Research Note 84-27

AN ATTEMPT TO DESIGN AN ARMY FIELD ARTILLERY TACTICAL DATA SYSTEM SIMULATION CAPABILITY

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This project was intended to have been part of a larger effort (1) to identify the man-machine transactions that could cause difficulty in the acquisition and retention of skills required to operate Army Field Artillery Tactical Data Systems (AFATDS) and that are related to the software generated interface characteristics of the system and (2) to develop ways of countering these difficulties. This project focused on developing a simulation capability (SIMCAP) in which these difficulties could be researched. The decision was made to use the existing TACFIRE Training System (TTS) to provide the simulation (cont'd)

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capability. A validation effort was undertaken to shake down and debug the equipment, facilities, and procedures that make up the TTS SIMCAP.

The components of the TTS SIMCAP are assessed with regard to seven characteristics for an ideal SIMCAP:

1. The general information processing functions required to coordinate artillery fires.
2. Man's information processing capabilities,
3. The characteristics of the information processing interface.
4. Characteristics of combat situations.
5. Meaningful operator performance measures.
6. Modifiability of operator/commander consoles, and
7. A readily programmable and expandable computer to operate the SIMCAP.

BRIEF

Requirement:

To develop a modest capability of simulating tactical data systems for determining the criticality and difficulty of learning and retaining operator/machine transaction skills. The simulation capability was to be used in a larger effort to determine whether or not such difficulties can be anticipated and reduced, and whether they are inherently hardware, software, or human problems.

Procedure:

Originally, it had been intended (1) to perform an analysis of the operational context within which learning and retention difficulties would be identified and targeted for research and (2) to use a commercially available microcomputer as the basic equipment around which to develop a simulation capability. Instead, the context analysis was deleted from the effort and the TACFIRE Training System (TTS) was substituted for the microcomputer as the basic equipment for the simulation capability (SIMCAP). A validation effort was undertaken to shake down and debug the equipment, facilities, and procedures that make up the TTS SIMCAP.

The components of the TTS SIMCAP were assessed with regard to seven characteristics for an ideal SIMCAP:

1. The general information processing functions required to coordinate artillery fires.

2. Man's information processing capabilities.

3. The characteristics of the information processing interface.

4. Characteristics of combat situations.

5. Meaningful operator performance measures.

6. Modifiability of operator/commander consoles.

7. A readily programmable and expandable computer to operate the SIMCAP.

Findings:

With regard to the conduct of the validation study, an insufficient amount of meaningful data was generated to allow for statistical analysis of the results.

With regard to the review of the components of the TTS SIMCAP, they were found to be severely deficient on all seven characteristics for an ideal SIMCAP.

Utilization of Findings:

Findings from the review of the TTS SIMCAP components may be useful in conceptualizing, designing, and using other simulation capabilities intended as vehicles for studying human factors problems in command, control, and communication systems. The characteristics of an ideal SIMCAP point to the need to go well beyond just a physical capability for simulating the man/machine interface. System context and human information processing characteristics must be taken into account by such simulation capabilities if fully useful results are to be obtained from them.

ACKNOWLEDGEMENT

The proposal for this project was written by one group of scientists, implemented by another group, and reported by the original group who wrote the proposal. Consequently, this report represents two different interpretations of the research needs underlying the design of a simulation capability (SIMCAP) for Army Field Artillery Tactical Data Systems (AFATDS). From the point of view of those who wrote the proposal and the final report, the implementation is seen as a failed attempt.

The major part of the report is based on notes prepared by the last member of the implementation group. The deficiencies in the implementation as perceived by the proposing and reporting group are detailed in the last section of the report.

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BACKGROUND

This project was intended to have been part of a larger effort (1) to identify the man-machine transactions that could cause difficulty in the acquisition and retention of skills required to operate Army Field Artillery Tactical Data Systems (AFATDS) and that are related to the software-generated interface characteristics of the systems and (2) to develop ways of countering these difficulties. An AFATDS is a command, control, and communication system (C^3) used to coordinate requests for and delivery of field artillery fires in combat situations. The first generation AFATDS is the TACFIRE system. However, this project addresses both current and future AFATDS. The objective of the larger effort and of the project is to anticipate the kinds of skills required to use different software approaches that could cause acquisition and retention difficulties and that have a significant impact on the operation of the system. Some kinds of skills are more difficult to learn than others. If these difficulties can be identified, then they might be countered either through software designs or through special training designs and/or printed skill performance aids or by means of personnel assignment policies.

The larger effort of which this project was a part was proposed to contain a preceding subtask to develop the context within which acquisition and retention difficulties would be identified and targeted for research. This subtask was to consist of three steps:

1. Develop operator performance criteria that are based on or reflect the mission effectiveness of the system.

2. Develop situational measures that are based on the mission demands placed on the system.

3. Identify the significant error-likely situations for AFATDS operators.

The first step was seen as providing a necessary basis for the rest of the effort in order to focus analysis on those difficulties that are most significant for system effectiveness. Those difficulties that have significant impact on system effectiveness would be given higher priority for investigation than those that have little or no impact on system effectiveness.

The second step was to have developed situational measures based on mission demands placed on the system. Operator performance should be assessed within realistic combat scenarios. The situational measures provide a means of specifying such scenarios. However, all scenarios are not equally difficult. Hence, it is also desirable to be able to scale scenarios by difficulty in order to compare the performances of operators operating against different threats in different environments.

The third step was to identify particular software design options from the literature and by means of rational and theoretical analyses that appear to have a high operator error potential with regard to those kinds of errors that are significant for system effectiveness. This step was to help ensure that the operational scenarios for use in the experimental studies would expose the operators to situations likely to result in errors of selected kinds. Having a firm idea of the potential range of the independent variables under study would permit scenario development to be driven by data requirements rather than by happenstance.

The three steps in the first subtask were to have provided (1) the context within which to develop an experimental simulation capability (SIMCAP) and (2) the context within which to formulate hypotheses for experimental investigation. This report only describes the development of the simulation capability itself.

The three steps of the first subtask were not performed. Hence, the operational context within which to design an AFATDS operational simulation was never developed. However, even without this context, it seemed clear that the SIMCAP would have to be capable of emulating the software-generated interface characteristics of the existing TACFIRE, of future TACFIRE hybrids, and of future AFATDS alternative design concepts. Furthermore, it seemed clear that an actual TACFIRE system would not easily provide the capability to explore the full range of possible software-generated interface characteristics of future AFATDS alternatives. Without a doubt, the first generation of a system will be limited because it invariably represents the least advanced application of a developing technology.

In addition to developing an experimental AFATDS SIMCAP the project was to conduct an initial series of studies to validate the SIMCAP facility. Validation, in this context, assesses the extent to which inferences drawn from the use of the SIMCAP would be similar to those drawn from similar data obtained through use of a real system--either the existing TACFIRE or some future AFATDS alternative. Since the TACFIRE is the only alternative that currently exists, the TACFIRE is the only available choice as a validation criterion.

Emphasis during the part of the project covered by this report was to have been on the design and validation of a SIMCAP. Only that research required by the validation was to be conducted at this time. Hence, there was no need to develop an extensive SIMCAP for processing large numbers of experimental subjects.

RATIONALE FOR THE SIMCAP DESIGN

Originally, it had been intended to use a microcomputer as the basic equipment around which to develop a simulation capability. Four reasons were cited by the SIMCAP designers for selecting the existing TACFIRE system instead as the hardware vehicle for the SIMCAP:

1. The TACFIRE terminal was deemed to be radically different from any microcomputer keyboard because it contains special character keys not found elsewhere. Furthermore, these special character keys are not all on the keyboard. Some of them are located on vertical surfaces on the console rather than on the keyboard itself. Some of the special characters--such as the end of text symbol--are not found on any other system.

2. The actual TACFIRE hardware would create a certain amount of realism or face validity for subsequent research studies.

3. The staff needed experience with the actual TACFIRE system.

4. The TACFIRE Training System (TTS) was available for research use. Since the TTS has eight artillery control console (ACC) operator positions and six variable format message entry device (VFMED) operator positions tied to one computer, it would make it possible to collect data on a number of subjects at once.

Although a microcomputer had already been purchased for the SIMCAP, the use of the TTS made it unnecessary, since the TTS already contained its own computer. This reasoning essentially equated the physical components of the SIMCAP to the TACFIRE Training System (TTS). For this reason, this version of the SIMCAP will be designated as the TTS SIMCAP to differentiate it from other possible SIMCAPs.

CHARACTERISTICS OF THE TTS SIMCAP

The TTS SIMCAP consists of the following parts:

1. The actual TACFIRE equipment consoles used at the two operator positions--the ACC operator position (eight stations) and the VFMED position (six stations).

2. The TACFIRE computer equipped with a larger memory.

3. The enhanced PLANIT computer language for programming the TACFIRE computer. PLANIT is a complete authoring language and operating system for computer assisted instruction.

4. The dependent variables made available by the TTS SIMCAP. These variables are largely determined by the student record capabilities of PLANIT.

The TTS SIMCAP consoles

The TTS based SIMCAP uses the same consoles used in the existing TACFIRE system. It possesses the same displays and controls used in the TACFIRE. The focus of the SIMCAP design was on the ACC (Artillery Control Console) operator. FM 6-1, Field Artillery Tactical Fire Direction System, TACFIRE Operations describes the ACC as follows:

> This console is the portion of the battalion set used by the people controlling processing in the computer group. The ACC has two display scopes: one for displaying messages from external sources and results of processing and one for selection of formats and initiation of processing. The ACC is the TACFIRE device that must be checked for system functioning. The ACC is operated by the fire direction sergeant/artillery control console operator (ACCO)(E6, 13E). He is supervised by the fire direction officer (CPT, 13A) and/or the assistant S3. These personnel make decisions agreeing or disagreeing with TACFIRE solutions, operate the ACC, and insure that the system is working properly. The FDO must be physically near the console to tell the ACC operator what action to take on the various messages processed. The ACC operator can cause computer action, transmission of information to remote devices, and operation of other associated equipment. The ACC operator is alerted to errors and violations by displayed computer warnings.

In addition to the ACC the operator has an electronic line printer (ELP) located just to the right of his console.

> The ELP provides a paper printout of the results of action accomplished by the computer. These printouts are used to review earlier computer actions and to provide copies of data stored in computer memory to interested personnel.

The TTS SIMCAP Computer

The computer uses several mass core memory units (MCMU), each of which provides a capacity of approximately 130,000 computer words (bytes). The computers used in battalion TACFIRE installations contains three MCMU. However, the version used in the TTS has been enhanced beyond this level.

The Enhanced PLANIT Computer Language

PLANIT contains a number of operating modes. In the system mode, the operator is able to create listings of PLANIT programs, read PLANIT programs from magnetic tape or write them to magnetic tape, shut down designated terminals, list student records, create history tapes, and delete programs and student records. In the command mode an author is able to create, edit, and run lesson programs and a student is able to run a program that has been released for student access. The control mode is used to run lessons which have complete control of the students terminal and determine where the output is to be written (top screen, bottom screen, or ELP). However, PLANIT lessons are typically run in the lesson mode. Although the lesson mode does not provide the control over outputs provided by the control mode, it does provide other desirable characteristics such as allowing the student to operate the system in a calculator mode.

PLANIT lessons are divided into sections called frames. The basic frame is the question frame. The question frame controls the presentation of text, the processing of answers to questions, and branching to subsequent frames based on the answers to the questions. Control mode processing uses question frames, programming frames, and decision frames. The latter two define functions and subroutines as well as playing a role in the presentation of text and in branching.

The answer section of a question frame contains a list of possible answers prepared by the author. Each of these answers has an identification label. Answers which the author deems to be correct are marked with a "+" after the label.

The PLANIT student record is a special file created by a PLANIT lesson to record the student's performance on that lesson. The student record normally records the answer to question frames only. The amount of time in each question frame is recorded in minutes and seconds along with the answer label. If a student's response matches one of the labeled answers in the answer section of the question frame, the label appears on the student record for that frame: Correct answers are marked with a plus. If the student's answer was not anticipated by the author, a "-" appears on the student record for that frame. In addition, the student record records the time and date the lesson was started and the time and date it was stopped. If the lesson was restarted, that is also indicated on the student record. At the end of the record, the total number of right and wrong answers to the question frames is given along with the total amount of time spent on the entire lesson.

A PLANIT history tape can be created to save the contents of the entire computer memory including all of the student records. If practice on a lesson is interrupted, the history tape allows the operator to restore the system at a later time to the same condition it was at when the lesson was interrupted.

The Dependent Variables

The dependent variables available in the TTS SIMCAP are determined largely by the information provided by PLANIT.

1. Number of question frames to criterion. Since the PLANIT student records contain the exact sequence in which question frames were presented to each student, a simple count can be obtained of the number of frames required by a student to reach the training criterion.

2. Total training time to criterion. Since the PLANIT student record records the time spent in each question frame by each student, total time can be obtained by summing the individual times for all the frames.

3. Number and types of errors. The PLANIT student record only records the content of responses that have been anticipated by the author. It was not considered possible to anticipate all of the ways in which students could make errors to each and every question frame. Consequently, it was decides to use the ELP located at each student station to record the exact response the student transmitted to the computer. After the student has finished a lesson, the printed ELP records can be examined and errors classified and counted.

The last two dependent variables were determined by an artificial response keyed by the student. It was desired to separate the time it took a student to decide what action to take from the time it took him to actually perform the action. That is, it was desired to measure the student's decision time separately from his performance time to each question frame. In order to obtain these two measures, two button lights on the switch panel assembly were used. At the beginning of a question frame, the message "PRESS 'PRIORITY MESSAGE' WHEN READY TO CONTINUE" appeared in the top screen. When the student pressed the priority message button the message light went off, the message in the top screen was replaced with a problem scenario with instructions, the message "PRESS 'ILL. SW ACTION' WHEN READY TO PERFORM TASK" appeared on the bottom screen, and the illegal switch button lighted up. After reading the scenario and deciding what to do, the subject pressed the illegal switch action button. This action caused the light in the button to be extinguished and cleared the bottom screen so that the student could call up a format or replace the message on the bottom screen with the initial menu, depending upon the particular experimental treatment. This procedure required the preparation of two question frames for what would ordinarily have required only one. Each ordinary question frame was reconstituted as a pair of frames. It resulted in the capability to measure two additional dependent variables:

4. <u>Decision time</u>. This was measured as the elapsed time from the presentation of the scenario to the student's pressing of the illegal switch action button (the second button). This time was recorded on the student record as the elapsed time for the first question frame in each pair.

5. <u>Performance time</u>. This was measured as the elapsed time from the student's pressing the illegal switch action button to the end of the overall question frame as seen by the student. This time was recorded on the student record as the elapsed time for the second question frame in each pair.

CONDUCT OF THE VALIDATION EFFORT

The Purpose of the Project

The effort which was undertaken apparently was intended to begin a program of research into the training implications of various AFATDS configurations without concern for validating the TTS SIMCAP. This initial effort was conducted largely as a shake down or debugging of the equipment, facilities, and procedures that made up the TTS SIMCAP. However, the effort was intended to be more than just an exercise of the TTS SIMCAP since three performance treatments were developed and applied within an experimental design.

Three groups of subjects were trained in four different tasks performed by ACC operators. Each group received a different performance condition: (1) One group was trained to fill in the standard mission formats used in the existing TACFIRE system, (2) one group used the same formats but was also provided with a printed job aid to use during both training and performance, and (3) one group was provided with specially designed menus in place of the conventional formats on the lower screen.

Method

1. Subjects. Thirty-nine (39) subjects initially entered the project. Data was collected from only 34 subjects. They ranged in rank from E-1 to E-6 with the majority having a rank of E-1. None of the subjects had had any prior TACFIRE training, but all were artillerymen representing a variety of MOS.

2. Performance conditions. Each subject was administered one of three different performance conditions. Each subject received the same performance condition in both training and testing.

a. Standard TACFIRE formats without any job aids. These formats require the operator to enter information into the appropriate blanks in the format on the screen by means of the keyboard. The blanks are labelled with abbreviations which designate the kind of information required.

b. Standard TACFIRE formats with job aids similar to those found in standard TACFIRE manuals (e.g., TM 11-7440-253-10-3) except that they had been specifically tailored for the four tasks selected for training and performance evaluation.

c. A menu selection system which in most instances simply required the operator to move the cursor to his choice in the menu and press the transmit button. Occasionally, a menu would request a typed entry.

In both the format and menu conditions, the cursor is moved from one field or menu choice to another by means of tabbing.

3. The tasks. Four ACCO tasks were selected as the performance vehicles for the project:

a. Build an ammunition and fire unit (AFU) file. This is reputed to be a very simple task consisting of but one format line.

b. Create an on-call or fire plan target list.

c. Initiate a fire mission.

d. Establish a fire unit in the AFU file. This is reputed to be one of the most difficult, if not the most difficult of the TACFIRE tasks. This task is performed when the fire units are initially setting up. Map coordinates of the various fire units are recorded along with the amount and type of ammunition, type of weapon and model, meteorological data, and zone of responsibility.

4. Training procedures. All subjects were given group instruction at the beginning of training on what a format or menu consisted and how each was used. Different performance conditions were run at different times, so the subjects saw only the one condition which was being administered to them.

Following the group instruction on the formats and menus, subjects received group instruction on the physical operation of the ACCO terminal. This instruction covered such points as the need to reset the cursor before sending or composing a message, the cursor movement buttons, the EOT (end-of-text) key, the tab key, the erase key, etc. After this instruction, each subject was allowed approximately eight minutes to "play" with the buttons on the console.

All subjects in all performance conditions were provided with a Table of Legal Entries to use during training and testing. These tables were taken from Field Artillery materials to provide the subjects with the legal entries for some of the format and menu fields. The entries were for weapon and model, ammunition, and target types and subtypes.

Subjects in the Aided Format condition also received a copy of the job performance aid developed for this condition. A copy of the job performance aids is presented in Appendix A.

A lesson was developed for each of the four tasks. Each lesson was divided into three section: (1) A pretest section, (2) an instruction and drill section, and (3) a posttest section.

The pretest section was included to determine how well a subject could perform without any formal practice. The question frames in this section did not provide feedback for correct responses. If the subject made an error, he would receive the message "YOU MADE AN ERROR" and nothing more.

The instruction frames presented informational material explaining the use of various mnemonics (formats and menus), what the various options stood for, how the system used various types of information, and so on. The instruction frames might also require a subject to enter specified information into the system, but the information was not placed in a scenario context. The drill frames presented the subject with a scenario and instructed him to fill out a specific format field or to make a menu selection. In both types of frames, feedback was given only for incorrect responses. It was partially corrective feedback in that it told the subject what the correct response should have been but did not explain why; that is, it did not correct the subject's misunderstanding.

The posttest section of each lesson contained four posttests. If any one of the posttests was completed correctly on the first trial, the subject terminated the lesson. Otherwise, the subject progressed to the next posttest. If the fourth posttest could not be answered correctly after the first trial, the subject was transferred back to the beginning of the main lesson section. He was required to repeat the entire lesson before attempting the posttest again.

The posttests used the "illegal switch action" button to separate decision time from performance time as previously described. At the beginning of a frame, the subject was presented with a scenario. In some frames the subject would be instructed as to what format or meny to call up. More than one format field or more than one menu were always required to respond to a scenario. If the subject's response was incorrect, he would receive a message like "YOU MADE AN ERROR, TRY AGAIN." The subject could not leave the frame until the correct response was made.

5. Experimental procedures. The experimental effort was conducted over a five week period. On the first day of each week a new group of subjects arrived. In the initial session with each group of subjects they were oriented to the TACFIRE system (what it is, its mission, and so on) and they were oriented to the SIMCAP (a performance test bed for alternative AFATDS and a vehicle for AFATDS related training and performance research). The group instruction on formats or menus and operation of the terminal followed the

orientation. Various administrative activities were conducted during this first day and subjects were administered a typing test and a reading comprehension test. Subjects then began the training program. However, no pretests or posttest were administered during the first two weeks.

Each subject proceeded through the pretest, training, and posttest at his own rate. Subjects proceeded to each subsequent task as soon as they finished the preceding task.

Results

Although the effort was designed as an experiment, many components of the project were not in place at the beginning of the effort. For instance, pretests and posttests were not introduced until the third week. The PLANIT lesson programs still had many errors in them. These errors frequently led to subjects (1) being held in a lesson frame even though their responses were correct, (2) being advanced to the next lesson frame even though their responses were incorrect, and (3) being presented with incomplete or erroneous scenario information. The researchers spent much of their time responding to the occurrence of these errors and correcting the programming that produced them.

The administrative difficulties described above greatly interfered with the subjects' progress during the first half of the project. No subject was able to attempt all four tasks until the fourth week of the project. And no subject completed all four tasks during the entire project. Consequently, complete data was not collected for any of the three performance conditions. At the end of the week they were released regardless of how far they had progressed on the four tasks. No more than nine (9) subjects completed any one task in any of the performance conditions. Many tasks in some performance conditions were completed by only two (2), three (3), four (4), or five (5) subjects. The changing conditions during the project and the very few number of subjects who completed many of the task/condition treatments mitigated against any statistical analysis of the results.

REVIEW OF THE RATIONALES UNDERLYING THE SIMCAP DESIGN

Concept for an AFATDS SIMCAP

The TTS SIMCAP appears to have been conceptualized simply as a context for training and performance research with the existing TACFIRE system. The emphasis on "realism" to TACFIRE precludes investigations of radically different AFATDS alternatives. It would have been more useful to conceptualize the SIMCAP as representing the behaviorally significant software-generated interface characteristics of a population of current and future AFATDS. This would have led to the identification and analysis of the necessary functional characteristics of any and all AFATDS and the early identification of advanced equipment technologies for performing these functions. In this way the SIMCAP could have been used as a way of anticipating AFATDS alternatives rather than being locked into the existing TACFIRE.

An AFATDS is basically an information processing system. In its crudest form, all the information processing functions of an AFATDS are performed by human beings. As the systems become more and more sophisticated, equipment is introduced to perform certain of these functions. Thus, the commander of a Roman ballista unit may have used pebbles to keep track of how many rounds each of his weapons still had available. He may have scratched out a representation of the battlefield on the dirt in front of him, showing the locations of his weapons and the location of potential targets. These are techniques for supplementing and enhancing his own internal information processing. They constitute the equipment components of a very crude AFATDS. The TACFIRE system is a much more sophisticated method for enhancing a commander's own internal information processing. But the information processing functions performed in each of these instances are essentially the same. Hence, it would appear that the general pattern of information processing functions required to coordinate artillery fires is a common component of all conceivable AFATDS--past, present, and future.

Man would also appear to be a common component of all conceivable AFATDS, although man's role in the system may become more and more circumscribed as the equipment becomes more and more sophisticated. As the systems become more sophisticated, the equipment takes over more of the information processing functions.

As equipment technology advances, equipment can be designed to perform some information processing functions more effectively than man. In fact, the basic problem faced by system designers is to allocate information processing functions best performed by equipment to equipment and to allocate information processing functions best performed by man to man and to design an optimum information processing interface to join the human and equipment components of the system. Of these two types of components, man is the more constant, the less amenable to changes in basic capabilities. Hence, the rest of the system components and the interfaces should be designed to serve man. An optimum equipment interface should provide man with information displays formatted to fit his information processing requirements and the controls should be designed to accept the natural formats of man's information outputs. It follows, then, that one major information base for designing an AFATDS or an AFATDS SIMCAP would be a catalog of man's capabilities for performing the various information processing functions required by an AFATDS.

All too often system designs are developed in the inverse manner: Equipment is designed on the basis of existing equipment technology and man is forced to fit the equipment demands. System design should not proceed by putting man into the loop as an afterthought. Initially, man is the entire loop. Equipment should be introduced only to relieve man of responsibility for those segments of the loop that equipment can perform better. But before we can know whether or not to assign a segment to equipment, we first have to identify all the functional segments in the loop and determine man's capability to perform each one.

Components of an AFATDS SIMCAP

We have identified three basic components for designing an AFATDS SIMCAP:

1. An identification of the general information processing function required to coordinate artillery fires.

2. A catalog of man's capabilities for performing each kind of information processing function.

3. An identification of the functional characteristics of the information processing interface between the human and equipment components of the system. Our concern here is with specifying the functional characteristics of display and control formats and contents that meet the information processing characteristics of human beings.

None of these components was included in the TTS SIMCAP.

Artillery units and AFATDS operate in real combat environments and real combat situations. The significant characteristics of these environments and situations need to be identified so that they can be properly represented in SIMCAP scenarios. In addition, the characteristics that define system effectiveness in these environments need to be identified. How else are we to judge performance in a given scenario? Now we can add a fourth component to our SIMCAP:

4. A specification of the more likely characteristics of the real combat environments and situations in which AFATDS systems will operate and a specification of the characteristics of effective system performance in those environments and situations.

No mention is made in the TTS SIMCAP regarding the source or development or representativeness of the scenarios used in training and testing.

The primary function of a SIMCAP is to assess human performance. In order to assess human performance, the performance must be measured and valued. The characteristics or consequences of human performance that we observe and record and analyze constitute the dependent variables of the SIMCAP. But measures which do not possess known significance cannot be valued. In an AFATDS, we are only concerned with measuring those characteristics of human performance which can be shown to contribute to or detract from system effectiveness. The only way to establish the significance of such measures is to relate them to the characteristics of system effectiveness in combat environment and situations. The operator performance measures can be related to characteristics of system effectiveness in either of two ways: (1) They can be derived from the characteristics of system effectiveness or (2) they can be shown experimentally to contribute to characteristics of system effectiveness--or both. We now have a requirement for another component for an AFATDS SIMCAP:

5. A set of dependent variables (operator performance measures) for measuring and valuing human performance in the AFATDS which are either derived from or experimentally related to the characteristics of system effectiveness in combat environments and situations.

The dependent variables specified for the TTS SIMCAP were apparently selected simply because they were available by the PLANIT programming language. These dependent variables are indeed measures of human performance, but there is no way of ascribing value to differences among these measures. Is one kind of error as damaging to system effectiveness as another kind of error? Is a given improvement in operator response time worthwhile in terms of its cost and its effect on system effectiveness? Without a system for valuing changes in human performance, we could waste research resources in trivial efforts.

Finally, we arrive at the equipment components of a SIMCAP. Clearly, a SIMCAP will require display and control consoles for operators and commanders. Such consoles should be capable of simulating the information processing characteristics of the man-machine interface in whatever ways as are suggested by existing and forseeable equipment technologies. What kind of information content is needed by the operator and at what level of abstraction? How should such information be represented and formatted? What kind of information content is produced by the operator and how does he represent and format it? We need displays and controls that are flexible enough to allow us to alter the characteristics of the information exchange at the man-machine interface. The physical displays and controls that make up the operator/commander consoles constitute the sixth component for a SIMCAP:

6. Operator/commander consoles consisting of displays and controls whose information processing characteristics can be modified to represent the potential characteristics which might be provided by developing equipment technologies.

The TTS SIMCAP adopted the consoles and their associated displays and controls provided by the first generation AFATDS--the TACFIRE system. Such a choice provides very little capability for simulating future systems and the potential of future equipment technologies. For instance, the existing TACFIRE ACC does not provide a means for representing data graphically or for allowing the operator to respond by using a light pen to indicate a location on the screen. This technology exists now but could not be tested on the TTS SIMCAP. It is certainly reasonable to believe that graphic representations are much closer to the manner in which battlefield information is naturally represented by human beings in their own internal information processing. But the TTS SIMCAP is not capable of supporting such research.

The equipment components of a SIMCAP must also include ways of scheduling and controlling information displays and ways of recording operator/commander performance. The physical SIMCAP must clearly be designed around a computer. The computer should be readily programmable and expandable to meet future requirements. There are many commercially available microcomputers on the market now that meet these requirements. The final component for a SIMCAP is a computer:

7. A readily programmable and expandable computer for scheduling and controlling information flow in the SIMCAP and for recording operator/commander performance.

Apparently, the computer used in the TACFIRE with the enhanced memory provided by the TTS and the PLANIT language was chosen to use in the TTS SIMCAP simply because it was available. PLANIT is not a commonly used programming language. And the TACFIRE computer represents an outmoded computer technology by today's commercial standards. A single double sided, double density floppy disk drive matches or exceeds the memory capacity of the TTS computer at a miniscule fraction of the cost. In addition, the TTS is not readily accessible for research use and it certainly could not be relocated for research purposes alone.

<u>Applications</u>

1. Training design. The training design used in the TTS SIMCAP validation project does not represent an application of the sophisticatdd training technology available today. It is task based rather than skill based. Consequently, it would have been difficult even if the project had been successfully completed to ascribe differences between the three performance condition groups to the performance conditions themselves or to differences in instruction. For instance, since all practice was performed on the TTS

equipment subjects in the format conditions engaged in constructed responses exclusively whereas subjects in the menu condition engaged principally in recognition responses. These are two response modes that are known to have different effects on learning, retention, and performance. Recalling (reciting) the content of formats or menus could have been practiced as separate skills under similar conditions before beginning whole task practice on the simulator. This would have greatly diminished the differences in practice conditions for the two kinds of performance conditions and it also would have made training more efficient.

The task based approach to training was not efficient with regard to use of the TTS. Each student used a station on the TTS for all the practice in which he engaged to learn the tasks. If the tasks had been analyzed into subordinate skills, practice on most of the skills could have been done on paper simulations. Students would not have begun whole task practice on the TTS until they had mastered the subordinate skills. This would have greatly reduced their need for whole task practice and, consequently, would have reduced the demand for expensive TTS equipment.

2. TTS SIMCAP validation. The selection of the TTS as the vehicle for the SIMCAP confounded the design of a project for validating the SIMCAP. If the SIMCAP configuration is identical to the existing TACFIRE configuration--indeed is the same equipment, then there is nothing to validate. The predictor conditions are the criterion conditions: Hence, there is nothing to be predicted. Under these conditions, the TACFIRE cannot be used as a representative of the population of existing and future AFATDS to use as the criterion condition in a validation effort. The project that was conducted did not compare the inferences drawn from performance on the TTS SIMCAP with inferences from similar performances on the TACFIRE. It would have made no sense to have done so, yet not doing so fails to validate the TTS SIMCAP.

APPENDIX A

BUILD AN AFU FILE

```
AFU;BUILD;PLAN:------;NEWPLN:------;FU:-/-/-/--/---;WPN:------;AMMO:--;
```

SELECT ONE OF THE SUBPROCEDURES BELOW:

- A - COPY THE ENTIRE AFU FILE (FOR ALL FIRE UNITS)
- B - COPY A SPECIFIC FIRE UNIT ONLY
- C - USE WEAPON TYPE TO SELECT FIRE UNITS TO COPY
- D - USE AMMUNITION TYPE TO SELECT FIRE UNITS TO COPY
- E - USE WEAPON AND AMMUNITION TYPES TO SELECT FIRE UNITS TO COPY

A - COPY THE ENTIRE AFU FILE (FOR ALL FIRE UNITS)

STEP	REFERENCE FIELD	ACTION
1	AFU;BUILD	Call up AFU;BUILD format
2	PLAN	Enter existing plan name from which fire units will be copied for new plan. (Default = current situation)
3	NEWPLN	Enter name assigned to new plan.

B - COPY A SPECIFIC FIRE UNIT ONLY

STEP	REFERENCE FIELD	ACTION
1	AFU;BUILD	Call up AFU;BUILD format
2	PLAN	Enter existing plan name from which a specified fire unit will be copied for new plan.
3	NEWPLN	Enter name assigned to new

STEP	REFERENCE FIELD	ACTION
4	FU	Enter fire unit name

Section number

Platoon number

Battery

Battalion or division

Regiment, brigade, or division

FU:-/-/-/--/---;

C - USE WEAPON TYPE TO SELECT FIRE UNITS TO COPY

STEP	REFERENCE FIELD	ACTION
1	AFU;BUILD	Call up AFU;BUILD format
2	PLAN	Enter existing plan name fr which selected fire units will be copied for new plan (Default = current situatio
3	NEWPLN	Enter name assigned to new plan
4	WPN	Enter weapon type to be use for NEWPLN. Refer to legal entries for weapon and mode (Table A, Page 1)

```
AFU;BUILD;PLAN:------;NEWPLN:------;FU:-/-/-/--/---;WPN:------;AMMO:--3
```

D - USE AMMUNITION TYPES TO SELECT FIRE UNITS TO COPY

STEP	REFERENCE FIELD	ACTION
1	AFU;BUILD	Call up AFU;BUILD format
2	PLAN	Enter existing plan name from which selected fire units will be copied for new plan. (Default = current situation)
3	NEWPLN	Enter name assigned to new plan
4	AMMO	Enter ammunition type to be used by fire units in NEWPLN. Legal entries are: HE = high explosives CH = chemical NU = nuclear Default = AL (all types) NOTE: Must be same type as entered in the APPL field of the AFU;UPDATE message. Also valid with WPN.

- USE WEAPON AND AMMUNITION TYPES TO SELECT FIRE UNITS TO COPY

STEP	REFERENCE FIELD	ACTION
1	AFU;BUILD	Call up AFU; BUILD format
2	PLAN	Enter existing plan name from which selected fire units will be copied for new plan
3	NEWPLN	Enter name assigned to new plan.
4	WPN	Enter weapon type to be use for NEWPLN. Refer to legal entries for weapon and mode (Table A, Page 1)
5	AMMO	Enter ammunition type to be used by fire units in NEWPL Legal entries are: HE = high explosives CH = chemical NU = nuclear Default = AL (All types) NOTE: Must be same type as entered in the APPL field of the AFU;UPD message. Also valid with WPN

CREATE AN ONCALL OR FIRE PLAN TARGET LIST

```
NNFP;INST;PLAN:------;FPTGT:-;ONCALL:-;DELETE:-;
TGTS:------,------,------,------,------,------,------,------,------;
PRIOR:-;PHASE:-,-,-,-;H:----;GROUP:-------;SERIES:------/-;
UFFES:-/-/-/--/---,-/-/-/--/---,-/-/-/--/---,-/-/-/--/---,-/-/-/--/---;
EFF:--;VOL:--;SH:---/---;FZ:----/----;ANGLE:----;
```

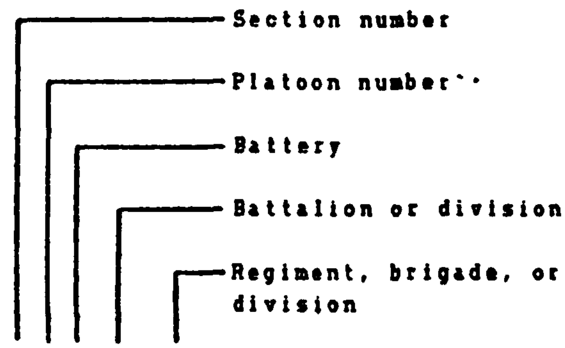
STEP	REFERENCE FIELD	ACTION

SELECT ONE OF THE SUBPROCEDURES BELOW:

- A - DESIGNATE AND INSTRUCT ONCALL TARGETS
- B - DESIGNATE AND INSTRUCT SCHEDULED TARGETS

A - DESIGNATE AND INSTRUCT ONCALL TARGETS

STEP	REFERENCE FIELD	ACTION
1	NNFP;INST	Call up NNFP;INST format
	PLAN	Enter plan name
	ONCALL	Enter X to indicate that targets specified at Step 5 are oncall targets. Note: Oncall targets are exempt from scheduling instructions such as PRIOR, PHASE, and H-TIME
	TGTS	Enter target number(s)
5	UFFES	If desired, enter logical subscriber name of fire unit to be used in fire plan against target



UFFES:-/-/-/--/---,

STEP	REFERENCE FIELD	ACTION
6	OPTIONAL: Perform only if changes in desired effects or number of volleys in attack method tables are required, or i non-HE shells are used. (Non-HE shells require an entry in the VOL field)	
	EFF	Enter percent (0 to 99%) of desired effects of attack method for targets. Do not use with VOL
	VOL	Enter desired number of volleys (0 to 99). Required entry for non-HE shells. D not use with EFF.

CREATE AN ONCALL OR FIRE PLAN TARGET LIST

(CONTINUED)

```
NNFP;INST;PLAN:------;FPTGT:-;ONCALL:-;DELETE:-;
TGTS:------,------,------,------,------,------,------,------,------;
PRIOR:-;PHASE:-,-,-,-;H:----;GROUP:------;SERIES:------/-;
UFFES:-/-/-/--/---,-/-/-/--/---,-/-/-/--/---,-/-/-/--/---,-/-/-/--/---;
EFF:--;VOL:--;SH:---/---;FZ:----/----;ANGLE:----;
```

STEP	REFERENCE FIELD	ACTION
7	SH	If desired, enter shells to be used against listed targets. If shell entered only in first subfield, it will be used for initial and subsequent volleys. Refer to legal entries for ammunition (Table B, Page 2). Required for non-HE shells. Default = HE.

```
     ┌──────── Initial volley
     │   ┌──── Subsequent volleys
SH:---/---;
```

STEP	REFERENCE FIELD	ACTION
8	FZ	If desired, enter fuzes to be used against listed targets. If fuze entered only in first subfield, it will be used for initial and subsequent volleys. Refer to legal entries for ammunition (Table B, Page 2). Required for non-HE shells

```
  ┌──────── Initial volley
  │   ┌──── Subsequent volleys
Z:----/----;
```

STEP	REFERENCE FIELD	ACTION
9	ANGLE	If high angle required, enter angle of fire. Legal entries are: HIGH = high LOW = low (default)

B - DESIGNATE AND INSTRUCT SCHEDULED TARGETS

STEP	REFERENCE FIELD	ACTION
1	NNFP;INST	Call up NNFP;INST format
2	PLAN	Enter plan name
3	FPTGT	Enter X to specify that targets entered in Step 4 are designated as scheduled targets.
4	TGTS	Enter target number(s)
5	PRIOR	Enter target priority number to be used in scheduling targets (1 to 4). First priority = 1. Default = 4.

CREATE AN ONCALL OR FIRE PLAN TARGET LIST

(CONTINUED)

```
NNFP;INST;PLAN:------;FPTGT:-;ONCALL:-;DELETE:-;
TGTS:------,------,------,------,------,------,------,------,------;
PRIOR:-;PHASE:-,-,-,-;H:----;GROUP:------;SERIES:------/-;
UFFES:-/-/-/--/---,-/-/-/--/---,-/-/-/--/---,-/-/-/--/---,-/-/-/--/---;
EFF:--;VOL:--;SH:---/---;FZ:----/----;ANGLE:----;
```

STEP	REFERENCE FIELD	ACTION
6		Schedule the targets by specifying either phase(s) or H-hour (H field) but not both
	PHASE	Specify phase(s) targets are to be scheduled. If not specified, targets scheduled during any phase.

- Enter phase (1 to 4) if first phase target is to be fired
- Enter phase (2 to 4) if second phase target is to be fired
- Enter phase (3 or 4) if third phase target is to be fired
- Enter phase 4 if fourth phase target is to be fired

PHASE:-,-,-,-;

STEP	REFERENCE FIELD	ACTION
	H	Enter time relative to H-hour that target(s) are to be fired on(±0 to 999). Enter + and number of minutes for after H-hour; enter - and number of minutes for before H-hour

STEP	REFERENCE FIELD	ACTION
7	UFFES	If desired, enter logical su scriber name of fire units t be used in fire plan against target

- Section number
- Platoon number
- Battery
- Battalion or division
- Regiment, brigade, or division

UFFES:-/-/-/--/---,

STEP	REFERENCE FIELD	ACTION
8		OPTIONAL: Perform only if changes in desired effects or number of volleys in attack method table are required, or if non-HE shells are used. (Use VOL for non-HE shells.)
	EFF	Enter percent (0 to 99%) of desired effects of attack method for targets. Do not use with VOL
	VOL	Enter desired number of volleys (0 to 99). Required entry for non-HE shells. Do not use with EFF.

CREATE AN ONCALL OR FIRE PLAN TARGET LIST

(CONTINUED)

```
NNFP;INST;PLAN:------;FPTGT:-;ONCALL:-;DELETE:-;
TGTS:------,------,------,------,------,------,------,------,------;
PRIOR:-;PHASE:-,-,-,-;H:----;GROUP:------;SERIES:------/-;
UFFES:-/-/-/--/---,-/-/-/--/---,-/-/-/--/---,-/-/-/--/---,-/-/-/--/---;
EFF:--;VOL:--;SH:---/---;FZ:----/----;ANGLE:----;
```

STEP	REFERENCE FIELD	ACTION
9	SH	If desired, enter shells to be used against listed targets. If shell entered only in first subfield, it will be used for initial and subsequent volleys. Refer to legal entries for ammunition (Table B, Page 2). Required for non-HE shells. Default = HE.

```
        ┌──────── Initial volley
        │   ┌──── Subsequent volleys
SH:---/---;
```

STEP	REFERENCE FIELD	ACTION
10	FZ	If desired, enter fuzes to be used against listed targets. If fuze entered only in first subfield, it will be used for initial and subsequent vol-leys. Refer to legal entries for ammunition (Table B, Page 2). Required for non-HE shells.

```
   ┌──────── Initial volley
   │    ┌─── Subsequent volleys
FZ:----/----;
```

STEP	REFERENCE FIELD	ACTION
11	ANGLE	If high angle is required, enter angle of fire. Legal entries are: HIGH = high LOW = low (default)

INITIATE A FIRE MISSION

```
FM;RFAF;-;MYEFF:--;TGT:------;KNPT:--;CORD:------/--------/-----;GZ:---;
SPHERE:-;DIR:----/--;DIST:----;SHIFT:-/----/-/----/-/----;ASF:---/----;
AUF:-/-/-/--/---;TYPE:------/------;DOP:------;SIZE:----/----;ATT:-----;
STR:----;RV:---;LAS:----/-;TOT:--/--;ME:----/---;CONT:----/----;ZF:--/-;
UFFE:-/-/-/--/---,-/-/-/--/---;SH:---/---;FZ:----/----;LOT:-/-/-;EFF:--;
VOL:--;OB:--;CHG:-;EOM:-;RAT:-;MIS:-;OPT:---;PRI:-;ASNFPF:-;BD:---.----;
```

STEP	REFERENCE FIELD	ACTION
1	FM;RFAF	Request FM;RFAF format
2	CORD	Enter coordinates and altitude to specify target location. Use short coordinates if in MAP MOD.

- Easting (0 to 999999)
- Northing (0 to 11000000)
- Altitude (± 0 to 9999 meters). Default = +

CORD:------/--------/-----;

STEP	REFERENCE FIELD	ACTION
3	DIR	Enter the observer to target direction.

- Observer to target direction (0 to 6399 mils)
- Do not make entry. (This field is for gun-target direction.)

DIR:----/--

STEP	REFERENCE FIELD	ACTION
4	TYPE	Enter target type/subtype if given. Refer to legal entri for target type/subtype (Table C, Page 7). Default PERS/UNK

- Type
- Subtype

TYPE:------/------;

STEP	REFERENCE FIELD	ACTION
5	DOP	If personnel try out target, enter degree of protection i given. Default = PRUC. Leg entries include:

	FIRST VOLLEY	SUBSEQUE VOLLEY
PRAND	= Half prone, half standing	All pron
PRONE	= Prone,	Prone
PRUC	= Prone,	Dug in
PROVER	= Prone,	Under overhead cover
DUG IN	= Dug in,	Dug in
COVER	= Under overhead cover	Under overhead cover

INITIATE A FIRE MISSION (CONTINUED)

```
FM;RFAF:-;MYEFF:--,TGT:------;KNPT:--;CORD:------/--------/-----;CZ:---;
SPHERE:-;DIR:----/--;DIST:----;SHIFT:-/----/-/----/-/----;ASF:---/----;
AUF:-/-/-/--/---;TYPE:------/------;DOP:------;SIZE:----/----;ATT:-----;
STR:----;RV:---;LAS.----/-;TOT:--/--;ME:----/---;CONT:----/----;ZF:--/-;
UFFE:-/-/-/--/---,-/-/-/--/---;SH:---/---;FZ:----/----;LOT:-/-/-;EFF:--;
VOL:--;OB:--;CNG:-;EOM:-;RAT:-;MIS:-;OPT:---;PRI:-;ASNFPF:-;BD:---.----;
```

STEP	REFERENCE FIELD	ACTION
	SIZE	For circular target, enter target radius (first subfield only). Default = 100 meter radius. For rectangular target, enter target length (first subfield) and width (second subfield). ATT (Step 7) is also required for rectangular target. — Radius or length (0 to 9999 meters) — Width (0 to 9999 meters) SIZE:----/----;
	ATT	Enter altitude (in mils) with rectangular size targets (0 to 6399)
	STR	Specify number of target elements (1 to 9999) if available
	ME	Enter method of engagement — Enter method of fire. Default = LOW. Legal entries are: HIGH = high angle LOW = low angle DEST = destruction — Enter method of attack. Default = (blank). Legal entries are: DC = danger close REC = registration TOT = time on target

STEP	REFERENCE FIELD	ACTION
10	CONT	Enter method of control and fire — Enter method of control. Default = WR. Legal entries are: WR = when ready AMC = at my command CNO = cannot observe DNL = do not load — Enter method of fire. Default = AF. Legal entries are: AF = adjust fire FFE = fire for effect RFFE = repeat fire for effect The only combination not legal is DNL/AF CONT:----/----;

INITIATE A FIRE MISSION (CONTINUED)

```
FM;RFAF:-;MYEFF:--;TGT:------;KNPT:--;CORD:------/--------/-----;GZ:---;
SPHERE:-;DIR:----/--;DIST:----;SHIFT:-/----/-/----/-/----;ASF:---/----;
AUF:-/-/-/--/---;TYPE:------/------;DOP:------;SIZE:----/----;ATT:-----;
STR:----;RV:---;LAS:----/-;TOT:--/--;ME:----/---;CONT:----/----;ZF:--/-;
UFFE:-/-/-/--/---,-/-/-/--/---;SH:---/---;FZ:----/----;LOT:-/-/-;EFF:--;
VOL:--;OB:--;CHG:-;EOM:-;RAT:-;MIS:-;OPT:---;PRI:-;ASNFPF:-;BD:---.----;
```

STEP	REFERENCE FIELD	ACTION
11	UFFE	If desired, enter logical subscriber name for fire units (up to 2) to fire for effect. Use battalion name if massed fires of battalion fire units desired. If battalion name used, enter VOL to specify number of volleys per fire unit. Default = computer selected

First fire unit

- Section
- Platoon
- Battery
- Battalion
- Regiment or Division

FFE:-/-/-/--/---,

STEP	REFERENCE FIELD	ACTION
	SH	If desired, enter shell to be used for initial volley of FFE (first subfield) and shells for subsequent volleys of FFE (second subfield). Default = computer selected HE munitions. Refer to legal entries for ammunition (Table B, Page 2)

For HE and Chemical (smoke or WP), specify HE-/SMB or HE-/SMA. Note: If chemical shell type is entered, FZ and VOL must also be specified

If only first subfield is entered, subsequent volleys will use same shell as entered for initial volley.

- Initial volley. Default = computer solution
- Subsequent volleys. Default = projectile used initially

SH:---/---;

STEP	REFERENCE FIELD	ACTION
13	FZ	If desired, enter fuze to be used for first and subsequent volleys during fire for effect Refer to legal entries for ammunition (Table B, Page 2)

For non-HE ammunition (except illumination), shell and fuze must be entered. Enter VOL if more than one volley desired

- Initial volley. Default = computer solution
- Subsequent volleys. Default fuse used in initial volley

FZ:----/----;

INITIATE A FIRE MISSION (CONTINUED)

```
FM;RFAF:-;MYEFF:--;TGT:------;KNPT:--;CORD:------/--------/-----;GZ:---;
SPHERE:-;DIR:----/--;DIST:----;SHIFT:-/----/-/----/-/----;ASF:---/----;
AUF:-/-/-/--/---;TYPE:------/------;DOP:------;SIZE:----/----;ATT:-----;
STR:----;RV:---;LAS:----/-,TOT:--/--;ME:----/---;CONT:----/----;ZF:--/-;
UFFE:-/-/-/--/---,-/-/-/--/---;SH:---/---;FZ:----/----;LOT:-/-/-;EFF:--;
VOL:--;OB:--;CHG:-;EOM:-;RAT:-;MIS:-;OPT:---;PRI:-;ASNFPF:-;BD:---.----3
```

STEP	REFERENCE FIELD	ACTION
14	OPTIONAL: Perform only if changes in desired effects or numbers of volleys in attack table are required. DO NOT enter data into both EFF and VOL fields.	
	EFF	Enter desired effects (1 to 99 percent) if given. This entry will override desired effects for this type target in attack method table, and commander's attack criteria entered.
	VOL	Enter number of desired volleys (1 to 99) if given. This entry will override data in attack method table, and commander's attack criteria. Do not enter if EFF is used. If chemical munitions are specified, enter VOL if default (1 vol) is not desired.
15	OB	Enter observer number (1 to 99) if given.
16	CHG	If desired, enter desired charge (1 to 8). Default = computer selected
17	PRI	If desired, enter fire mission priority designator. Enter 1 to specify Category A (Urgent), 2 to specify Category B (Priority). If left blank, specifies Category C (normal). Default = computer determined.

ESTABLISH A FIRE UNIT IN THE AFU FILE

```
AFU;UPDATE;PLAN:------;FU:-/-/-/--/---;WPN:------;MODEL:------;MSN:---;
CORD:------/--------/-----;CZ:---;SPHERE:-;APPL:--/--;ST:-;ZONE:------;
VSTR:--;AZ:----;DF:----;TIME#:---;UREINF:-/-/-/--/---;FSP:-/-/-/--/---;
MAXRNG:-/----,-/----,-/----,-/----,-/----;MINRNG:-----;TRAVLR:----/----;
MAXEL:----;MAXRTE:--.-;SUSRTE:--.-;BPLOC:-/---/-/---;FULAT:---.-;BKUP:-;
DELETE:-;RT:-;RS:-;READY:-;OUTTIL:--/--/--;PTEMP:----;DTG:--/--/--;
```

STEP	REFERENCE FIELD	ACTION
1	AFU;UPDATE	Call up AFU;UPDATE format
2	PLAN	Enter fire plan name. Use ALL if data applies to all fire plans. Default = current situation
3	FU	Enter logical subscriber name of new fire unit or fire unit to be updated

FU:-/-/-/--/---;

- Section number
- Platoon number
- Battery
- Battalion or division
- Regiment, brigade or division

STEP	REFERENCE FIELD	ACTION
4	WPN	Enter weapon type used by fire unit. If fire unit uses mix of types, establish new fire unit for each weapon type. Refer to legal entries for weapon and model (Table A, Page 1)
5	MODEL	Enter weapon model number. Refer to legi entries for weapon and model (Table A, Page 1)
6	MSN	Enter mission of fire unit Legal entries are:

GS = general support
DS = direct support
GSR = general support reinforcing
R = reinforcing

STEP	REFERENCE FIELD	ACTION
7	CORD	Enter grid coordinates of unit. Use short coordinat[e] if located within MAP MOD; otherwise, use long coordinates.

CORD:------/--------/-----

- Easting (0 to 999999)
- Northing (0 to 11000000)
- Altitude (± to 9999 meters). Default = +

STEP	REFERENCE FIELD	ACTION
8	APPL	Enter ammunition type authorized for use by fire unit. Enter any combination of HE, CH, or NU. If all types are authorized, enter AL. Legal entries are:

HE = high explosive
CH = chemical
NU = nuclear
AL = all

ESTABLISH A FIRE UNIT IN THE AFU FILE

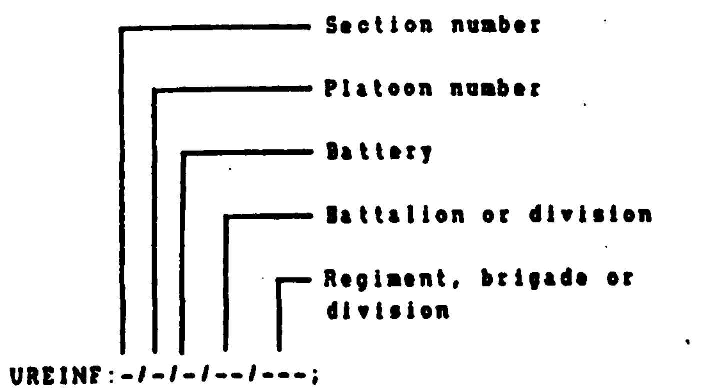
(CONTINUED)

```
AFU;UPDATE;PLAN:------;FU:-/-/-/--/---;WPN:------;MODEL:------;MSN:---;
CORD:------/--------/------;CZ:---;SPHERE:-;APPL:--/--;ST:-;ZONE:------;
WSTR:--;AZ:----;DF:----;TIME#:---;UREINF:-/-/-/--/---;FSP:-/-/-/--/---;
MAXRNG:-/----,-/----,-/----,-/----,-/----;MINRNG:-----;TRAVLR:----/----;
MAXEL:----;MAXRTE:--.-;SUSRTE:--.-;BPLOC:-/---/-/---;FULAT:---.-;BKUP:-;
DELETE:-;RT:-;RS:-;READY:-;OUTTIL:--/--/--;PTEMP:----;DTG:--/--/--;
```

STEP	REFERENCE FIELD	ACTION
9	ST	Enter type of sight used by fire unit. Legal entries are: 1 = 3200 MIL sight 2 = 6400 MIL sight (default) 3 = bearing sight
	ZONE	Enter name of zone of responsibility as estabished in SPRT;ZNE
11	WSTR	Enter number of tubes (1 to 99)
	AZ	Enter azimuth from grid north on which fire unit is laid (0 to 6399 mils)
13	DF	Enter deflection when fire unit is pointing on original azimuth of fire. Common deflections are:

WEAPON	DEFLECTION IN MILS
105MM (M101A1)	2800
105MM (M102)	3200
105MM (M108)	3200
155MM (MM114A1)	2400
155MM (M109)	3200
8IN (M110, M115)	3200
175MM (M107)	3200

STEP	REFERENCE FIELD	ACTION
14	TIME#	Enter fire unit nuclear response time. No entry required for nonnuclear fir units (0 to 999 minutes)
15	UREINF	Logical subscriber name of artillery unit being reinforced if own artillery battalion is in reinforcing mission (or your backup unit)



ESTABLISH A FIRE UNIT IN THE AFU FILE

(CONTINUED)

```
AFU;UPDATE;PLAN:------;FU:-/-/-/--/---;WPN:------;MODEL:------;MSN:---;
CORD:------/--------/-----;GZ:---;SPHERE:-;APPL:--/--;ST:-;ZONE:------;
VSTR:--;AZ:----;DF:----;TIMEF:---;UREINF:-/-/-/--/---;FSP:-/-/-/--/---;
MAXRNG:-/----,-/----,-/----,-/----,-/----;MINRNG:-----;TRAVLR:----/----;
MAXEL:----;MAXRTE:--.-;SUSRTE:--.-;BPLOC:-/---/-/---;FULAT:---.-;BKUP:-;
DELETE:-;RT:-;RS:-;READY:-;OUTTIL:--/--/--;PTEMP:----;DTG:--/--/--3.
```

STEP	REFERENCE FIELD	ACTION
16	FSP	Enter logical subscriber name of maneuver force being supported

- Section number
- Platoon number
- Company/troop
- Battalion or squadron
- Brigade or division

FSP:-/-/-/--/---;

STEP	REFERENCE FIELD	ACTION
17	MAXRNG	Enter identity of ammunition (1 to 5) and its maximum range in tens of meters (0 to 9999)

- Ammo type legal entries are:

  1 = HE normal
  2 = HE extended
  3* = CH normal
  4* = CH extended
  5 = NUC

  (*Also used for white phosphorous and illuminating)

- Maximum range in tens of meters (0 to 999)

MAXRNG:-/----;

STEP	REFERENCE FIELD	ACTION
18	MINRNG	Enter minimum range of fire unit weapons in tens of meters (0 to 999)
19	TRAVLR	Enter left and right traverse limits (in mils). Default - 0400/0400 for specified unit (0 to 6399/0 to 6399)
20	MAXEL	Enter maximun elevation in mils to which fire unit weapons can be elevated. Default = 1200 (0 to 1600)
21	MAXRTE	Enter maximum rate of fire in rounds/minute for 3-minute period for specified fire unit (0 to 99.9)
22	SUSRTE	Enter maximum rate of fire in rounds/minute that can be sustained over period greater than 3 minutes for specified fire unit. Default - 00.0 (0 to 99.9)

ESTABLISH A FIRE UNIT IN THE AFU FILE

(CONTINUED)

```
AFU;UPDATE;PLAN:------;FU:-/-/-/--/---;WPN:------;MODEL:------;MSN:---;
CORD:------/--------/-----;CZ:---;SPHERE:-;APPL:--/--;ST:-;ZONE:------;
WSTR:--;AZ:----;DF:----;TIMES:---;UREINF:-/-/-/--/---;FSP:-/-/-/--/---;
MAXRNG:-/----,-/----,-/----,-/----,-/----;MINRNG:-----;TRAVLR:----/----;
MAXEL:----;MAXRTE:--.-;SUSRTE:--.-;BPLOC:-/---/-/---;FULAT:---.-;BKUP:-;
DELETE:-;RT:-;RS:-;READY:-;OUTTIL:--/--/--;PTEMP:----;DTG:--/--/--ã
```

EP	REFERENCE FIELD	ACTION
2	BPLOC	Enter location and distance (in meters) of base piece relative to battery center Default = blank/000/blank/000. If base piece is over battery center, make no entry

```
            ┌── F if base piece is forward of battery center; B if
            │   base piece is behind battery center
            │ ┌── Distance forward of or behind battery center
            │ │   (0 to 999 meters)
            │ │ ┌── R if base piece is right of battery center; L if
            │ │ │   base piece is left of battery center
            │ │ │ ┌── Distance left or right of battery center (0 to 999
            │ │ │ │   meters)
OC:-/---/-/---;
```

EP	REFERENCE FIELD	ACTION
	RT	Enter reaction time of fire unit. Default = 2 (0 to 9 minutes)
	RS	Enter unit's radiation status. Default = blank, unit's RS unknown (0 to 3).

STEP	REFERENCE FIELD	ACTION
26	Select one of the two following fields:	
	READY	Enter X if fire unit is ready or available. Do not use with OUTTIL.
	OUTTIL	Time fire unit will return to action. Do not use with READY

```
        ┌── Day (0 to 31)
        │  ┌── Hour (0 to 23)
        │  │  ┌── Minute(0 to 59)
OUTTIL:--/--/--;
```

STEP	REFERENCE FIELD	ACTION
27	PTEMP	Enter powder temperature to be applied to all ammunition (power lots) for single fire unit. Default = +70 (±0 to 130)
28	DTG	Enter day, hour and minute of message

```
     ┌── Day (0 to 31)
     │  ┌── Hour (0 to 23)
     │  │  ┌── Minute (0 to 59)
DTG:--/--/--ã
```