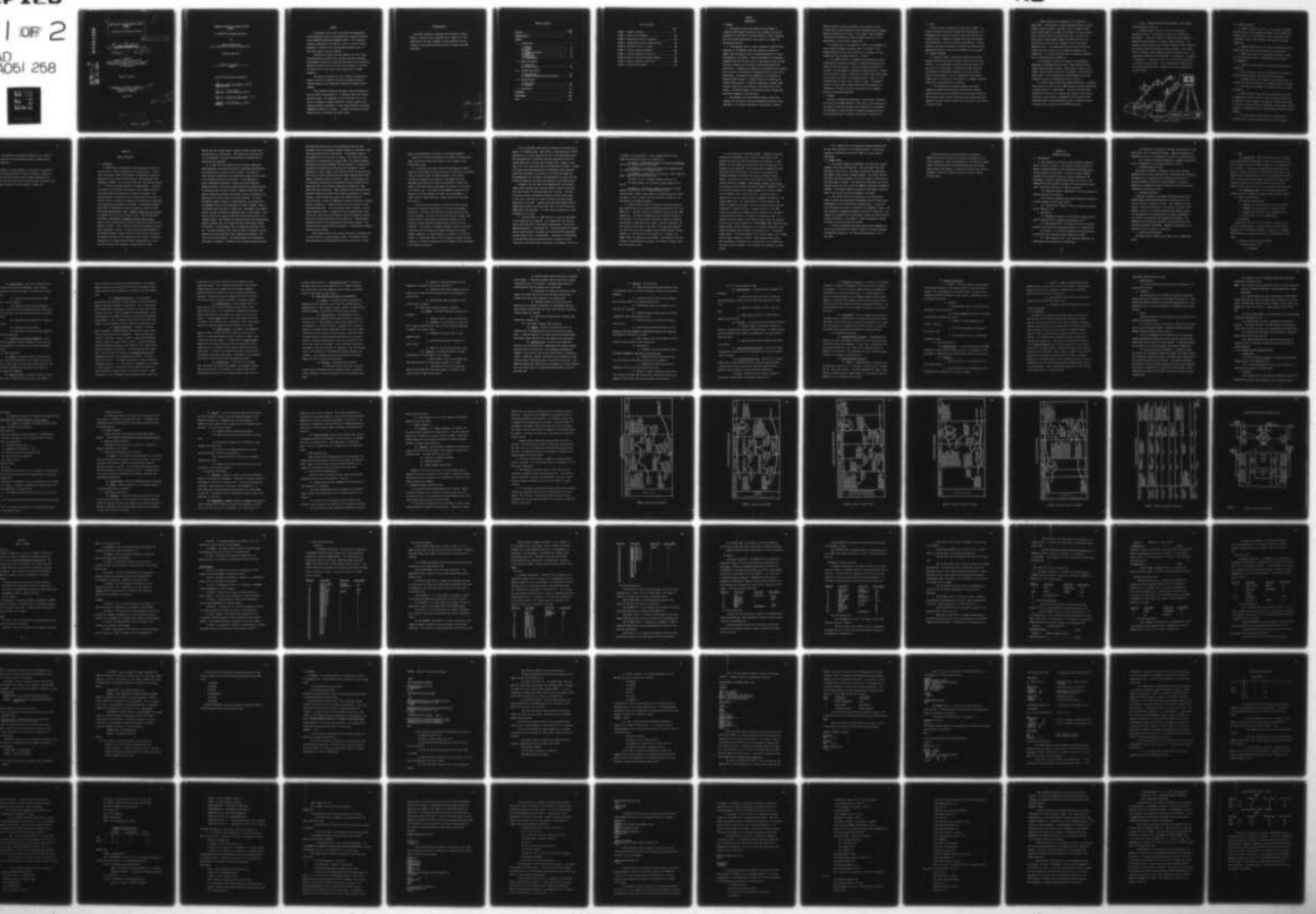
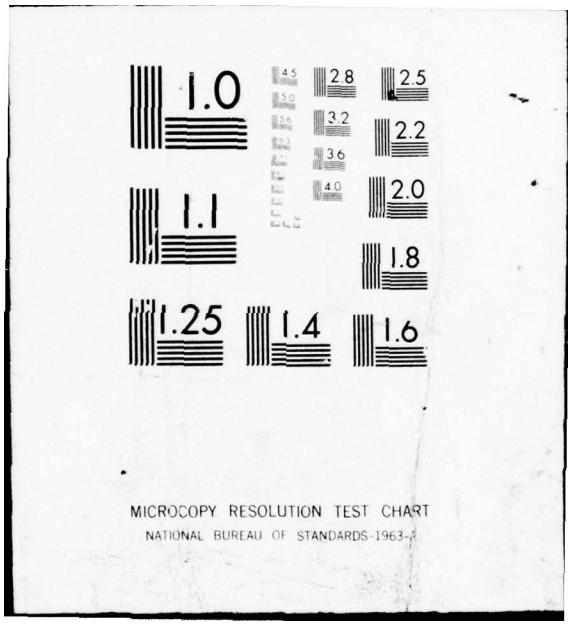
AD-A051 258 LOUISVILLE UNIV KY DEPT OF INDUSTRIAL ENGINEERING F/G 15/7
COMPUTER ASSISTED MAP MANEUVER SYSTEM (CAMMS). A COMBINED ARMS --ETC(U)
APR 77 E L CHILDS

UNCLASSIFIED NL

1 OF 2
AD
A051 258




1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD A051258

COMPUTER ASSISTED MAP MANEUVER SYSTEM (CAMMS)

A Combined Arms Wargame Simulation

(9) Master's thesis,

By

(10) Ernest Lincoln Childs
B.S., University of Southern Colorado, 1972

(11) Apr 77 (12) 123P.

A Thesis
Submitted to the Faculty of the
Graduate School of the University of Louisville
in Partial Fulfillment of the Requirements
for the Degree of

Master of Science

Department of Industrial Engineering
University of Louisville
Louisville, Kentucky

April 1977

AD NO. DDC FILE COPY

DDC RECEIVED MAR 16 1978 A

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

JOB 410 605

COMPUTER ASSISTED MAP MANEUVER SYSTEM
(CAMMS)

A Combined Arms Wargame Simulation

By

Ernest Lincoln Childs
B.S., University of Southern Colorado, 1972

A Thesis Approved on

April 15, 1977
(DATE)

by the Following Reading Committee:

Signed/ M.R. WILHELM 4/21/77
Thesis Director

Signed/ R.D. Shelton 4/21/77

Signed/ Osman M. El-Refaie 4/21/77

Signed/ S.G. Russman 4/21/77
Chairman

ABSTACT

The purpose of this work is to present the documentation and developmental history of the combined arms wargaming simulation titled "COMPUTER ASSISTED MAP MANEUVER SYSTEM." This simulation system was developed by the author for use as a tactical training technique, in support of the training being offered at the U.S. Army Armor School, Fort Knox, Kentucky.

Specifically discussed are the programs, with their underlying math models, the data files, and the simulation techniques. The procedures and details outlined are applicable to the simulations presented and were tailored to the use of the system as a tactical training vehicle for the lower to mid range leaders of combat formations.

The material presented will be of interest to proponents of computer assisted or supported instruction, computer science or simulation majors, and to operations research and systems analysis students.

This simulation system has provided a viable alternative to the very costly field maneuvers it is replacing within the military education system. The uniqueness of this application lies in its ability to represent a dynamic battlefield situation under a time produced stressful environment, in which the participant must execute command and control of his assets. It thereby reinforces previously acquired skills and motivates additional study.

ACKNOWLEDGMENTS

The author gratefully acknowleges the assistance of Captain Robert J. Cross and First Lieutenant John K. Rogers, U.S. Army Armor School, Fort Knox, Kentucky, for the preparation and refinement of the computer programs required to support the CAMMS simulation.

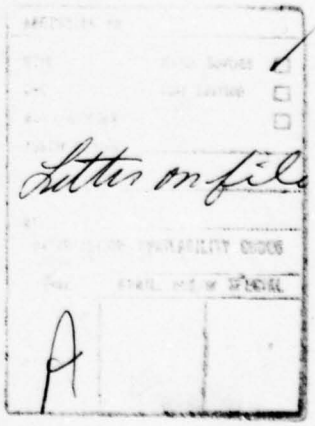


TABLE OF CONTENTS

	Page
ABSTRACT	iv
ACKNOWLEDGMENTS	v
CHAPTER	
I. Introduction	1
1.1 General	1
1.2 Purpose	2
1.3 Scope	3
1.4 Computer Interface	3
1.5 Objectives	6
1.6 Advantages	6
1.7 Disadvantages	7
II. Model Development	
2.1 Background	9
2.2 Current Status	16
III. Systems Applications	
3.1 Map Maneuvers	18
3.2 Computer Assisted Instruction (CAI)	40
IV. System Software	
4.1 Data Files	43
4.2 Programs	63
V. Conclusions	101
APPENDICES	104
BIBLIOGRAPHY	282
VITA	283

LIST OF FIGURES

		Page
FIGURE 1	Computer Interface	5
FIGURE 2	Battle Start Procedures	42a
FIGURE 3	Change Battle Control Procedures	42b
FIGURE 4	Change Battle Control Procedures(STOP)	42c
FIGURE 5	Airstrike Control Procedures	42d
FIGURE 6	Artillery Control Procedures	42e
FIGURE 7	Exercise Preparation Flow Chart	42f
FIGURE 7a	Exercise Planning and Conduct Summary	42g
FIGURE 8	Layout of Maneuver Control Room	42h
FIGURE 9	Communications Diagram	42i

CHAPTER I

INTRODUCTION

1.1 GENERAL

a. The Computer Assisted Map Maneuver System (CAMMS) is a combined arms wargaming simulation used to support the tactical instruction for the lower to mid range leaders of combat formations. One of the primary applications of the system is in support of map maneuver exercises.

b. A map maneuver (MM) is a type of exercise in which military operations of two opposing forces are portrayed by markers or symbols that are moved on a map to represent maneuvering of troops and equipment on the ground. Players participate in the wargame as commanders and staff officers of one or both opposing sides and make decisions, prepare plans and orders, and exercise command-staff coordination. Leadership and teamwork are introduced by the establishment of specific relationships and responsibilities for the various participants. Map maneuvers are appropriate for instruction in advanced tactical subjects, introduce realism, and reinforce the decision making process. A system of controllers considers player actions as they occur and continuously feed results back to the players. The control element in a MM places primary reliance upon qualitative judgment of the controllers.

c. Map maneuvers vary from elaborate setups in which both opponents and the control group are represented extensively, (two-sided MM), to an informal setup where a single group of players

maneuver against an enemy represented by the controller system. All MMs require varying degrees of control dependent upon the subject material presented and the level of play desired. Many acceptable variations and combinations of MMs are possible according to the requirements of the particular subject area.

d. The player must first become well versed in the techniques of troop leading (estimates, decisions, plans, and orders) at the company/battalion/brigade level, before he is introduced to a more advanced type of applicatory exercise . . the MM.

e. In a CAMMS exercise, as opposed to the conventional manually controlled MM, there are no "canned" or prefabricated messages used except to start the exercise. Initially, players are placed in a situation, the requirement is indicated, a planning period is allowed, and the exercise is begun. Thereafter the course of the battle depends on the actions and orders of the opposing forces. There is no pre-ordained winner or loser, and no "school solution". The degree of success of a given player element depends upon the soundness and timeliness of the plans, decisions, and orders of the commanders and their subordinates and staffs.

1.2 PURPOSE

This work is prepared and published to provide basic information on the use of the CAMMS simulation, assist users in their preparation and conduct of specific exercises, and to meet partial requirements for the Master of Science Degree in Engineering Management granted by the Graduate School, University of Louisville, Louisville, KY.

1.3 SCOPE

This work presents information relevant only to CAMMS. It briefly introduces the system, discusses the documentation of its development, and explains how users can apply this resource as a training vehicle. Examples of computer print outs are provided with explanations in order to facilitate understanding. Specific controller functions are presented in outline form along with the appropriate checklists, but are only intended for use as guides.

1.4 COMPUTER INTERFACE

a. A control system is required to monitor and calculate maneuver effects as they apply to specific player units or staff sections. In a conventional or manually controlled system, this would require a large number of controllers to make the manual calculations and computations necessary to give the players a result of their actions. This is a lengthy and time consuming process that relies heavily on the controller's judgment, expertise, objectivity, and experience as a controller.

b. The introduction of computer programs, specifically designed to support military tactical and logistical problems, greatly reduces the exercise preparation time, provides faster and more accurate results, ensures objectivity, and possibly even more important, provides historical data that can be used in the critique of player actions.

c. CAMMS accomodates the employment of all conventional combat means. The employment of armor, mechanized infantry, armored cavalry, attack helicopters, artillery, close air support, mines, and all combat support and combat service support up to the division level is possible under the existing data files. The data files also include a Threat segment capable of fielding two full tank divisions and a motorized rifle regiment with all their normal supporting units. The programs can be used to play any unit from platoon and section level up to full maneuver brigades in any combination. It is highly complex system of programs and submodels, yet is relatively simple in operation.

d. The computer functions are designed to accomodate the employment of conventional ground and air combat assets with their normal supporting weapons systems. Combat support, combat service support, and intelligence activities are handled as they would be in actual battle. Task organizations can be programmed to allow the scrambling of units to accomplish any specific mission.

e. Unlike a manual system where combat effectiveness is computed from tables or the rolls of dice, CAMMS reports the combat effectiveness of player actions in a timely manner. Tactical errors and faulty planning by the players will come back very quickly to haunt them in the form of mission failure or unnecessarily high casualty rates. Overlooked details present devastating results, forcing the players to execute timely, accurate, and coordinated decisions.

f. Figure 1 depicts the role of the computer in the execution of the map maneuver exercise.

g. Only the control staff has access to the computer input/output devices. The players do not actively interact with the computer. Players are required to follow the normal sequence of command and staff actions in a simulated combat environment. The computer tabulates battle data and produces feedback to the controllers who provide resulting information to player personnel. The constant flow of information forces subsequent command and staff actions. This interactive information flow (from player - to controller - to computer - to controller - to player) creates a cycle that forces the dynamics of the battle onto the player. The time constraints created by the ever changing situation adds an element of pressure not experienced in other systems.

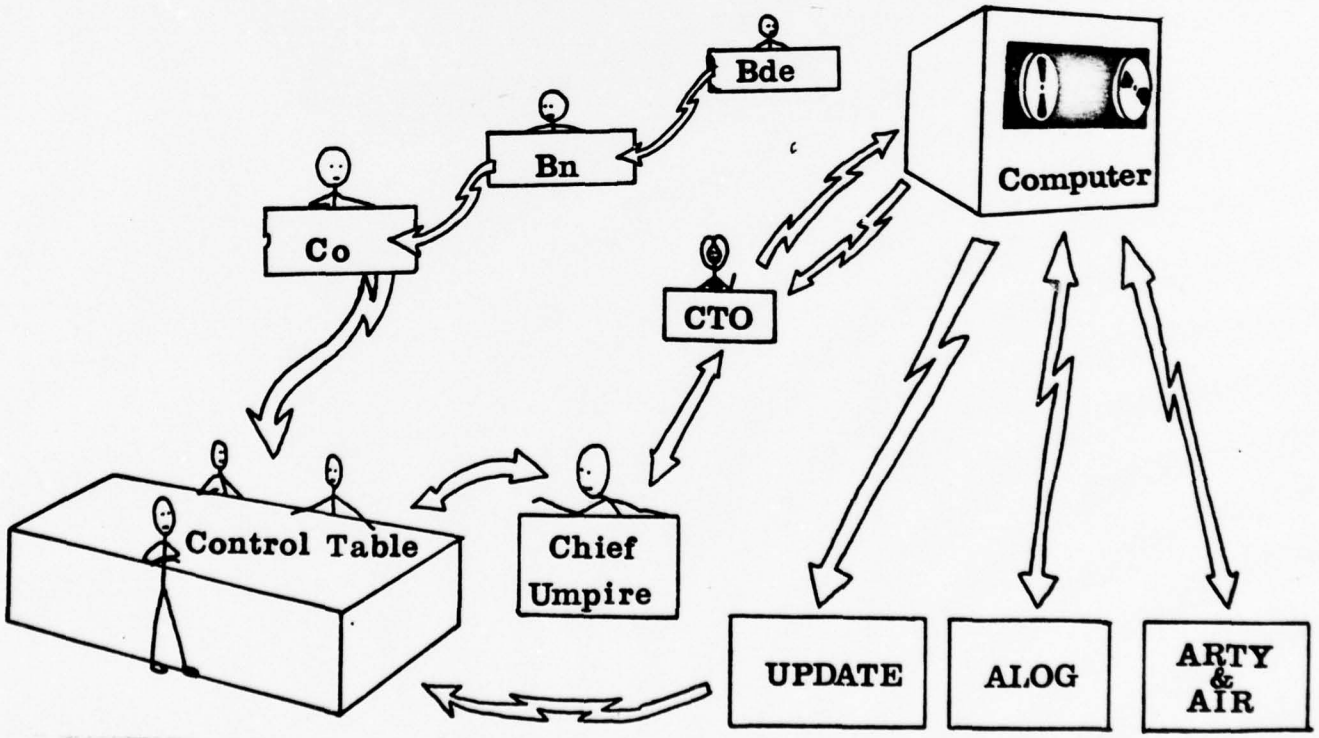


Figure 1, Computer Interface

1.5 SYSTEMS OBJECTIVES

a. CAMMS is designed to provide a driving force for command and staff actions at the company, battalion, and/or brigade level. Primary interest is to force actions, orders, and proper staff coordination, rather than representing the actual field/combat conditions.

b. CAMMS allows the play of all tactical operations based on current doctrine as well as the application of new concepts.

c. CAMMS will realistically and economically assess command and staff proficiency under a time dependent stress situation.

1.6 ADVANTAGES

a. Players are shown the need for proper staff planning and coordination.

b. The system gives a realistic representation of the battle while providing the player with an active enemy situation.

c. Strategy, tactics, administration, and logistical play at virtually any level of command can be simulated during the exercise.

d. The facilities to conduct this exercise can be as austere as desired.

e. CAMMS eliminates costly troop and equipment usage typical of command post exercises (CPX) and field training exercises (FTX). In addition to being economical and suited to training large numbers of officers, it has no artificial limitations of safety zones, private property, or understrength units, which sometimes detract from field training.

f. The system offers a broad range for selecting terrain to fit any type of exercise, since any terrain can be played if

suitable maps are available.

g. Once starting data is programmed into the computer, very little lead time is required for preparation by the participants or controllers.

h. CAMMS provides real time response to requests for information on administrative/logistical and combat situations.

i. The computer programs apply the real world effects of weather, terrain, target exposure, weapons effectiveness, rates of march, logistical support, failure to apply proper and timely staff actions, and the expected effects of Threat doctrine on the proposed friendly maneuver.

j. Once a basic core of personnel are trained as controller representatives, future exercises become greatly simplified.

1.7 DISADVANTAGES

a. CAMMS is not a suitable vehicle for imparting new skills since the player is primarily concerned with playing his part as a commander or staff officer in an operational headquarters.

b. Individual players do not participate in all instructional areas being applied or exercised at the same level. Thus, the value derived by the players will vary with his exposure.

c. The player may be required to perform many clerical duties that he would not normally perform under actual combat conditions where all enlisted positions would be filled.

d. Map maneuvers provide only a limited opportunity for the introduction of problems that arise from human imperfection and mechanical failures.

e. No simulation can adequately portray the full impact of constant supervision and determined execution by aggressive and capable leadership.

In Chapter II, the development of the system is discussed as well as the current direction of future refinements. Chapter III shows the system applications currently being supported by this simulation, and discusses specific controller/player responsibilities. The programs and data files are discussed in Chapter IV.

CHAPTER II

MODEL DEVELOPMENT

2.1 BACKGROUND

a. CAMMS traces its beginings to the conventional map exercise used at the U.S. Army Armor School prior to January 1975. In early 1973, the manually controlled MM exercise (Brigade MM) was under the supervision of the Internal Defense Branch of the Command and Staff Department, USAARMS. As it was run at that time, the exercise required a 1 : 1 ratio of instructor/controller to student/player. Austerity and the war in Viet Nam had drawn heavily on the personnel assets of the faculty making the exercise very difficult to support. Some alternative means of presenting this instruction had to be sought. An initial effort to introduce the computer to the exercise as a man/space saving technique was directed by the School. The programs developed were primarily "bookkeeping" routines designed to lessen the burden of the then limited control staff. Computer outputs were very limited and program efficiency was unreliable at best. Even as restrictive as this was, some savings in personnel positions were realized. However, many on-going manual functions in the control of the exercise remained as before. Those functions that had been automated lost their manual counterpart, forcing the control staff to become dependent on the computer programs to operate the most critical aspects of control. The exercise continued in this fashion until April 1974. An exercise scheduled for the Armored Officer Advance Course (AOAC) was set to run for four days as the "capstone" of their course of study.

Shortly after the exercise began a complete software "crash" forced the cancellation of the exercise. This proved to be the fatal blow for the Brigade MM. The entire MM apparatus was disbanded and all future exercises cancelled.

b. In July 1974, the Advanced Tactics Division, Command and Staff Department, was given the mission of redesigning the Brigade MM and reintroducing it as part of the curriculum. The author was given the task of developing a new system from scratch using as little of the original exercise as was possible. It was necessary to write a completely new exercise, relocate the control apparatus, design and develop a new control system, develop new computer programs to facilitate ease of control, install a complete closed-loop fixed-position communication system, and provide a series of scenarios to be employed by the various tactical instruction branches. To develop the computer support programs, LT Emanuel Herrera, was assigned from the Management Office of the Directorate of Support, USAARMS. Work on the physical layout was begun in August 1974. By December, the computer software had been developed and expanded to meet the new demands. Every control function was studied to determine the best application of the automated system. Where needed, new controller guides were developed and scenario sequences were cross checked with the instructional branches for validity. By late December 1974, the system was ready for a test run. The newly organized control staff was given an extensive training program on the new system and a dress rehearsal was conducted. The first run was not successful. The system crashed after approximately three hours of operation. Problems in file size and construction would

not allow the interative use of four terminals at the same time. The manual side of the operation needed refinement in the detail of the instructions provided to the controllers. An additional rehearsal was scheduled for the first week in January. The initial full scale exercise was to take place on 21 January 1975. The necessary changes were made and the second rehearsal ran more smoothly. LT Herrera left the Army the day before the exercise was to be conducted. He was replaced by LT John K. Rogers, just two days prior to the exercise date. Until the day of the actual exercise the system software had not been loaded or operated at exercise capacity. Since it was designed to be an interactive system with four input/output devices operating from a common data base, file contention problems and program wait times should have been anticipated. These problems had not been experienced during the rehearsal phase while the system was operating at a reduced capacity. System software was lagging and somewhat defective on the first day. Since no documentation had been provided by LT Herrera before his departure, LT Rogers was left to his own resources to keep the system operational. The first day was almost a disaster. With an almost superhuman effort, LT Rogers was able to reprogram many of the file errors, and correct the problems in the basic programs all before this initial exercise reconvened for the second day. Some additional problems developed on the second day but were quickly overcome. The third and fourth days were totally successful. An operational simulation system had been achieved.

A full scale critique of the exercise was held on 25 January with all the controllers and participants present. The response from all the participants was overwhelmingly positive for the system. Several

areas of improvement were discussed and corrections scheduled.

Based on the initial performance of the system, the decision was made to continue the system and expand its use in support of the instructional areas.

d. It occured to the author that since the system was running remote from the computer time sharing service in Louisville, why couldn't it be run remote to other locations elsewhere in the country? The idea was proposed to the Director of the Command and Staff department, who approved the concept and authorized a feasibility study in conjunction with the refinement and expansion of the system for "in-house" use. This began the developmental process that has resulted in the Army adopting the system, now called CAMMS, as a formal tactical training exercise. However that decision was made much later on.

e. One of the points brought up in the first formal critique was that the outcomes of the direct fire conflicts were somewhat unrealistic. This meant that the basic firepower computations had to be re-examined. An article in the Infantry Journal (January 1975) outlined the work being done at Fort Benning, Georgia, on a new simulation system called CATTS,(Combined Arms Tactical Training Simulator). This system is a computer operated, partially controlled simulation, which uses some very advanced techniques for sensing targets, computation of target effects, and movement of units on the ground. It incorporates state of the art computer equipment and uses a mock-up of a tactical command post and enviromental control techniques to add realism to the play.

A trip to the CATTS facilities was arranged for the author and LT Rogers, on 13 February 1975. Upon arrival, it was found that the CATTS system was not in actual operation but still in the development stage. The TRW Corporation of California, had been contracted to build the initial model with a delivery date of January 1975. However, at the time of our visit, the actual date was forecasted for 15 March. A severe cost overrun was being predicted by the TRW people, which eventually forced the curtailment of the project to the proto-type model only. No documentation was available on the math models to be used, and very little assistance was provided by the personnel of the CATTS project.

A parallel visit was made to the Combined Arms Training Board, (CATB), which reportedly was working on manual simulation techniques. This visit proved to be the more productive of the two. The areas of exercise control, performance evaluation, and the effectiveness of this type of exercise as a training vehicle, were being studied extensively by the board. Contacts were established between CATB and CAMMS project officers that would later lead to the field testing of CAMMS under field conditions. This test that was necessary for later acceptance of the system.

f. The math models for CAMMS were still in need of improvement if the system was to be expanded. On 6-7 March 1975, the Fort Knox Team visited the Office of the Deputy Undersecretary of the Army for Operations Research, in Washington, DC. A broad discussion of firepower scores, decision models, and models used in research and development, provided several areas of investigation. Since none of the Department of the Army (DA) agencies work specifically on computer assisted instruction, the research models would have to be adapted to their use

in support of training models. It was suggested that Fort Knox study the following R&D models for possible use:

(1) EINFALL, a land battle simulation (DA Contract 49-092-ARO-10, Oct 69, Stanford Research Institute.).

(2) TARTARUS II, a computerized differential wargaming model, U.S. Army Strategy and Tactics Analysis Group).

(3) JEREMIAH, a computerized, high reaction, visual projection model, (Lawrence Livermore Laboratories).

(4) CONAF IV, Part II (General Research Corp.,Nov 74)

(5) CONAF (Theater Force Evaluation System, Research Corp, May 72).

(6) COMCAP III (NATO Combat Capabilities Analysis, DA-Navy Contract C19-69-C-0017, Jul 74, General Research Corp.).

After a careful review of these models it was decided that the EINFALL and CONAF IV, Part II models would provide the best sources for the refinement of the CAMMS math models.

g. From the EINFALL study the firepower/attrition computations were adapted to work with the data previously developed for use in the CAMMS files. The CONAF simulation provided the rate of movement (ROM) computations. The specific methodology used to compile the data was not recorded in all cases, however, sufficient technical information was available to begin work on the models. Work was completed by the end of March and the initial field test of the system was scheduled for 19-20 April 1975, using elements from the 100th Maneuver Training Command, U.S. Army Reserve, as the testing unit. A regular Army combat (table of organization and equipment - TOE) battalion staff was selected to participate as the players, the 100th MTC personnel would act as the control staff.

h. The exercise was a qualified success. Problems in controller training were highlighted, and an extensive re-evaluation of the program of instruction given the controllers was indicated. No major problem with the software was experienced, and the reliablity of the outcomes was not questioned. Since this test was conducted using the facilities of the Armor School at Fort Knox, it was necessary to conduct an additonal validation from facilities somewhat further removed. The 78th MTC of Fort Dix, New Jersey was selected, and an exercise planned for November. Some priority interest in the system was generated at the Training and Doctrine Command, (TRADOC) as a result of a briefing conducted for the Deputy Commander for Training, TRADOC on the responses to the initial field test. Support was given in setting up the next test and providing an independent evaluation of the systems capabilities. The summer months of 1975 were spent on the further refinement of the manual controller functions and the necessary coordination to conduct the test. In-house exercises for the AOAC classes were conducted, and these provided information for improvements in the supporting software. By October, the system was ready. An extensive training program for the 78th MTC control staff was conducted and the actual exercise schedule for 14-16 November 1975. About this time TRADOC decided to shift proponentcy for all training simulations to the Command and General Staff College, Fort Leavenworth, KA. This brought another agency into the evaluation of the various systems, (CATTS, CAMMS, and the manual simulations at CATB). C&GSC attended the New Jersey test and added the requirement for a field exercise to be conducted at Fort Hood, Texas in December. Both of these were conducted with great success.

i. On 1 January 1976, Fort Leavenworth assumed responsibility for the future exportation of the CAMMS simulation. Fort Knox was from then on restricted to the use of CAMMS for its own internal requirements.

2.2 CURRENT STATUS

a. The original CAMMS was programmed in the BASIC-PLUS computer language of the time sharing service. The user programs were also restricted to 16K of core. This greatly restricted the expansion of the system to meet the ever increasing demands. The current contract with Armor time sharing computer service was allowed to expire and new bids were opened in January. The Control Data Corporation won the new contract and the Fort Knox version of CAMMS was converted to FORTRAN IV EXTENDED. This change allowed the expansion of the system to meet the needs of the tactical instruction branches of the school.

b. The current version of the system is in use at the Armor School to support the Map Maneuver and Computer Assisted Instructional requirements for the Armored Officer Advanced Course. In the past only the capstone exercise was presented to the graduating classes. Now this technique is presented throughout the course of instruction. Each student has an opportunity to participate at least four times during his tactical instruction. His exposure is further increased by rotating his player position with each new exercise.

c. At Fort Leavenworth, the export model has been packaged and sent to the field (the active Army as a whole) for further validation. The production schedule for the final exercise package is set for July 1977.

In the next section systems applications are discussed. CAMMS will continue to evolve as new ideas are implemented by its current developers. Close liaison between Fort Knox and Fort Leavenworth is being maintained and new developments are being shared. Careful study of the problems in simulating logistical play and the employment of tactical nuclear warfare are of current interest at both schools.

CHAPTER III

SYSTEMS APPLICATIONS

3.1 MAP MANEUVERS

a. Map exercises are carried out under conditions resembling battle as nearly as possible. The realism of the map exercise is greatly increased through the use of technically and professionally trained personnel as controllers. The need to provide competent personnel for the control functions is just as important as the requirement to maintain competent participants in the units. The commander must balance these requirements to obtain maximum training value. Controllers contribute to tactical realism by:

(1) Simulating agencies, headquarters, and other elements not actually playing in the exercise.

(2) Providing information that cannot otherwise be developed by player elements through player actions.

(3) Causing player elements to react to conditions portrayed by the information flow.

b. Definitions:

(1) Map Maneuver Director - the individual charged with the overall responsibility for preparing and monitoring a MM.

(2) Map Maneuver Staff - the controllers and unit monitors required to man the control headquarters/element in a particular MM.

(3) Monitor - an individual responsible to the MM Director for monitoring and evaluating a player maneuver unit staff.

(4) Chief Controller (CC) - the individual responsible for coordinating the activities of all controllers.

(5) Controller--an individual assigned to assist the CC in controlling the play of a particular MM group. Controllers represent all headquarters and units not represented by players as directed by the CC.

(6) Player--an individual assigned to a command or staff position in a headquarters or unit being exercised in the MM.

c. Influencing Maneuver Play.

Since this map maneuver is designed so that either force may accomplish their mission, controllers will avoid artifically influencing the maneuver play. Generally, they influence the action by releasing information concerning the enemy, weather, or terrain in preference to attempting to guide or influence the action by issuing directives from division or corps.

d. Controller Checklists

Controller checklists for the Operations/Intelligence section, support command, administrations/logistics controllers, air, and artillery play are included in the text. These checklists are provided as a guide for controllers to assist them in the play of the maneuver. As this is a partially controlled map maneuver, many of the requirements will be appropriate to the actual development of the situation, but additional requirements may be devised. The imagination and professional knowledge of the controller will dictate these additional requirements. Checklist requirements are not sequential and will be used as a guide only.

e. Control Room Arrangement.

See physical set-up Figure 8; and Figure 9 for a communication set-up.

f. Maps

(1) Control Maps. There are two control maps in the control room maintained by the control section. The terrain map of the area of operations (scale 1:25,000) is posted so as to be visible to all controllers. This map is a situation map for both forces and portrays the actual dispositions of both Red and Blue forces. Unit symbols, made to appropriate scale, will be posted by the control section to reflect the minute-by-minute activities of the player units. A general situation map (1:50,000) is used to plot airstrikes, nuclear strikes, and artillery fires at the proper time and location.

(2) Supplementary Maps. All controllers may maintain supplemental maps (1:50,000) to accomplish their individual duties.

g. Control Representation

The control group represents:

1. Commanders and staff officers of division and corps.
2. Commanders and staff officers of adjacent units.
3. Commanders and staff officers of supporting units.
4. Platoon leaders for each company/troop.

h. Coordination

Coordination within the controller group is critical to the success of the map maneuver. Each controller must have a general knowledge of all controller activities, in addition to a thorough understanding of his assigned job position, to ensure proper coordination.

i. Individual Job Positions and Functions

(1) Chief Controller (CC)

(a) Functions.

1. Supervise and coordinate the activities of the control section. Ensure that the section is organized properly and functions efficiently.

2. The sole function of the control section is to determine the most probable outcome of the actions and orders initiated by the player units. Determination of the most probable outcome is based on the following criteria:

a. Professional judgement.

b. Strict impartiality between Red and Blue units.

c. Objective analysis of each brigade and subordinate battalion's plans, orders, and actions.

d. Time-distance factors.

e. Proper application of combat power and rates of advance as determined by the computer.

f. Attrition-casualties and damage assessment as provided by the computer.

3. The analysis of player actions and orders, and application of the above cited criteria result in a determination of Red and Blue force's exact status at all times. The status of both forces is then portrayed on the control map. Because there is only one situation control map and because all controllers refer frequently to the control map for the present situation, the importance os properly maintaining the control map by the control section cannot be stressed too strongly.

(b) Major Decisions. The CC must make major decisions, in coordination with the two commanders, that critically affect the outcome of tne entire maneuver. Such decisions include the following:

(1) Decision to provide additional combat power means to a unit in contact.

(2) Resolution of critical time-distance factors, such as time available for employment of major combat units in the area of operations, and time-distance factors for the commitment of reserves.

(3) Determination of breakpoint or ineffectiveness of units.

(4) Evaluation of shock effect.

(5) Resolution of conflicts between opposing Red and Blue table controllers.

(c) Relationship with Player Commanders. The CC and the two force commanders share the responsibility for maneuver play. Close coordination is essential to the realistic employment of player forces.

(2) Table Controllers.

(a) General. The general duties of the table controllers are to depict the dispositions of the player forces on the maneuver table, provide input to the maneuver computer terminal, and to provide situation information to the lowest level player for relay to the appropriate commander.

(b) Realism of Play. The table controllers are key to the maneuver play. Timely and accurate input to the command

chain is essential to the realism and effectiveness of the maneuver. Computer output must be translated into real world language, passed to the players and then followed up with continual real time information.

(c) Disposition of Forces. The table control party depicts the disposition of their respective forces on both the maneuver table and the general situation map. This is done by placing the appropriate unit symbols on the map location for the center of mass of the unit. Rates of movement must be reflected by a real time movement of the symbols on the map as provided by the computer output terminal. This information is then given to the lowest level players as grid coordinates of their locations in spot report form.

(d) Conflict Initiation. A conflict is started when an agreement is reached between the Red and Blue table controllers as to the possibility of engagement. Items for consideration include: The terrain, situation, mission, range (distance between forces), weather, and type of units involved. These considerations and the professional knowledge of the controllers will significantly affect the outcome of the conflict. Once the two controllers agree that a conflict should be initiated, the Initiate Conflict Form is completed by the controller suggesting the conflict. The form is then given to the CC who reviews the request and either approves or disapproves the conflict. If the conflict is approved, it is assigned a conflict number and entered in the play through the conflict computer terminal and becomes a part of the battle situation. Impact information, a rate of movement and the appropriate spot reports will

be provided to the table controller once the computer has processed the request. This information must be fed to the affected platoon controllers for transmission to the company commander. Conflicts should be initiated only after a careful evaluation has been made. An excessive number of ongoing conflicts will detract from the real world situation the maneuver is designed to depict.

(e) Conflict Update. Periodic updates of all ongoing conflicts will be fed to the table control party in spot report form by the CC. This information is processed by the table control party and fed to the lowest level players for the units in contact. A special output terminal will provide update data every 15 minutes. This constant flow of information, input to the command chain, will stimulate command and staff actions at all levels.

(f) Conflict Change. Any change in the commander's maneuver scheme, a change in terrain situation, the addition of units, or a significant weather change will require a change in the conflict data for the computer. In these cases, a Conflict Change Form must be initiated by the controllers and processed by the CC. Change data will be reflected on the periodic update following the change input. A careful cross-check must be made to make sure that the computer has picked up the change. Change data is then processed by the table controller and fed to the appropriate player.

(g) Conflict Stop. A conflict will be stopped when: Directed by the appropriate commander, the computer indicates that one of the units in the conflict is no longer effective, an uncorrectable error exists in the computer data for that conflict,

or when directed by the CC. A Stop Conflict Form is initiated by the table controllers and processed by the CC. Update information will be provided on the next scheduled periodic update, translated, and fed to the players as spot reports.

(3) ALOG (Administration/Logistics) Controllers.

(a) General. The ALOG controllers represent the administrative and logistical staffs G1/G4, the Adjutant General, Provost Marshall, Judge Advocate, Inspector General, Surgeon, Medical Battalion Commander, and chaplain for the division and corps.

(b) Realism of play. The ALOG control section must exercise sound judgement when providing logistical support to the player units. Replenishment of units across the board will not be considered as a reasonable request. Resupply of all classes of supply will be done from the combat/field trains of the unit, before ALOG allows for the provision of other services. Once ALOG accepts a request from the battalion/squadron (Bn/Sqdn) S1/4, it can then provide a reasonable replenishment of that unit to bring its field trains basic loads up to strength. At no time should these levels be brought to more than 98 percent of authorized. Real time-distance factors must be applied in the movement of supplies, weapons, and personnel. Sound judgement and active participation will greatly enhance the overall success of the exercise.

(c) Functions. The ALOG Controller Should:

1. Ensure that player unit S1/S4's actively participate in the maneuver play by requesting reports, providing timely information, and making frequent visits to the Bn/Sqdn staff areas.

2. Maintain a situation board/map for the combat service support of both forces (optional).

3. Provide accurate input information on the combat service support posture of both forces to the computer historical files.

4. Provide ALOG update information to the control staff on request.

(4) G2/G3 (Operations/Intelligence) Controllers

(a) General. The G2/G3 controllers represent the following:

1. Brigade, division, corps, and Army G2/G3.

2. Commander of all divisional or corps units with a combat support function (less artillery) when being employed in support of the player units.

3. Commander of the divisional or corps engineer assets.

4. Intelligence acquisition capability of Army aviation.

5. G2/G3 air for the division and the corps.

(b) Functions. The G2/G3 controllers functions are generally, but not limited to the following:

1. Make frequent visits to the Bn/Sqdn staff area keeping abreast of the tactical situation at all times.

2. Add realism to the play by requesting required intelligence and operations updates, as outlined by the division Tactical Operating Procedures.

3. Provide combat support activities as requested by the players. Professional judgment must be exercised to prevent "stacking the deck" by the players. Unlimited combat power will greatly detract from the problem play by both sides.

4. Coordinate all requests for additional combat support from player staffs with the CC and Table Control Party. Allocate only those assets approved by the control staff.

5. Coordinate closely with the Tactical Air Control Party/Fire Support Coordinator for intelligence data that would normally originate from that level, then feed this information into the problem as required.

6. Refer to the G2/G3 controller checklist when required to stimulate play.

(5) Fire Support Elements (FSE) Controller.

(a) General. The FSE is the focal point for all artillery play, and represents the FSE at the division and corps level. It may be required to play some of the Corps Tactical Operations Center (CTOC) functions for intelligence at the corps level.

(b) Realism of Play. As with all the controller sections, the unrestricted use of combat power will detract from the real world play of the exercise. The professional knowledge and judgment of the FSE staff must be used to the fullest in stimulating realism. Unrealistic requests from players must be cancelled or modified to prevent "stacking the deck" for one side or the other. The Ammunition Supply Rate (ASR) must not be exceeded to suit any particular unit, but rather used as a controlling condition that a real world unit must face.

(c) Functions. The FSE Should:

1. Ensure that Bn/Sqdn FSO participates actively in the maneuver play by providing information, requests, and reports as necessary.

2. Coordinate the activities of the controller FSE, artillery players, and forward observers (FO).

3. Provide input data to the computer for all artillery fire requests.

4. Translate computer output data to real world language for relay to the requesting unit.

5. Receive, process, and record fire missions from the FO's.

6. Ensure that the proper application of fire support (or the lack thereof) is permitted to have its full impact on the outcome of the tactical situation.

7. Make frequent visits to the Bn/Sqdn artillery players and stay abreast of their future plans.

8. Coordination:

a. Coordinate with the Table Control Party for mutual agreement on the status of artillery play.

b. Coordinate with the G2/G3 controllers for the release of intelligence through artillery channels.

c. Coordinate with ALOG controllers for logistical control of artillery support activities.

9. Maintain a situation map/chart of the artillery situation for both sides and keep this information current on the maneuver situation map in the maneuver control room (optional).

(5) Air Liaison Controller (ALO)

(a) Representation. The ALO controller represents the following:

1. The entire tactical air force for both the Red and Blue forces (inclusive of the intelligence acquisition capability).

2. S3/G3 air at brigade, division, corps and Army.

3. Combat support functions of Army aviation. (Special requests only)

(b) Functions. The ALO performs the following functions:

1. Process requests for offensive tactical air missions initiated by the player unit (Red and Blue). Fly those missions that are determined to be logical and appropriate, and assess predetermined time lags.

2. Keep the control group informed of the status of airstrikes.

(c) Standing Operating Procedure. The division Standing Operating Procedure specifies the procedure by which units request close air support.

(d) Air Mission Status Chart. Maintain an air mission status chart for Red and Blue divisions' close air support missions. This chart must reflect missions that have been flown, missions in process, missions pending, and future aircraft availability.

(e) Maps. Maintain close air support situation on the general situation map in the maneuver control room.

(f) Allocation of Aircraft. By analysis of the general and special situations and employment of tactical aircraft, determine a reasonable allocation of close air support sorties to be made available each day to the Red and Blue forces. As a general guide, the policy is to play relatively few air sorties thereby placing primary emphasis on techniques and procedures rather than glutting the forces with air sorties that cannot be utilized or processed efficiently. Obtain concurrence from the CC on the number of sorties to be allocated each force.

(g) Intelligence. Close air support sorties acquire information that is disseminated to the ground units concerned through the ground liaison officer teams located with the fighter units. Determine and release that information that would be logically acquired by this agency after coordination and approval by the G2 controller.

(6) Maneuver Unit Monitors.

(a) Brigade/Regimental Monitors. Brigade/regimental monitors are those staff members responsible for the instruction being reinforced during the map maneuver. As such, they, in conjunction with the battalion monitor(s), must ensure that all teaching points are emphasized and exercised. They coordinate with the CC and map maneuver director or his deputy to achieve this end.

(b) Battalion/Squadron Monitors.

1. General. Bn/sqdn monitors are responsible to the bde/regt monitor for the reinforcement of teaching points throughout the MM. They must be versed in the proper employment of combat, combat support, and combat service support elements in the conduct of tactical operations on the conventional battlefield.

(c) Company/Troop Monitors.

1. General. The co/trp monitors are responsible to the bn/sqdn monitors for the proper function of the co/trp HQ and players. As a representative of the Control Staff, they must be well versed in the proper employment of armor, cavalry, and infantry units at the company/troop level.

2. Functions

a. Keep detailed notes on the performance of the players during the exercise.

b. Provide requested assistance to the player on the proper employment of his units.

c. Maintain a through knowledge of the tactical situation.

d. Act as liaison between the player and the control staff.

e. Use evaluation criteria in preparation of formal critique.

(7) Threat Controller(s)

(a) Representation. In a one sided exercise the THREAT controller(s) plays the entire opposing force. All decisions, actions and orders are coordinated with the Blue Force controllers and the CC.

(b) Functions.

1. Employ the Red force in accordance with current Threat doctrine.

2. Tailor the Red force to accommodate and facilitate the Blue force mission in a realistic manner.

3. Employ all combat and combat support assets normally found in Threat units in a real world manner. The Red force should not be arbitrarily weakened or reinforced in an unrealistic way that would lead to Blue force success.

4. Stay abreast of the tactical situation and interact with the Blue force control staff.

5. Accurately portray the Red situation on the Tactical Control Map.

3.1.10 EVALUATION

The purpose of evaluation for the CAMM system is to assist the participating units in deriving maximum training benefits from the exercise. The system can be easily utilized to realistically assess command and staff proficiency or whatever area of interest the director wants evaluated. Once this area of interest is identified by the director, specific situations can be entered into the play of the exercise. The controllers then evaluate the level of proficiency in the particular target area. These specific situations are referred to as Situation Probes and once initiated become part of the critique process (i.e., a specific probe is referred to along with the actions taken and results obtained). These follow-up actions by the controller would then be discussed in detail during the critique. Situation probes used in the above manner allow the commander to gain a realistic assessment of how his staff performs and take necessary steps to alleviate shortcomings. There are innumerable possibilities for utilizing the situation probe as an evaluation tool.

Intelligence (G2/S2) Controller Guide

a. Representation.

(1) The G2 controller for the Blue forces represents G2, or the Division and Corps.

b. Functions.

The G2 controller will coordinate the release of all enemy weather and terrain information and intelligence to player S2s. Information/intelligence released will be provided automatically on a time-phased basis and as a result of requests for information/intelligence from S2s.

c. Duties.

During the conduct of the map maneuver, the G2 controller will perform the following duties:

(1) On the first day of the exercise, orally brief the player S2s on the current enemy situation. Distribute current Intelligence Summary (INTSUM) and enemy situation overlay.

(2) On a time-phased basis, provide player S2s preprinted update information/intelligence concerning the enemy situation until beginning of free play part of the map maneuver. Information provided will be posted in the G2 staff journal and/or enemy situation map.

(3) During the conduct of maneuver, in response to player S2s requests for information, prepare and dispatch intelligence reports for information; prepare and dispatch information/intelligence reports that reflect the current enemy situation. Intelligence information provided must reflect the current tactical situation and be consistent with collection capabilities of agencies at division level or above. Information provided will be posted in the G2 staff journal and enemy situation map.

(4) Receive, post, and integrate intelligence information collected by subordinate units.

NOTE. The G2 controller should periodically check with table controllers to ensure information developed is being disseminated to higher headquarters.

(5) Each day before the start of the maneuver, contact local United States Weather Service and obtain weather forecast for a 24-hour period. Weather data should include as a minimum: Precipitation, fog, temperature, wind, and visibility. Forward weather data to player S2s.

(6) When deemed necessary and/or appropriate, levy intelligence collection requirements on S2s.

(7) Ensure player S2s submit integrated surveillance plan each day. Plan should include as a minimum location and coverage of radars, patrol routes, and location of unattended ground sensors (UGS).

(8) Ensure player S2s submit a daily INTSUM that summarizes enemy activity for the past 24 hours.

(9) Effect coordination with controllers and play S2s to ensure an active and realistic intelligence play during conduct of the map maneuver.

3.1.13 OPERATIONS (G3/S3) CONTROLLER GUIDE

a. Representation

(1) The S3 controller represents all operational and combat support assets of the higher/parent HQ.

(2) If a two-sided maneuver is used, the S3 controller for each force will perform in the same manner.

b. Functions.

The S3 controller will control and coordinate the operation of Red/Blue forces and all units adjacent to and in support of them.

This will include:

(1) Performing all functions for which Assistant Chief of Staff G3 has staff responsibility as they affect the brigade/regiment.

(2) Coordinating troop movements, air space fire support, and maneuver control measures at brigade/division/corps level.

(3) Coordinating and use of brigade/division/corps assets by Red/Blue Forces.

c. Duties.

During the conduct of the map maneuver, the S3 controller will perform the following duties:

(1) On the first day of the exercise, orally brief and distribute the written brigade/division/corps Operations Orders (OPORDS) to the Blue/Red players.

(2) Receive, review, and clarify all orders published by the brigade/regimental staffs in support of the division/corps OPORDS.

(3) Maintain a situation map with acetate drop overlay depicting current dispositions and plans of Blue/Red Forces down to battalion/squadron, company/troop level.

(4) Receive and log the following required reports from Blue units (division tactical Standard Operating Procedures (SOP)).

(a) Jamming reports (as occur).

(b) Situation reports Not Later Than 1300 hours, as of 1200 hours).

(c) Unit progress report (after significant change).

(d) Minefields and barriers report (as occur).

(5) Provide the following information to Red/Blue Forces:

(a) Dispositions of friendly adjacent units (after

significant changes).

(b) Approval/disapproval of requests from Red/Blue forces of Air Defense Artillery, aviation engineer, or other support.

(c) Changes in brigade/division/corps plans and orders due to changes in Red/Blue Force situations.

d. Other Functions

Other than responses to player requests for information or support, no specific activities in the following S3 areas of staff responsibility are anticipated.

(1) Electronic warfare (EW).

(2) Communications-electronics (C-E).

(3) Chemical-biological-radiological (CBR).

(4) Tactical cover and deception.

(5) Traffic control.

INSTRUCTIONS FOR PLAYERS

a. Functions

The function of each player unit is to prepare all plans,orders, and reports and to take appropriate action necessitated by the mission.

b. Organization

The player unit represents only the headquarters of the brigade, battalion or company. All higher, subordinate, and adjacent units not played are represented by the control group.

(1) The commander supervises and controls all activities of his staff.

(2) The staff officers perform the normal functions prescribed for them.

(3) Fire support coordination will be effected through the battalion fire support officer.

c. Information Material

All information necessary for players to initiate the play of this maneuver is included in the operations order. All players will tnoroughly familiarize themselves with this material before the start of the map maneuver.

d. Brigade Commanders

Controllers fulfill these functions and monitor players' progress. This is done to insure compliance with training objectives.

e. Battalion Executive Officer

Coordinates staff activities and functions in capacity of battalion commander in his absence.

f. Administration/logistics (S1-S4) Players

(1) General. S1-S4 players must keep abreast of the tactical situation and adjust their personnel and logistical plans. Failure of some phase of personnel or logistical planning usually adversely affects the tactical situation. The S1-S4 must circulate and confer with fellow members of the unit and special staff. He devotes most of his time to planning and coordinating S1-S4 matters, which must be accomplished realistically.

(2) Situation Map. Maintain an administrative situation map.

(3) Orders. Prepare paragraph 4 of all operation orders or a service support order, as required.

g. Intelligence (S2) Players

(1) Functions. The S2 will perform the normal duties associated with the S2 section. He will keep all sections and personnel abreast of the enemy situation and informed on the terrain and weather. He must be prepared to give an intelligence estimate to the commander or other staff officers at any time.

(2) Planning. The S2 must project himself into the future and plan in advance in order to get the information needed in time. Orders and requests for information must be issued promptly. In addition, he must maintain close liaison with all intelligence by controllers. To do this, the S2 should:

(a) Maintain current intelligence estimate.

(b) Make and maintain current intelligence collection plan.

(c) Send specific requests for information to lower, adjacent, and higher units.

(d) Plan for and recommend employment of Ground Surveillence Radar section and scout platoon.

(e) Plan for and request if necessary, Unattended Ground Sensors (UGS).

(f) Process and evaluate information received (to be presented in intelligence estimates).

h. Operations (S3) Players

(1) Functions. Prepare all orders pertaining to operations matters as directed by the commander. Coordinate S-3 actions and orders with members of the unit and special staff. S-3s do not operate alone; the orders issued by the S-3 in the name of the commander will, in most cases, have a direct bearing on the planning of the other members of the staff. Be prepared to give an operations estimate or make recommendations, as required.

(2) Cooperation. Remember, the S-3 is dependent upon subordinate and adjacent units, higher and supporting headquarters, and members of his own unit staff for information. As a staff officer, he

cannot guess what action is going on. The closest cooperation and coordination is necessary between the S-3 and the previously mentioned headquarters and units, and especially between S-3 and the S-2. The plans the S-3 recommends can be most effectively supported administratively only if the S-3 prepares them in continuous coordination with the S1-S4.

(3) Plans and Orders. Work with the special staff officers in preparing plans for the employment of field artillery, air defense artillery, and engineer units. Issue these plans to subordinate units. The S-3 is responsible for the preparation of the operation/order.

i. USAF Representatives

When available, USAF representatives will be assigned as air liaison officers and forward air controllers at brigade and battalion level. When Air Force officers are not available, assistant S3 air players will represent Air Liaison and Forward Air Controller.

j. Field Artillery Representatives

Field artillery fire support officers (when available) are provided and work for the FSE controller. They will:

(1) Represent the artillery commander (FSCC controller) at the headquarters of assignment.

(2) Keep the maneuver battalion informed of the situation plans, policies, and capabilities of the artillery battalion he represents.

(3) Keep the artillery battalion (FSC) informed of the situation, plans, policies, and capabilities of the maneuver battalion.

(4) Facilitate necessary coordination between the maneuver

and artillery battalions.

(5) Send requests for fire to FSE, based on intelligence produced by battalion staff.

k. Company Commanders

(1) Functions. All company commanders will perform all the normal duties associated with that position. They must fight and control their command as if it were actually in combat. Subordinate platoon leaders are controllers, but provide all normal information required to conduct ground operations.

(2) Planning. Once the Company Commander has received his mission, he must plan the employment of the company to accomplish all specified tasks. His plans should include use of:

(a) Attached or supporting elements.

(b) Supporting weapons.

(c) Organic weapons and personnel.

Chapter IV, will discuss the data files and programs used to support the activities presented in this chapter. Systems flow charts and technical material provided will be detailed with reference to the manual functions they support.

3.2 COMPUTER ASSISTED INSTRUCTION (CAI)

a. CAI uses the same systems programs used in the MM. However, the major difference here is the pace at which the exercise is run. The interest here is in a discussion of the main teaching points rather than the speed and accuracy of the action taken.

b. The players are organized into staff groups and given a home study assignment of preparing for the exercise. They must be totally

familiar with the tactical situation prior to entering the exercise facilities. Operations orders (OPORDS) are discussed and specific situations outlined by the instructor. As in the MM, a control map is posted with the operations plan indicated. The instructional requirements are designed to force the player staff group to respond with orders, which are then fed to the computer in the standard format for the MM. The results are then given to the group and a discussion usually follows.

c. Normally only a single staff group executes its orders at one time. The other groups are either in their work areas preparing for their turn, or in the observation area watching the group being exercised. At appropriate intervals the groups are rotated and the problem repeated for the new group.

d. At the end of the exercise, a general critique/discussion period is provided. Here the instructor gives his assessment of all the groups' performances.

e. The instructor to student ratio is 1:50, since only the instructor is needed to control the entire exercise. This CAI technique is especially suited for the presentation of tactical instruction that allows the student to try out his own ideas in a given situation.

f. The simulation of logistical problems requires that a tactical situation be presented within which the logistical play can be conducted. This requires a little more planning on the part of the instructor, but is well worth the effort if it results in a successful block of instruction.

BATTLE START PROCEDURE

Summary of Typical Control Activities

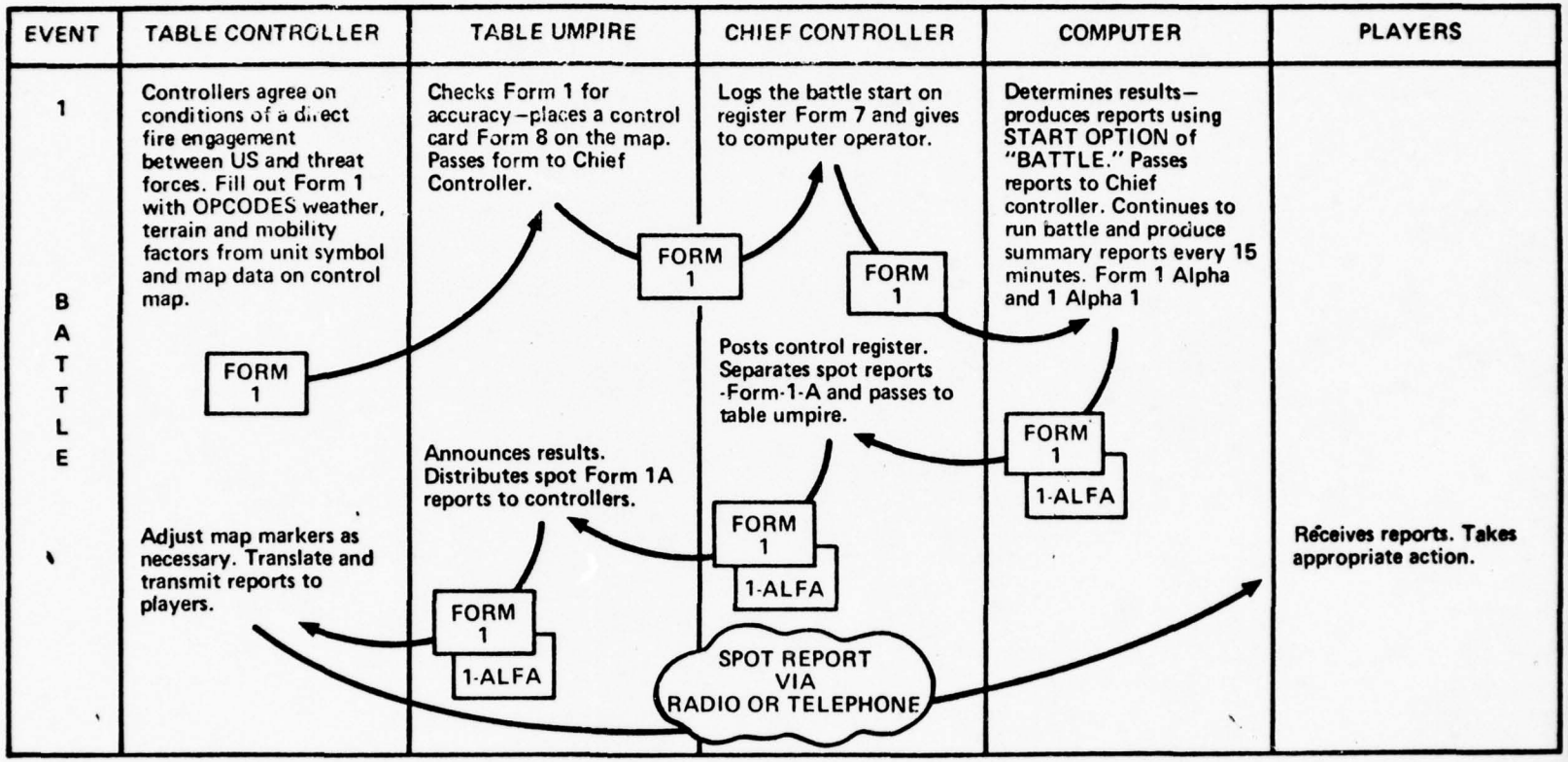


FIGURE 2, Battle Start Procedures

CHANGE BATTLE CONTROL PROCEDURES (ADD)

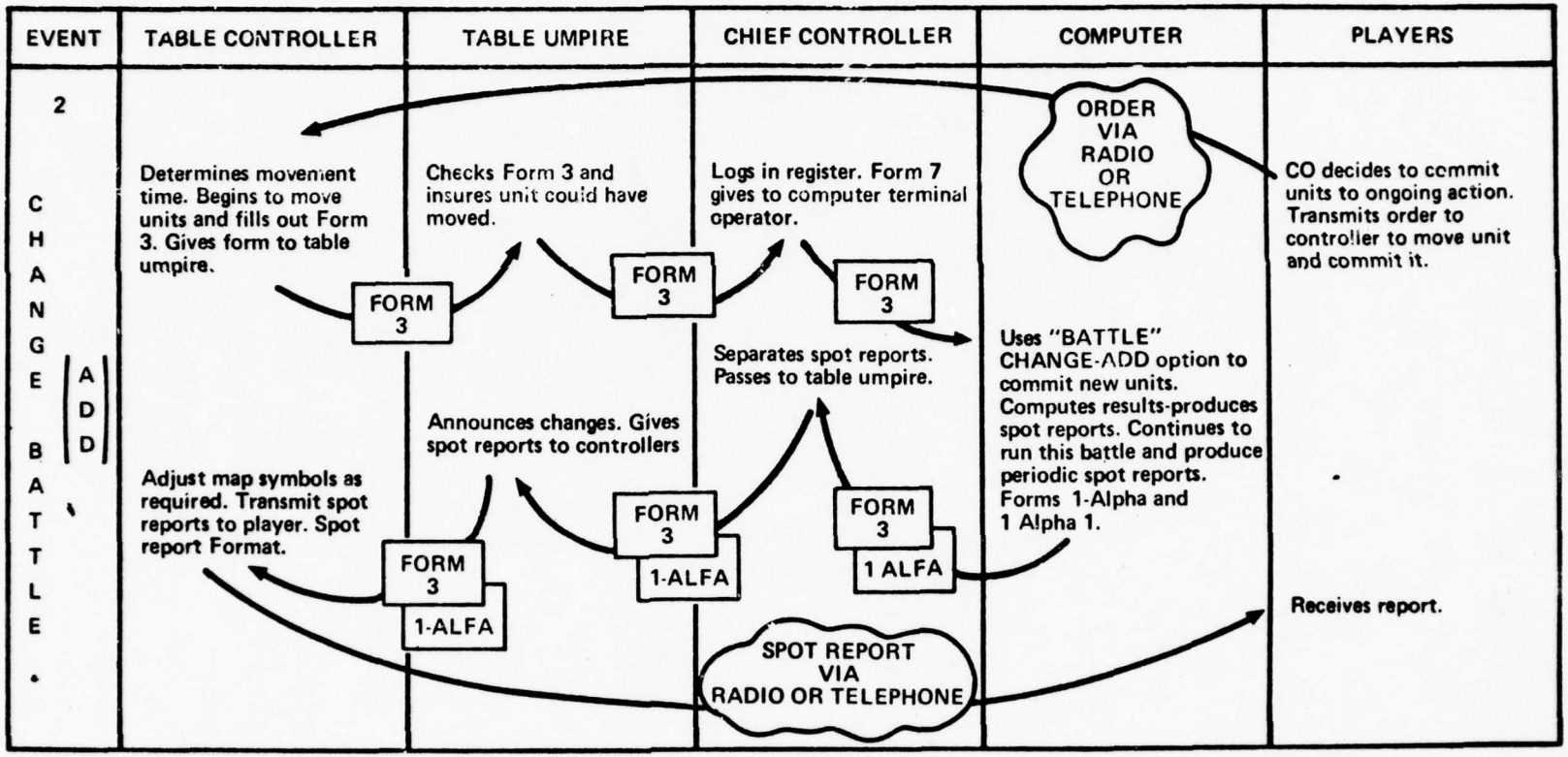


FIGURE 3, Change to Battle (ADD)

CHANGE BATTLE CONTROL PROCEDURES (STOP)

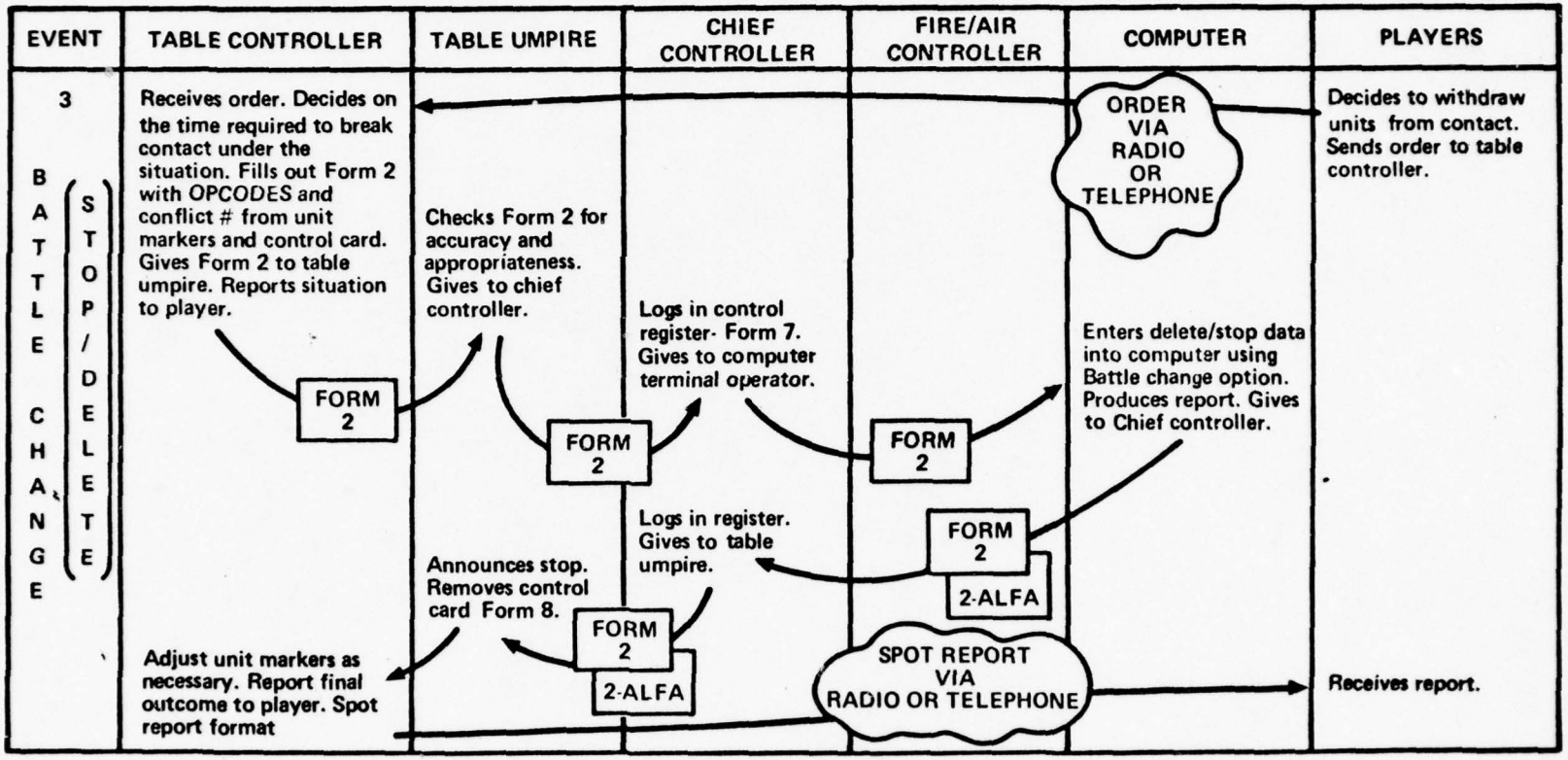


FIGURE 4, Change to Battle (STOP)

AIRSTRIKE CONTROL PROCEDURES

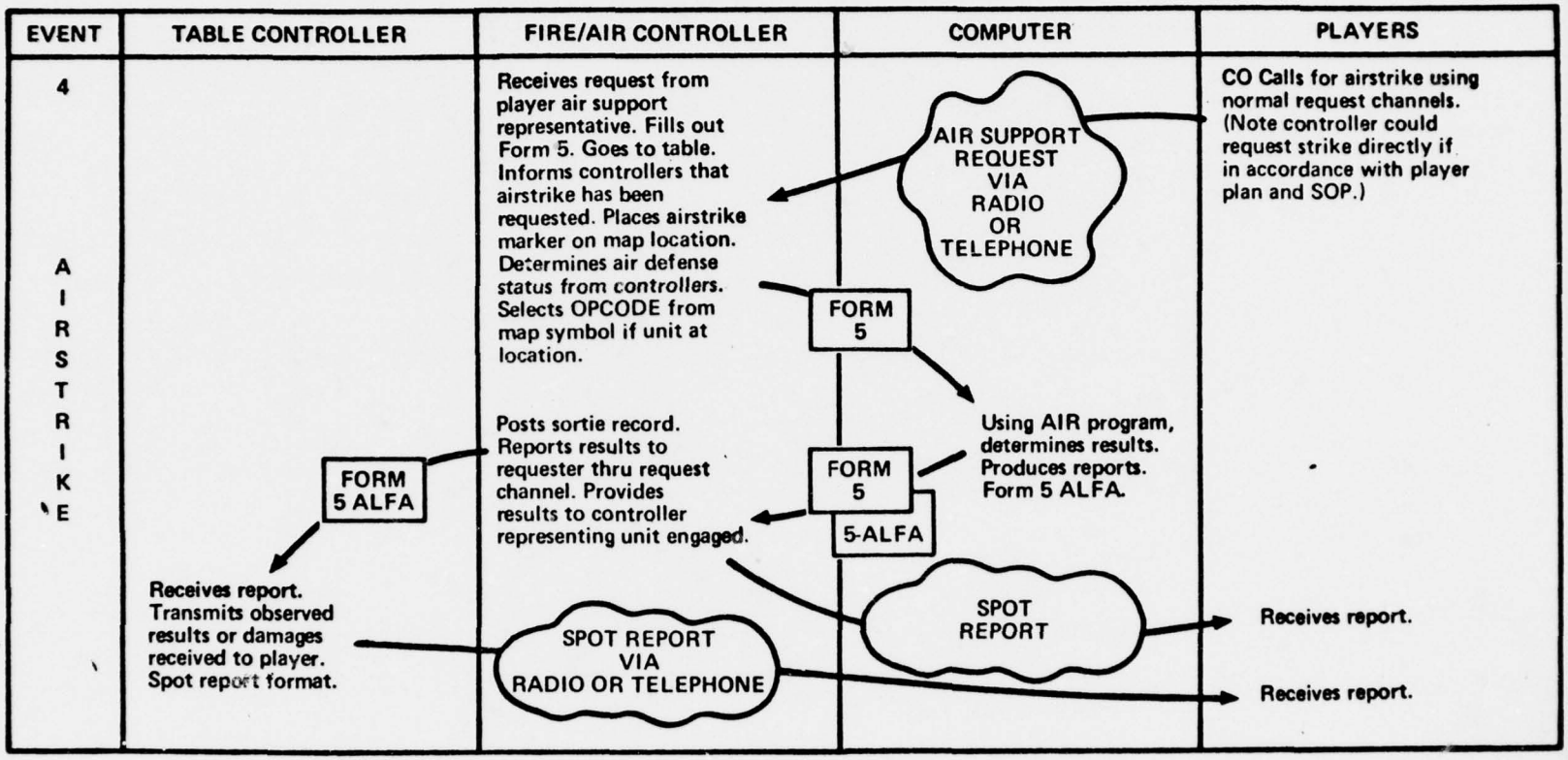


FIGURE 5, Airstrike Control Procedures

ARTILLERY CONTROL PROCEDURES

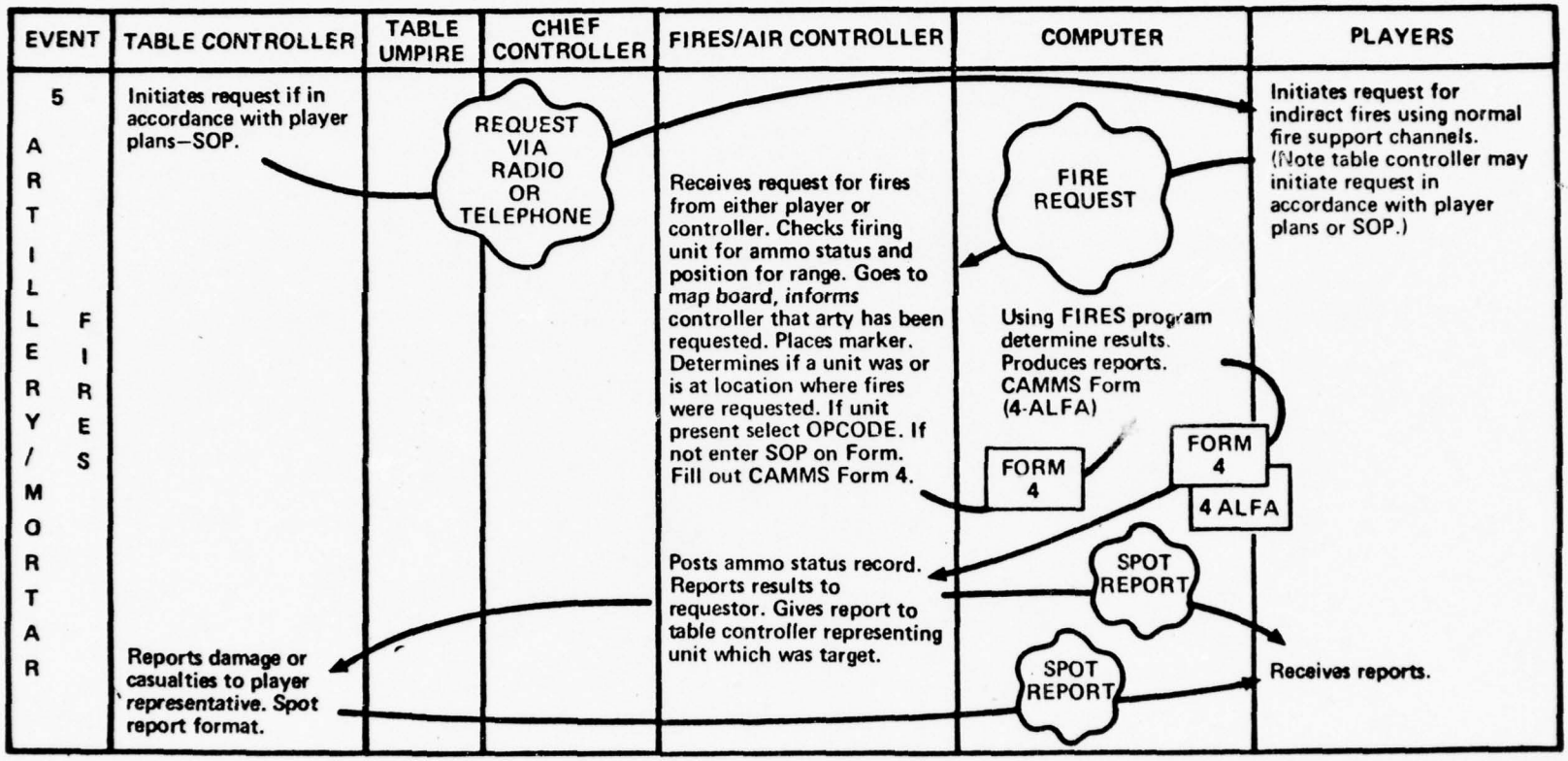


FIGURE 6, Artillery Control Procedures

EXERCISE PREPARATION FLOW CHART

Chief Controller	Conducts controller training as necessary. Opens exercise Headquarters.	Issues Operation Order-Briefs player unit.	Supervises setup of control area and control group preparation.		Supervises Final posting of control Map. Initializes computer programs. Final check of Controller communications.
Table Umpire and Table Controller	Attend final controller training sessions as required. Study player unit SOP's.	Attend Note: Threat controller does not attend	Prepare and set up control map, unit markers, CAMMS Forms.	Attend Obtain unit dispositions record on worksheet	Post player unit locations, boundaries and fire plans to control map.
Fire Controller	"	Attend	Conduct final rehearsal and coordinate.	Attend Obtain Firing unit locations, fire plans.	Begin processing any fire requests received during planning period.
Air Controller	"	Attend	Coord	Attend Obtain Air Fire plan, allocation.	Begin processing any air support requests received during planning period.
ALOG Controller	"	Attend	Coord	Attend Become familiar with final log plans.	
G2/G3	"	Attend	Coord	Attend	Initiate any requests for intelligence received during planning period.
PLAYER UNIT Headquarters	Begin installation of communications and set up of command posts as required by exercise directive.		Receives Order Begins planning	Issues Ordered overlays.	Opens radio/wire nets.
Subordinate/Spting Units	"	Attend	Participate	Receive	
TIME	D-Day−1	D-Day H−5 hrs		H−2 hrs	H−1 hr	H-Hour Exercise Begins

FIGURE 7, Exercise Preparation Flow Chart

LAYOUT OF MANEUVER CONTROL ROOM

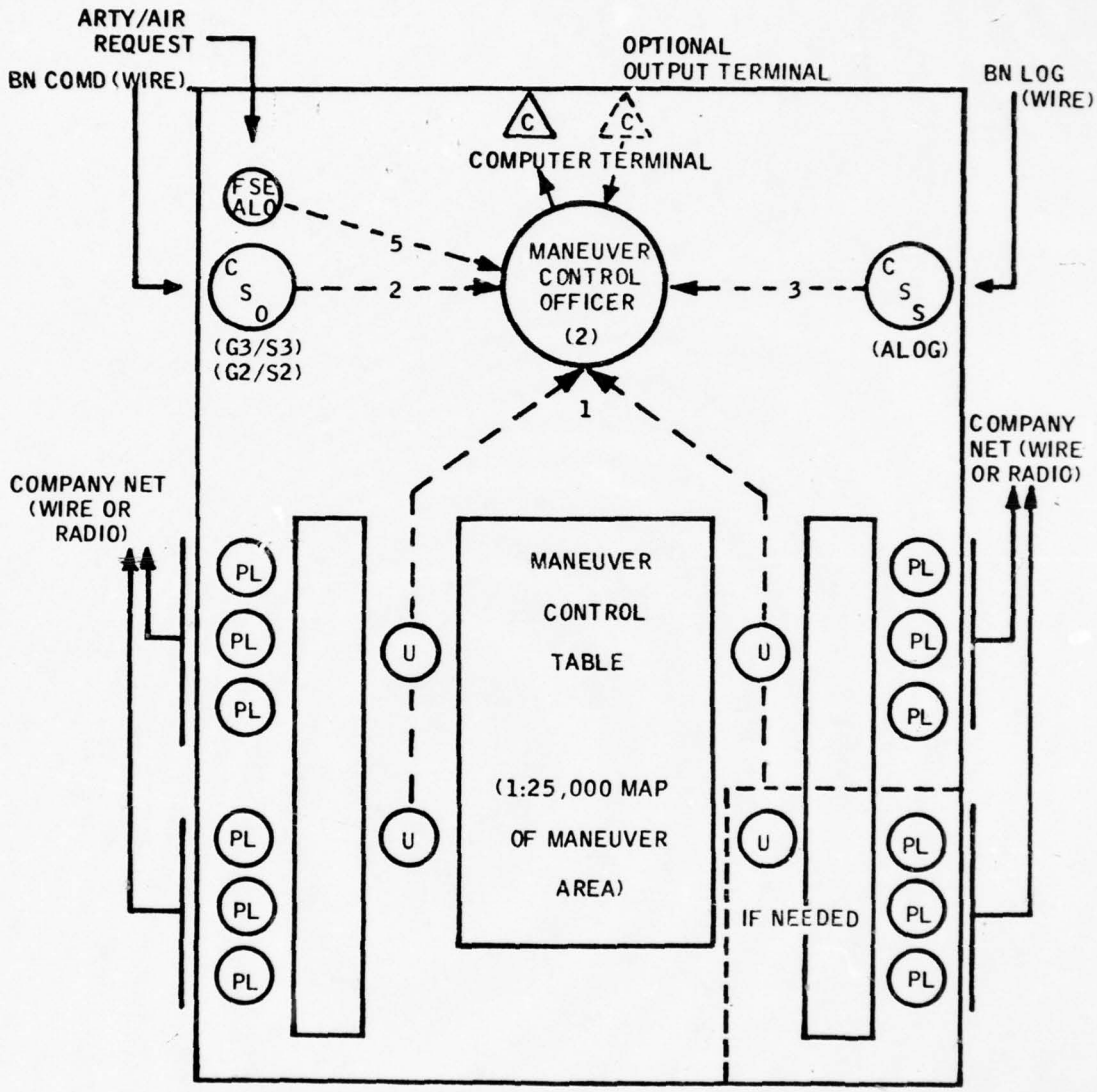


Figure 8, Layout of Maneuver Control Room

COMMUNICATIONS DIAGRAM

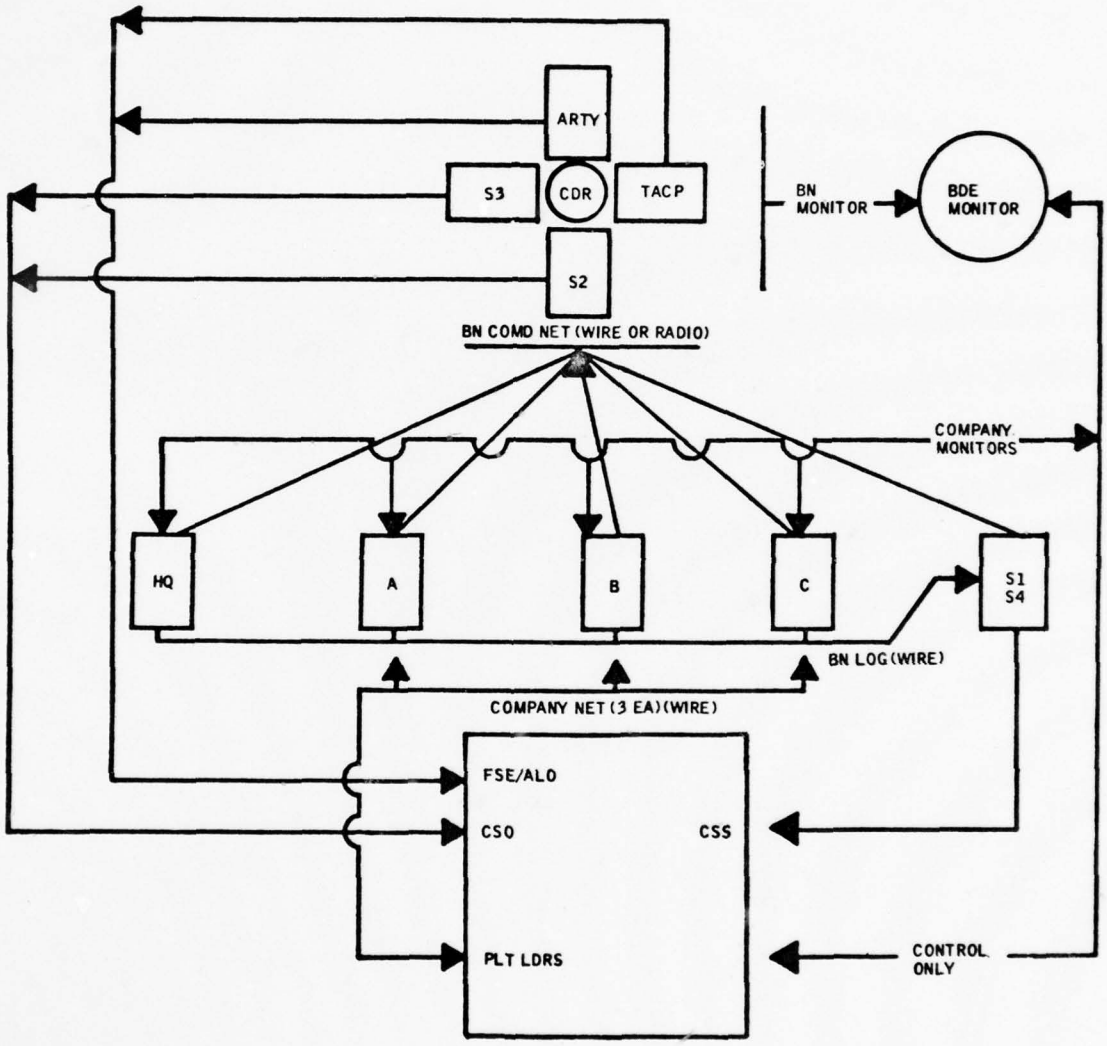


Figure 9 - COMMUNICATIONS DIAGRAM

CHAPTER IV

SYSTEM SOFTWARE

4.1 DATA FILES

a. CAMMS is supported by a series of computer programs and related data files that are combined to calculate and maintain records of actions that would otherwise be done manually. The CAMMS programs are totally interactive. Four to five terminals, TTYs or SILENT 700 type, are utilized for interactive input and output functions. These terminals are operated simultaneously throughout the exercise in order to accomodate the following requirements:

(1) Administration (S1) and logistics (S4) operations.

(2) Indirect fire computations (Artillery and Mortars).

(3) Direct fire computations (Conflict and Ambush operations).

(4) Periodic update or summary operations.

(5) Air strikes.

b. The programs are written in FORTRAN IV EXTENDED and COMPASS (CDC Assembly Language). The COMPASS part of the programs accesses, updates, or purges the data files. There are seven major programs and seven data files in the system.

DATA FILES:

(1) UNIT D - This file contains all data pertaining to each unit that can be placed in conflict.

(2) TYPE D - This file contains all data needed to describe

each unit in the UNITD file.

(3) WEAPON D - This file contains data on all weapons used to make up the TYPE D fields of the UNITD file.

(4) CONFLD - This file contains information on conflicts that are initiated during the exercise.

(5) CONFLK - Exercise start time, status of on-going conflicts (1-60), and total number of active conflicts, are recorded in this file.

(6) REFFILE - All UNITD file OPCODES with corresponding reference numbers to be used as numeric KEYS to the UNITD file are recorded in the REFFILE. OPCODEs are in numeric order.

(7) UNITD2 - This file contains data necessary for the creation of the UNITD file. Specifically, this file contains separate records that provide the 1-9 fields of the UNITD file during the initialization of the system.

PROGRAMS:

(1) BATTLE - This is the main program of the system. All data for direct fire confrontations are entered in this program.

(2) AMBUSH - This program allows the employment of direct and indirect fire weapons simultaneously on a given target or group of targets for an engagement of relatively short duration (15-45 seconds).

(3) ALOG - All administrative (S1) and Logistical (S4) functions are handled in this program.

(4) AIR - The purpose of this program is to allow the employment of tactical air power in support of the ground operations.

(5) FIRES - This program computes the effects of the use of indirect fire from artillery or mortar weapons.

(6) SUMMARY - The summary program allows the periodic update of ongoing conflicts that are active in the CONFLD file.

(7) INIT - The program initializes the CAMMS data files before the start of the exercise, and purges the files at the end.

FUTURE PROGRAMS:

(1) EW - This feature will allow the simulation of effects expected from the employment of electronic warfare.

(2) CBR - The effects of chemical, biological, and radiological warfare will be simulated in this program.

(3) ADA - Air defense artillery will be played as a separate function independent of the AIR program.

(4) MINES - Currently the system plays mine warfare as a manual function. This play will be automated in future refinements.

(5) NUKES - Nuclear warfare on the tactical battlefield will be played separately from the CBR program.

(6) ATKHEL - A program similar to the AIR program will be used to compute the effects of attack helicopters on the battlefield.

(7) PLRP - Resupply for platoon level simulation will be a function of the PLRP program for use in conjunction with the ALOG program. This feature may become a subroutine of the ALOG program.

(8) QBAT - The program will feature a routine capable of making a long range forecast of the outcome of any particular conflict.

c. Data file descriptions:

(1) UNIT D

(a) General description: The UNITD file is organized as a random mass storage file and contains all the data pertaining to each unit within the CAMMS exercise. This file maintains all the current totals for fuel (POL), ammunition (AMMO), personnel (PERS), and weapons by unit within seperate logical records. These logical records are structured utilizing an array 35 words in length, with 10 characters per word. Field specifications are listed below as follows:

FIELD NO.	FIELD NAME	FIELD TYPE	FIELD LENGTH
1	CONFLICT CODE	INTEGER	I2
2	ADMIN CODE	ALPHANUMERIC	A5
3	OPCODE	"	"
4-8	DESCRIPTION	"	5A10
9	TYPE CODE	INTEGER	I2
10	WEAPON #1	"	I6
11	WEAPON #2	"	"
12	WEAPON #3	"	"
13	WEAPON #4	"	"
14	WEAPON #5	"	"
15	WEAPON #6	"	"
16	WEAPON #7	"	"
17	AMMO #1	"	"
18	AMMO #2	"	"
19	AMMO #3	"	"
20	AMMO #4	"	"
21	AMMO #5	"	"
22	AMMO #6	"	"
23	AMMO #7	"	"
24	POL 1	"	"
25	POL 2	"	"
26	POL 3	"	"
27	POL 4	"	"
28	POL 5	"	"
29	POL 6	"	"
30	POL 7	"	"
31	PERS	"	"
32	EMPTY		
33	"		
34	"		
35	"		

(b) Field descriptions:

(1) The CONFLICT CODE field is used as a flag. If it is equal to zero, then that particular unit is not in conflict. Otherwise this code contains the number of the conflict in which the unit is involved.

(2) The ADMIN and OPCODE fields are the same for each unit and are used as a unit identification code.

(3) The DESCRIPTION field is the name of the unit. This description usually conforms to the military nomenclature used to identify units.

(4) The TYPE CODE field is a number that represents the type of unit on which its table for organization and equipment (TOE) levels are determined and is the key used to access the correct record in the TYPED file.

(5) The WEAPON #1 - #7 fields maintain the number of weapons on hand for each weapon type authorized by the TOE of the unit.

(6) The AMMO #1 - #7 fields maintain the number of rounds of ammunition on hand for each weapon shown in the WEAPON fields.

(7) The POL #1 - #7 fields maintain the number of gallons of fuel on hand for each vehicle authorized and on hand in the WEAPON fields.

(8) The PERSONNEL field (PERS 1) is used to maintain the total number of personnel remaining in the unit based on the TOE level authorized. No distinction is made between types (officer,NCO or EM).

(9) The number of weapons remaining in a unit (WEAPON #1 - #7) is stored as the actual number on hand. However, the amount of AMMO, POL, or PERS remaining in the unit is represented as a percentage. This percentage is transformed into INTEGER format by multiplying by 1,000. Therefore, a unit with 100% of PERS remaining would have 1,000 stored in the PERS field. Similarly, a unit with 50% of AMMO #1 remaining would have 500 stored in field AMMO#1.

(2) TYPE D

(a) General description: The TYPE D file is organized as a random mass storage file that contains all the authorized levels for weapons, ammunition, fuel, and personnel, as directed by the TOE for that type unit (i.e. Mechanized infantry, Armor, Artillery, etc.) and is identified by type number in the UNITD file. This file does not change during the exercise but is used as a reference point when updating the UNITD file. Within this file each unit is described by one logical record. This logical record is structured as an array of 36 words and is described as follows:

FIELD NO.	FIELD NAME	FIELD TYPE	FIELD LENGTH
1	TYPE NO.	INTEGER	I2
2-3	NAME	ALPHANUMERIC	2A10
4	WEAPON #1	INTEGER	I6
5	WEAPON #2	"	"
6	WEAPON #3	"	"
7	WEAPON #4	"	"
8	WEAPON #5	"	"
9	WEAPON #6	"	"
10	WEAPON #7	"	"
11	NO. AUTH #1	"	"
12	NO. AUTH #2	"	"
13	NO. AUTH #3	"	"
14	NO. AUTH #4	"	"
15	NO. AUTH #5	"	"
16	NO. AUTH #6	"	"

FIELD NO.	FIELD NAME	FIELD TYPE	FIELD LENGTH
17	NO. AUTH #7	INTEGER	I6
18	AMMO AUTH #1	"	"
19	AMMO AUTH #2	"	"
20	AMMO AUTH #3	"	"
21	AMMO AUTH #4	"	"
22	AMMO AUTH #5	"	"
23	AMMO AUTH #6	"	"
24	AMMO AUTH #7	"	"
25	POL #1	"	"
26	POL #2	"	"
27	POL #3	"	"
28	POL #4	"	"
29	POL #5	"	"
30	POL #6	"	"
31	POL #7	"	"
32	PERS	"	"
33	EMPTY		
34	"		
35	"		
36	"		

(b) Field Descriptions:

(1) The TYPE NO. field specifies the type of unit this record describes, e.g., a TYPE 1 unit is a tank platoon. This number is identical to the key used to access a particular record.

(2) The NAME field is the identification placed on that type of unit based on the TOE it is authorized.

(3) The WEAPON #1 - #7 are numbers that correspond to the type weapon authorized and is an index to the WEAPON file.

(4) The NO. AUTH #1 - #7 fields are the numbers of each type weapon authorized when the unit is at 100% of the TOE authorization.

(5) The AMMO AUTH #1 - #7 fields are the number of rounds of ammunition authorized by type equipment/weapon when the unit is at 100% TOE authorization.

(6) The POL #1 - #7 fields are the number of gallons of fuel authorized by vehicle set at 100% capacity by TOE authorization.

(7) The PERS field is the number of personnel authorized for the unit at 100% TOE without distinction of specific catagories.

(8) The remaining fields are left EMPTY to allow for expansion.

(3) WEAPON D

(a) General description: The WEAPOND file is organized as a random mass storage file and contains the data pertaining to all the weapons, vehicles and equipment authorized by the TYPED file. The WEAPOND file maintains the necessary variables for those weapons which have a firing capability, and provides names for each piece of equipment/weapon authorized. Information for each piece of equipment is maintained on seperate logical records within the file. These records are structured utilizing an array, eight (8) words in length. The fields are specified below:

FIELD NO.	FIELD NAME	FIELD TYPE	FIELD LENGTH
1	TYPE	FLOATING PT.	F3.0
2	PRECISION	"	G11.6
3	QUAD VAR 1	"	G13.6
4	QUAD VAR 2	"	"
5	QUAD VAR 3	"	"
6	RANGE	"	F6.0
7-8	NAME	ALPHANUMERIC	2A10

(b) Field description:

(1) The TYPE field specifies the number of the weapon/vehicle/piece of equipment for identification and is used as a key to access a record in the WEAPOND file.

(2) The PRECISION and QUAD VAR 1-3 fields are values that are used in the quadratic equation needed to compute the firepower score of the unit.

(3) The RANGE field represents the maximum effective range of the weapon in meters.

(4) The NAME field is the description of the particular item, e.g., M60A1 = Main Battle Tank,M60 A1, .50 CAL = Calibre 50 machine gun, etc.

(4) CONFLD FILE (Conflict Data)

(a) General description: The CONFLD file contains all information on direct fire conflicts that are initiated during the entire exercise. A logical record is created in this file for each unit involved in a conflict upon initiation of the confrontation. The following is the description of one logical record in this file:

FIELD NO.	FIELD NAME	FIELD TYPE	FIELD LENGTH
1	CONFLICT NO.	INTEGER	I2
2	O/D Code	ALPHANUMERIC	A1
3	UNIT	"	A5
4	Type ATK/DEF	INTEGER	I1
5	Start Time	ALPHANUMERIC	A10
6	Last Update	"	"
7	ATK DEG	FLOATING PT.	F10.5
8	DEF DEG	"	"
9	Range	INTEGER	I5
10	March Rate	"	I4
11	E/V Factor	"	I3
12	REF NO.	"	I4
13	Fill	ALPHANUMERIC	A1

(b) Field descriptions:

(1) The CONFLICT NO. field is the number to which that particular record is related.

(2) The O/D code field is either an A or a D depending on whether the unit for which the particular record was created is an attacking or defending unit.

(3) The UNIT field contains the OPCODE of the unit that is in conflict.

(4) The Type ATK/DEF field is either a 1,2, or 3. This coding is explained later in the program descriptions.

(5) The START TIME field contains the conflict initiation time.

(6) The LAST UPDATE field is the time that the last update was performed. The start time and last update time will be the same upon creation of the logical records for the conflict. However, the start time will remain constant while updates are performed approximately every 15 minutes on active conflicts, thus causing the last update field to change.

(7) The ATK/DEF DEG fields consist of the degradation factor for the attacking or defending unit in the form of a percentage.

(8) The RANGE field is the number of meters separating the attacking and defending units, and will change as determined by the rate of closure established in the MARCH RATE field.

(9) The MARCH RATE field is the speed of closure for the attacking units in meters per hour.

(10) The E/V Factor field is a number corresponding to the type visability/fields of fire and target exposure value used to compute ATK DEG and DEF DEG. These values will be described later.

(11) The REF NO. field corresponds to the location of the logical record in the UNITD file, where the associated OPCODE number can be found.

(12) The Fill/field is used to store the characters M or D depending on whether the unit in question is M - mounted, or D - dismounted. These characters are used in computing the MARCH RATE in the programs.

(5) CONFLK FILE (Conflict Master File)

(a) General description: The CONFLK file contains general information on the exercise. This file is one record in length. A description of this record follows:

FIELD NO.	FIELD NAME	FIELD TYPE	FIELD LENGTH
1	TIME	ALPHANUMERIC	A10
2-61	INDEXC	INTEGER	60I1
62	NO. OF CONFLICTS	"	I2

(b) Field descriptions:

(1) The TIME field contains the exercise start time. Later this time is updated when the POL attrition routine is run.

(2) The INDEXC fields are an index of the conflicts. It is represented by a series of 60 zeroes once the exercise is initialized. When a conflict is initiated a "1" is placed in the particular position based upon the conflict number, per the example below:

Situation: NO ACTIVE CONFLICTS

000000000000000000. . . . . (N=60).

Situation: CONFLICT NUMBER 1 ACTIVE

100000000000000000..... (N=60).

Situation: CONFLICT NO. 1 and 3 ACTIVE

101000000000000. . . . . .(N=60).

Whenever a conflict is terminated, a zero is placed in the particular position corresponding to the conflict number. In the situation above, conflict 1 and 3 were active. If conflict 1 were terminated the index would be:

001000000000000. . . . . .(N=60).

(3) The NUMBER OF CONFLICTS field is a counter that contains the total number of conflicts initiated during the exercise.

(6) REFFILE (Reference File)

(a) General description: The REFFILE is a sequentially organized file containing the OPCODE and KEY for reading the specific units in the UNITD file. This file is created during the running of program -INIT. As each record of the UNITD file is written so is the REFFILE, insuring identical KEYS on the UNITD and REFFILE for each OPCODE. Each logical record of REFFILE is organized as follows:

FIELD NO.	FIELD NAME	FIELD TYPE	FIELD LENGTH
1	OPCODE	ALPHANUMERIC	A5
2	KEY	INTEGER	I4

(b) Field descriptions:

(1) The OPCODE field,identical to the ADMIN CODE, is the field compared during program execution to determine if the unit OPCODE input is valid, and if so, what its UNITD KEY is.

(2) When a valid OPCODE is found, the KEY field, (File reference number), is its output. This KEY is a positive integer no greater than the total number of units in the UNITD file.

(7) UNIT D2 FILE

(a) General description: The UNITD2 file is organized as a sequential file and contains necessary data for creation of the UNITD file. This file provides the fields 1 - 9 for the UNITD file, and is only accessed during the initialization routine (execution of -INIT), accomplished at the start of each exercise. Fields for each record are as follows:

FIELD NO.	FIELD NAME	FIELD TYPE	FIELD LENGTH
1	CONFLICT CODE	INTEGER	I2
2	ADMIN CODE	ALPHANUMERIC	A5
3	OPCODE	"	"
4-8	DESCRIPTION	"	5A10
9	TYPE CODE	INTEGER	I2

(b) Field description:

(1) The CONFLICT CODE field is used as a flag. If its value is equal to zero, then that particular unit is not in a conflict. If its value is other than zero, it will indicate the conflict number in which the unit is involved.

(2) The ADMIN/OPCODE fields are identical for each particular unit and used for identification of the unit in the files.

(3) The DESCRIPTION fields contain the name of the unit, and conform to the military nomenclature.

(4) The TYPE CODE field is a number that represents

the type of unit, and acts as the KEY used to access the correct record in the TYPED file.

d. COMPASS subroutines:

(1) Within each of the source programs for the CAMMS system there is programmed in, COMPASS, the assembler language for the CDC 6500 computer system. The COMPASS instructions along with some FORTRAN subroutines, are used to perform certain necessary functions not normally allowed in CDC FORTRAN IV EXTENDED.

(2) The COMPASS subroutine has five entry points. These are PFATT1,PFCAT1, RETURN, PFPRG1, and REQUEST.

(a) PFATT1 - Allows a program to access/attach cataloged disk files. PFATT1's function is similar to the function of the "ATTACH" command of CDC SCOPE. The PFATT1 part of COMPASS is called in the following manner:

GENERAL FORM - CALL PFATT1 (LFN,PFN,ID,RD,MR)

EXAMPLE: CALL PFATT1 (5LTAPE1,6LCONFK,6RCGSCIF,4RBENZ,0)

where:

LFN = Logical file name using FORTRAN L format.

PFN = Permanent file name using FORTRAN L format.

ID = Owner identification where permanent file is stored using FORTRAN R format.

RD = Read permission password using FORTRAN R format.

MR = Flag for multi-read/exclusion file access,(MR=0 exclusive access, MR=1 multi-access(more than one user may access file at a time)).

NOTE: PFATT1 will attach the highest cycle of the permanent file requested and insure that any logical file name identical to that requested in LFN is returned to the system.

(b) PFCAT1 - Allows a program to make an existing local file into a permanent file similar to the function of the CDC SCOPE "CATALOG" command. The PFCAT1 part of the COMPASS subroutine is called in the following manner:

GENERAL FORM - CALL PFCAT1(LFN,PFN,ID,RD,CN,MR,IC)

EXAMPLE: CALL PFCAT1(5LTAPE1,6LCONFLK,6RCGSCIE,4RBENZ, 5RBROWN,0,0)

where:

LFN,PFN,ID,RD,and MR are identical to PFATT1.

CN = Control password containing highest permission level using *FORTRAN R format.*

IC = Flag for initial or additional cycle to PFN,(IC=0 for additional cycle, IC=1 for initial cycle).

NOTE: PFCAT1 will catalog the LFN as PFN with the next highest cycle number. In the event there are no prior PFN cycles, cycle 1 is used. After cataloging the file, PFCAT1 will return the LFN and PFN to the system.

(c) RETURN - Allows a program to release files back to the system for control. The RETURN part of the COMPASS subroutine is called in this manner:

GENERAL FORM- CALL RETURN(LFN)

EXAMPLE: CALL RETURN (5LTAPE1)

where:

LFN = The logical file name to be returned, using the FORTRAN L format.

(d) PFPRG1 - Allows a program to remove a permanent file from disk storage and release its related local file. This entry points' function is similar to the function of the "PURGE" command in CDC SCOPE. The PFPRG1 part of the COMPASS subroutine is called in the following manner:

GENERAL FORM - CALL PFPRG1(LFN,PFN,ID,CN)

EXAMPLE: CALL PFPRG1(5LTAPE1,6LCONFLK,6RCGSCIE,5RBROWN)

where all parameters are as defined in (a) and (b) above. PFPRG1 is used in CAMMS for the updating of certain permanent files, (i.e.,UNITD, etc.), and is always preceded by the RETURN subroutine. The RETURN is necessary to insure purging is allowed with CN as the password.

(e) REQUEST - Allows a program to seek permanent file storage space on a system assigned mass storage device other than those established as public devices. The REQUEST function is similar to the function of the "REQUEST" command in CDC SCOPE. The REQUEST part of the COMPASS subroutine is called as follows:

GENERAL FORM - CALL REQUEST(LFN)

EXAMPLE: CALL REQUEST (5LTAPE1)

where:

LFN = The logical file name upon which a new file will be written. This LFN can later be cataloged with the PFCAT1 subroutine. If there is already a logical file name identical to that specified, REQUEST will return the existing file and establish the new file.

e. The subroutines and commands discussed here generally allow the user programs to perform the following operations on the CAMMS files:

(1) REQUEST

(2) ATTACH

(3) OPEN

(4) READ/WRITE

(5) CLOSE

(6) RETURN

The OPEN, READ/WRITE, and CLOSE commands are standard FORTRAN IV EXTENDED commands and need no explanation here.

4.1 PROGRAMS

a. Commands: All program execution is controlled by a series of procedure files. These procedure files are made up of the following code:

(1) Get binary deck of the program.

(2) Execute binary program.

Execution of the procedure file takes place by entering the procedure file name preceeded by a dash,(-ARTY).

b. Initialization of data files: Prior to the start of each exercise, the data files must be purged and initialized. In the past this procedure required the running of a complicated series of routines, a mistake in which could have dramatic effect in program outputs. This procedure has been replaced by a single program, -INIT.

NOTE: **Simulated computer outputs are included to facilitate reader** understanding of the functions being described. This procedure will be followed throughout the remainder of this section.

PROGRAM: - INIT

(1) This program is designed to build the UNITD, CONFLK, and REFFILE, and create the CONFLD file.

(2) It then initializes the conflict counter, conflict index, and the exercise start time. The time of day is acquired from the system and stored as a floating point variable (A10),i.e. the hour. minute.second is recorded - Ø00.00.00Ø.

EXAMPLE: (Operator inputs are underlined)

```
-INIT

FILE INITIALIZATIØN PRØGRAM

WHICH EXERCISE IS TØ BE RUN
A. MAP MANEUVER
B. CAI

ENTER LETTER ØF DESIRED ØPTIØN

? A

ENTER PERCENTAGE LEVEL ØF U.S.FØRCES FØR START
ØF PRØBLEM. (NØ DECIMALS I.E. 100)
? 100

ENTER PERCENTAGE LEVEL ØF THREAT FØRCES FØR START
ØF PRØBLEM. (NØ DECIMALS I.E. 100)
? 100

****CREATING UNITD FILE NØW.....WAIT!

TØE LEVEL FØR U.S. FØRCES ESTABLISHED AT 100%.
TØE LEVEL FØR THREAT FØRCES ESTABLISED AT 100%.
INITIALIZATIØN ØF UNITD FILE CØMPLETED.

STØP
```

(3) The program has automatically accomplished the following:

(a) Opens the CONFLK file.

(b) Gets the first record of the file.

(c) Stores the ALPHA representation of the time in the first 10 positions.

(d) Sets the Conflict Index equal to 60 "0"s and stores it as 60I2.

(e) Sets the conflict counter to zero, and stores it in the last two characters of the first record.

(f) Writes the entire record to disc in the appropriate location.

(g) Creates the CONFLD file as an empty record.

(h) Opens the UNITD2 and TYPED files, and gets the first logical record from the UNITD2 file.

(i) Builds the UNITD file. For those fields within the UNITD file that contain percentages, the percentage value is entered. For those fields that contain actual numbers (WEAPON 1 - 7), the percentage is multiplied by the NO. AUTH fields for the weapons fields in the TYPED file and then are written to the UNITD file.

(j) Builds the REFFILE. For each logical record read from the UNITD2 file, the OPCODE and REF NO. with respect to the UNITD file is written into the REFFILE.

(k) If the last logical record has been read from the UNITD2 file, the files are closed. Otherwise, execution continues begining with (h) above.

(4) Since this program requires full and unlimited access to the files, no other program can be executed until it is completed.

(5) If for some reason the -INIT program must be executed while other exercise programs are running, the following steps must be taken:

(a) Stop all exercise programs, by either letting the execution complete normally or by typing STOP; CLEAR.

(b) Execute -FKPURGE.

(c) Run -INIT, and wait for completion.

(d) Restart exercise programs.

c. Exercise Programs: The primary programs used in the MM exercise and CAI classes are as follows:

(1) Battle.

(2) Ambush.

(3) ALOG.

(4) Air.

(5) Fires.

(6) Summary.

A description of each of these programs will be given along with a detailed analysis of how each program executes. The programs Battle and Ambush, are run on one data terminal; whereas ALOG, Air/Fires, and Summary are each run on a separate terminal.

PROGRAM: -BATTLE

(1) This is the main exercise program in which data is entered for all direct fire conflicts. It is divided into four distinct segments, each of which allows data to be entered for the following operations:

(a) Start a conflict.

(b) Add units to an ongoing conflict.

(c) Delete units from conflict or stop a conflict.

(d) Change data within an ongoing conflict.

(2) In order to simplify the explanation of these four segments of the Battle program and the subsequent execution of the specific coding, each segment will be explained seperately with the resultant execution described with sample outputs.

(3) The first segment includes a listing of the program options: (Operator inputs are underlined for clarity)

```
DO YOU DESIRE THE OPTIONS LISTED (Y/N)
? Y

OPTIONS

START - TO INITIATE
ADD - TO ADD UNITS
DEL - TO DROP UNITS OR STOP CONFLICT
CHANGE - FOR CHANGING THE CONFLD FILE
END - TO STOP ENTRY OR PROGRAM

ENTER OPTION

?START

RANGE
?1000

ENTER ATK DATA
? 69316,2,2,M,2
NEXT ATK DATA
? END
ENTER DEF DATA
? 01923,3,3,M,3
NEXT DEF DATA
? END
```

Once the option START was selected the program came back and asked for the RANGE. This range represents the distance between the opposing units at the start of the conflict. This input is used as a cross check with the TYPED file for each weapon to determine the fire power score (FPS). A weapon with a maximum range of 500 meters will not be counted in the FPS if the initial range factor is 1000. When the range has closed to the 500 meter point in the battle, then that weapon will be included in the computations.

The next entry, ENTER ATK DATA, is a one line entry for each seperate unit in the attacking force. The first five digits are the

OPCODE, the next two digits refer to the EXPOSURE/FIELDS OF FIRE, variables. This is followed by the M/D characters which indicate whether the force is mounted or dismounted. This variable is used in computing the attrition rate for the unit. A dismounted unit is far more vulnerable to fire than one with armor protection. The last variable represents the type attack/defense being employed by the force. These codes represent the following:

CODE	TYPE ATTACK	TYPE DEFENSE
1	Meeting Engagement	Delay
2	Hasty Attack	Hasty Defense
3	Deliberate Attack	Prepared Defense

At the end of the attack data the word END is entered. The program will then ask for the defense data in the same manner outlined above.

After all the data has been entered, the program will print all the data at the terminal for verification by the operator.

```
OPTION:  INITIATE A CONFLICT

ATK UNITS
69316    2 2 M            2

DEF UNITS
09123    3 3 M            3

CHANGE ANY DATA (Y/N)
? Y
```

When "Y" for yes is indicated on the CHANGE ANY DATA line, the program will list the change options:

```
OPTIONS
RANGE- CHANGES THE RANGE
CHANGE - CHANGES EXPOSURE/VISIBILITY
ENTER - ADDS UNITS
DELETE - ERASES UNITS
HALT - HALT INITIATION
CONT - NO CHANGES

OPTION
? HALT

ANOTHER PROGRAM OPTION
? N
```

The commands shown will stop the initiation routine and erase the data. If another program were desired then the program would begin the initiation routine again.

If the answer to CHANGE ANY DATA ?, had been "N":

```
CHANGE ANY DATA (Y/N)
? N
```

the program would have gone into the computation of the data and returned the following to the terminal:

```
WAIT

**************************************************

14.54.51

CONFLICT NO.  23

OFF DEG    .70353
DEF DEG  36.34223
  RANGE  1000
  RATE OF MARCH  1098 METERS PER HOUR
  RATIO IS     ATK    DEF
               40      1
  UNITS         6      2
```

```
*******ATK UNITS********          ( Information on the attacking force)

SPOT REPORT

A:  3RD CO 1-11 TK               ( Specific unit for which report is
                                   intended)
B:
EQUIP LOSSES                     ( Equipment losses for the unit )
  NONE
***AMMO***    70%                ( Ammunition status by percent )
***POL ***    69%                ( Fuel status by percent )

PERS LOSSES                      ( Personnel losses )
  NONE
***PERS***    37%                ( Current personnel status )


********DEF UNITS********        ( Information for the defense force )

SPOT REPORT

A:  CO A 2-11 ARMOR CP&TRNS      ( Same as above )

B:
EQUIP LOSSES
 1 M60A1          (C)            ( The "C" indicates a catastrophic loss )
 1 CAL.50         (C)
 1 1/4 TON        (O)            ( The "O" indicates an operational loss )
***AMMO***    90%
***POL ***    79%

PERS LOSSES

KIA   2                          ( KIA = killed in action )
WIA   5                          ( WIA = wounded in action )
***PERS***    49%

**************************
```

The first information returned shows the degredation factor, for both forces, the range and rate of march, the ratio of ATK to DEF, the number of units in the conflict, the number of the conflict in the CONFLD file, and the time of initiation.

A spot report is then printed for each OPCODE which indicates the specific losses and changes to status that effect that unit. This

information is reported to the table control party who in-turn pass it on to the players. The computation information is used by the table control party in controlling the movement of the units on the control map.

(3) Computations: When the OPCODE of the unit is entered in the conflict initiation segment of the BATTLE program, a binary search for that OPCODE is made in the REFFILE. When the OPCODE is found, the reference number is retained. The program then takes the Ref. No. to the UNITD file and gets the particular logical record. If the record is not there, then it will print INVALID OPCODE at the data terminal. If the CONFLICT CODE is not equal to zero, then it will print UNIT ALREADY IN CONFLICT #____, at the terminal. If the OPCODE is present and the CONFLICT CODE is equal to zero, the program will check for correctness of the visibility and fields of fire entries. As the data is entered and verified, it is stored in an array that allows easy access for changes to it later. After all the data has been entered, printed for verification and verified by the operator, the program begins the processing. The program can handle initiation data for 10 ATK and 10 DEF units at one time.

The fire power score (FPS) of each ATK/DEF unit is the computed and totaled for a total FPS for each force. The computation involves the following:

(1) Fire effectiveness of each unit of each force is computed from the Fire Effectiveness matrix.

FIRE EFFECTIVENESS MATRIX

		TYPE DEFENSE 1	2	3
TYPE ATTACK	1	1	2	3
	2	.5	1	.66
	3	.43	.5	.56

(2) The program will enter the type attack and type defense data and determine the fire effectiveness. If the number of attack and defense units are not equal, the following takes place:

(a) If the number of ATK units is greater than the number of DEF units, the fire effectiveness is computed for all ATK and DEF units for the number of DEF units. Then:

- the type of DEF for all DEF units are totaled and averaged.

- the fire effectiveness of the remaining ATK units is computed by the type of ATK of each remaining ATK unit and the average type of defense.

(b) If the number of DEF units is greater than the number of ATK units, the fire effectiveness is computed in the same manner except the average of the types of ATK is utilized for the remaining defense units.

(3) The FPS for both forces is then computed using the following equation:

(NOTE: If the maximum range for a given weapon is less than the range set in the initialization segment, then that weapon is not counted in the FPS. Also, if the ammunition field for any weapon is equal to zero, then the score is not computed for that weapon.)

IF THE MAXIMUM EFFECTIVE RANGE OF THE WEAPON IS GREATER THAN OR EQUAL TO THE RANGE BETWEEN THE ATK AND DEF UNITS,

DO = 1/RANGE + PRECISION (FOUND IN WEAPOND FILE)

FPS = QUAD VAR 1 + QUAD VAR 2*DO + QUAD VAR 3 * DO ** 2

(4) The FPS for each individual weapon is computed as above and then added to the following for the unit FPS:

FPS OF EACH WEAPON * NUMBER OF WEAPONS BY TYPE * THE FIRE EFFECTIVENESS OF THAT UNIT * THE EXPOSURE/VISIBILITY FACTOR = UNIT FPS

(NOTE: The fire effectiveness of DEF is divided into 1.)

(5) The exposure/visibility factor is computed from the VIS/FOF, EXPOSURE matrix below:

VISIBILITY/FIELDS OF FIRE

TARGET EXPOSURE	1	2	3
1	10	25	50
2	25	50	75
3	50	75	100

The value obtained is then divided by 100, before it is input to the

FPS computation equations. As these values are computed, the maximum range for both the ATK and DEF units and the percentage of equipment remaining is saved for later computations.

(6) Following the computation of the UNIT FPS, the degree of degradation is computed as follows:

(a) If the FPS of the ATK and DEF units is equal to zero, then the degradation for both is set at .01 as the weapons cannot engage at this range. The rate of march factor is set at some value between 50 and 2500 meters per hour depending on the movement code for the ATK unit, and the ratio is set at 1:1.

(b) If the FPS for the ATK unit is zero and the FPS for the DEF is greater than zero, the degradation of the ATK unit is set at 50% (the ATK unit has no weapons that can engage the DEF units at this range), the DEF degradation is set at .01%. The rate of march (ROM) is set at some value between 50 and 2500 meters per hour as above, and the ratio is set at 1:50 in favor of the DEF.

(c) If the FPS of the DEF is zero with the ATK at some value greater than zero, (b) above is reversed in favor of the ATK units.

(d) If neither the ATK or DEF FPSs are equal to zero the following computations are made:

DEF DEG = D5/D6 * M1 * H3/H4 * H5/H6

ATK DEG = D6/D5 * M1 * H3/H4 * H5/H6

D5 = ATK UNITS FPS

D6 = DEF UNITS FPS

M1 = 15 (15 minute interval)

E/V FACatk = Exposure/visibility factor for ATK units

E/V FACdef = Exposure/visibility factor for DEF units

MA Matrix = Movement allocation matrix

RF = Rate factor

ROMu = ROM unopposed

ROMo = ROM opposed

ROM = Final computed rate of march

MOVEMENT ALLOCATION MATRIX

TYPE ATTACK	Roads	Cross country	Foot
1	.5	.4	.1
2	0	.5	.5
3	0	.2	.8

COMPUTATIONS:

AVGatk = ($\sum$ Tatki/Natk)

FPR = FPSatk/FPSdef. (if FPR is .LT. 1, the DEF is overpowering the ATK units and the ROM is set to 250 meters per hour).

If MC = 2 (mounted, then unopposed ROM is:

ROMu = 16.670 Km/Hr * MA Matrix(AVGatk,1) + 1.67 Km/Hr * MA Matrix (AVGatk,3) + 8.34 Km/Hr * MA Matrix (AVGatk,2)

RF = FPR-1/FPR

If MC = 1 (dismounted, then unopposed ROM is:

ROMu = 1.67 Km/Hr * MA Matrix (AVGatk,3)

H3/H4 = % of ATK equipment remaining

H5/H6 = % of DEF equipment remaining

RANGE FACTOR ATK = RANGE/MAX EFF RANGE DEF*¢

RANGE FACTOR DEF = RANGE/MAX EFF RANGE DEF*¢

RANGE DEG FAC DEF = EXP(-RANGE FACTOR DEF)

RANGE DEG FAC ATK = EXP(-RANGE FACTOR ATK)

FINAL DEG FAC ATK = 1 - (1-RANGE DEG FAC ATK * .03) ** DEG ATK

FINAL DEG FAC DEF = 1 - (1-RANGE DEG FAC DEF * .03) ** DEG DEF

*¢ Values are limited to greater than .00001 and less than 25.

(7) If either of the degradations is greater than 50%, then they are set at 50%. The ratio of ATK to DEF is computed as follows:

RATIO = FPS ATK/FPS DEF

If RATIO = 1, then ratio is set to 1:1.

If RATIO .GT. 1, then ratio is: Quotient : 1 in favor of ATK.

If RATIO .LT. 1, then ratio is: Quotient : 1 in favor of DEF.

The degradation and ratio formulas were drawn from the EINFALL study as indicated earlier. The ROM formulas that will be discussed next were obtained from the CONAF study and are as follows:

DEFINITIONS:

Tatki = Type of attack for ith attacking unit

FPSatk = FPS for attacking units

FPSdef = FPS for defending units

Natk = number of attacking units in the conflict

MC = DEF movement code, either mounted (2) or dismounted (1).

AVGatk = Average of the types of attacks conducted by ATK units.

FPR = Firepower ratio

ROMo = ROMu * RF * .25.

ROM = ROMo * (E/V Fac ATK + E/V Fac DEF)/2.

DISCUSSION:

The assumptions made in the computations are as follows:

(1) The DEF units are capable of containing the ATK fire power equal to its own.

(2) Any excess of firepower on either side should be allowed to maneuver.

(3) The ROMo factor is considered to be one fourth the ROMu.

The movement allocation matrix was taken from the CONAF study and interpreted as follows:

If the attacking unit is in a meeting engagement, .5 of the movement is assumed to occur at road rate for track vehicles, .4 at the cross-country rates for track vehicles, and .1 at foot rates.

The average rates of movement are defined in the CONAF model as follows:

(1) Foot(dismounted) = 1.67 km/hr.

(2) Tracks(roads - mounted) = 16.67 km/hr.

(3) Tracks(cross-country - mounted) = 8.34 km/hr.

(8) After all the computations above have been made, then the computer program prints all the information obtained. The conflict counter is increased and the conflict index is updated. By using the REFFILE index the logical record for each unit is obtained. The respective degradation factor is applied to the on-hand values by multiplying the % degradation by the on-hand value. The remaining quantities are then written back to the units' logical record and the

losses written to a scratch disk file for later print in SPOT REPORT format at the terminal. The program then builds logical records for each unit to be placed in the conflict file and writes them to the CONFLK file. It then sets the CONFLK file index to show Conflict #__ active and writes the file back. After all the multiple user files are updated and released, the scratch disk file is rewound, read and written to the terminal. At the end of the print state ment the operator has the option of selecting another program option or stopping the execution.

```
ANOTHER PROGRAM OPTION (Y/N)

?  Y

ENTER OPTION
?  ADD
```

Since the ADD option was selected, the operator has indicated that additonal units are to be included in an ongoing conflict. The program will then asks for the data:

```
CONFLICT NO.
?  14
ENTER ATK DATA
? 69316,2,2,M,3
NEXT ATK DATA
? END
ENTER DEF DATA
? END
OPTION: ADD THE FOLLOWING UNITS TO CONFLICT 14
ATK OPCODE

69136      2  2       M       3
CONTINUE (Y/N)
?  Y
WAIT

UNIT 69136 ADDED TO CONFLICT 14
ADD MORE UNITS (Y/N)
?  N
```

Once all the data is entered, the program first searches the conflict index to determine if the conflict no. entered by the operator is actually an active conflict. If it is not, the program will respond accordingly and ask again. The ATK data is then requested, followed by the DEF data. Either of these can be terminated by entering END in reply to the question. Once processing begins, the program executes the following:

(1) Read conflict file - search for conflict #.

(2) If EOF - GO TO 9.

(3) If conflict # read .EQ. # requested, GO TO 6.

(4) Write record to scratch disc file.

(5) GO TO 1.

(6) Write record to scratch disc file.

(7) Write new records.

(8) Read all file, If EOF, write all files to scratch.

(9) Execution completed

(10) Purge old file, catalog new file.

The processing of the ADD request is now complete. The program will now ask for another option. If no more units are to be added to an ongoing conflict, or the operator does not desire another option, the control is then returned to the program.

To continue the discussion, it is assumed that an additional option is desired by the operator. In this case we will investigate the functions of the DEL (delete) option. Again, the program has asked if another option is desired. The response will be "Y" followed by the option desired, in this case "DEL".

```
ANOTHER PROGRAM OPTION (Y/N)
? Y

ENTER OPTION
? DEL
```

By selecting the DEL option the operator can now drop units from an ongoing conflict, or stop the entire conflict if desired.

```
CONFLICT NO.
? 14
ONE, MANY OR ALL UNITS TO BE DELETED /O,M,A/
? ALL
UNIT TO BE DELETED OR /ALL/
? ALL
OPTION: TERMINATE CONFLICT 14
CONTINUE (Y/N)
? Y
WAIT

CONFLICT 13 STOPPED
ANOTHER CONFLICT TO STOP OR UNIT TO DELETE (Y/N)
? N
```

Had the operator wished to delete a single unit from the conflict, the OPCODE of the unit to be dropped would have been entered in place of the ALL statements.

```
ANOTHER PROGRAM OPTION (Y/N)
? N
```

As was the case in the ADD option, when the data is entered the program conducts a search of the conflict index and the REFFILE to access the particular logical record in the UNITD file. The same responses are printed at the terminal if the conflict no. or OPCODE is not found.

If the operator elects to drop one ATK unit and the number of ATK units .EQ. 1, the program prints a message at the terminal informing the operator that this unit can not be deleted unless the entire conflict

is stopped. The operator is then given the option of stopping the entire conflict or stopping the request for deletion of the unit. The same procedure is used if the number of DEF units is .EQ. to 1.

If the number of ATK or DEF units is greater than one then a search of the CONFLD file is conducted for the record. When it is found, the reference number is saved and that data field in the conflict logical record is set to zero. Then, using the reference no., the record for that OPCODE is obtained in the UNITD file and the conflict code field is changed to zero. Control then passes to the program.

If the operator wishes to stop a conflict the command ALL is entered as shown. The procedures outlined above are accomplished for all OPCODES having the same conflict code field identifier as requested by the operator. Once all the units have been deleted then control passes to the program.

```
ANTOTHER PROGRAM OPTION (Y/N)
? Y

ENTER OPTION
? CHANGE
```

The operator has indicated the desire to change some of the data fields of the CONFLD file for an ongoing conflict. This option is somewhat more complicated than the others and can be best explained in the coding format used earlier in the ADD option.

(1) Enter Conflict #.

(2) If conflict active- GO TO 5.

(3) Print conflict not active at the terminal.

(4) GO TO 32

(5) Request change for one or many units (O/M)

(6) If change for one - GO TO 8

(7) If change for many units - GO TO 38

(8) ENTER OPCODE

(9) If OPCODE = END - GO TO 35

(10) Check if OPCODE is valid

(11) Check if OPCODE is in conflict # requested

(12) If Invalid OPCODE - PRINT ERROR - GO TO 8

(13) If unit not in specified conflict -PRINT ERROR-GO TO 8

(14) Enter whether ATK or DEF unit

(15) Enter field to change (E/V,TY,MO,UT)

E/V = Exposure/Visibility

TY = Type ATK or DEF

MO = movement code

UT = Update time

(16) Make change in data

(17) Write changed record to scratch file

(18) Rewind scratch file

(19) Read OLD CONFLD file

(20) If EOF (CONFLD) GO TO 32

(21) If conflict # (from file) .GT. conflict # entered

GO TO 26

(22) Read from scratch file

(23) If EOF (scratch) - GO TO 26

(24) If OPCODE from file .EQ. OPCODE entered - GO TO 29

(25) GO TO 22

(26) Write record from OLD CONFLD file to NEW CONFLD file

(27) Rewind scratch file

(28) GO TO 19

(29) Write new record to NEW CONFLD

(30) Rewind scratch file

(31) GO TO 19

(32) Place EOF mark on NEW CONFLD file

(33) Catalog NEW CONFLD file

(34) Purge OLD CONFLD file

(35) Enter more data to change

(36) If more data to change - GO TO 1

(37) TERMINATE

(38) Enter if ATK/DEF/BOTH

(39) Enter field to change

(40) Make change in data

(41) Write changed record to scratch file

(42) Read CONFLD file

(43) If EOF (CONFLD) - GO TO 19

(44) If conflict # in file .EQ. conflict # entered and the type unit .EQ. (A,D,or BOTH) - GO TO 46

(45) GO TO 42

(46) Enter data to change

(47) Write record to scratch

(48) GO TO 42

(49) Rewind scratch, CONFLD

(50) GO TO 19

This completes the sequential discussion of the BATTLE program. This being the largest and most complicated program, the discussion was somewhat more detailed than will be required for the remaining programs.

PROGRAM: AMBUSH

The basic theory behind the AMBUSH program is driven by the requirements of the Active Defense concept. This concept bases its planned success on the premise that the defending force will have some freedom of movement on the battlefield, and will engage the enemy in very short but violent engagements. These engagements will hopefully take the enemy force by surprise and allow the defender to escape before effective return fires can be employed. Artillery fires for both suppression and target destruction will be coordinated in advance to facilitate the maximum target effect.

Processing the data in this program is similar to the procedures used to verify and process data in the other direct and indirect fire programs. Particular coding differences will be described, those sections using coding from other programs will be referenced to the program concerned.

Once initiated, the program asks for the engagement length. The length can be from 1 - 45 seconds. The next entry is whether or not DEF smoke was fired. If it was, the operator must enter the OPCODE for the artillery unit that fired the smoke mission, e.g. 01330 and the number volleys fired. This is done just as it would be in the FIRES program. Once the firing unit and volleys fired are entered the degradation is computed and compared to the fixed values.

IF DEG (degradation) .GT. .1 -PRINT SMOKE EFFECTIVE

IF DEG .GT. .075 - PRINT SMOKE PARTIALLY EFFECTIVE

ELSE - PRINT SMOKE INEFFECTIVE

The operator then inputs the ATK OPCODEs with their respective E/V coefficients. Each OPCODE is checked for validity and conflict status as described in the BATTLE program. If the OPCODE is valid and not in conflict, the system will ask for the next ATK OPCODE. If not an ERROR message is printed and the operator is given the option of reentering the OPCODE or stopping the processing.

Once all the ATK data has been entered, the program will ask for the DEF unit's OPCODES, RANGE, E/V. Again the checks of the data are made for all DEF OPCODES. After the DEF data has been entered and verified, the program asks if WITHDRAWAL ARTY FIRES PLANNED (Y/N). If "Y" then the firing unit OPCODE and no. of volleys is input. The computation for the DEG in this case is the same as in the FIRES program which will be described later.

Following the last FIRES computation, the system totals the RANGES for the DEF units and averages them to be used in the computation of the FPS. If smoke was used and was effective, the FPS of only 2/3 of the ATK units is figured. Then the DEF FPS is figured just as done in the BATTLE program. Once all the FPS values have been computed, the attrition for ATK and DEF is computed. Each attrition value is then multiplied by the coefficient drawn from the FIRE EFFECTIVENESS MATRIX to weight the attrition for ATK and DEF depending on the two varibles SMOKE and WITHDRAWL ARTY FIRES. These values also account for the element of surprise.

FIRE EFFECTIVENESS MATRIX - ATTACK

		SMOKE		
WITHDRAWL		EFFECTIVE	PART EFFECTIVE	NOT EFFECTIVE
ARTY	YES	12.5	20	50
FIRES	NO	35	45	100

FIRE EFFECTIVENESS MATRIX - DEFENSE

		SMOKE		
WITHDRAWL		EFFECTIVE	PART EFFECTIVE	NOT EFFECTIVE
ARTY	YES	150	135	125
FIRES	No	80	65	40

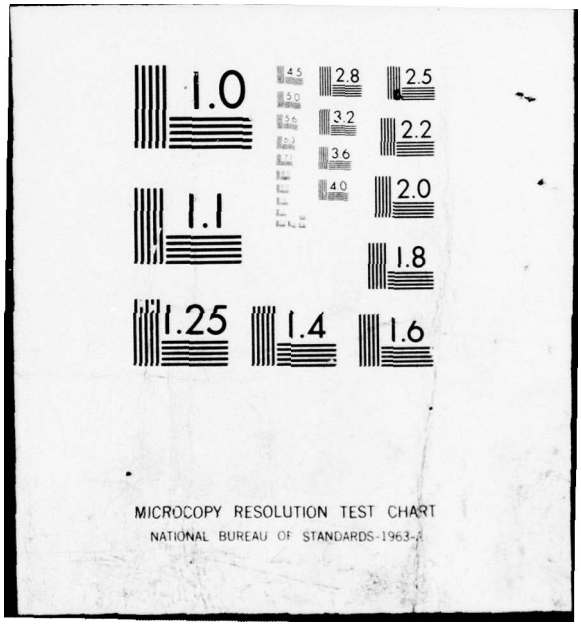
Once the final attrition is figured, SPOT REPORTS for each ATK and DEF unit are printed at the terminal. Losses for the individual units are computed as described in the BATTLE program and recorded in the UNITD file. However, if SMOKE was effective or partially effective, the attrition for the ATK is only applied to the first 2/3 of the ATK units in the order they are entered. The remaining 1/3 will receive none of the direct fire attrition. After the direct fire SPOT REPORTS have been printed, the reports for the WITHDRAWL ARTY FIRES are sent to the terminal. Attrition here is computed as described for the DEG computations in the FIRES program. The following sample printout is provided for reference:

AD-A051 258 LOUISVILLE UNIV KY DEPT OF INDUSTRIAL ENGINEERING F/G 15/7
COMPUTER ASSISTED MAP MANEUVER SYSTEM (CAMMS). A COMBINED ARMS --ETC(U)
APR 77 E L CHILDS

UNCLASSIFIED NL

2 OF 2
AD A051 258

END
DATE FILMED
4-78
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
AMBUSH PROGRAM


ENGAGEMENT LENGTH
? 40

DEF SMOKE PLANNED (Y/N)
? Y
ENTER SMOKE FIRING UNIT (S)
FIRING UNIT (S)
? 158

NO. VOLLEYS
? 4

15810    RNDS REMAINING:  141
15820    RNDS REMAINING:  141
15830    RNDS REMAINING:  141

ENTER ATK DATA

 ENTER OPCODE
? 69706
EXP COEFF
? 2
VIS COEFF
? 1
 NEXT ATK OPCODE
? END


ENTER DEF DATA

 ENTER OPCODE
? 01821
ENTER RANGE
? 800
EXP COEFF
? 3
VIS COEFF
? 1
NEXT DEF OPCODE
? END

AMBUSH DATA

LENGTH:  40 SEC

***ATK DATA***

UNIT     EXP     VIS

69706    2        1
```

```
***DEF DATA***

UNIT     EXP     VIS     RANGE

08121     3       1       800


CHANGE ANY DATA (Y/N)
? N

DEF WITHDRAWL ARTY FIRES PLANNED (Y/N)
? Y

FIRING UNIT(S)
? 158

NO. OF VOLLEYS
? 6

15810    RNDS REMAINING:  135
15820    RNDS REMAINING:  135
15830    RNDS REMAINING:  135

RESULTS OF AMBUSH          12.39.40

DEF SMOKE EFFECTIVE

DIRECT FIRE LOSSES FOR ATK UNITS

FOR UNIT:  2ND RECON SECT 11TK 18 MRD


EQUIP LOSSES

   1  PT-76       (C)
   1 BRDM-2       (C)
   1 SAGGER       (C)
   1 URAL-375     (O)
   1 PKS 7.62 MG (C)
***AMMO***   80%
***POL ***   82%

PERS LOSSES
   2 KIA
   5WIA
***PERS***   63%

DIRECT FIRE LOSSES FOR DEF UNITS

FOR UNIT:  1ST PLT B/2-10 AR

EQUIP LOSSES
NONE
```

```
***AMMO***    85%
***POL ***    82%

PERS LOSSES
NONE
***PERS***    85%

WITHDRAWL ARTY FIRES PLANNED

ATK LOSSES TO WITHDRAWL ARTY FIRES

FOR UNIT:  2ND RECON SECT 11 TK 18 MRD

EQUIP LOSSES
NONE
***AMMO***    80%
***POL ***    82%

PERS LOSSES
  1 WIA
***PERS***    62%

ANOTHER AMBUSH (Y/N)
? N
```

This concludes the operation of the AMBUSH program. Discussion of the remaining programs will parallel that presented here. The next program to be presented is the ALOG or administrative/logistical program.

PROGRAM: ALOG

The purpose of the ALOG program is to allow the play of the administration and logistics problems associated with the maneuver of forces on the ground. These functions are implemented by providing the service support officer with requested updates of all the units and the opportunity to resupply those units. To simplify the explanation of the ALOG program the options will be discussed seperately as done in the other programs. The first option is UPDATE.

Upon entering this option, the program will ask for the OPCODE

of the unit to be updated or resupplied. At this point the operator enters either a 3, 4, or 5 digit code for the unit. A 3 digit code is used to indicate a battalion size unit, the 4 digit code is used for the company, and a 5 digit code for the platoon or section. A binary search of the REFFILE is made to locate the reference number of the unit in the UNITD file. The same checks for validity are made as was discussed in the other programs. When the checks are complete the program prints out the current status of all fields for that unit. The program then asks if another option is desired.

To conduct a resupply of a unit, the operator selects the RESUPPLY option with input "R" when the program asked for the desired option. If the 5 digit OPCODE is entered, then resupply of WPN, PERS, AMMO, and POL is allowed. The operator may elect to resupply only the AMMO and POL fields. If the "R" option is selected the operator is required to enter the number of weapons(WPN)to be resupplied for each field, with each number separated by a comma:

5,3,2,0,0,0,0

The system will decode the input and list it at the terminal for the operator's verification.

The program will then ask for the % of AMMO and POL to be resupplied. The operator enters the values again separated by commas:

50,30

After all the data required is input, the program will ADD/SUBTRACT the appropriate values entered from the UNITD file fields and will automatically print an update for that unit.

If the operator needs to resupply only the AMMO and POL fields, then the option "RAP" is used.

After the 5 digit OPCODE is entered the "RAP" command will signal the program that only the AMMO and POL fields are to be changed. The operator then inputs the % of POL and AMMO as explained previously. No automatic update is provided with this option. If the operator had input a 3 or 4 digit OPCODE, the AMMO and POL for the entire numbered unit and its subordinate units would receive the resupply. The print out below shows an UPDATE option:

```
-ALOG

RESUPPLY/UPDATE PROGRAM

UNIT OPCODE
? 15211

INPUT OPTION
? U

UNIT:  15211   1-E/2-201 ACR

WPNS
   1   M551
   1   M113A1
   1   CAL.50
   1   7.62 MM
   2   M-16

AMMO
23  0  800  2400  272  0  0

POL
 142  108  0  0  0  0  0

PERS
  5

UNIT OPCODE
? END
```

PROGRAM: AIR

The purpose of this program is to introduce the effects of air power as they effect the ground maneuver.

In response to the INPUT AIR MISSION ?, the operator makes a one line entry for the data. The first entry is the target CPCODE. This is either the 5 digit code or the characters "PT" which are used to indicate a point type target. If "PT" is used only type 5 and 7 targets can be entered, as the next digit. The presence or absence of air defense artillery in the target area is indicated by a "Y or N" entry. The next two digits indicate the type of ordnance being carried on the aircraft. Two types are allowed on each Air Mission. The last two digits indicate the number of aircraft to strike the target and the number of passes each aircraft will make over the target. If ADA is "N" then a maximum of 4 passes can be made. If ADA is "Y" then only 2 passes can be made per aircraft. The entries look like this:

```
INPUT AIR MISSION

?68226,1,Y,7,6,4,2
INPUT WAS  68226   1   Y   7   6   4   2

VERIFY (Y/N)
?Y
```

The standard verification checks of the OPCODE and data are made in this program as was described earlier. Once the logical records for the target unit are obtained the degradation DEG is computed using the matrices below:

AIRCRAFT PASS EFFECTIVENESS

	PASS NUMBER			
VALUE	1	2	3	4
OBTAINED	.5	.3	.2	.1

ORDNANCE EFFECTIVENESS MATRIX

ADA = Y

		1 BOMBS 500/750	2 ROCKETS 2.75/5"	3 20-mm API/HE	4 NAPALM All	5 CBU-24 AP	6 CBU-20 Rockeye	7 MAVERICK AGM-65	8 SMART LGM
TANKS	1	6.4	5.1	X	25	12.9	X	73.8	82.7
ACP/M551	2	11.2	9.1	X	45	20.7	X	73.8	82.7
ARTILLERY	3	4.8	4.0	X	65	20.7	X	73.8	82.7
CBT TNS	4	4.8	12.3	34.0	45	20.7	X	X	X
BRIDGE (AVLB)	5	11.2	X	X	X	X	X	73.8	82.7
FIELD TNS	6	2.4	22.3	68.0	75	X	55.7	X	X
BRIDGE (PONTOON)	7	9.6	X	X	X	X	X	73.8	82.7
ASSEMBLY AREA	8	2.4	12.3	33.2	75	X	55.7	X	X
TROOPS	9	2.4	6.0	68.0	75	X	55.7	X	X
CLOSE AIR	10	6.4	29	80	75	X	X	X	X

ORDNANCE EFFECTIVENESS MATRIX

ADA = N

		1 BOMBS 500/750	2 ROCKETS 2.75/5"	3 20-mm API/HE	4 NAPALM All	5 CBU-24 AP	6 CUB-20 Rockeye	7 MAVERICK AGM-65	8 SMART LGM
TANKS	1	8	7	X	30	16	X	84	95
APC/M551	2	12	11	X	50	24	X	84	95
ARTILLERY	3	6	6	X	75	24	X	84	95
CBT TNS	4	6	14	36	50	24	X	X	X
BRIDGE (AVLB)	5	12	X	X	X	X	X	84	95
FIELD TNS	6	4	14	73	80	X	64	X	X
BRIDGE (PONTOON)	7	11	X	X	X	X	X	84	95
ASSEMBLY AREA	8	4	14	36	80	X	64	X	X
TROOPS	9	4	8	68	80	X	64	X	X
CLOSE AIR	10	8	32	92	80	X	X	X	X

The effectiveness of a particular type of ordnance is obtained by entering the appropriate matrix (ADA + Y or N) with the type of target and the type ordnance. As 2 types of ordnance can be carried, 2 values can result. From the matrices, the results should be:

EFF 1 * (TGT TYPE, ORD 1)

EFF 2 = (TGT TYPE, ORD2)

These values are then used in the following computation:

For i = 1 to Number of passes

DEG 1 = No. of Aircraft sorties * EFF i * Pass effectiveness for ith pass

If two types of delivered ordnance are used, then the following value is added to the DEG 1 computed above.

DEG 2 = No. sorties * EFF 2 * Pass eff. for ith pass

The values for DEG 1 and DEG 2 are added together to obtain the final DEG factor. If the final DEG is .GT. 50% then it is set at 50%.

After the computations are complete and the final DEG factor obtained, it is applied to all the on-hand fields of the UNITD file for the unit under attack. These losses are then reported at the terminal for subsequent transmittal to the players.

If a point type target were being attacked, then the system would report either TARGET NOT DESTROYED, TARGET PARTIALLY DESTROYED, or TARGET TOTALLY DESTROYED, based on the following:

DEG .LT. 16% - TARGET NOT DESTROYED
DEG .GT. 16% & .LT. 33% - TARGET PARTIALLY DESTROYED
DEG .GT. 33% - TARGET TOTALLY DESTROYED

The following printout is provided for reference:

```
AIR STRIKE PROGRAM

INPUT AIR MISSION
? 67126,1,Y,6,0,2,2
INPUT WAS  67126,1,Y,6,0,2,2

VERIFY
? Y

AIRCRAFT HIT ON INGRESS
AIRCRAFT RETURNED TO BASE


AIR STRIKE MISSION   13.23.20.

TGT IS:  2ND CO 1-20 MRR

PERSONNEL LOSSES
KIA  1
WIA  3

EQUIPMENT LOSSES
        1  BMP            (O)
        1  SAGGER         (O)
        1  PKS 7.62 MG    (C)

ANOTHER AIR MISSION
? Y
```

A random seed is used to compute the damage done to aircraft as they attack the target area based on the answer to the ADA (Y/N) question and a set parameter for the mission being flown. A blank before the mission results printout will indicate no damage. If damage was s suffered, the following would be printed:

```
AIRCRAFT HIT ON INGRESS
AIRCRAFT DESTROYED
```

```
                        AIRCRAFT HIT ON INGRESS
                        AIRCRAFT RETURNED TO BASE
```

```
                                    AIRCRAFT HIT ON EGRESS
                                    AIRCRAFT DESTROYED
```

```
AIRCRAFT HIT ON EGRESS
AIRCRAFT RETURNED TO BASE
```

AIRCRAFT HIT ON EGRESS
ORDNANCE DROPPED ON TARGET

AIRCRAFT HIT ON EGRESS
PILOT EJECTED PARACHUTE OPENED

These various possibilities are intended to create planning of possible rescue operations for the downed pilots, and to give the player a feel of real aircraft vulnerability to the effects of ADA.

This concludes the discussion of the AIR program. The next to receive attention is the FIRES or artillery/mortar program.

PROGRAM: FIRES

All indirect fire effects are computed within this program. The verification checks and file search described earlier is made here once the initiation of the fire request is made. After the print statement INPUT FIRE MISSION, the operator must input the one line data entry. The TGT OPCODE is first, followed by the OPCODE for the firing unit(s), followed by the no. of volleys to be fired, M or D for target mounted or dismounted, finally the TGT activity code. The program will print the input back for verification, and then report the number of rounds remaining in the firing artillery/mortar unit. It would look like this:

```
INPUT FIRE MISSION
?69236,013,3,M,1
INPUT WAS:  69236   013   3   M   1
VERIFY (Y/N)
? Y

      01310  RNDS REMAINING : 105
      01320  RNDS REMAINING : 107
      01330  RNDS REMAINING :  96
```

If a 3 digit entry is made for the firing unit, the entire battalion of artillery will fire, if a 4 digit OPCODE is used, only the battery selected will fire. The 5 digit number is used for the mortar platoons organic to the maneuver units. If an OPCODE other than a mortar or artillery unit is entered as the firing unit, an error will result and the appropriate message sent to the terminal.

The following matrices are used to compute some of the values used in the DEG computations:

VOLLEY EFFECTIVENESS MATRIX

	VOLLEY NUMBER					
VALUE OBTAINED	1	2	3	4	5	6
	.8	.4	.5	.6	.7	.8

TARGET MOBILITY/ACTIVITY CODE MATRIX

	Attacking	Defending	Assembly Area
MOUNTED	1.5	1.2	1.3
DISMOUNTED	1	.8	1.2

Utilizing the outputs from the above matrices and the FPS of the main weapons of each unit, the following computations are made:

ENTER TGT MOB/ACT CODE MATRIX WITH (M/D,ATK/DEF,AA)

TO GET EFF 1.

COMPUTE FPS OF MAIN WEAPON (WEAPON 1) AS DESCRIBED IN BATTLE PROGRAM.

FOR i = 1 to No. of volleys

DEG 1 = EFFECTIVENESS OF VOLLEY i * FPS

DEG 2 = DEG 1 /2 * EFF 1

If DEG 2 is .GT. 50%, then it is set at 50%. The final DEG is obtained

by multiplying DEG 2 by a random number obtained from the system. The final DEG is applied to the on-hand fields of the UNITD logical record for the target unit, and the losses are printed to the terminal. The operator is then free to input another fire mission or stop the execution by entering END. Suppressive fires for both mortars and artillery can be fired by entering SUP in place of the TGT OPCODE. The OPCODE of the firing unit is input as described and the RNDS REMAINING is reported. The DEG is then computed as follows:

If DEG = .LT. 25% - SUPPRESSION INEFFECTIVE

If DEG = .GT. 25% - SUPPRESSION EFFECTIVE

The following simulated printouts are supplied for reference:

```
INPUT FIRE MISSION
? 02164,67606,6,M,2
INPUT WAS : 02164  67606   6  M  2
VERIFY (Y/N)
? Y

          67606              RNDS REMAINING : 958

ARTY FIRE MISSION  11.56.07.


TGT IS : 4TH AT SECT CSC 2-91

PERSONNEL LOSSES
WIA  1

EQUIPMENT LOSSES
          1  TOW            (C)
          1  M113A1         (C)
          1  CAL.50         (O)
          1  M16            (C)
```

```
INPUT FIRE MISSION
? SUP,01310,6,M,2
INPUT WAS :  SUP  01310  6  M  2
VERIFY (Y/N)
? Y

          01310              RNDS REMAINING : 198

ARTY FIRE MISSION      13.45.08.

SUPPRESSION EFFECTIVE

ANOTHER FIRE MISSION (Y/N)
? N
```

This concludes the discussion of the FIRES program. The last program to be discussed in this text will be the SUMMARY program.

PROGRAM: SUMMARY

This program gives periodic updates on all on-going conflicts throughout the exercise. Once initiated, the program is automatic unless the operator wishes to ask for an update of a specific conflict. To execute properly, the program should not be initiated until at least 15 minutes has elapsed since the first conflict was entered. The program executes by searching the conflict index of the CONFLD file for the first active conflict or specified conflict no. After the appropriate conflict is found, a search of the CONFLD file is conducted. All logical records with that conflict no. are obtained and the data therein is broken down and stored in arrays within the program. When the last logical record has been found, the computations begin. The last update time is noted from the logical record for the unit in conflict. If the difference between the present system time and the last update time is .LT. 15 minutes, the program will send a message to the terminal to the

effect: "INSUFFICIENT TIME HAS ELAPSED FOR UPDATE OF CONFLICT#___"
It will then look for the next active conflict. If the time difference is .GT. 15 minutes, the program then computes the new range between the ATK and DEF units by multiplying the the elapsed time by the ROM which is stored in the conflict logical record. The distance is then subtracted from the last range figure. If the resulting range is .LT. 200 meters, the terminal will inform the operator that the conflict is being stopped by the system. Warning messages are also provided if the percentages on hand for POL, AMMO, or PERS is 20% or less. These warning messages are printed as part of the SPOT REPORTS of that particular unit. If the range is .LT. 200 meters the defensive unit is said to have been overrun, and all on-hand values for all fields are captured by the ATK unit. The conflict is terminated in the same manner as the DELETE option of the BATTLE program. After all the updates have been completed and the SPOT REPORTS printed to the terminal the program computes the POL attrition.

In the POL attrition section of the program, the last UPDATE time is taken from the first logical record of the CONFLD file and compared with the present time. If 1 or more hours has passed since the last POL update, then the system will deduct 8% for the POL fields for all units in the UNITD file. The new update time is then recorded and the program sleeps until the next update is scheduled. If the last POL update was performed less than an hour before, then the program will respond " INSUFFICIENT TIME HAS ELAPSED FOR POL UPDATE. TERMINAL NOW AWAITING SUFFICIENT TIME TO ELAPSE".

The following simulated printouts are provided for information and to aid in understanding this program:

```
SUMMARY PROGRAM


SUMMARY FOR A SPECIFIC CONFLICT /S/ OR ALL CONFLICTS /A/
? S

CONFLICT NO.
? 1

SUMMARY OF CONFLICT NO. 1

OFF DEG      .00802
DEF DEG    72.68446
RANGE  393
RATIO IS       ATK       DEF
               223         1
NO. UNITS        3         1
RATE OF MARCH 1868 METERS PER HOUR
**********************************
****SPOT REPORT FOR ATK UNITS******


SPOT REPORT
A:  1st CO 3-24 MRR

B:
EQUIP LOSSES
NONE

***AMMO***    80%
***POL ***    90%

PERSO LOSSES
NONE

***PERS***    90%

****SPOT REPORT FOR DEF UNITS*****


SPOT REPORT
A:  1ST SCT SECT CSC 2-11 AR

B:
EQUIP LOSSES
    1 M16              (C)
***AMMO***    80%
```

```
SUMMARY PROGRAM

SUMMARY FOR A SPECIFIC CONFLICT /S/ OR ALL CONFLICTS /A/
? A

INSUFFICIENT TIME HAS ELAPSED TO OBTAIN A SUMMARY OF CONFLICT # 1

INSUFFICIENT TIME HAS ELAPSED TO OBTAIN A SUMMARY OF CONFLICT # 15

TERMINAL NOW CHECKING FOR ELAPSED TIME FOR POL ATTRITION
UNITS NOW BEING DEGRADED FOR POL
LAST POL UPDATE  1325 HOURS

. . . . . .

. . . . . .

. . . . . .
.
. . . . . .

. . . . . .POL ATTRITION NOW COMPLETE
NEW POL UPDATE TIME IS 1436 HOURS

TERMINAL NOW AWAITING SUFFICIENT TIME FOR NEXT UPDATE
```

This completes the discussion of the SUMMARY program. More detail may be obtained by study of the specific coding of the programs outlined here.

What has been presented in this thesis is the current version of the CAMMS programs and supporting instructions being used at the U.S. Army Armor School, Fort Knox, KY. This is a dynamic project which is constantly being improved and upgraded as better information becomes available. The interested reader should contact the Project Officer CAMMS, Command and Staff Department, USSARMS, Fort Knox, KY 40121, to obtain the latest information.

CHAPTER V

CONCLUSIONS

It should be noted that the work specifically done by the author included the conceptualization of the system, design of the physical facilities, the communications links, development of the wargame scenarios, research and development of the input data for the system files, and management of the overall system development. Computer applications were developed to the specifications outlined by the author, and programmed by LT Herarra, LT Rogers, and CPT Cross. The importance of the work done by these officers can not be over emphasized. CAMMS could not operate at the speed or the capacity that it does without the computer.

Cost effectiveness is always a major concern when a new project is propossed. In this case, it was couched in terms of manspaces saved. The initial version provided for an overhead of three students per instructor/controller. Later revisions and improvement in control techniques cut this to five to one for an overall savings of 60 mandays per exercise. In terms of dollar costs, a difficult matter in this context, the exercise of a single battalion staff in the conventional CPX, is estimated to cost $60,000. CAMMS can exercise 10 battalions and two brigade headquarters elements for just under $800. If these figures seem skewed towards the CAMMS exercise, it should be noted that CAMMS is set in a sterile classroom environment,

while the CPX is done in the field. The value of the field type training can not be measured in this paper, but are of some real benefit. The question being addressed here is the dollar effectiveness of the training being presented. If the field CPX were supported by the CAMMS programs, the cost of the computer would have to be added to the costs of the exercise.

The conventional CPX relies on the ability of the control staff to generate "canned" messages and requirements to keep the exercise alive. The emphasis is on the planning and preparation for the mission rather than the execution of the plans and orders generated by the player. CAMMS places the emphasis on the actual execution of the orders prepared, and allows the player to change his scheme of maneuver if necessary. It also allows the director of the exercise to stop the play, roll back the clock and restart the exercise if he feels the training value is being lost by some error made in either the control or player response. It would be all but impossible to quantify these aspects. However, the participant response to this exercise has been overwhelmingly favorable. Player comments repeatedly indicate the need for more exposure to this type of execution oriented practice in all their tactical exercises.

The Army has recognized the value of this type of application and has made it a major part of the new training developments being studied and fielded. CAMMS may eventually evolve into a multi-kinetic system serving several types of exercises from locations all over the globe. If current plans are carried out the system will soon be available to Army units throughout the United States, Europe and

Korea. The Venezuelian government has already installed a version of the system in their Armed Forces Staff College, at Caracas.

The major innovative approach introduced by CAMMS is the "free play" execution aspect which is not found in the conventional CPX or MM. At the present there are no studies that will show specifically that this aspect is more important than the planning and preparation phase. However, it is the opinion of the author that a good plan poorly executed is no better than no plan at all. Our future combat leaders must be able to think on their feet if we are to survive in the next war. CAMMS provides a vehicle forcing the player to think, react and command. How do we place a price tag on survival? We can not.

APPENDIX 1

SAMPLE COMPUTER INPUT FORMS

MAP MANEUVER
QUICK ENGAGEMENT
40 ENGAGEMENT LENGTH (0-45 sec)

15 H L

(Y) N Defense Smoke Planned (Y/N) (Y) N Defense Withdrawal Arty Planned

IF YES .... IF YES ....

159 FIRING UNIT 159 FIRING UNIT

1 2 (3) 4 5 6 NUMBER OF VOLLEYS (1-6) 1 2 3 4 5 (6) NUMBER OF VOLLEYS (1-6)

ATTACK OPCODE	EXPOSURE	VISIBILITY
67236	1 (2) 3	1 (2) 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3
	1 2 3	1 2 3

DEFENSE OPCODE	RANGE (1-3000)	EXPOSURE	VISIBILITY
02112	600	1 2 (3)	1 2 (3)
		1 2 3	1 2 3
		1 2 3	1 2 3
		1 2 3	1 2 3
		1 2 3	1 2 3
		1 2 3	1 2 3
		1 2 3	1 2 3
		1 2 3	1 2 3
		1 2 3	1 2 3

AMBUSH INITIATION FORM

BRIGADE MAP MANEUVER
ADD UNIT(S) TO BATTLE

Must be in Battle Program

Reef

ADD — Option?

17 — Conflict Number?

69136 — Unit(s) OPCODE?

2/2

A — Atk or Def Unit (A/D)?

M — Mounted or Dismounted (M/D)?

3 — Type of Attack (1/3)/Defense (1-3)

1. Meeting Engagement	1. Delay
2. Hasty Attack	2. Hasty Defense
3. Deliberate Attack	3. Prepared Defense

BRIGADE MAP MANEUVER
DELETE UNIT(S) FROM BATTLE/STOP CONFLICT

Must be in Battle Program

DELETE — Option?

8 — Conflict Number?

Unit(s) to be Deleted (unit OPCODE)

* * * * * * *

All — Stop Entire Conflict? (All)

START BATTLE FORM FOR MAIN PROGRAM

START OPTION 1 1

800 RANGE (MAX 3,000)

ATTACK UNITS

OPCODE (5 digits)	69116	69126				
EXPOSURE (1-3)	1 (2) 3	1 (2) 3	1 2 3	1 2 3	1 2 3	1 2 3
VISIBILITY (1-3)	1 (2) 3	1 (2) 3	1 2 3	1 2 3	1 2 3	1 2 3
MOUNTED/DISMOUNTED (M/D)	(M) D	(M) D	M D	M D	M D	M D
TYPE ATK (1-3)	1 2 (3)	1 2 (3)	1 2 3	1 2 3	1 2 3	1 2 3

1. Meeting Engagement
2. Hasty Attack
3. Deliberate Attack

DEFENSE UNITS

OPCODE (5 digits)	01912					
EXPOSURE (1-3)	1 (2) 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
VISIBILITY (1-3)	1 (2) 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
MOUNTED/DISMOUNTED (M/D)	(M) D	M D	M D	M D	M D	M D
TYPE DEF (1-3)	1 (2) 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

1. Delay
2. Hasty Defense
3. Prepared Defense

ARTILLERY FIRE REQUEST

ENTER

OPS CODE OF TGT _____

FIRING UNIT OPS CODE _____
OP CODE DIGITS:
3 = Bn to fire
4 = Btry to fire
5 = Plt to fire

NUMBER OF VOLLEYS _____

TGT MOUNTED OR DISMOUNTED _____

TGT ACTIVITY CODE _____
1 = Attacking
2 = Defending/Delaying
3 = Assemble Area

RECEIVE

AMMUNITION STATUS: _____ Rds remaining.

ATSB 1 FORM Mar 75 3705

ARTILLERY REQUEST FORM

BIBLIOGRAPHY

(Sources consulted)

Army Field Manual FM 105-5,(MANEUVER CONTROL) U.S.Army, 1973.

Special Text 105-5-1, (COMPUTER ASSISTED MAP MANEUVER SYSTEM) The Author, U.S.Army Armor School, Ft. Knox, KY, 1975.

Venture Simulation in War, Business, and Politics, Hausrath, A.H., New York: McGraw Hill, 1971.

The Bomb and the Computer, Wilson,A., New York: Delacorte Press, 1968.

EINFALL, Land Battle Simulation, DA Contract 49-092-ARO-10, Stanford Research Institute, 1969.

CONAF IV, PART II, Complex Battle Simulation, General Research Corporation, 1974.

VITA

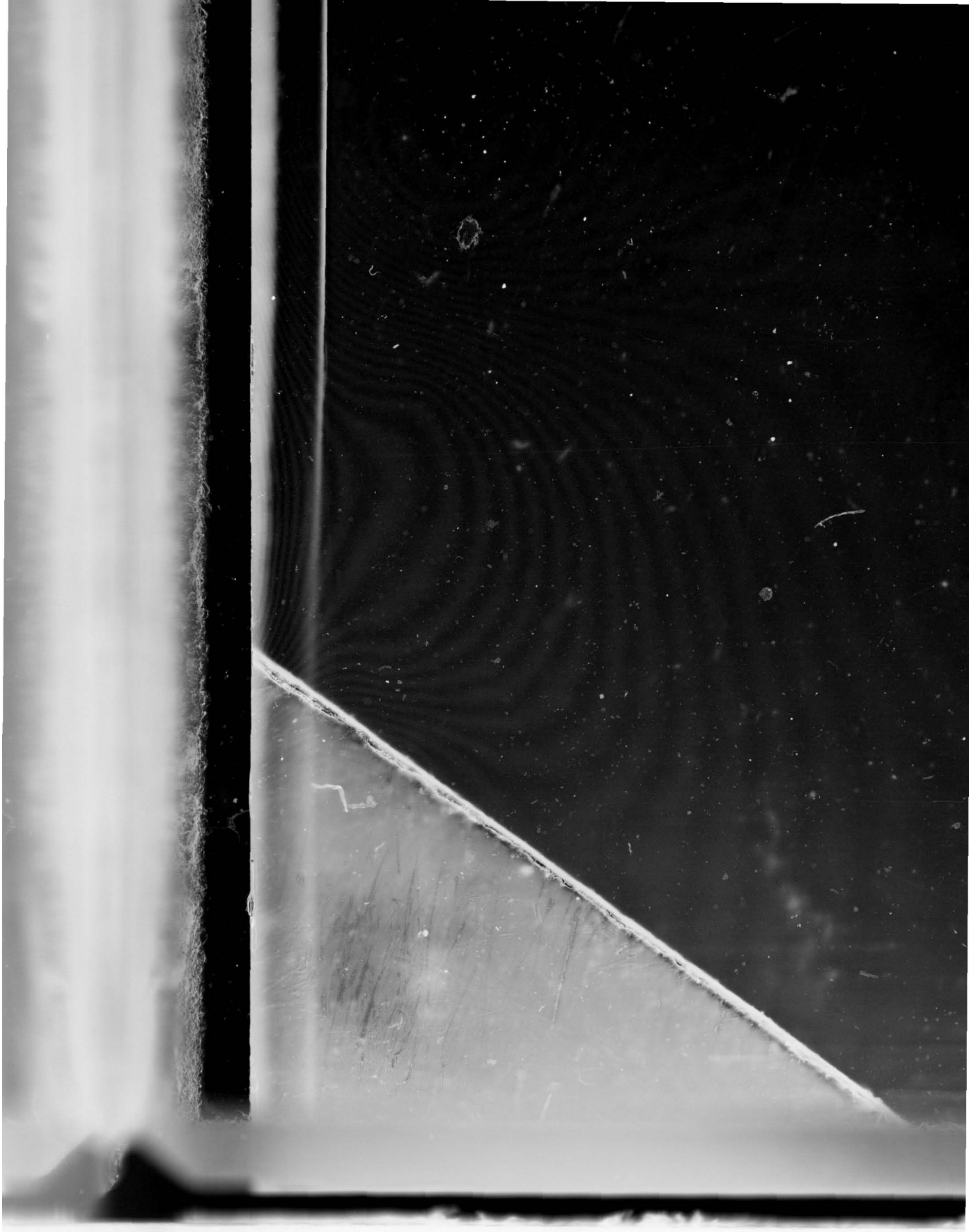
The author, Ernest Lincoln Childs, is the son of Garnold A. Kimball Sr. and Jeannette D. (Jackson)(Childs) Kimball. He was born November 11, 1939, in Portland, Maine.

His elementary and secondary education was obtained in the public schools of Glendale, California.

Entering the military services in 1954, he completed his secondary education in 1958. He served as an enlisted man until June 1965. On June 1, 1965, he was commissioned as a Second Lieutenant, Armor and has since risen to the rank of Major.

He received a Bachelor of Science degree from the University of Southern Colorado in 1972, in the field of Reserach Psychology.

His most recent military assignment was as a tactics instructor at the U.S. Army Armor School, Fort Knox, Kentucky.

He has served tours in Europe and the Far East, and has served in combat with the famous Big Red ONE, 1st Infantry Division. In May of 1977 he received a Master of Science degree in the interdisciplinary field of Engineering Management.

78