INSTRUMENTATION SUPPORT FOR EVALUATING MILITARY EXERCISES

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SUMMARY

A feasibility study of low-cost feedback information mechanisms for Multiple Integrated Laser Engagement System (MILES) was conducted at University of Central Florida. An optimum mix between man and machine was the approach used in the analysis and design of the proposed system. System includes mechanisms for data collection, analysis, and displaying information for exercise evaluation. Instrumentation includes hand-held terminals, central computer, and the necessary man-machine interfacing software and devices. In addition to feasibility and cost, system compatibility with more sophisticated follow-on systems was also considered.

INTRODUCTION

Military ground engagement exercises are structured to simulate battle field conditions. Every aspect of the training exercise is directed towards achieving realism and credibility. The more realistic the simulation, the better it is in producing higher tactical proficiency levels for individual soldiers and units.

Arbitrary casualty assessment systems based on probability tables or the subjective opinion of controllers (people who oversee the exercise), have not created the desired effect. For a casualty assessment system to work, it must be realistic; i.e., soldiers must believe that the casualty assessment method used accurately reflects their performance. To satisfy this objective, casualty assessment must be related to the ability of soldiers and crews to use their weapons.

The training methodology for tactical field exercises involves two opposing forces and a team of controllers (observers). The number of controllers depends on the size of the forces (Platoon, Company, Battalion, Brigade, or Division) and the training system used.

In general, the following activities take place during any ground engagement exercise, and in the following sequence:

1. Unit trainers develop a tactical scenario based on a certain mission (choice of terrain, the opposing force size, and the type of weapons employed).
2. The units (infantry, vehicles, controllers) and the terrain are prepared based on the training system requirements.
3. The exercise is conducted with "simulated" firing and casualties.
4. Following the engagement, troops are assembled for an After Action Review (AAR). The discussion, guided by the senior controller, reviews the battle chronologically, focusing on each action in which casualties occurred. During the AAR the benefits of the exercise are assessed with respect to the strategies and tactical training. An information system (data gathering and processing) is needed to reconstruct the battle during the AAR.

ENGAGEMENT TRAINING SYSTEMS

In the past a training system called REALTRAIN [5] was used for tactical training for combined elements. The system works as follows: After trainers develop a tactical scenario, optical devices, telescopes or plastic sighting plates are mounted on or in weapons, tanks, etc., of the two opposing unit forces. These devices are aligned with the weapon sights, allowing controllers to see the same sight picture as the gunners, and permitting them to verify a gunner's aim during target engagements. Gunners "shoot" at targets by announcing an identification number worn by soldiers or displayed on vehicles while the target is aligned in their sights. The controllers verify the aim, and award "hits" or "misses." Hits are reported on a casualty assessment communication network to the controller assigned to the target engaged, who determines the damage caused by the firing weapon. The amount of damage is determined according to a set of rules for engagement based on the relative firing power between the engaged units. During the AAR, the soldiers themselves describe how they were able to engage and destroy a target, or were "killed" themselves.

Among the limitations of REALTRAIN is its dependency on controllers in assessing the casualities, which requires about as many controllers as there are participants (infantry men, vehicles, tanks, etc.). This makes it only usable for small sizes of opposing forces, with damage assessment based on controller judgement.

A major disadvantage of REALTRAIN is,in spite of large numbers of controllers, the battle can never be reconstructed in the AAR on a battalion level due to lack of information (positon/time, and who killed who).

A new battle simulation technique developed recently avoids many of the disadvantages in REALTRAIN. The technique uses "safe laser" guns and mounted detectors to simulate the firing and the hit during the exercise, making the battle almost realistic in this regard. The technique is used in a training system called Multiple Integrated Laser Engagement System (MILES) [4]. The system is designed in a way that it automatically assesses casualties with a great degree of realism. Each weapon (rifle, tank, etc.) is equipped with a mounted laser gun which duplicates the effective range and power of the real weapon. Each vehicle, tank, soldier, etc., is equipped with a set of laser detectors in the critical location of the unit. When a unit scores a "hit", the casualty is assessed by disabling the "destroyed" unit laser guns and activating a smoke bomb signaling a visual kill. This automation of the real-time casualty assessment eliminates the controller's role in this event, and reflects with precision the range and firing powers of the engaged units.

PROBLEM STATEMENT

The use of lasers make it possible to simulate battles on a battalion, or even a brigade level. On the other hand, an AAR--where the battle is reconstructed and military techniques are discussed--would be impossible to conduct without an information system that would record the events of the battle as they develop. The characteristics of such a system include the ability to collect information on a real-time basis leading to the determination of "who killed who, when and where."

The existing information system in MILES uses human controllers as the primary means of data collection. This operation is done by completing data forms (Figure 1), and reporting it on a communication network to a Central Control. The system uses a large number of controllers/collectors. Table 1 lists estimated manpower for different levels of training exercises. Operational costs as well as manpower allocation is extensive.

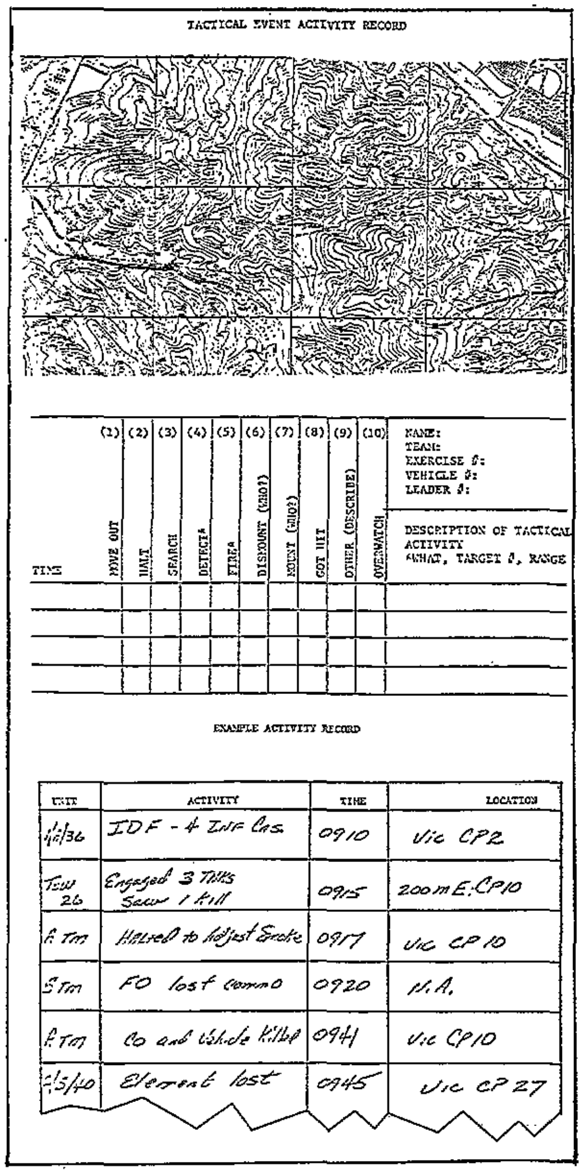

Figure 1 - Operational Data Collection Forms in MILES

Table 1

COLLECTION MANPOWER ESTIMATES FOR MANUAL DATA COLLECTION ON DIFFERENT LEVELS OF ENGAGEMENT SIMULATION (E/S) [1]

Level of E/S	No. of Collector-Controllers	Est. Operators of Networks
*Platoon	85	3
*Company	170	6
*Battalion	298	12
*Brigade	600	24
*Division	1190	48

The purpose of this paper is to present a feedback information system for MILES which uses an optimal mix of man and machine to collect data necessary for a MILES after action review, where computer plays a major role in completing, processing and presenting the data.

ANALYSIS AND DESIGN

Data Type

The data required for the AAR can be grouped in terms of two categories.

- Planning data (e.g., geographical boundaries of the exercise; instructions to participants)
- Process data (e.g., timing and events during the engagement exercise)

Planning data can be determined prior to and at the start of the exercise from commander/leader and collected via their oral, written, and drawn operations orders. Process data is the most difficult to observe and collect. Process conditions, events, must be sensed with only minor control/monitoring intervention and collected without exercise disruption. Process data can be defined for each participating unit as the following:

- Position time data
- Direct fire exchange data
- Indirect fire exchange data
- Casualty data
- Battalion command and control

When combined with planning data, these elements of process data will form the source and cross-checks for all outcome data required in the AAR to reconstruct the battle.

SYSTEM DESIGN

Along with the minimum data required defined previously, three main constraints were defined prior to the analysis and design. These constraints are:

1. Cost Constraint: The cost of any data collection mechanism should not exceed $200,000 for a battalion level.

2. Time Constraint: Battle analysis and data for AAR should be ready for demonstration within 30 minutes from the completion of the exercise.

3. The transition from the existing manual system to any proposed system, as well as the transition from the proposed system to any future more sophisticated system, should be smooth; i.e., only improvements over the current systems towards automation.

Subject to these constraints, sophisticated tracking and fire detection mechanisms are too expensive. A mix between contollers/collectors and instrumentation support is the chosen approach.

The suggested system is composed of three phases:

1. Data collection
2. Data processing
3. Data management, display and presentation

In the first phase, a set of human data collectors would send real-time data over a radio network to a central computer (Figure 2).

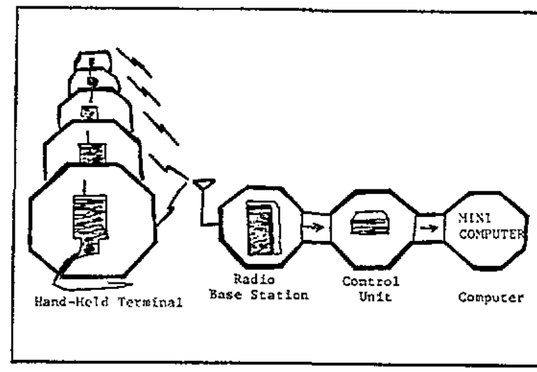

Figure 2 – Data Collection Mechanism Network

Controllers use hand-held terminals in relaying compact messages describing the event. It is estimated that one controller using a hand-held terminal can cover the events of five participating units. The message contents are as follows:

- Controller identification code (could be built in)
- Unit number or code
- Action description code (firing vs hit)
- Unit location coordinates (approximate)

Message items are either preceded by a key word or according to a predetermined sequence. The software would be designed in a way to minimize the redundent information. Based on an average of 20 events per unit per battle, a maximum of 4000 messages could be relayed to the central computer for an engagement on a battalion level (200 participating units).

The second phase is a processing phase (Figure 3) where the central processor will receive the data messages and pass them through two routines.

1. Message validation and completeness routine (COMPLETE): Its function is to validate the message against a set of rules related to the exercise, and to complete the data messages with necessary information.

The message would be completed to contain the following items:

- Time of message
- Controller number
- Unit identification number
- Action (Fire/Hit)
- Unit type
- Unit team
- Firing range and effect
- Unit location

Time is added to the message as it is relayed through a built-in clock (set to zero at the beginning of the exercise).

Unit type, team, and firing range are added through accessing a unit specifications file, with a record for each participating unit, and using the unit number as its access key. Messages are stored in 3 arrays with a capacity of 20 messages per array. Each array is sorted into an ascending sequence with respect to time, before passing the array to the next routine.

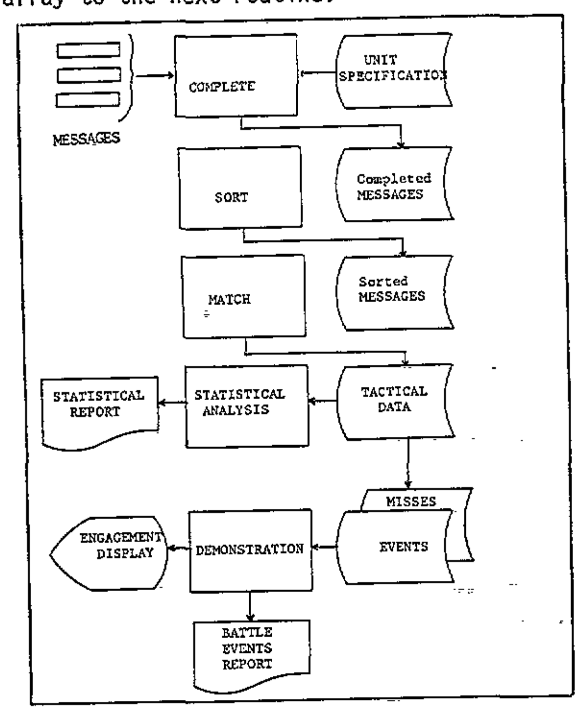

Figure 3 System Block Diagram - Processing Phase

2. Matching messages routine (MATCH): This function is to determine the "hit event". Messages within the same array are matched according to their times. The following rules coordinate the match:

a. Time is computable within ± limits
b. Units are of opposing teams
c. One unit action is fire while the other is hit
d. Units in the two messages are within the range of firing of the fire unit
e. The hit of killed unit should be within the killing "spectrum" of the firing unit

Two messages match if they meet at least the first 4 rules, since the fifth can be programmed in the laser software. A match would result in the creation of an "event" record, that would be output to an "EVENTS" file. The file would be used in reconstructing the battle in the AAR. The event record has the following information:

- Time of kill
- Unit fired
- Unit killed
- Position of firing unit
- Position of killed unit

Events will be recorded in chronological order. The maximum size of the EVENTS file will be 200 records for a battalion level exercise.

Other output files from the matching run are a "MISSES" file which records all units which fired and missed, with their respective time and location. A statistical data file could be produced containing data pertaining to the exercise to assess the practice in a sequence of engagement exercises.

The third phase involves data management, display formatting, and storage. The vast majority of planning data will be collected in manual form and, therefore, will require data management in at least its first stage of handling. As for the data analysis and reconstructing of the battle, it is subject to computer versus manual trade-off decisions. The EVENTS file would be used to output the events in a printed list that can be used to back up reconstruction of the battle on a three dimensional scaled map or to display the battle on a CRT screen superimposed over a background map.

Regardless of the demonstration method, each unit commander specifies his path, and with the aid of the events report, facts are demonstrated to the participants with alternative actions suggested.

HARDWARE CONFIGURATION

Based on an engagement exercise on a battalion level (200 participating units), a total of 25 controllers/collectors are estimated requirement for both enforcing the rules of engagement, indirect fire assessment, and data collection.
Basic hardware requirements [2] include the following:

- Mini Computer, with no less than 64 k Byte memory, portable, and interfacable with peripherals.
- Photo enlargement map system and material support.
- Peripherals include: Printer, disk unit, and a CRT.
- Hand held terminals (25 on a battalion

level) with a radio network to the central processor.

Software requirements include programming of the previously described logic. It is estimated that the cost of the system lies within the cost limit specified previously. Since the original project included studying all the potential state-of-the-art equipment, other systems were also investigated. Table 2 is an outcome of comparison between investigated systems (estimated costs are not mentioned). For more details refer to [2] where other factors such as cost, accuracy etc., are included.

TABLE 2
INFORMATION FEEDBACK SYSTEMS AND THEIR DEGREE OF AUTOMATION

	TYPE OF SYSTEM COMPONENTS			
Degree of Automation	Data Collection Method/Equipment	Approximate No. of Controllers	Data Processing Equipment	Data Display Equipment
Manual	1. MILES equipment with form and manual data collection	160	Network operators-manually match events	3 dimensional demonstrates manually displayed with models
Semi	2. MILES equipment with hand-held terminals	50	Mini Computer, and compatable prepherials (printer, disks)	Graphic projection on screen/or events report
Semi	3. MILES equipment with voice entry system	30	Mini Computer and compatable prepherials (printer disks)	Graphic projection on screen/or events report
Fully	4. Range Measurement system (General Dynamics) with modified MILES equipment	20	Compatable equipment to the Data Collection	Graphic projection on screen/or events report
Fully	5. Position locating and reporting system (Hughes) with modified MILES equipment			
Fully	6. Global Positioning System (SAMSO)			

SYSTEM IMPLEMENTATION

The described system is considered the first step to instrument the purely manual data collection and information system for MILES battalion exercises. The system currently in use is operated on a manual basis, where controllers report messages verbally over a radio network to a central command. Another team of controllers perform the matching operation (processing). Matching is time consuming and so far has only been implemented on a company level with a total of about 20 units participating in the exercise. The transition from manual to man-machine mix should be smooth, since the logic of the operation is the same. The number of controllers could be reduced with proper training on the usage of hand-held terminals. A more sophisticated system could use a voice data entry devices [3] in place of the hand-held terminals as input to the system. Such transition should also be smooth since the software will not change.

CONCLUSION

MILES as an engagement exercise is successful. The pace by which battles are conducted as well as the casuality assessments are on a real-time basis. Instrumentation of the accompanying data gathering system is essential on a battalion level to gain full credibility of the exercise during the AAR. A semiautomated system is suggested here to be the first step towards complete automation. The system uses an optimal mix between man and equipment. It is theoretically feasible; however, it needs simulated laboratory testing and experimental justification. The system is flexible to accept new technologies in data gathering and processing without major changes.

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