the use of cover and concealment in selecting halt positions. In the context of offensive missions, these positions include overwatch positions selected prior to actual contact and firing positions. In the context of defensive missions, they include primary, alternate, and supplementary firing positions.

Data Requirements: enemy and friendly location data; terrain data.

Locations of friendly indirect fire relative to enemy location. Some standards in this category are concerned with using indirect fire on known enemy locations, while others are concerned with using indirect fire on likely enemy locations.

Data Requirements: locations of enemy vehicles; locations of friendly indirect fire missions; major terrain features; unit plans.

Spatial relationships among moving vehicles. This category of standards assesses the quality of movement techniques used by a unit, the location of the Platoon Leader's and Platoon Sergeant's vehicles relative to other vehicles, and whether an appropriate interval is maintained among vehicles.

Data Requirements: friendly vehicle positions; terrain data.

Rate of movement. This category of standard addresses movement rates over both short and longer periods of time. Movement rates over very short periods (a few seconds) are examined to assess a unit's response to an actual threat situation (i.e., moving quickly and continuously to a covered and concealed position) or to assess if vehicles move continuously at critical points in time to avoid blocking the movement of other vehicles (such as when a unit is moving into an assembly area or shifting from one formation to another). Observing movement rates over longer periods of time makes it possible to assess whether a unit's momentum is reduced by unnecessary halts or overly cautious movement.

Data Requirements: friendly positions; terrain data; firing events; odometer readings.

Reporting of locations in terms of control measures. These standards are concerned with assessing whether a unit reports to a higher headquarters when it reaches key locations or takes a required action at a key location.

Data Requirements: locations of friendly vehicles; locations of control measures; tactical communications.

Reporting of enemy contact and firing events. This category is concerned with assessing whether a unit reports initial contact, casualties inflicted, and casualties sustained.

Data Requirements: tactical communications; firing events.

We examined the initial UPAS system and found that it contains the information needed to address only one of the categories entirely, friendly fires cued by enemy firing events. The other eleven categories are only partially covered. Seven of these categories could be raised to fully covered with the integration of terrain data (friendly movement cued by firing events, use of cover and concealment when moving, rate of movement, orientation of weapon systems as a function of METT-T, spatial relationships among moving vehicles, use of indirect fire against the enemy, and use of cover and concealment in halt positions). The addition of communications data would raise the eighth category to fully covered (reporting of enemy contact and firing events), and the addition of control measures would add the ninth category (compliance of movement with control measures). The addition of both tactical communications and control measures would add a tenth category (reporting of position information). The final category could be addressed by adding terrain data and tactical planning data (appropriateness of movement techniques as a function of METT-T).

In summary, the prototype UPAS needs to be enhanced to support the integration of network data with other data sources. Without this integration, at platoon level, only 10% of the standards supported by SIMNET are addressed effectively by the UPAS.

Rapid Identification and Illustration of Key Exercise Events

A performance measurement or feedback system must support the rapid analysis and interpretation of data. Unlike a field training exercise, there are few post-mission tasks after a SIMNET exercise to keep a unit occupied while a trainer analyzes unit performance in preparation for providing feedback. It is critical that UPAS support the preparation of timely AARs.

The prototype UPAS cannot meet this criterion fully, because it fails to integrate network data with other data sources. However, the use of the menu of tables and graphs within the UPAS, combined with information available in the Plan View, does address the 10% of standards supported by SIMNET relying entirely on automated data.

We also considered the amount of time required to identify and illustrate key exercise events using the UPAS, resulting in the discovery of additional requirements for improving the UPAS. The Plan View is not efficient in terms of its ability to move quickly from one point in the battle to another. The system works by reading every data packet in the sequence in which the packets were collected. Although the Plan View has a nominal search function and the capability to move through the sequence of events from the Mission Event List, it must cycle through every interpolated data packet in moving from one point in time to another. As a result, there is no time savings gained by using the "search function" on the Plan View.

The speed of the Plan View replay is not selectable by the user. Replay speed is a function of the operating speed of the host PC and the number of data packets being generated per unit of time. When there is little action during an exercise, the replay is conducted at high speeds (roughly 4 x real time with a Zenith 286 and roughly 15 x real time with a Zenith 386 operating at 25 megahertz). At points in an exercise when the level of movement and firing activities are high, generating large numbers of data packets, the replay slows down to speeds slower than real time.

In summary, two types of improvements are required in the UPAS if it is to support the identification and illustration of key exercise events in a comprehensive and timely manner. First, other data sources must be integrated with network data. Second, the UPAS Plan View must be enhanced to allow the user to move quickly from one point in the exercise to another.

Flexibility

The UPAS should be flexible enough to allow the outputs of the system to be modified easily without major reprogramming of software. The military still has very limited experience applying DIS to training, and little data are available that can be used to justify detailed formats for measurement outputs in terms of their utility to users. The UPAS should be viewed as a tool that will allow us to try out different output formats during the initial fielding of a DIS application and make prompt changes in response to these tryouts. Rigid, formal programming of the entire performance measurement system will not provide us with the flexibility to refine the system promptly at a reasonable cost.

The prototype UPAS offers flexibility by giving users the capability to modify graphs and tables based on data from the SIMNET/NTC database. To accomplish such modifications, the user needs to know SQL and the UPAS procedures for defining graphs and tables.

The prototype UPAS also provides the user with the flexibility to change the scale of the Plan View to focus on the action in a small part of the battlefield or examine the battle from a broad perspective. However, the UPAS provides the user with little or no capability to control the speed of the replay or the point in time in the battle to be replayed.

In summary, the prototype UPAS offers the user the ability to modify AAR aids to meet diverse information needs. The prototype UPAS is also a tool that can be used to try out the effectiveness of specific tables and graphs, and it can be used to modify these tables and graphs in response to lessons learned about the adequacy of feedback.

Decentralized Data Analysis to Support Multiple After Action Reviews

The performance measurement system must provide decentralized data analysis to support multiple After Action Reviews (AARs), with each AAR tailored to meet the information needs of a distinct population. For example, after a company team exercise, at least four separate AARs need to be supported; each of the armor and infantry platoons should be provided with feedback about how well their crews worked together in performing their platoon tasks, and the company team should receive feedback about how well its platoons worked together. As the scope of an exercise is increased to include higher echelons and more types of units, the number of groups requiring tailored feedback increases.

Since UPAS is a low-cost PC-based system, multiple PCs with UPAS software may be used to collect data from the same exercise. Each UPAS could then be used to identify and illustrate key events from the perspective of a different unit. For example, one system could be used to support a company-level AAR, while three other systems might be used to prepare AAR materials for each of the three platoons in the exercise, respectively. It is important to note that a single PC could be used to support all four AARs if necessary. The use of multiple PCs is advantageous, because it reduces the amount of time required to prepare AAR aids.

Enhanced After Action Review Aids

We designed concepts for improving the Plan View and creating new types of AAR aid formats to support AARs more effectively. Our major goals in developing these concepts were to facilitate the integration of network data with other data sources and expedite the preparation of AAR aids. The University of Central Florida Institute for Simulation and Training (IST) implemented these concepts through software development.

In developing AAR aid concepts, a heavy emphasis was placed upon the use of figures for two reasons. First, figures were believed to be a useful vehicle for integrating network and non-network data. Second, figures were believed to be a good vehicle for summarizing unit performance in a manner that can be interpreted quickly by experienced trainers.

In addition to providing ideas for improving the Plan View Display, we developed concepts for three new types of UPAS AAR aids; Battle Flow Charts, Battle Snapshots, and Exercise Timelines. The design concept for each type of aid is described below, and each description includes a listing of the categories of performance measures that might be applied with each aid.

Improved Plan View Display

Major terrain features (highways, unimproved roads, buildings, bodies of water, treelines, and clumps of trees), other than contour lines, were added to the Plan View. In addition, unit control measures from the unit's operations order were added to the Plan View. An example of the improved Plan View is shown in Figure 6.

In addition to integrating network and non-network data, the improved Plan View Display also includes two new features that make it easier to use. First, a rapid search capability has been added to make it possible to move forward and backward from one point in an exercise to another quickly. This feature applies to both the search function and Mission Event List function of UPAS. Second, the capability to magnify the battlefield has been increased by making it possible to display a section of the battlefield as small as 200 meters by 200 meters.

The categories of performance measures that can be applied using the improved Plan View Display are friendly movement cued by firing events, spatial relationships among moving vehicles, friendly firing events cued by enemy firing events, weapon system orientation as a function of METT-T, and rate of movement. Until contour lines are added to the Plan View, it will partially address use of cover and concealment during movement and halts, and it will partially address the appropriateness of movement techniques as a function of the METT-T situation.

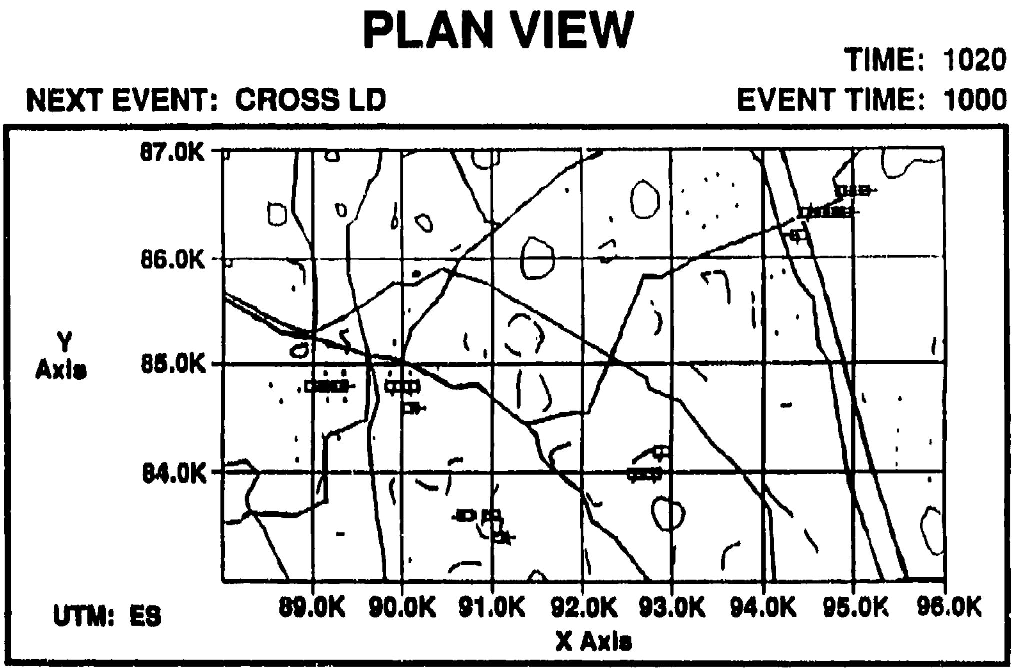


Figure 6. Improved Plan View Display.

The addition of control measures to the Plan View makes it possible to track unit actions and rate of movement as a function of the planned use of control measures. Because the Mission Event List is linked to the replay of the exercise in the Plan View, the user can move from one time-tagged event to another to assess whether the unit is following the rate of movement implied in the operations order, and it can be used to assess whether the unit is taking any required actions when it reaches a control measure. The types of actions at control measures that can be assessed include changing movement formations, changing the orientation of weapon systems, and moving into a halt position.

In order to display the location of control measures, the user must first load information about these measures into the SIMNET/NTC database. This information is taken from map overlays or other graphics and loaded using a series of menus. The first menu allows the user to select a control measure from the following options: Assembly Areas, Line of Departure, Phase Lines, Start Points, Release Points, Check Points, and Objectives. The user is then asked to type in the name of the control measure and the UTM coordinates that define its location. Points are identified with a single coordinate, lines with a minimum of two coordinates, and areas with a minimum of three coordinates. After defining one control measure, the user is returned to the original menu to select another control measure. Figure 7 illustrates the series of menus used to load information about unit control measures.

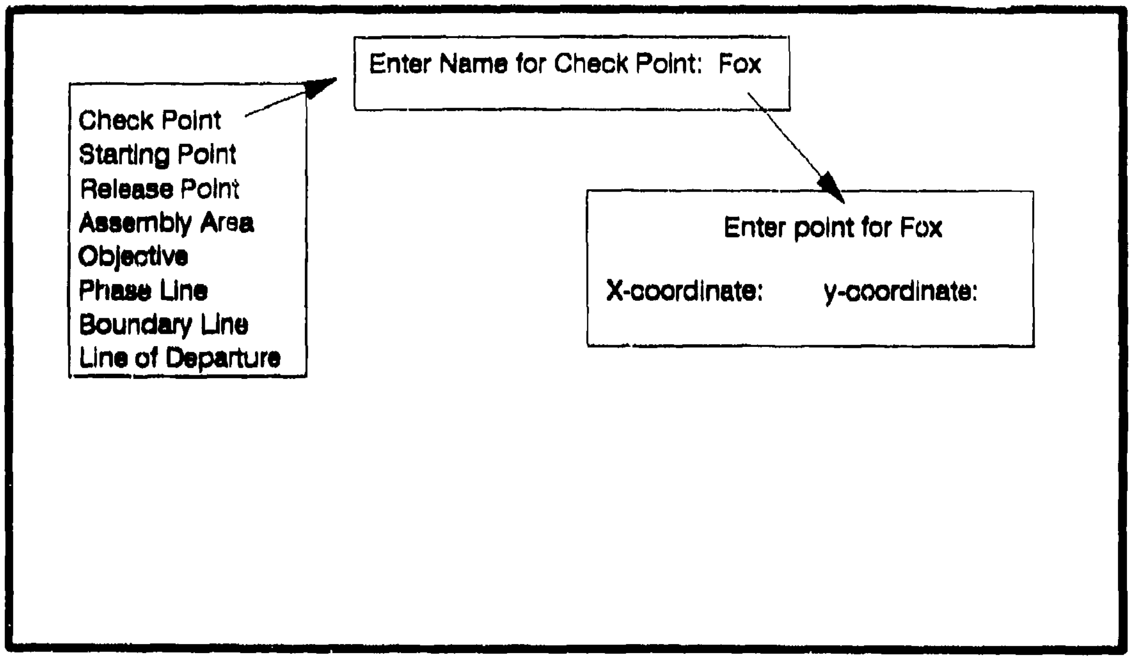


Figure 7. Series of menus used to load information about unit control measures into the SIMNET/NTC database.

Battle Flow Chart

A Battle Flow Chart is an animated figure that traces the movement of vehicles and units throughout the course of a mission or during a significant segment of a mission. The trace is implemented by showing vehicle locations at a predetermined interval, such as every minute. Movement is displayed over a grid map that includes major terrain features and the control measures for a particular mission (Figure 8). The user can stop at any point during the trace of the movement of vehicles and create a hard copy of the display.

The icons used to represent vehicle locations are plus signs and numerals. Unlike the case with the Plan View Display, the icons provide no information about weapon system orientation. The Battle Flow allows the user to specify the time interval at which vehicle positions are to be marked. This important feature allows one to adjust the position updates to avoid cluttering the screen with data. As in the case of the Plan View, the Battle Flow also allows the user to magnify portions of the battlefield of particular interest up to the point where the entire display is filled by an area that is only 200 meters by 200 meters.

Events and relationships that might be assessed with this aid are compliance of movement with control measures, movement rate, appropriateness of movement techniques as a function of the METT-T situation, use of cover and concealment during movement, and use of cover and concealment when halted.

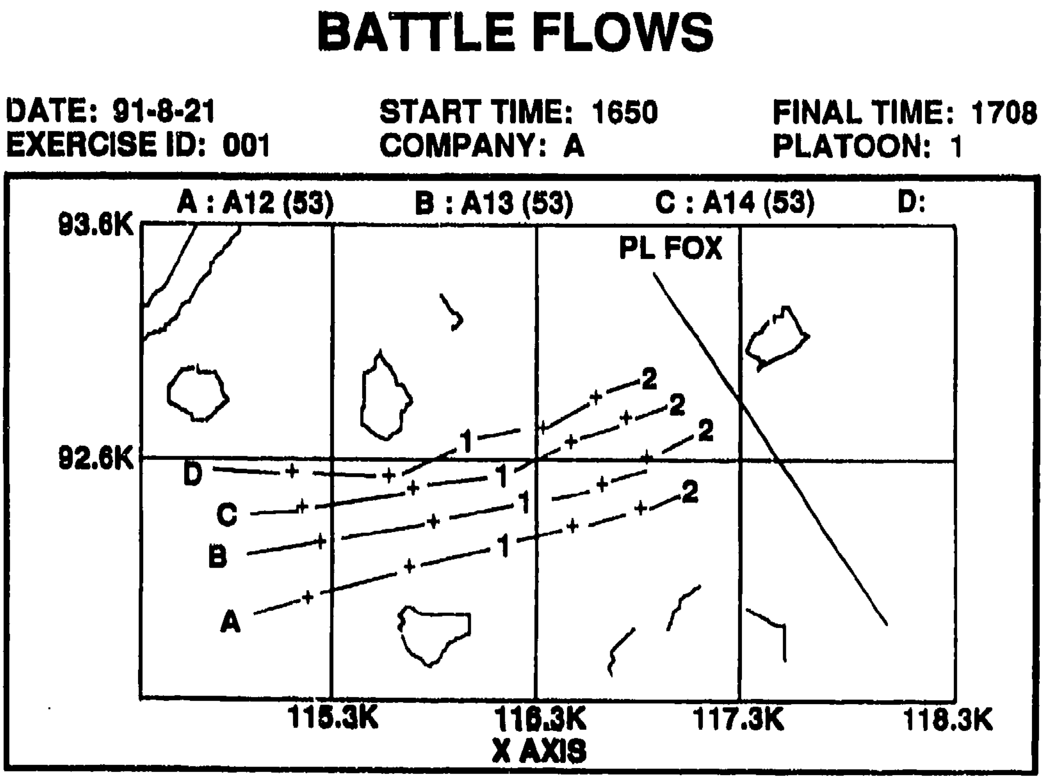


Figure 8. Sample Battle Flow Chart.

Battle Snapshots

A Battle Snapshot is another tool that shows the position and orientation of vehicles and weapon systems from a bird's-eye view (See Figure 9). A Snapshot can be taken at any time in the exercise designated by the user. Like the Plan View and the Battle Flow, the Snapshot allows the user to magnify the battlefield. Like the Battle Flow, the Snapshot shows the location of vehicles on a grid map that includes control measures. These control measures are taken from the SIMNET/NTC database in the same manner as for the Battle Flow Chart.

Like the Plan View, vehicles are represented by oversized icons that indicate vehicle and weapon system orientation. Performance aspects that can be assessed with this aid are compliance of movement with control measures, spatial relationships among moving vehicles, and weapon system orientation as a function of METT-T.

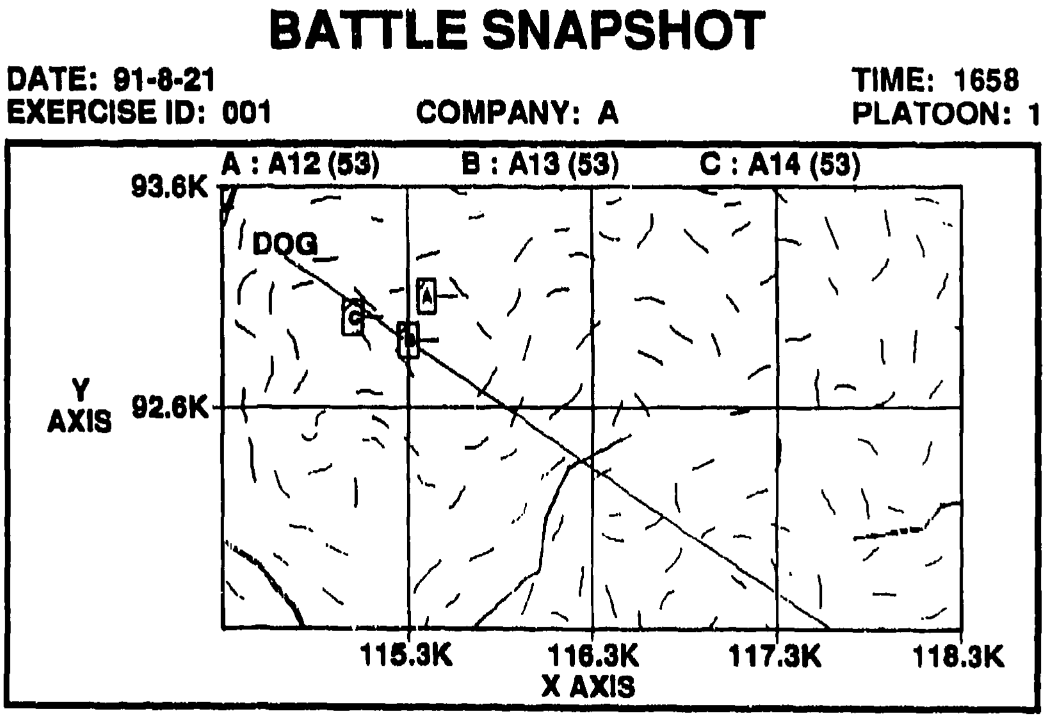


Figure 9. Sample Battle Snapshot.

Exercise Timeline

An Exercise Timeline is a tool for looking at temporal coordination of movement, control measures, and firing events. The top line of the Timeline in Figure 10 indicates time of day during the exercise. The second line describes movement of the platoon as a function of time and unit control measures. The bars at the bottom of this line indicate the time when the first and last vehicle of a unit crossed a control measure. This information, combined with time-tagged events from the unit plan contained in the Mission Event List, provides a quick method for comparing the planned and actual rate of movement of a unit.

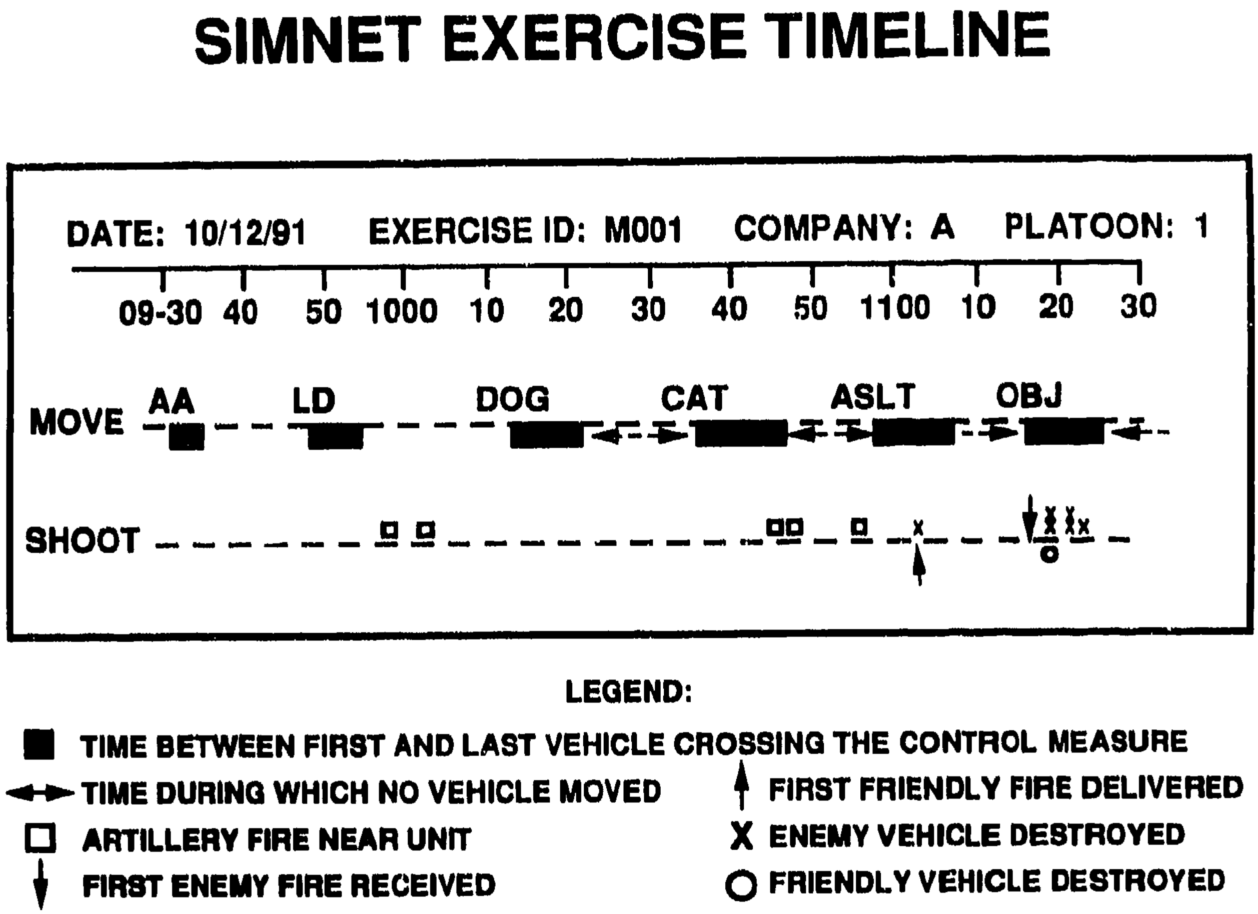


Figure 10. Sample Exercise Timeline.

The second line of the Exercise Timeline also indicates the beginning and ending of periods in time when the entire platoon was halted. Information about halts may be used in a variety of ways. First, they can be used to compare the halts employed with the planned halts. Second, they can be used to identify points in time when the movement of the unit was bogged down by unnecessary halts, indicating a command and control or land navigation problem. Third, these data may be used to examine the appropriateness of halts as a function of direct fire and indirect fire events indicated on the third line of the Timeline.

The third line of the Exercise Timeline provides information about the time of direct and indirect firing events. A small square is used to indicate when the unit receives artillery fire, and an arrow pointed down indicates when the first enemy direct fire was received by the unit. A small circle is used to indicate when a friendly vehicle is destroyed. An arrow pointed up indicates when the unit first delivers fire on the enemy, and a small "x" indicates when an enemy vehicle is destroyed.

A fourth line is envisioned for the Exercise Timeline to provide information about the time of tactical communications. At a minimum, we would like this line to indicate whether a unit contacted a higher headquarters around the time of any major tactical events indicated in lines 2 and 3 of the Timeline. For example, did the unit communicate with its headquarters after receiving direct or indirect fires? Further, we would like to know the type of radio message and the content of the message.

Unfortunately, because the UPAS is PC-based, it can only perform one task at a time. During a SIMNET exercise, use of the UPAS is limited to collecting data from the simulation network, and it cannot be used to collect data on tactical radio communications. However, an effort is under way to apply a separate PC to the task of monitoring radio communications. The output of the radio monitoring activities will be loaded into the SIMNET/NTC database at the end of an exercise.

Concepts for Applying UPAS AAR Aids to the Task of Identifying Key Exercise Events

Two considerations are critical in developing a plan for applying AAR aids to performance measurement. First, one must consider which of the categories of standards mentioned in a previous section of this report are addressed by each type of AAR aid. Second, one must consider how to navigate through the AAR aids in an efficient manner.

Table 5 shows which categories of standards are appropriate to each AAR aid format. This table also serves to illustrate the unique contributions made by the various aids in addressing MTP standards, as well as illustrating their overlap. The logic behind the assignments for categories of standards which might be addressed by each type of AAR aid is provided below.

Friendly Movement Cued by Enemy or Friendly Firing Events

The Plan View is the only figure that displays movement of both enemy and friendly vehicles with continuous updates. The Plan View also indicates vehicle firing events as a function of time. To the extent that the Plan View displays information about terrain features, it would appear to support this category of standards. The Battle Flow Chart and Battle Snapshot, on the other hand, are not expected to provide information on enemy firing events. This gap in information, combined with the lack of continuous position updates, suggests these two aids would not support this category of standards. The Exercise Timeline partially supports this category of standards by providing information about the temporal relationships between movement of the unit as a whole and firing events (enemy and friendly). However, the Timeline lacks information on terrain features, volume of enemy fires, and movement of individual vehicles.

Friendly Firing Events Cued by Enemy Firing Events

Tables and graphs describe time, volume, and effectiveness relationships between enemy and friendly fires. The Plan View provides this same information but in a form that is less concise and precise than that available with tables or graphs. Battle Flow Charts and Battle Snapshots are simply not expected to provide firing event data. The Timeline is expected to contain some information about the temporal relationships between enemy and friendly firing events, but this information does not include volume of fires.

TABLE 5. CATEGORIES OF STANDARDS APPROPRIATE TO EACH TYPE OF AAR AID

CATEGORY OF STANDARDS	AAR AID FORMAT				
	TABLES/ GRAPHS	FLOW CHART	SNAPSHOT	PVD	TIMELINE
MOVEMENT AND FIRING EVENTS				●	●
FRIENDLY AND ENEMY FIRES	●			●	
MOVEMENT AND CONTROL MEASURES		●	●	●	●
MOVEMENT TECHNIQUE AND METT-T		●	●	●	●
MOVEMENT AND COVER/CONCEALMENT		●	●	●	
WEAPON ORIENTATION			●	●	
HALTS AND COVER/CONCEALMENT		●	●	●	●
LOCATIONS OF FRIENDLY INDIRECT FIRE AND ENEMY POSITIONS	●				
SPATIAL RELATIONSHIPS AMONG MOVING VEHICLES		●	●	●	
RATE OF MOVEMENT				●	●
LOCATION, CONTROL MEASURES, AND COMMUNICATIONS					●*
FIRING EVENTS AND COMMUNICATIONS					●*

* Requires addition of communications data to the Exercise Timeline

Compliance of Movement With Control Measures

Every AAR aid can be used to at least estimate the distance between vehicles and control measures. The Exercise Timeline would indicate when a unit crossed or reached a control measure (based on a precise measurement of the distance between vehicles and the control measure).

Appropriateness of Movement Technique as a Function of the METT-T Situation

Tables, graphs, and Exercise Timelines would not be useful for this category of standards, because they provide no information about movement techniques. The other three types of aids are expected to display vehicle positions in a manner that would allow a trainer or researcher to identify the movement technique being employed. Because these aids also contain information about the METT-T situation (such as the possibility of imminent enemy contact, terrain features), they can be used to assess the quality and appropriateness of movement techniques.

Use of Cover and Concealment During Movement

To apply standards in this category, one must have information about the location of friendly elements during movement, terrain features, and the location of enemy elements. The Plan View, Battle Flow, and Battle Snapshot are all expected to display friendly and enemy positions relative to major terrain features.

Weapon System Orientation

The Plan View and Battle Snapshot are expected to display the orientation of gun tubes, and the location of enemy positions. Further, since gun tube orientation is often a function of movement techniques, it is important to note that both of these displays are expected to make it possible to identify the movement technique being employed by a unit (as described above). Only the Plan View and Battle Snapshot are expected to display weapon system (turret or gun tube) orientation. Of these two aids, only the Plan View is capable of the animation necessary to assess turret movement. However, a sequence of Battle Snapshots might be used to assess whether weapon system orientation is changing over short periods of time.

Use of Cover and Concealment in Halt Positions

The Plan View, Battle Snapshot, and Battle Flow Chart provide information about terrain features, threat positions, and friendly positions that can be used in applying this category of standards. With the Plan View and the Battle Flow it should be possible to decide whether a unit is in a halt position, but with the Battle Snapshot, the user would have to know when a unit was halted before creating a Snapshot.

Locations of Indirect Fire Missions Relative to Enemy Positions

Tables and graphs are likely to be the best data source for applying this category of standards. Tables are expected to provide information about the time, location, and results of indirect fire missions, as well as information about the exact location of enemy forces during friendly indirect fire missions. Addressing locations of enemy forces and friendly indirect fire missions in an Exercise Timeline would be entirely outside the concept of this aid. The Plan View, Battle Flow, and Battle Snapshot are all expected to display the location of enemy vehicles and major terrain features, but none of these aids display the location of friendly indirect fire missions. Given that tables and graphs are expected to address this category of standards adequately, and given the possibility that adding indirect fire locations would create a screen clutter problem for the three types of bird's-eye view of the battlefield, trying to use these three aids to address this category of standards appears to be unwarranted.

Spatial Relationships Among Moving Vehicles

The Plan View, Battle Snapshot, and Battle Flow are all expected to display the location of vehicles in adequate detail to allow trainers and researchers to decide what kind of formation a unit is employing at a particular time. Tables and graphs might conceivably be used to assess formations in terms of geometric or trigonometric relationships, but this would appear to be a needlessly complex way of supporting a decision in comparison with a bird's-eye view.

Rate of Movement

The majority of standards in this category require that a unit move continuously without stopping. For selected standards there is also the requirement that vehicles move quickly. Of the three figures, only the Plan View is capable of continuously monitoring movement. The fact that position data are updated within the Plan View on a continuous basis offers the potential to look at disruptions of movement in individual vehicles during tiny movement segments, such as the transition from one formation to another. The Exercise Timeline is expected to identify intervals during which all vehicles in a unit are halted so that this aid should be a good source of information about when the movement of the unit as a whole is stopped or delayed seriously.

Reporting of Locations in Terms of Control Measures

The Exercise Timeline is the most appropriate aid to address this category of standards. The Timeline is the only aid expected to address tactical communications. Further, the

Timeline is expected to provide the most precise information about when a unit crossed or reached a particular control measure (as described in the section above on "compliance of movement with control measures").

Reporting of Enemy Contact and Firing Events

The Exercise Timeline is also the most appropriate aid to address this category of standards, because it is the only aid expected to address tactical communications. Further, the Timeline is expected to show the temporal relationship between tactical communications and many of the firing and contact events calling for communications (e.g., first enemy fire received, first friendly fire delivered, destruction of enemy or friendly vehicles).

In addition to considering the aspects of unit performance that can be addressed with each aid, it is important to consider how each type of aid can be used most efficiently. Efficient use of the Plan View and Battle Snapshot requires that a trainer know the times when key events occurred during and exercise. The times listed for planned exercise events in the Mission Event List provides one means of identifying times in the exercise that are potentially key to the outcome. A trainer can identify other key times using the overviews of the exercise provided by the Exercise Timeline and the Battle Flow. For example, the Timeline would indicate when a unit first was fired upon by the threat force, and it would indicate each time when the unit received indirect fire, as well as providing information about the unit's rate of movement as a function of control measures. Therefore, the most efficient strategy for using the UPAS AAR aids calls for using the Exercise Timeline and Battle Flow Chart first to provide an overview of the exercise and to identify exercise key events.

Summary and Future Considerations

The Improved UPAS

Figure 11 provides an overview of the improved UPAS, indicating new system components with asterisks. The Plan View, Battle Flow, and Battle Snapshot use the data packets collected from the network, while the Exercise Timeline used the data that have been converted and loaded into the SIMNET/NTC relational database.

The improved UPAS requires the user to input data on the locations of unit control measures from the unit's operations order. These data are loaded into the SIMNET/NTC relational database in a manner transparent to the user. The UPAS then displays these measures in the Plan View, Battle Flow, and Battle Snapshot to help integrate unit planning data with network data. In addition, the program for the Exercise Timeline uses control measure data and network data to automatically identify the point in time when a unit crosses each control measure.

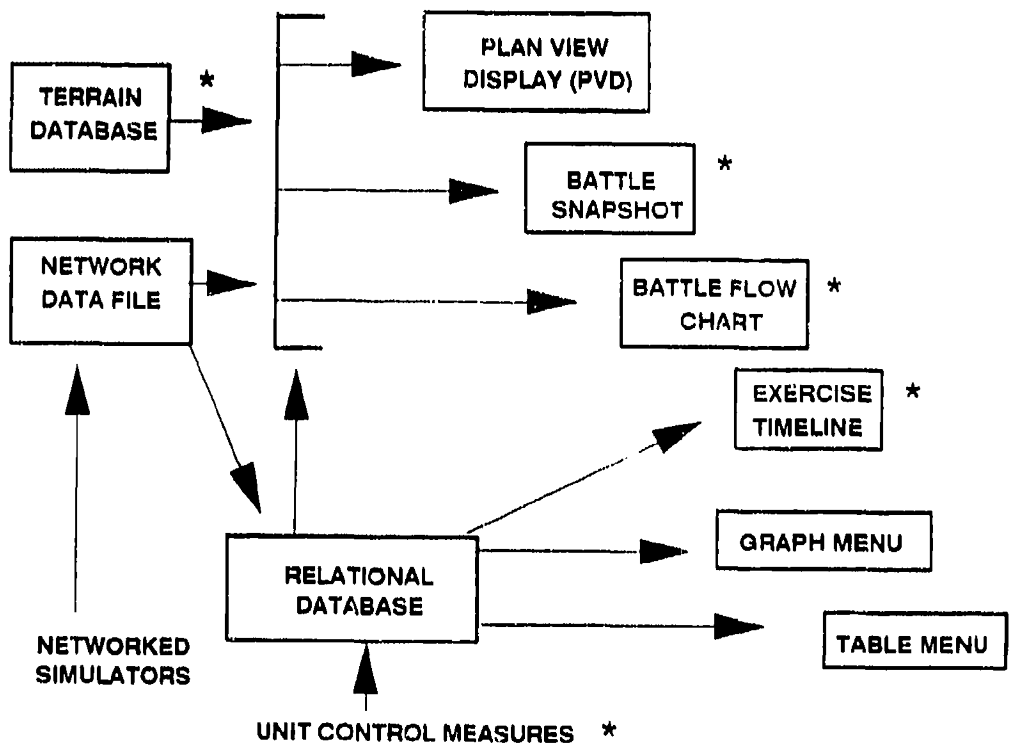


Figure 11. Overview of major components of the improved UPAS.

The SIMNET terrain database has been added to the UPAS to support the display of major terrain features in the Plan View, Battle Flow, and Battle Snapshot. This addition supports the integration of terrain data with network data.

The integration of network data with unit planning data and terrain data in the UPAS triples the number of Armor Platoon MTP standards that can be applied during SIMNET exercises. The planned addition of communications data to the Exercise Timeline will result in a quadrupling of the standards addressed by the UPAS, in comparison with the prototype UPAS. Further, the standards addressed by the UPAS are believed to be especially important, because they tend to be concerned with assessing the outcome of the movement, shooting, and communication tasks that are critical to armor and infantry platoon missions.

The UPAS AAR aids require user testing. One goal of this testing is to decide whether these aids are capable of supporting the application of performance standards assigned to each aid. For example, we estimate that the Battle Flow Chart will trace the movement of a unit in adequate detail to allow the UPAS user to identify the specific movement technique used by a unit at particular points within a mission. During user testing we may find that the Battle Flow is inadequate to meet this need.

Application to Training Above Platoon Level

The concepts for AAR aids described in this report also apply to training at company team (Department of the Army, 1988b) and battalion task force (Department of the Army, 1988c) levels. However, the categories of standards and the types of information to be included in each type of aid are expected to differ from platoon level, because the topics addressed by training differ across echelons. For example, platoon level training is concerned with training crews to work together as a team, while company team level exercises emphasize training platoons to work together as a team. The analytical procedures used to define the functional requirements at platoon level should be employed at company level and above to define the AAR needs at these echelons. The Burnside (1990) report provides the beginning of such an analysis by identifying company team and battalion task force MTP standards that are supported by SIMNET.

Application to Future Generations of Networked Simulators

In the near future, networked simulators are expected to become a major tool in the conduct of training for Army units, and they are expected to incorporate more combined arms elements. The next generation SIMNET, the Close Combat Tactical Trainer (CCTT), will make it possible for armor and infantry units to interact with engineer, aviation, artillery, air defense, and logistical units on a simulated battlefield (U.S. Army Armor School, 1990).

At the start of this effort, an expanded UPAS was viewed as a tool that could be used for training research to develop information pertinent to the future SIMNET, CCTT, as well as providing information about how to best employ the current SIMNET. Due to recent events, UPAS has the potential to serve as a tool for developing feedback systems and training strategies for a wide variety of applications far into the future.

All future applications of DIS, including CCTT, will be interoperable (McDonald, Pinon, Glasgow, and Danisas, 1990), and the functional specifications for CCTT require that CCTT be interoperable with SIMNET (U.S. Army Armor School, 1990). Therefore, a translator between the standard protocol and the SIMNET protocol will be developed that will link UPAS to all future DIS applications.

By basing the design of the UPAS relational database on the design of the NTC database, the UPAS is already prepared to address combined arms elements that are not included in SIMNET but will be added in future DIS applications. Further, in the Fourth Interservice DIS Meeting a list of automated data collection requirements was developed that cuts across the services, and this list overlaps substantially with the list of data elements in the UPAS database. The unique requirements not addressed by UPAS are in the areas of "switchology" and electromagnetic emitters.

Finally, the lessons learned from UPAS development are being used as a basis for the preparation of interservice standards for the interoperability of defense simulations. More specifically, these lessons were used in preparing a draft standard for a unit performance feedback system at the Fifth Workshop on Standards for the Interoperability of Defense Simulations.

<u>Application to SAFOR Performance Measurement</u>

Current interest in SAFOR behavior includes describing the expected behavior and deciding how to measure this behavior to insure that expectations have been met (Mullally, Petty, and Smith, 1991). SAFOR modeling includes the behavior of enemy and friendly units. Both types of SAFOR have the same job, cuing and reinforcing the actions of the unit to be trained. Descriptions of the expected actions of SAFOR must be extracted from MTP documents through careful analysis of task conditions, task standards, subtasks, and subtask standards.

SAFOR measurement techniques are needed to assess the effectiveness of tools being developed to control behavior of the SAFOR, and the UPAS can meet this need. Unlike measuring the performance of actual units, SAFOR measurement involves only four sources of data; network data, terrain data, tactical communications (simulated communications from friendly units), and unit plans (when SAFOR are used to play the role of friendly forces). Three of these four data sources are addressed by the current UPAS. The addition of tactical communications to the UPAS in the near term will allow it to address all aspects of SAFOR performance.

Application to Performance Measurement Systems for Embedded Training

Embedded Training (ET) is "training that is provided by capabilities designed into or added in to operational systems" (Department of the Army, 1987). The potential targets of opportunity for ET include collective tactical training requirements. For example, the Systems Training Plan for the Main Battle Tank Block III states "embedded training will include one or more stand-alone modules for force on force simulation" (U.S. Army Armor School, 1989b).

ET may take three forms as described in Witmer and Knerr (1991); fully embedded, appended, and umbilical. In the fully embedded version, all training features except for certain software and courseware are contained within the prime weapon system. Appended ET can be installed or attached temporarily to the prime weapon system to support training. Umbilical ET involves temporary connections to external components to support training. The application of ET to collective training above crew level will involve a form of appended or umbilical ET, because the various vehicles must exchange information with one another. A rough translation of the SIMNET model to the ET model would involve replacing the vehicle simulators with prime weapon systems that include graphics generators. The vehicles would then be linked to allow data broadcast from one vehicle to be picked up by other vehicles.

The capability to include an automated feedback system is a major variable in determining if and how ET might be applied to a particular training requirement in a cost-effective manner (Oberlin, 1987; Strassel, Dyer, Roth, Alderman, and Finley, 1988). In many cases, the requirement to include training software and an automated performance measurement system within the prime weapon system would overload the weapon systems organic computers. However, the UPAS system is capable of being linked to a network of vehicles and providing its own computing power. Therefore, the UPAS might be applied directly to future attempts to embed collective training.

Research on SIMNET Practice and Feedback Variables

The fact that SIMNET is an electronic battlefield means that data are available to support training research. However, translating this wealth of information to a format that supports documentation of training (practice and feedback) and measurement of unit performance is a substantial task, comparable to that of preparing and organizing NTC data for analysis (McFann, Hiller, and McCluskey, 1990). The UPAS can be used to support training research, as well as supporting AARs.

Thorpe (1988) provides a summary of evidence that SIMNET is an effective training method. TEXCOM (1990) examined the transfer of SIMNET training to field testing of platoons on collective tasks from MTP documents and concluded that "both tank and mechanized infantry units improved in overall performance after receiving SIMNET training." Bessemer (1990) provided evidence that the addition of SIMNET training to the program of instruction for Armor Officer Basic (AOB) students had a beneficial effect in terms of leader performance evaluations during subsequent field exercises. None of these efforts was able to use appropriate control groups, provide information about the specific collective influenced by SIMNET, or document practice and feedback variables in detail.

The SIMNET training transfer research was accomplished in order to decide whether the relatively low level of fidelity of certain aspects of SIMNET prevent transfer to field training (Kerins, Atwood, and Root, 1990). However, there is a need to identify and assess the impact of practice and feedback variables that influence the transfer of SIMNET training. Two reports have examined variables that might influence SIMNET training. Bessemer (1990) concluded that the effects of SIMNET training on subsequent leader evaluations increased with the instructor's experience in using SIMNET. He also noted that the conduct of AARs tended to improve over time. A later effort by Shlechter, Bessemer, and Kolosh (1991) looked at the effects of the role played during SIMNET training on subsequent evaluation of leader performance and found evidence that students serving in the roles of platoon leader or platoon sergeant gained more benefits from SIMNET training than did those students that served only as vehicle commanders, gunners, drivers, and loaders. As in the case of Bessemer's work, these researchers found evidence that the beneficial effects of SIMNET training were enhanced as the instructors collectively gained more experience with SIMNET. These efforts address only a few of the many practice and feedback variables that need to be examined in the SIMNET environment.

The UPAS has several features that are expected to facilitate future SIMNET training research. First, the UPAS has the capability to generate a wide variety of displays for providing feedback to units, allowing researchers to vary and document feedback in a systematic fashion. Second, the UPAS provides a means of documenting the practice actually received on specific collective tasks during SIMNET exercises. Third, the UPAS contains a variety of flexible tools that can be used to measure unit performance.

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