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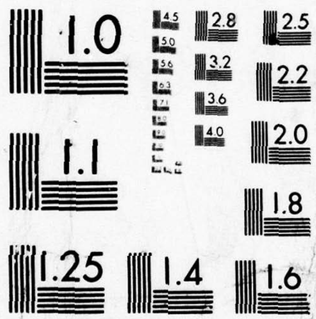

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Research and Development Technical Report
ECOM-76-1955-1

BATTLEFIELD RELATED ELECTRONIC WARFARE SIMULATION (BREWS)

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February 1977

First Quarterly Report for Period July 1976 to September 1976

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Results of the effort to modify BREACH, an existing battlefield simulation model to evaluate antitank guided missile electronic countermeasures (ATGM-ECM) are documented. The modified model is named BREWS and is a high-resolution company-level model formulated to evaluate electronic warfare (EW) hardware in a battlefield environment. Included in the simulation are detailed terrain modeling including rolling hills and vegetation; armor vehicles including Soviet and United States tanks, armored (contd) over

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20. Abstract (concluded)

personnel carriers, and antitank guided missile launchers; various United States tank EW hardware systems to detect and counter Soviet antitank guided missiles. Gaming rules have been devised to allow realistic engagements based on target detection criteria, probability of hit, kill, and damage assessment, and realistic countermeasures development for an interactive free play by Red and Blue Forces. The model is designed as an interactive war game for use with the UNIVAC 1108 computer. In addition to running interactively it is also used in batch mode for systems analyses. The model occupies approximately 75K decimal words of core overlayed eight times and utilizes 20 read and write files.

PREFACE

This is the first quarterly report on IIT Research Institute Project J6385; entitled "Battlefield Related Electronic Warfare Simulation (BREWS)." The work was performed for the Electronics Warfare Laboratory (EWL), Fort Monmouth, New Jersey under contract DAAB07-76-C-1955.

Team personnel who have made major contributions to the technical progress during this report period are Mrs. Patricia Taska and Mr. Louis A.C. Barbarek. Special acknowledgement is made to Mr. Eugene Oddi, EWL, for the threat and countermeasure material he supplied for inclusion in this report. Program manager and principal investigator is Louis A.C. Barbarek.

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1. INTRODUCTION

There is a preponderance of antitank weapons in the armies of the world. These include antitank guided missile systems (ATGM), antitank artillery, rocket propelled grenade launchers, illumination devices, guided munitions, and tanks. To date, there are no systems in the field to provide automatic detection and countermeasures to these threats. Techniques that can be utilized to detect these threats include visual, radar, infrared, laser, and ultraviolet. Techniques for countering these threats include vehicle maneuvering, smoke, high intensity lamp, flare (visible/infrared), and laser.

A need has been established by the U.S. Army Electronic Warfare Laboratory (EWL) to perform scenario simulations for tactical electronic warfare protection of armored vehicles. The purpose of this program is to provide the U.S. Army with the capability of conducting these simulations.

1.1 BREWS Model

BREWS is the simulation model, being developed during this study effort, that is the response to that need. BREWS will not be an entirely new model. It will be a modified version of an available battlefield simulation model that was specifically formulated for the evaluation of countermeasure hardware in a battlefield environment. This model, Battlefield Related Evaluation of Countermeasure Hardware (BREACH) is an existing model currently in use by a number of government agencies representing all three services - Army, Air Force, and Navy/Marines. It is documented by the Joint Munitions Effectiveness Manual (JMEM) of the Joint Technical Coordinating Group (JTCG), a triservice activity.

BREWS, when modifications made during this program are complete, will be capable of the indepth analysis and evaluation of antitank guided missile electronic countermeasures (ATGM-ECM) in the context of a high-resolution company level battlefield scenario. Specifically it will address:

- the ATGM threat,
- visual, radar, and infrared threat detection techniques, and
- vehicle maneuvering, smoke, and high-intensity lamp countermeasuring.

BREWS is unique is many respects and is a powerful tool.* Most important is its versatility and capability to handle a highly detailed one-on-one hardware evaluation, and also the broad scope of the interaction of tactics and hardware performance in an integrated battlefield. To accomplish this wide range of utility, BREWS is designed to be run both in batch and interactive modes.

For hardware and system studies BREWS is normally used in the batch mode. It is formulated to efficiently and economically facilitate computations that require numerous replications such as parametric, sensitivity, and tradeoff analyses. In the interactive mode, the operator uses BREWS in real-time evaluations and makes dynamic decisions based upon the status of the problem. In this way BREWS provides the computer-assisted capability for operational studies where dynamic tactical decisions are made by players in a war game. During the game, hardware parameters, performance, and tactics can be changed readily so that various alternatives can be investigated.

BREWS is a simulation model that has the capability to:

- evaluate EW/CM hardware effectiveness in the battlefield such that the engagement outcome is sensitive to hardware design parameters
- consider tactics and doctrine as part of the complete countermeasure system; evaluate and determine the optimum system; hardware, tactics, and cost

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* Note that these characteristics are inherent in the current model BREACH.

- conduct hardware systems, and operations analyses within compatible constraints incorporating realistic data and tactics in an organized methodology using one simulation model
- involve field officers, as well as analysts and engineers in the dynamic play of engagements.

1.2 Report Organization

This first quarterly report has been prepared to document the progress of this study effort, and to discuss the nature of the study effort. Specifically included are sections treating the program plan, BREWS simulation model, BREWS requirements, and the ATGM-ECM problem. In the final section the progress is summarized to date, activities planned for the next quarter are listed, and the amount of effort expended during this quarter is reported.

2. PROGRAM PLAN

This program ecompasses four main areas of endeavor: preliminary modeling; preliminary analysis; model refinement; and model demonstration. The first of these areas is being conducted currently and is concerned with the modeling required to enable BREWS to be used for the preliminary analysis of ATGM-ECM in a battlefield environment. The result of this subsequent analysis will then be used to direct the refinement of the model to the level of detail required to conduct indepth evaluations of the effectiveness of ECM in increasing vehicle survivability. The model will be demonstrated by performing sample analyses to the level of detail and scope of those to be conducted in the following study. During a following study, attention will be given to additional threats, countermeasures, and vehicles, and a program will be defined to conduct similar simulation and analyses.

2.1 Preliminary Modeling

Some modifications are necessary to the BREACH model reflecting the nature of the threat and countermeasures to be considered during this study. It can, as it has been demonstrated, simulate the ATGM-ECM engagement in a battlefield environment, but certain routines must be made more sophisticated to provide the indepth analysis of ECM that will be required. Some examples would be the line-of-sight, launch signature, and missile flight profile routines.

The completion of the first phase of the program is somewhat arbitrary since this process continues throughout the development of BREWS. However, for the purposes of identifying the completion of specific goals this phase must come to some sort of quantitative end, namely, a version of BREWS that can be exercised with a prepared data base that in an overall sense treats the ATGM-ECM engagement scenario.

During this preliminary phase the emphasis is being focused upon only those modifications to the model that are needed to permit the conduct of the preliminary analysis of the ATGM-ECM engagement. It is planned to further refine the model based upon those requirements resulting from that analysis. Appropriate experience will be gained through actual play of simulations as well as preliminary hardware and systems studies.

Whereas model improvements are necessary with regard to the detail in which the environment, threat, and ECM are treated by the code, attention must be given to the engagement on the battle-field. The engagement must be developed in sufficient detail so that a realistic portrayal of the sequence of events involving ATGM-ECM is achieved. Tactics, vehicle formation and maneuvers, communications, and human dynamic decisionmaking will be considered in the simulation. Interactions with other units, on both sides, as well as placing the engagements in context with the battle plan will ensure meaningful results to EWL and to other organizations such as Training and Doctrine Command.

The purpose of this phase of the program is to provide a preliminary version of BREWS version 1 (/VER1) that can be exercised with initial data to investigate the first engagement scenarios. This investigation will be of a preliminary nature focusing upon the requirements for BREWS to perform realistic analyses.

The process of developing BREWS is at best an iterative one wherein the required capabilities of the model are evolved through continual analyses of the problem. First the problem is treated in a gross manner ensuring that the engagement simulation is functionally correct and then slowly increasing the capability of the model to handle more and more complex and detailed computations depicting reality.

To direct this support modeling effort, four areas proceed at once. Two concerning the data base: (a) environment and hardware data preparation and characterization, and (b) scenario development in terms of tactics and doctrine as well as the normal "nitty gritty" functional analysis of the engagement operation.

2.2 Preliminary Analysis

During the latter months of the first phase the second phase is initiated. Again it is difficult to state exactly when it starts because it so intimately grows out of the preliminary modeling effort. Since the preliminary hardware analysis is concerned with the refining of the model, rather than the creation of BREWS/VER1, it is identified as the start of a new phase. Quickly following the analysis of hardware comes the treatment of total systems and the integration of the functions of the attack/defense/countermeasure process that occurs in the tactical engagement. Once into the consideration of the tactics, focus will be upon the operations of the engagement.

During this phase of the program the model will be used to analyze the nature of the threat, ECM, and environment in the context of an engagement. Each aspect of the tactical electronic warfare protection of armored vehicles will be studied from the level of the overall scenarios down to the smallest detail of ECM hardware. From these analyses will evolve the nature and level of detail required of the simulations.

Three levels of analysis will be conducted: hardware, systems, and operations. In the hardware analysis each item of hardware will be subjected to a critical evaluation with regard to its physical and functional characteristics, as well as performance, to determine the degree of sophistication to be modeled. Consideration will also be given to its relationship to the environment and the tactical engagement in which it will be utilized.

Complete systems will be integrated into the tactical encounters that will be experienced in the engagements, and evaluated with regard to the measures of effectiveness of system performance and its influence upon the "rules of the game." In this manner the nature and extent of the computed output of the simulations can be tailored to provide that information which will facilitate indepth analyses. The results of these evaluations will also generate the necessary feedback to the hardware analyses ensuring the adequacy of the degree of sophistication of the modeling.

The operation analyses will include complete simulations with two-sided play of engagements. These analyses will focus upon the tactical aspects of the simulation and will at the same time, "debug" the rules of the game and the modeling of the threat, ECM, and environment. Particular emphasis will be placed upon the nature and extent of the output and the flexibility of the format to ensure appropriate measures of effectiveness from the simulated engagements.

As the evolution of BREWS is continued, analysis leads to modeling requirements, and once implemented, the refinements allow further analysis and the iterative process gathers momentum. The end of this phase is a decision point, at which it is agreed that the level of detail is sufficient to proceed to production runs.

2.3 Model Refinement

This phase of the program will continue the modeling effort initiated during the preliminary modeling phase of the program. This effort will support and be directed by the preliminary analyses described and will be concerned primarily with providing the code with the degree of sophistication appropriate for the evaluation of ECM in the battlefield environment.

In addition to the simulation model itself the results of this phase will include appropriate documentation of the code. This documentation will be comprised of a set of three documents:

- Volume 1, USER MANUAL which shall describe the interfacing of the user with the simulation program and the means to enter user input.

- Volume II, PROGRAMMER MANUAL, which shall describe the basic program and subroutines of which the simulation program is comprised.
- Volume III, ANALYST MANUAL, which shall describe the processing of information by the simulation program and how to make changes in the basic program.

2.4 Demonstration of BREWS

There comes a point in the preliminary analysis at which decisions of completeness naturally lead to "proof." At this time it is decided that the hardware models are adequate and then are demonstrated as such by the exercising of the refined BREWS. Shortly thereafter the ECM system modeling is verified as in fact simulated and operable as are the engagement scenarios. The complete checkout is the demonstration that BREWS is ready to be used for production runs.

The BREWS model with its refinements will be used to evaluate ATGM-ECM. As in the preliminary analyses, hardware, systems, and operational evaluations will be conducted. During the interactive plays, *military personnel* will be utilized as much as possible to ensure realistic engagement simulations.

The hardware, system, and operation evaluations will be an extention of the corresponding preliminary analyses. Emphasis will be placed upon obtaining data that will allow the effectiveness/lack of effectiveness be determined of the ATGM-ECM in increasing the survivability of the M60 tank in the postulated threat environment.

2.5 Defining Additional Simulations and Analyses

Attention will be given to other threats, ECM, and armored vehicles even though it is recognized that these additional items of interest cannot be evaluated within the limited time and funds of this program. It will be possible however, to consider their nature with regard to use and performance when model changes are made to BREWS for ATGM-ECM.

During the latter part of the program, plans for simulations and analyses of these additional items of interest will be made and a program outline will be described to accomplish this additional effort.

2.6 Program Schedule

The schedule of activities for this program is presented in Figure 1. These activities, in outline form, present the approach that will be taken during the program. Depicted on the schedule are a number of milestones:

- Δ1 Completion of preliminary ATGM-ECM model formulations
- Δ2 Preliminary version of BREWS operational
- Δ3 Completion of preliminary analysis
- Δ4 Completion of refined ATGM-ECM model formulations
- Δ5 Refined version of BREWS operational
- Δ6 Evaluation of the ATGM-ECM complete
- Δ7 Future simulation and analysis program defined

The schedule also includes report/document submission dates:

- ●1 Quarterly Technical Report, Preliminary Modeling (DRAFT)
- ●2 Quarterly Technical Report, Preliminary Analysis (DRAFT)
- ●3 BREWS Manual, Volume 1, USER MANUAL (DRAFT)
- ●4 BREWS Manual, Volume 2, PROGRAMMER MANUAL (DRAFT)
- ●5 BREWS Manual, Volume 3, ANALYST MANUAL, (DRAFT)
- ●6 Monthly Technical Reports
- ●7 Final Technical Report (DRAFT)

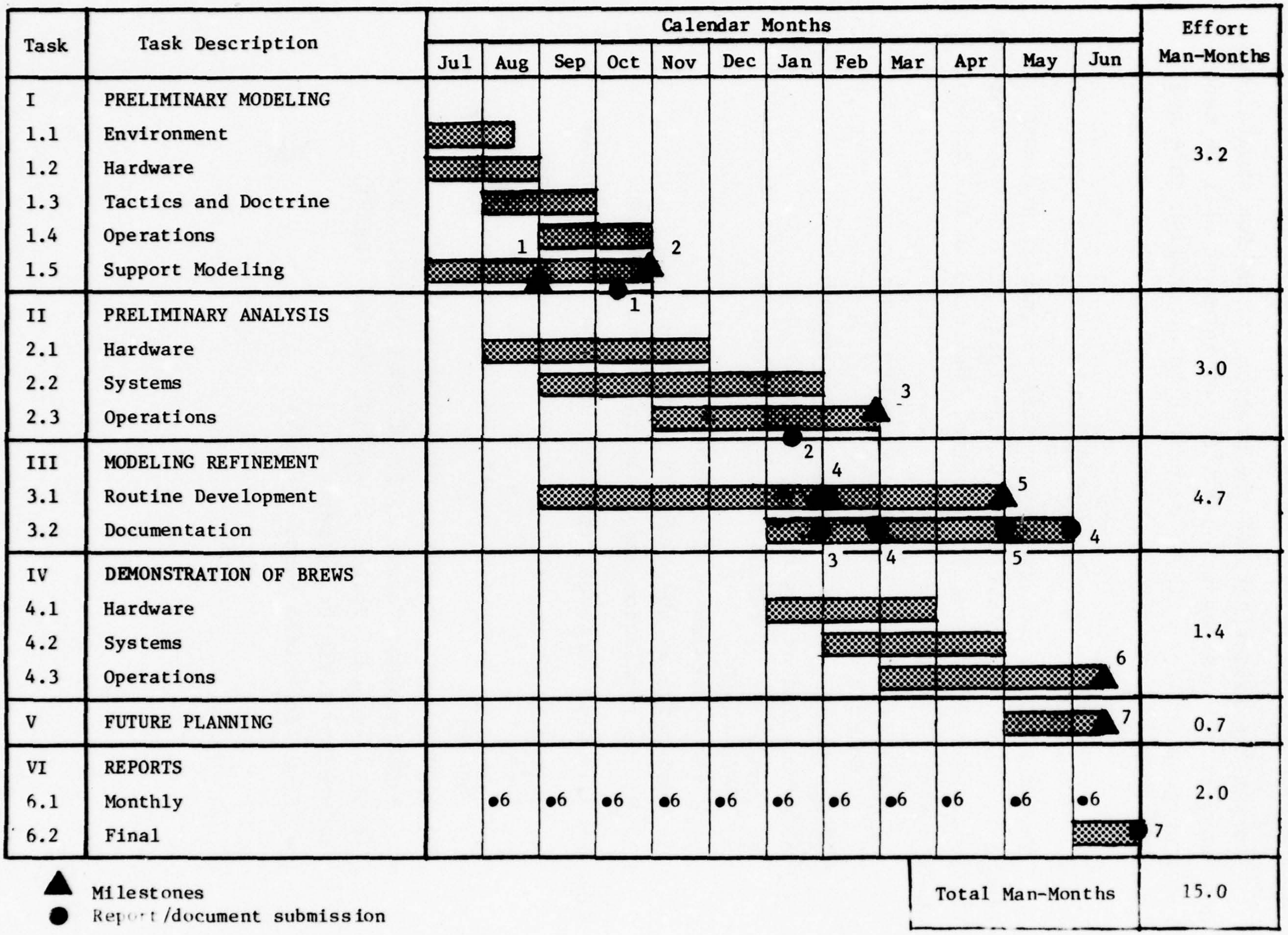


Figure 1. Program schedule.

3. BREWS SIMULATION MODEL

BREWS is a high-resolution company-level model formulated to evaluate electronic warfare hardware in a battlefield environment. Included in the simulation are detailed terrain modeling including rolling hills and vegetation; armor vehicles including Soviet and United States tanks, armored personnel carriers, and antitank guided missile launchers; various United States tank electronic warfare systems to detect and counter Soviet antitank guided missiles. Gaming rules have been devised to allow realistic engagements based on target detection criteria, probability of hit, kill, and damage assessment, and realistic countermeasures development for an interactive free play by Red and Blue Forces. The model is designed as an interactive war game for use with the UNIVAC 1108 computer. In addition to running interactively, it is also used in batch model for systems analyses. The model occupies approximately 75K decimal words of core overlaid eight times and utilizes 20 read and write files. Some of the features of BREWS are identified in Table 1.

3.1 Origin of BREWS

BREWS is not a new model. It is a version of a well tested and accepted battlefield simulation (BREACH) that is being modified to address the electronic warfare problem. Basically, these modifications involve treating specific interactions in the simulation to a greater level of detail to be used in the meaningful analysis of electronic warfare hardware.

BREACH was conceived and formulated to provide the means to evaluate the performance of countermining hardware in a battlefield environment. It was structured to have the high resolution necessary to be sensitive to the details of hardware design characteristics and at the same time the scope to consider the tactics involved with its use and effectiveness in an integrated battlefield. To address this goal BREACH was developed to have the capability to run in the batch mode and the interactive mode.

This left the computer code to be concerned with the detailed one-on-one interactions and bookkeeping chores and the operator to control the implementation, operation, and tactical use of the hardware with a special BREACH language. The operator was given the option of "preprogramming" instructions and/or interacting with the code (batch and/or interactive modes) in applying the model as a simple analysis tool or a war game simulation.

TABLE 1. SELECTED FEATURES OF BREWS PREVIOUSLY ESTABLISHED IN BREACH

1. Mounted and dismounted troops as well as air, land, and sea type vehicles in virtually unlimited numbers.
2. Direct and indirect cover fire (i.e., guns, artillery, missiles) from ground and/or air positions.
3. Tactical and close air support.
4. Any type of minefield patterns from singly emplaced to clustered AT/AP as well as scatterable.
5. Emplacement of mines (i.e., time, error) by hand, machine, and remote (aircraft, rocket, missile, shell) at any time before and/or during the engagement.
6. Battlefield is described in terms of maps (i.e., elevation, vegetation, mobility) and locations of elements, installations, and threats are accounted for in both global and local coordinates.
7. Dynamic decisions are made during the play of the engagement either by individual players in the interactive mode or by a programmable input deck of instructions in the batch mode of execution.
8. Status of the engagement (or any part) can be stored at any time during the play and recalled at some future time -- valuable in investigating alternative courses of action and/or varying levels of performance (men and equipment).
9. Printer plots, status of the minefield and elements is available in plots of any portion of the battlefield.
10. Analyses -- hardware, systems, and operations analyses are built-in capabilities (replications, random numbers, effects, summary tables, etc.).

3.2 Applications

Over the years the model was expanded considerably from its original countermining beginning. It is now capable of evaluating many other types of hardware. Types of engagements in which BREACH has been used:

Armored assaults through undefended and defended minefields

Infantry assaults through undefended and defended minefields

On-road operations (i.e., convoys, small unit movements)

Off-road infantry operations involving nuisance and scatterable minefields

Helicopter landing zones (defended and undefended)

Amphibious assault of mounted and dismounted troops (defended and undefended beach)

Urban warfare involving building-to-building fighting

3.3 Organization

BREWS is a simulation that can be best characterized as an executive system exercising a family of models as shown in Figure 2. These models range from the highest in resolution, the one-on-one, to the largest in scope, the integrated battlefield. The code has been programmed to compute the results of the first two and the language has been structured to implement the last two as the examples illustrate:

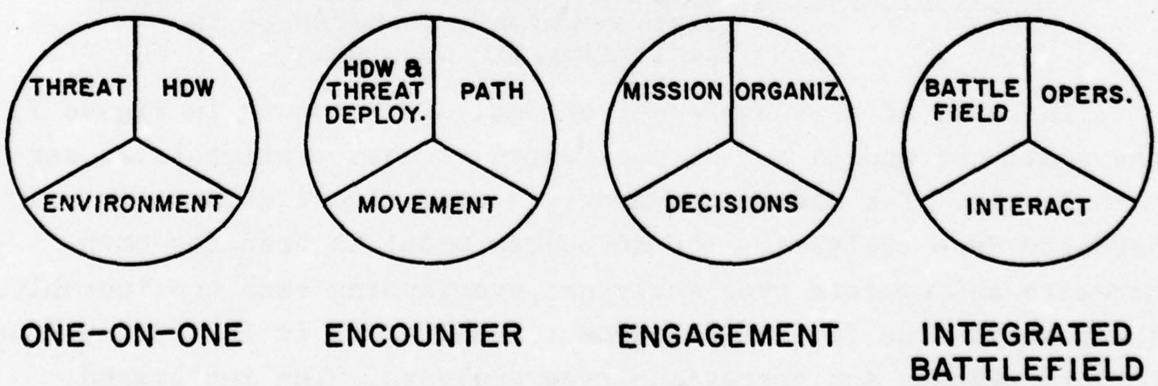


Figure 2. BREWS models.

- One-on-one models are used to determine the performance of hardware interacting with a single target/threat in a given environment.

  example: missile being tracked by radar in a light rain (see Figure 3)

- Encounter models are used to determine the performance of hardware deployed in a given area with movement of the hardware and/or threat along specified paths.

  example: RPG being fired by a man pack at a tank moving across terrain (see Figure 4)

- Engagement models are used to determine the performance of hardware when used by organizations in given missions with dynamic tactical decisions during the course of those missions.

  example: early warning surveillance of approaching armored column communicated to defending unit (see Figure 5)

- Integrated battlefield models are used to determine the performance of hardware in varied engagements on the battlefield including interactions with other operations and units.

  example: coordinated assault on objective (see Figure 6)

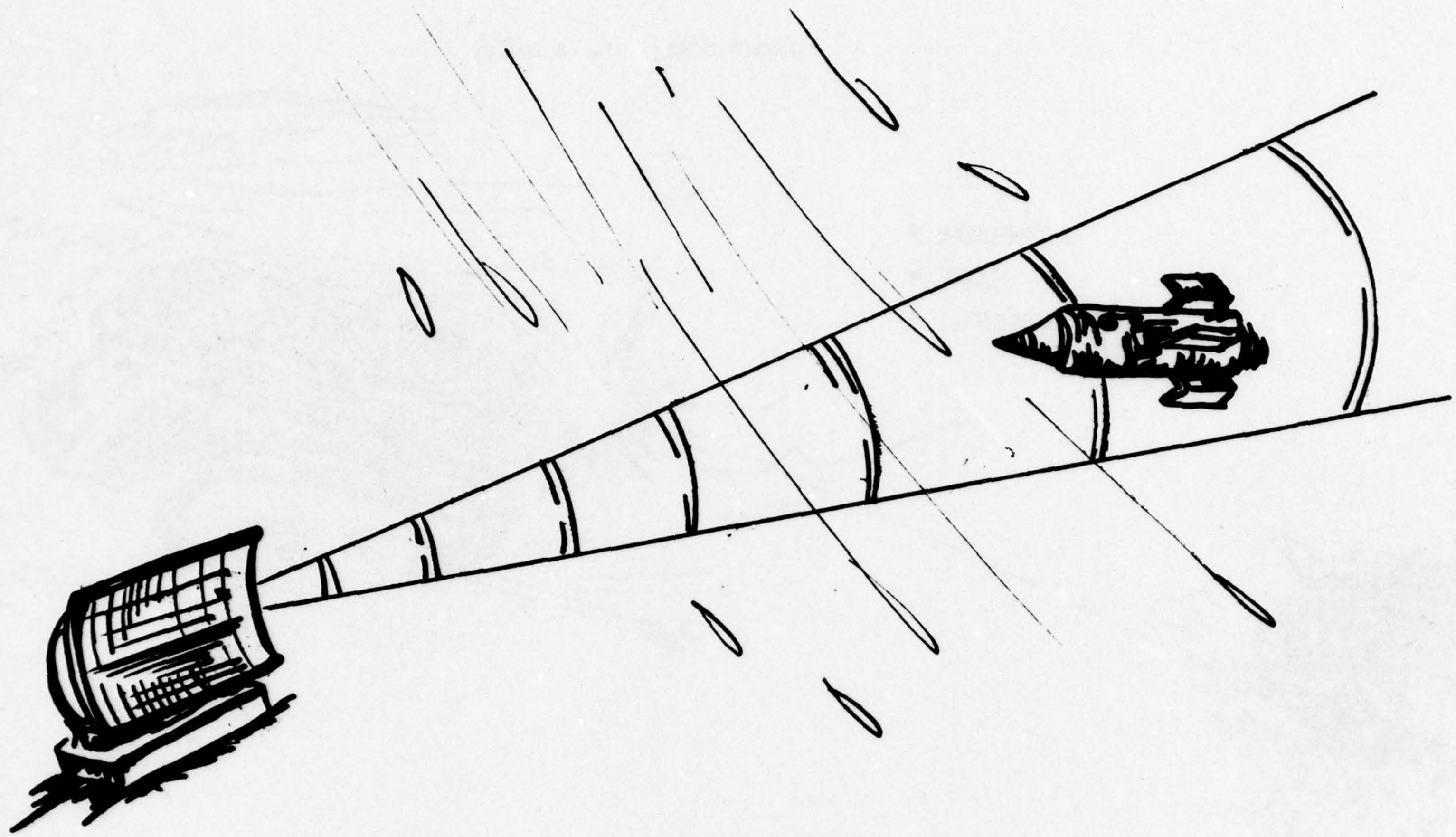
Another way to view the family of models inherent with BREWS is in the context of the analyses that are conducted by the analyst:

<u>Hardware Analysis</u>: determine effectiveness of hardware in performing its basic function

<u>Systems Analysis</u>: determine effectiveness of hardware systems in performing given tasks

<u>Operation Analysis</u>: determine effectiveness of an organization using this hardware in performing its mission.

In terms of this hierarchy of analysis as shown in Figure 7, the family of models can be considered as most applicable at certain levels. The one-on-one model is used almost always for only hardware type analyses. The encounter model is used for both hardware and systems type analyses, overlapping each considerably. The same is true for the engagement model where it is readily used in both systems and operations type analyses. The integrated battlefield model is mostly used for the operations analysis.



- MISSILE
- DETECTOR
- ENVIRONMENT

Figure 3. One-on-one.

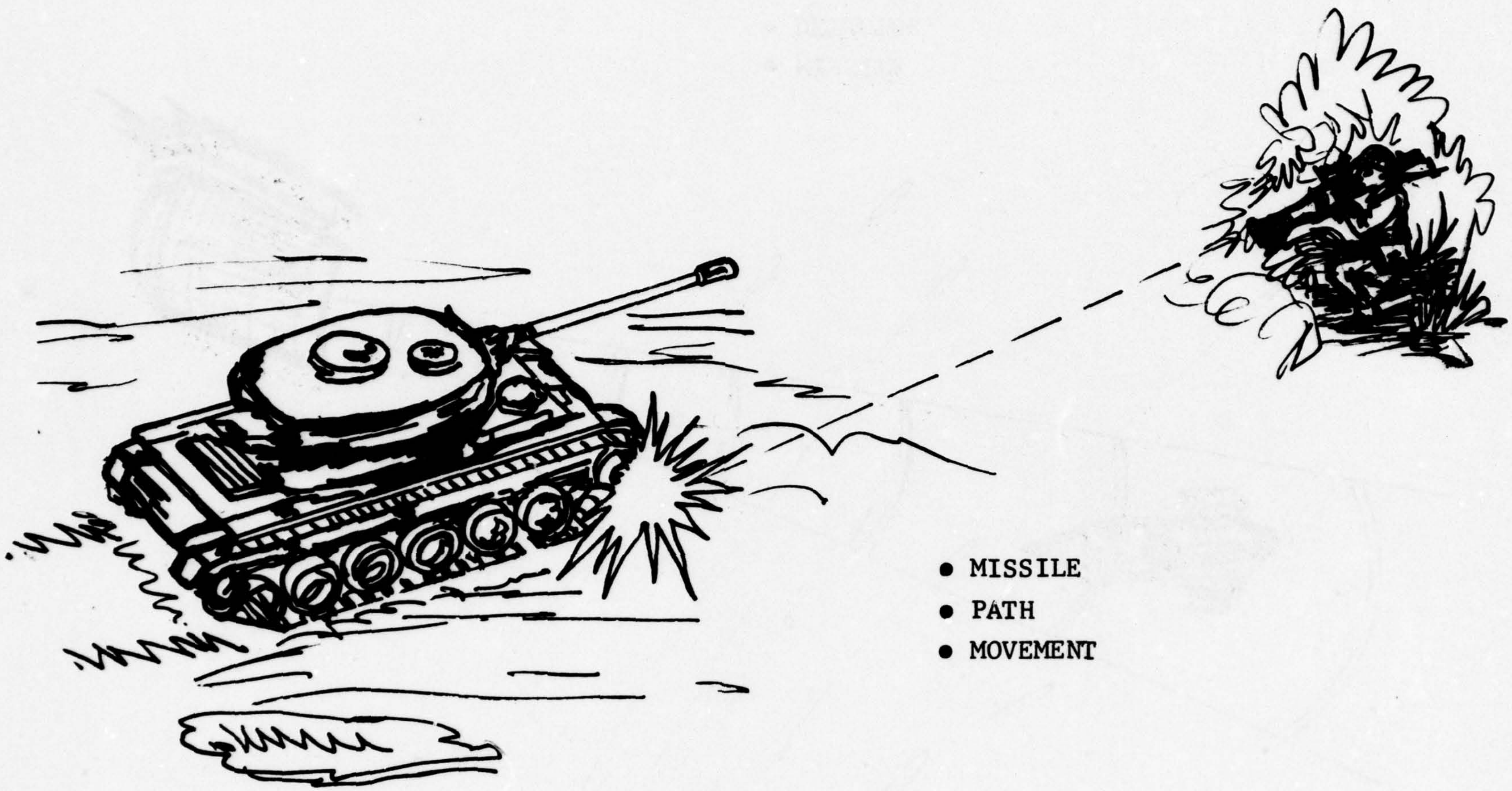


Figure 4. Encounter.

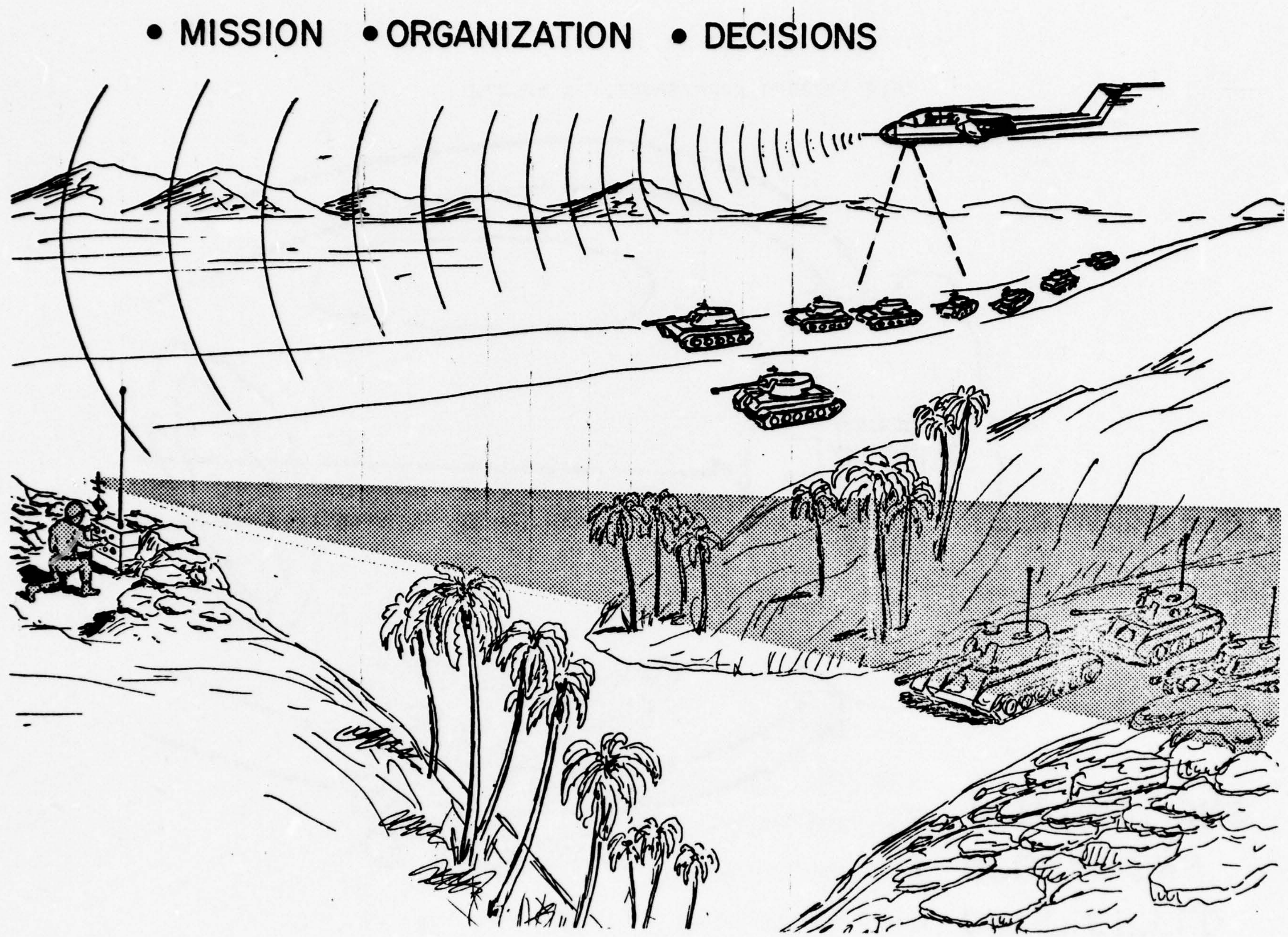


Figure 5. Engagement.

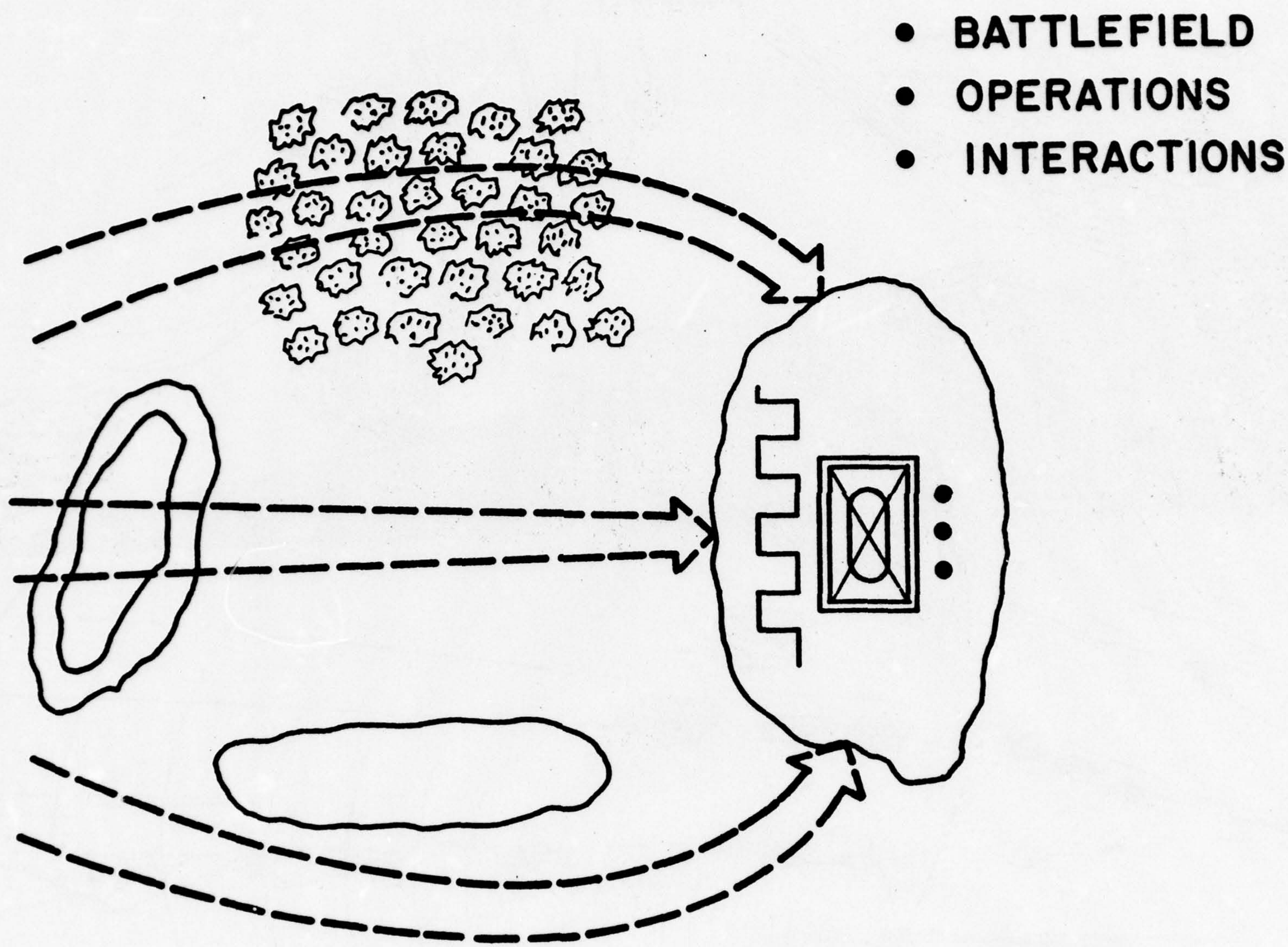


Figure 6. Integrated battlefield.

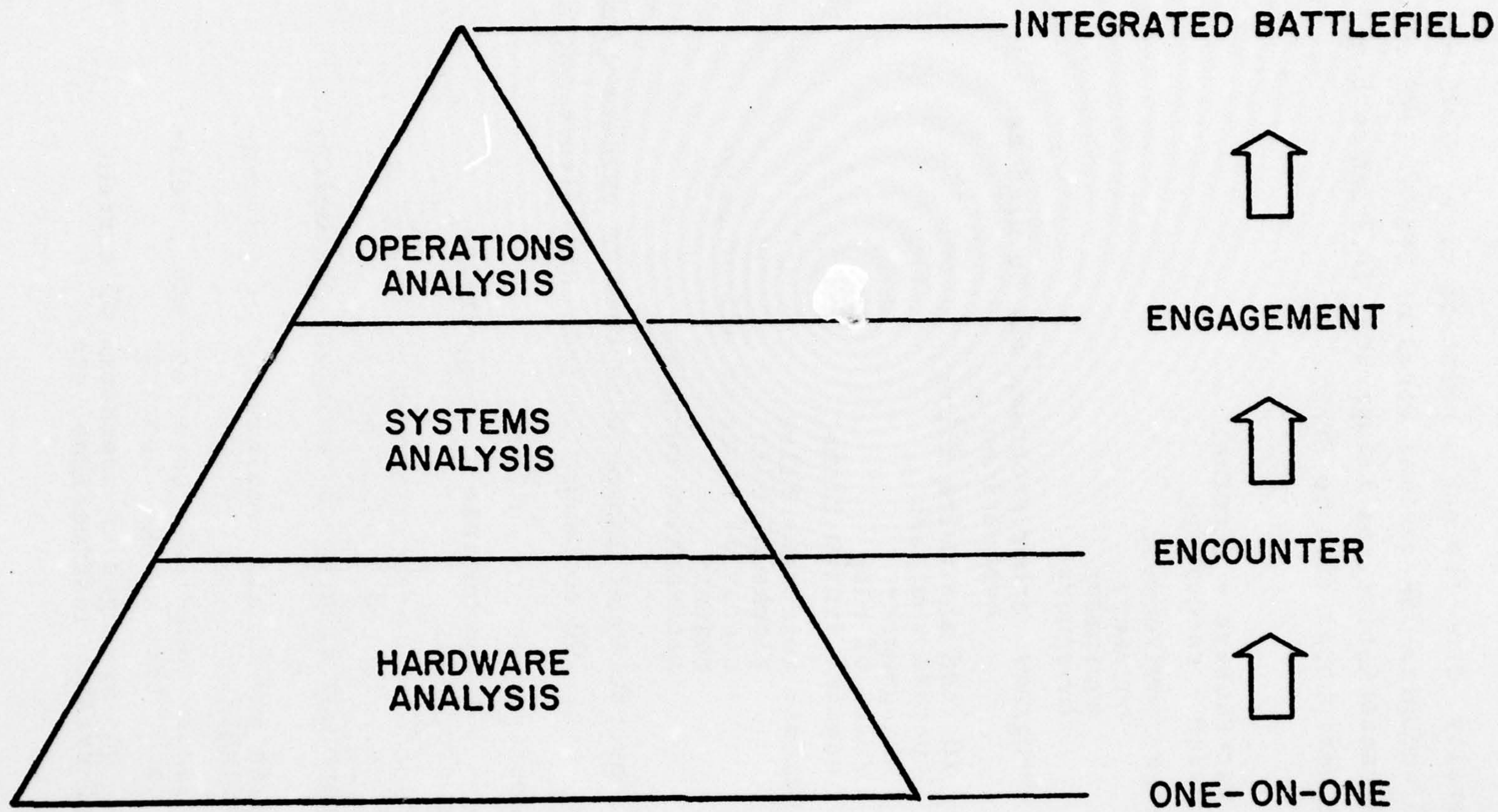


Figure 7. Hierarchy of analyses.

3.4 Structure and Operation

Structurally, from the users point of view, BREWS has eight overlays and occupies 75K decimal words of UNIVAC 1108 core. The following characteristics, as illustrated in Figures 8 and 9, describe the peripheral ties to BREWS.

Input: interactive - terminal
batch - cards/tape

Data Banks: environment
hardware
equipment
inventory

Special Programs: other programs may be used as subroutines

Storage: 20 read and write files
special routines
engagements
rules of play
special instructions

Random Access: load/save files
blocks of data
status of parts or all of play
restart
alternative outcomes

Actively, a conversational language is used to execute commands. This language, over 100 commands, include such directions as:

PATH: describe path to follow

MOVE: move a given vehicle in a specified manner/speed, etc.

DETECT: look for targets (obstacles, vehicles, missiles, dismounted troops, etc.)

PLOT: graphical display of vehicles, obstacles, etc.

PRINT: list any or all combinations of information available

LOCATE: locate vehicles, obstacles, etc., relation to each other (range, bearing)

MESSAGE: type messages to operators of current status of events, instructions, etc.

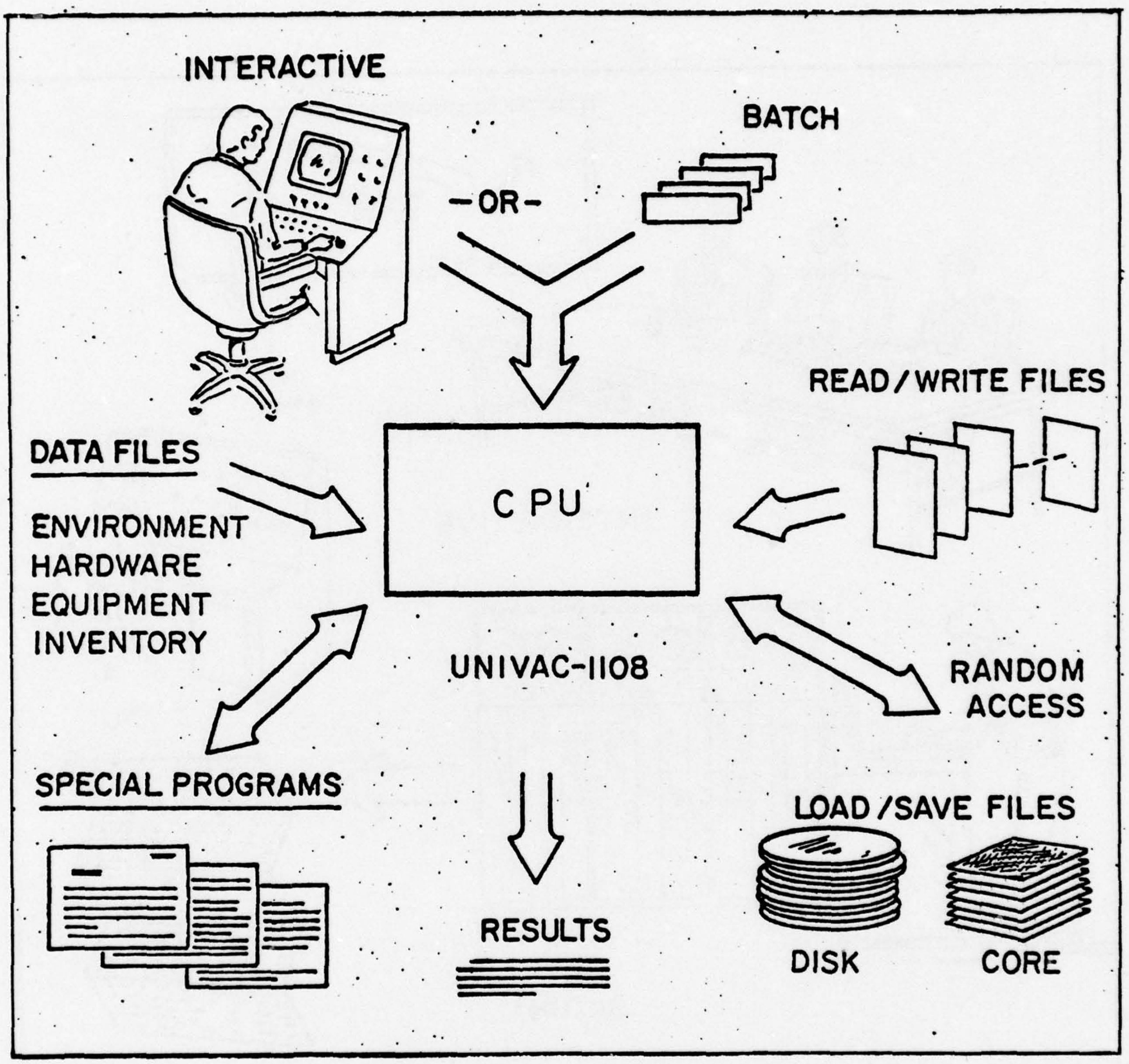


Figure 8. BREWS structure.

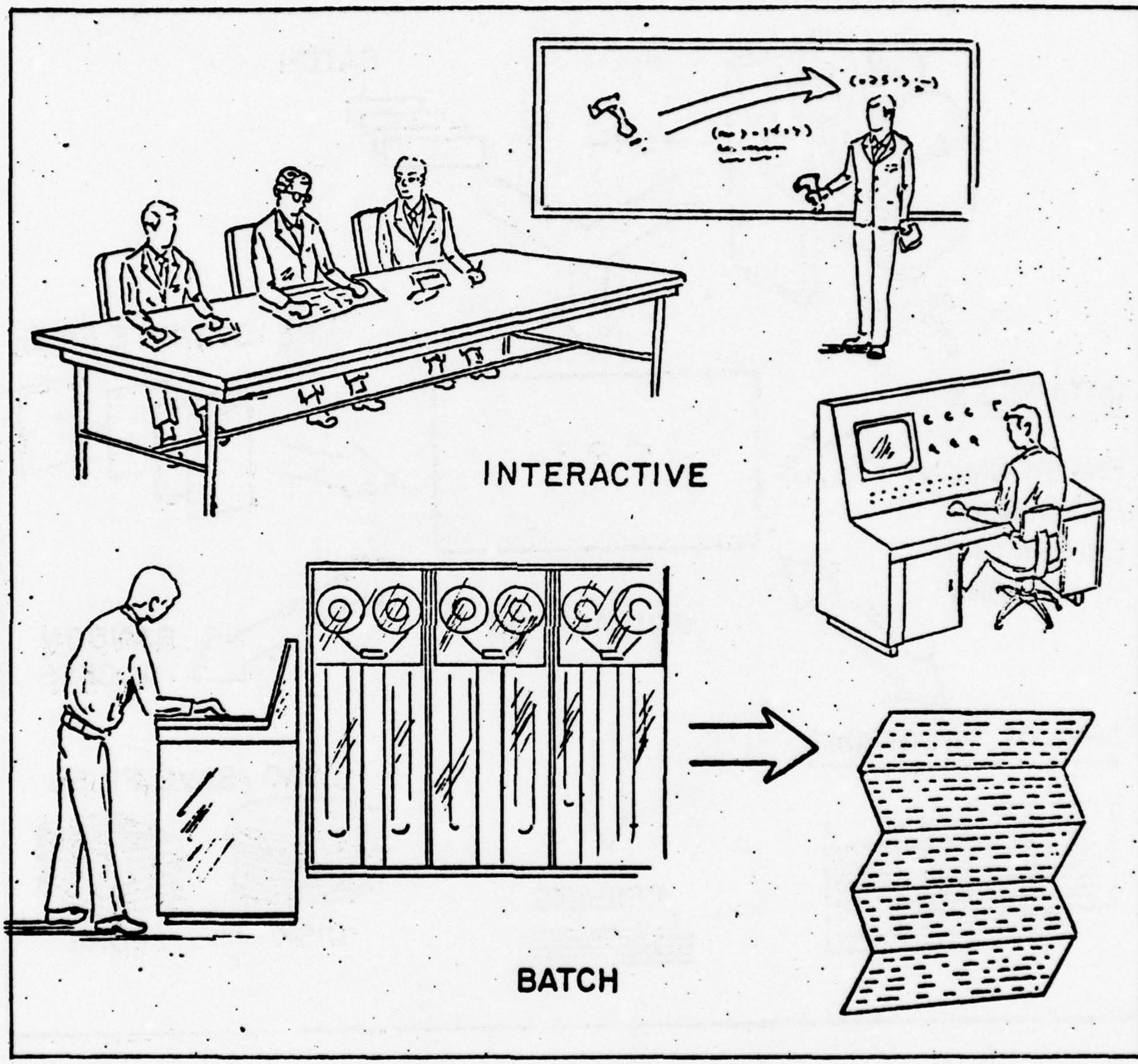


Figure 9. BREWS operation.

Commands are also available for replications that not only run a number of cases but automatically compute statistics on selected simulation parameters on each encounter. There are many other commands available to support the operator in playing out the scenario; load/save commands to store any part or all of the current status of play for future recall so that "what if" can be explored. What if, is a process whereby various alternatives can be investigated at any given decision point always restarting the scenario at the same status. In other words, if A option is exercised how will the outcome compare to option B?

Scenarios, as such, are not wired into the simulation but are only the way the model is exercised. After the data are entered, and the inventory of vehicles and/or hardware is established, the play of the scenario is at the complete control of the operator. The vehicles and/or hardware can be placed (delivered) anywhere and moved in any manner. The operator, at any time, can change any or all of the data, add or subtract any mine, and render ineffective or effective any mine with simple commands.

For hardware and system studies BREWS is normally used in the batch mode. It has been formulated to efficiently and economically facilitate computations that require numerous replications such as parametric, sensitivity, and tradeoff analyses. In the interactive mode, the operator uses BREWS in real-time evaluations and makes dynamic decisions based upon the status of the problem. In this way BREWS provides the computer-assisted capability for operational studies where dynamic tactical decisions are made by players in a war game. During the game, hardware parameters, performance, and tactics can be changed readily so that various alternatives can be investigated.

3.5 Data Base

As has been discussed in the other manuals, BREWS, as other simulation models, requires a data base before any problem solving can be done. These data need only be as much as the problem being addressed requires. For discussion purposes it is best to clarify what is considered as part of the data base and what is not. Basically, the map and its feature overlays; obstacles, stationary objects, detection hardware, weapon hardware, and vehicle characteristics comprise the data base.

Each of the following phases (or overlays) of BREWS process one or more of the above categories of data:

ENVIRONMENT: map and feature overlays

OBJECT: characteristics of stationary objects and obstacles

EMPLACE: emplacement of stationary objects and obstacles

DETECT: detect hardware characteristics

WEAPONS: weapon hardware characteristics

VEHICLES: vehicle characterization and inventory

These six processors process the input data and load appropriate arrays (data banks) with the data after it has been manipulated, packed, and/or transformed into a useable form by BREWS. It should be noted that one of the many uses of the random access file, Tape 8, is for the storage of this processed input data in array format which since preprocessed can be loaded into core at a considerable saving of time and money each time a computer run is made. This reading and writing using Tape 8 is accomplished by the LOAD/SAVE commands.

3.6 Versions of BREWS

Three versions of BREWS are anticipated during the course of this effort.

- Version 1 has those modifications that are required to conduct preliminary ATGM-ECM engagements, namely routines to accomplish:

  a. sector scan

  b. LOS computations

  c. vegetation and terrain interference with LOS

  All other necessary capabilities for preliminary engagements are inherent in BREACH.

- Version 2 has additional refinements that enable more detailed interactions as well as a more "realistic" play of the engagements. Specifically these refinements will include:

  a. looking through smoke and vegetation

  b. blocking LOS by items on the map, both stationary and moving

  c. depressions in the terrain that are placed by the user; holes and craters for cover

  d. range gates for detection

  e. fire suppression from direct and indirect fire as a function of miss distance

  f. three-dimensional flight paths for missiles

  g. continuous terrain for LOS and sector scan

- Version 3 will contain refinements that are required for production runs. These modifications will build in those computations that will reduce running time as well as those that represent additional detail in the simulation of technical hardware characteristics.

  It is anticipated that most of these improvements will evolve during the preliminary analysis. Some of these have already been identified (they are rather specific in nature and involve the "guts" of the code and may not be fully appreciated by one not familiar with the code):

1. Increase significant digits for R1, R2 packing for weapons and detectors.
2. Azimuth of targets in event table for neutra.
3. End move on clock time or path time.
4. Move down only portion of path (any) in terms of start and stop distance.
5. Override for vegetation and mobility limitations to operate on roads (i.e., path through forest).
6. Stop vehicles without damage or encounter with obstacles.
7. Vehicle vulnerability zones; continuous instead of stop function.
8. Change status and location of stationary items with an EXEC command.
9. New function $d = \sqrt{a^2 + b^2 + c^2}$ (FUNCT command in EXEC)
10. Designate additional shooters and targets in five tables.
11. Detect fire events in event table.
12. $\pm$ burial depth for stationary items on map.
13. Detections during scan keyed to clock time.
14. Option for either cumulative probability or straight line detection probability functions.

It should be noted that some of the above will be incorporated within Version 2 depending upon what part of the code is affected. However, they are planned for completion in Version 3.

4. REQUIREMENTS OF BREWS

The end product of this study is basically a simulation capability that will enable an indepth evaluation of ATGM-ECM hardware in a battlefield environment. The model, in its current status can, and has, been used to address this problem but not to the depth and level of detail required by EWL. These requirements can be best understood by considering the nature of the ATGM-ECM problem on the battlefield.

Survivability in a threat electromagnetic (EM) environment is a major concern of armor. The armored vehicle has become a prime target of weapons categorized as electronically directed threats. One such example is the guided missile that is launched toward an unaware target tank. An obvious solution is to alert the tank that it is a target by using some type of electronic detection means. Although, the detection would provide needed information, there remains the problem of what action (CM) should be taken.

It is obvious that the detection and CM action in question must be evaluated in the context of a tactical engagement within the total battlefield environment. Before determining how effective the device or technique is, the measures of effectiveness (MOE) and the scenarios used to measure this effectiveness must be defined. Launch detector MOE for a lone tank fired upon by a helicopter launcher missile is significantly different than the MOE of a launch detector for a company of tanks encountering multiple threats. In the first example the information from a launch detector may be adequate to allow evasive maneuvers and/or effective counterfire. In the second example, many interrelated factors are involved which effect the MOE:

- which tank is the target?
- how much time to act?
- if smoke is available should it be used? how and by whom?
- what should each tank do?

- is there really enough information to act?
- will tracking information be more useful?
- should each tank have a detector or a tracker?
- what should the tactics be for each tank or company?
- would it help if it was known that one or more tanks were being irradiated by radar, infrared, or laser?
- could tactics be coordinated?
- is there enough time to make choices?
- how much complication and sophistication makes sense?
- can more survivability be bought? for what price?
- even though some tanks may be lost, what is the outcome of the engagement or the battle?
- where on the tank will the hardware be installed?
- how reliable are the systems in operation, combined with tactics?

This list represents only a portion of factors that must be addressed. Most of these factors are interrelated and the total picture incorporates basically different aspects: the vehicle, countermeasure equipment, the user, and the threat itself, inasmuch as the enemy tactics and weapons will be a very dynamic influence in any engagement.

Presently, armored vehicles have been given very little capability to increase their survivability in the hostile EM environment. A number of hardware items are in various stages of development (some are ready to purchase and install), including: Vehicular Radar Illumination Detector (VERID), Vehicular Infrared Alarm (VIRA), Scanning Optical Augmentation Locator (SOAL), and various forms of smoke and aerosols.

The EM threat has become so acute the United States Army has directed that all armored vehicles be considered with regard to their survivability in an EM environment. The basic requirement of BREWS is to address this need for the effective use of countermeasure hardware and tactics. Further, BREWS must have a capability that would:

- increase the survivability of present and future armor in the most cost-effective way
- provide direction for future development of EW/CM hardware that will increase survivability
- provide the necessary information to make decisions resulting in a fielded vehicle that best meets United States Army requirements
- provide the builder of EW hardware with a means of guiding development of the most effective equipment within constraints established
- provide the builder of armor with a means for determining the maximum armor survivability at the minimum cost
- provide the user of armor with a means of evaluating proposed detection and CM hardware and its tactical use in a battlefield environment.

To meet these requirements, this program is concentrating upon two basic areas of effort: (a) definition of the countermeasure problem, and (b) demonstration analyses using BREWS.

4.1 Definition of Countermeasure Problems

The objective of this area of effort is to determine the ATGM-ECM problem in the battlefield and to identify all the input that will lay the groundwork and orient a comprehensive study. Such effort includes the statement of the problems, functional analysis, scenarios, threat analysis, terrain definition, data base, and other information required for use in the evaluation of ATGM-ECM. Specifically, these types of information are being obtained:

- terrain description/analysis of area selected for system evaluations
- tactical/technical threat data and analysis
- operational concepts, to include opposing force structures, logistical support, and description of material encountered on the integrated battlefield which may be relevant to the countermeasure problem
- scenarios, tactical maps and overlays, tables of organization and equipment, field manuals, and other detailed data, to support the above

- ATGM-ECM hardware characteristics and performance data
- previous countermeasure studies and other relevant documentation.

4.2 Demonstration Analyses Using BREWS

The objective of this area of effort is to ensure that BREWS can be used effectively in conducting hardware, systems, and operations analyses of candidate countermeasure equipment and techniques in a battlefield environment. Such effort will involve a limited exercising of BREWS demonstrating three types of analyses:

Hardware Analysis -- ATGM-ECM analyzed with regard to the capability of performing a specific task in a one-on-one relationship. Primarily emphasis placed upon design considerations and the effectiveness of the concept over the entire range of application.

Systems Analysis -- ATGM-ECM considered from a total system viewpoint (hardware, facilities, personnel, software, support equipment, etc.). The encounter model used to assure compatibility of all functional and performance characteristics and/or requirements.

Operations Analysis -- ATGM-ECM simulated in a battlefield environment with mission objectives, organizational constraints, and operational tactics. The effectiveness determined in performing its ultimate objective countering the EM threat capability of the enemy -- and the impact upon the outcome of the engagement as reflected by the effect upon time, losses, mobility and other related measures of effectiveness.

Measures of Effectiveness -- in all three analyses (hardware, systems, and operations) measures of effectiveness established compatible with the scope of the countermeasure activity and its mission in the overall battlefield operations down through the particular function in the one-on-one situation.

Cost Effectiveness -- a common focal point of all the analyses will be the life cycle costs of the hardware. Particular emphasis will be given to the level of survivability of individual vehicles as well as groups (platoon, company) as a function of these costs.

5. THE ATGM-ECM PROBLEM IN THE BATTLEFIELD

5.1 The ATGM Threat

Antitank guided missiles (ATGM) are small, weigh from 25 to 65 lb, and fly essentially a direct path from the launcher to the target tank. The warhead consists of a shaped charge. Soviet ATGM are capable of penetrating all current United States armor.

These missiles are generally divided into three classes. First generation ATGM utilize wire trailing out of the rear of the missile to provide guidance commands from the gunner's joy-stick control. The gunner flies the missile (first generation: 80 to 160 m/sec) into the targeted tank. The current Soviet SAGGER and SWATTER are first generation ATGM. Second generation ATGM generally have a higher velocity (160 to 300 m/sec) and utilize a semiautomatic guidance system (i.e., infrared/wire) to follow the line of sight established from the gunner to the target (tank). Third generation ATGM are primarily characterized by higher speeds (550 to 700 m/sec) and utilize fully automatic guidance (i.e., infrared/laser beam riding).

The combat effectiveness of ATGM will vary depending upon the sophistication of the ATGM (first, second, or third generation) and the tactical situation. First generation ATGM are more effective in a defensive, as opposed to offensive role. This is due in part to their relatively long time of flight and their dependence upon the skill of the gunner while under the obvious pressures of a tactical engagement. The defensive role allows the gunner to choose his target, fire from well concealed positions, and essentially maximize a "low silhouette" posture.

Second generation ATGM are not only more effective (higher kill ratio) in the defense but also lend themselves to an offensive role. Second generation ATGM generally give the tactical advantage of extending the traditional short range (1000 m) effectiveness of the recoilless rifle out to a range of 3000 m.

Third generation ATGM are expected, due to their speed being higher than the conventional tank round, to be more effective than conventional shaped charge tank ammunition (105 mm). Third generation ATGM will have an equally highly effective role in the defense or offense.

In determining the threat effectiveness it would be dangerous to start with the assumption that only unsupported tank attacks face mass destruction from accurate and lethal antitank guided missiles. This leads to the erroneous belief that tank attacks supported by combined arms task forces will completely negate any enemy ATGM effectiveness. Instead, the "bottom line" of the effectiveness of enemy ATGM lies in their system's capabilities which can be maximized to achieve the tactical advantage of surprise and shock. The threat capabilities modeled will be restricted to those of the first generation Soviet antitank guided missiles and a postulated second generation threat missile.

5.2 The Available Countermeasures

5.2.1 Weapon Systems - Obviously ATGM that are destroyed are effectively countered. Many Soviet ATGM move about the battlefield on vehicles vulnerable to tank fire. Thus, destruction of a BMP is more significant than the mere destruction of an armored personnel carrier; it is the destruction of four or five SAGGER missiles. Similarly, destruction of a BRDM represents the destruction of 14 SAGGER missiles and not just the destruction of an enemy scout vehicle.

The M60A1 tank has several means by which suppressive fires (direct or indirect) can be brought to bear on known or likely enemy locations. BREWS/VER1 will incorporate the use of the HEAT round and the armor piercing discarding sabot (APDS) by the M60A1* tank.

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*Although the M60A1 is currently the primary source of data, the M60A3 will be utilized should sufficient data become available.

The primary weapon system engagements played will be the Blue Forces M60A1 main gun and the Red Force ATGM. However, since these weapons engage within the constraints imposed by other battlefield weapons, at least the general effects of mortars, recoilless rifles, RPG-7, and artillery will be played.

5.2.2 Maneuvering - Skilled tankers can learn to dodge some Soviet ATGM in flight. Evasive maneuvers or moves to cover can be taken by tankers if adequate warning is received. Maneuverings can be particularly effective when used with obscurations such as smoke or high intensity lamp. Maneuvering also includes the effective use of terrain such as bounding and overwatch, firing from hull defilade positions, and using covered routes of approach even at long ranges (3 to 4 km) from suspected enemy positions. Specific countermeasure maneuvering will be initiated by visual detection of ATGM or by ATGM warning systems (radar or infrared).

5.2.3 Smoke - Onboard, rapid-disseminating, self-protecting, smoke will enhance the survivability of the vehicle. Obscuration by smoke is currently being studied by the Army Materiel Systems Analysis Agency (AMSAA). Results of their studies will be utilized by BREWS. No current United States or United Kingdom smoke system is considered a likely candidate for a smoke countermeasure to ATGM in BREWS. Thus an "optimum" smoke system, within current state of the art capability, will be utilized in the simulation. The AMSAA smoke study results will be modified accordingly. Smoke will be initiated by visual detection of ATGM or by an ATGM warning system (radar or infrared).

5.2.4 High Intensity Lamp - Two types of high intensity lamps can be used as countermeasures to ATGM. A tank-mounted high intensity lamp with a sufficient visual (as opposed to infrared) output can produce a fireball (dazzle) obscuration. This obscuration will cause the first generation missile gunner to be unable to distinguish the missile tracking flare within the radius of the fireball obscuration. A second type of high intensity lamp with an infrared output matched in PRF and wavelength to the receiver of a second generation missile tracker can effectively jam that missile's tracker, preventing the correct guidance signals, from being provided to the missile.

5.3 Scenario

A single overall scenario is being developed based on the guidance obtained through the SCORES developed by CACDA. Within this scenario several engagements will be played. A Blue armor company team/battalion task force/brigade task force in the offense will engage, respectively, a Red motorized rifle platoon/company/battalion.

A Red Force player will initially position his forces along suspected Blue Force routes of advance. In doing so, he will be responsible for each weapon's sector of fire and their order of battle. For order of battle, he may select the target for each ATGM section or have each ATGM fire at will (at identified targets within a given range).

The Blue Force player will select his route of approach to a given objective. He will then select the deployment of his forces as they cross the line of departure (LD). In doing so, he will be responsible for each tank's field of observation, its engagement of identified targets (ATGM positions), and its reaction to identified threats (ATGM in flight). The amount of warning of ATGM and the countermeasure options a tank has will be dependent upon the black boxes (warning devices) and countermeasures given the tanks for that particular simulation.

In general the program effort is proceeding in three distinct steps, which, for the purposes of this discussion are identified as phases:

PRIMARY THREAT: antitank guided missiles

THREAT DETECTION: visual, radar, infrared

COUNTERMEASURE: maneuvering, high intensity lamp visual, high intensity lamp infrared, smoke, tank main gun counterfire.

Phase A	Phase B	Phase C
Blue: AR Co Tm	Blue: AR BN TF	Blue: AR BDE TF
Red: MR Plt	Red: MR Co	Red: MR Bn

The composition of these units and their weapons are presented in Tables 2 and 3.

TABLE 2. UNIT COMPOSITION

	BLUE FORCES	RED FORCES
Phase A	Company Team (Tank Heavy) (2 Tk Plts, 1 Mech Inf Rifle Plt)	Motorized Rifle Platoon
	M60A1 (12) M113A1 (4) M106A1 (2 support only)	BMP (3) RPG-7 (3)
Phase B	Battalion Task Force (Tank Heavy) (1 Tk Bn, 1 Mech Inf Rifle Co)	Motorized Rifle Company
	M60A1 (54) M557A1 (6) M114A1 (9,1) M106A1 (4) M125A1 (3) M113A1 (9,14) TOW (2) M151A2 90 mm RR (6)	T62 (3) RPG-7 (9) BMP (10)
Phase C	Brigade Task Force (Tank Heavy) (3 Tk Bn, 2 Mech Inf Bn)	Motorized Rifle Battalion
	M60A1 (162) M557A1 (18,14) M114A1 (27,30) M106A1 (12,8) M125A1 (18) M113A1 (27,120) TOW (36) M151A2 90 mm RR (36)	T62 (10) *BRDM (3) BMP (30) SAGGER MANPACK SET (2) RPG-7 (2) 120 mm MORTAR (6) 122 mm HOWITZER (2 support only)

* During some simulations will be replaced with BMP equipped with ATGM-2 (3)

TABLE 3. MAJOR WEAPON SYSTEMS

BLUE FORCES	RED FORCES
M60A1 105 mm HEAT APDS	T62 115 mm HEAT HV APFSDS
M106A1 4.2 inch MORTAR	BRDM SAGGER SWATTER
M125A1 81 mm MORTAR	BMP SAGGER 73 mm
M577A1 M114A1 M113A1 TOW M151A2 90 mm RECOILLESS RIFLE	BMP ATGM-2
	SAGGER MANPACK RPG-7 120 mm MORTAR 122 mm HOWITZER

Currently Phase A is being addressed. A basic engagement has been formulated for the first generation ATGM and is presented in Subsection 5.5

5.4 Tactics Using ECM

Established tactical doctrine on the use of maneuvering, smoke, or a high intensity lamp to counter ATGM does not exist. The tactics employed in the scenario will center on the conventional armor tactics a Blue Force would use to conduct a penetration (through the old "forward edge of the battle area") to seize an objective (prominent terrain feature). Battle drill, formations, and the bounds and overwatch technique will be utilized. BREWS/VER1 will specifically address the use of ATGM by a Red Force in the defense. This is the primary use of first generation ATGM. Later phases may address the use of ATGM by the Red Force (motorized rifle unit) in the offense or withdrawal.

5.4.1 Weapon Systems - As the Blue Force advances toward their objective, the M60A1 tanks will have the capability of engaging targets with their main gun (105 mm). The method of acquiring targets will be either visual or via an ATGM detection device (radar/infrared).

It is assumed, since the Red Forces are in the defense, that Red Force positions will be camouflaged. Thus for visual target (ATGM) acquisition the tank's field of observation must overlap the ATGM launch position and activity must occur at the ATGM position (missile launch or positioning of ATGM launchers). The M60A1 then acquires the Red weapon by pinpoint for the purpose of returning fire.

A 0.15 probability of pinpoint (target acquisition) per observed Red ATGM launch signature is used. This is an order of magnitude below the value commonly used for pinpoint acquisition of tank guns. An ATGM launch does not have the cuing that a tank gun firing has. For example, the tank gun has smoke and dust immediately surrounding the tank position. The ATGM firing has relatively no dust, and the launch smoke, if visible, appears to momentarily follow the ATGM (as a short vapor trail). This causes distraction from the launch location. Tank guns fire several rounds seconds apart. ATGM are launched simultaneously from several locations and with more time between "waves" of launches. Visually detecting an ATGM launch is at least an order of magnitude more difficult than detecting tank guns.

The two preceding paragraphs address the engagement of a Red ATGM position by the Blue Force following the detection of the launch of the ATGM. Once a missile(s) is in flight, the criteria for ATGM detection changes. It will be assumed that ATGM will be launched in waves (i.e., more than one missile in the air).

The radar or infrared ATGM detection device will automatically provide warning information. The specific threat information given and the reaction time will depend on the type of device.

Upon identifying the location of a Red ATGM, the M60A1 can proceed to engage the position with either HEAT or APDS rounds or take evasive action. Probability of hit will be determined and degradation or destruction of ATGM ascertained.

5.4.2 Maneuvering - Maneuvering such as the effective use of terrain will be expected to be used by the Blue Force as standard operating procedure (SOP) during their advance. Specific maneuvering countermeasures can be initiated by M60A1 tanks after receiving warning of ATGM via visual detection or ATGM detection device (radar/infrared). The criteria for determining whether an M60A1 has either visually acquired the threat or received warning from an ATGM detection device will be the same utilized in determining whether the M60A1 could engage a target with the tank main gun via visual or automatic alarm threat detection.

It is expected that utilizing these maneuvers alone will have a minimal effect as a countermeasure. However, it is expected that maneuvering with smoke and maneuvering with the high intensity lamps will provide a degradation in the effectiveness of Red ATGM. Once maneuvering is initiated, the BREWS program will ascertain the probability of hit, kill, and damage assessment.

5.4.3 Smoke - Visual ATGM detection or ATGM detection device (radar/infrared) warning will determine the M60A1 capability to initiate a smoke countermeasure. Once the M60A1 deploys smoke, with or without maneuvering, the BREWS program will ascertain the hit or miss by the ATGM by correlating the effect of the smoke in conjunction with the programmed ATGM flight profile.

5.4.4 High Intensity Lamp - The two high intensity lamps that will be used as countermeasures will be the high intensity lamp visual (HILV) and the high intensity lamp infrared (HILIR).

5.5 Basic Engagement for the First Generation ATGM Threat

The engagements for this study will be played at a very high resolution to effectively evaluate the design characteristics and performance of ECM hardware in a battlefield environment. scenario is developed from SCORES on specially selected terrain. The engagement is formulated in context of an overall battle plan and is developed so as to provide a basis for playing the engagement with and without countermeasures.

It is recognized that the procedure that must be followed is iterative and that this first cut of the scenario is only a preliminary version that must be refined before any meaningful analysis can be attempted. It is anticipated that this initial version will provide a framework not only for tactical refinement but for the development of appropriate strategies for the utilization of ECM hardware. The goal of this initial scenario description is to identify the basic elements of the engagement and to ensure that the segments of events are in fact realistic within the bounds of the nature of the terrain, the size and elements of the opposing forces, the formation and/or deployment of the units involved, and the actions assumed in the movement and maneuver to engage.

5.5.1 Situation - The scenario is concerned with the interaction of two opposing armored forces. The Red Force which is the defending unit, is a motorized rifle battalion positioned in the northeast portion of the engagement area. The Blue Force which is the attacking unit, is a tank heavy brigade task force advancing from the southwestern portion of the engagement area. The area of engagement as shown in Figure 10, is moderately hilly, rolling terrain located in West Germany. Running throughout the area are several main arterial roadways, one running directly north and south and the other running to the northwest. Additionally there are numerous secondary and unimproved roadways throughout the area. The ground cover over the northeastern portion of the area is primarily forested with both coniferous and disiduous trees. A major portion of the terrain in the

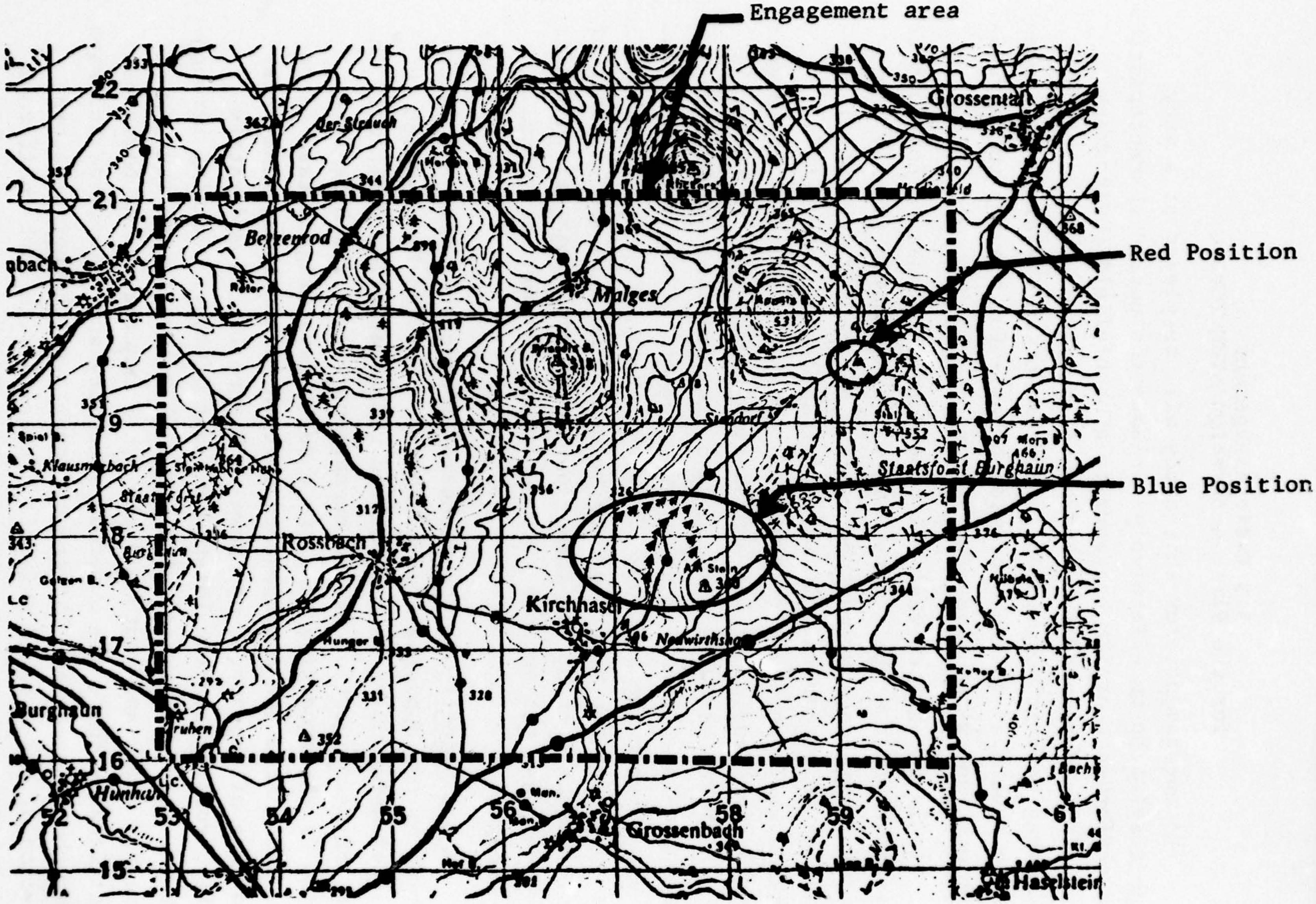

Figure 10. Area of engagement.

southwestern half of the engagement area is covered with numerous small cultivated plots, several hundred meters along the side. There are three main towns located in the area, they are Rossbach, Malges, and Kirchhasel. In addition there are several other small village type clusters, including one at grid reference 5819 of Stendorf.

The Red Force has positioned several motorized rifle platoons defending passes that are possible routes of advance of the Blue Forces. Each platoon consists of three squads, operating with BMP vehicles. The BMP armored vehicle is equipped with SAGGER type missiles and a 73 mm smooth-bore gun. Each squad is also equipped with a RPG-7 crew for antitank support. The initial Red deployment (see Figure 11) has each rifle platoon operating separately and defending one pass through the hills located in the northeast portion of the area. The BMP vehicles will fire missiles from camouflaged positions and each RPG-7 team is located under concealment approximately 300 m forward of its BMP.

The Blue Force lead element is a company team consisting of two tank platoons and a mechanized infantry platoon. There is a total of 18 vehicles; 12 M60A1-tanks, four armored personnel carriers, and two M106-mortars (4.2 inch). Of the 12 tanks there are five in each platoon with the remaining two tanks command and communication vehicles. The infantry platoon includes three squads of 11 men each, each operating out of a M113 Armored Personnel Carrier (APC). In addition there is a M577 APC for communication purposes.

The formation of this team is shown in Figure 12. The two tank platoons in echelon (left and right) form a wedge with the APC in open column in the pocket. Trailing the main formation by 500 to 700 m are the two M106-vehicles postioned to allow for effective target ranging; approximately 1000 m ahead of the basic wedge. Nominal spacing of all vehicles is 50 m.

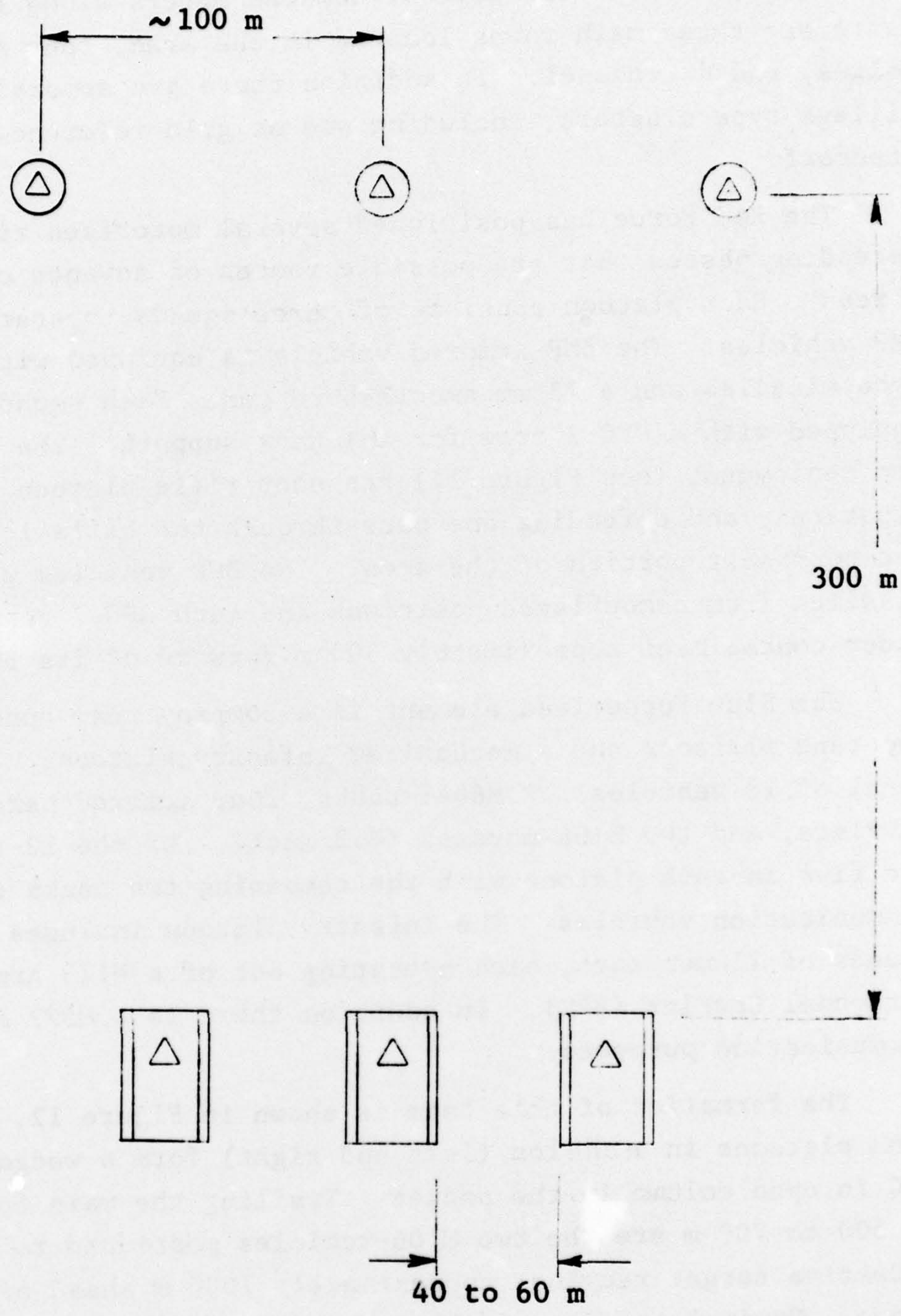

Figure 11. Red initial deployment of motorized rifle platoon.

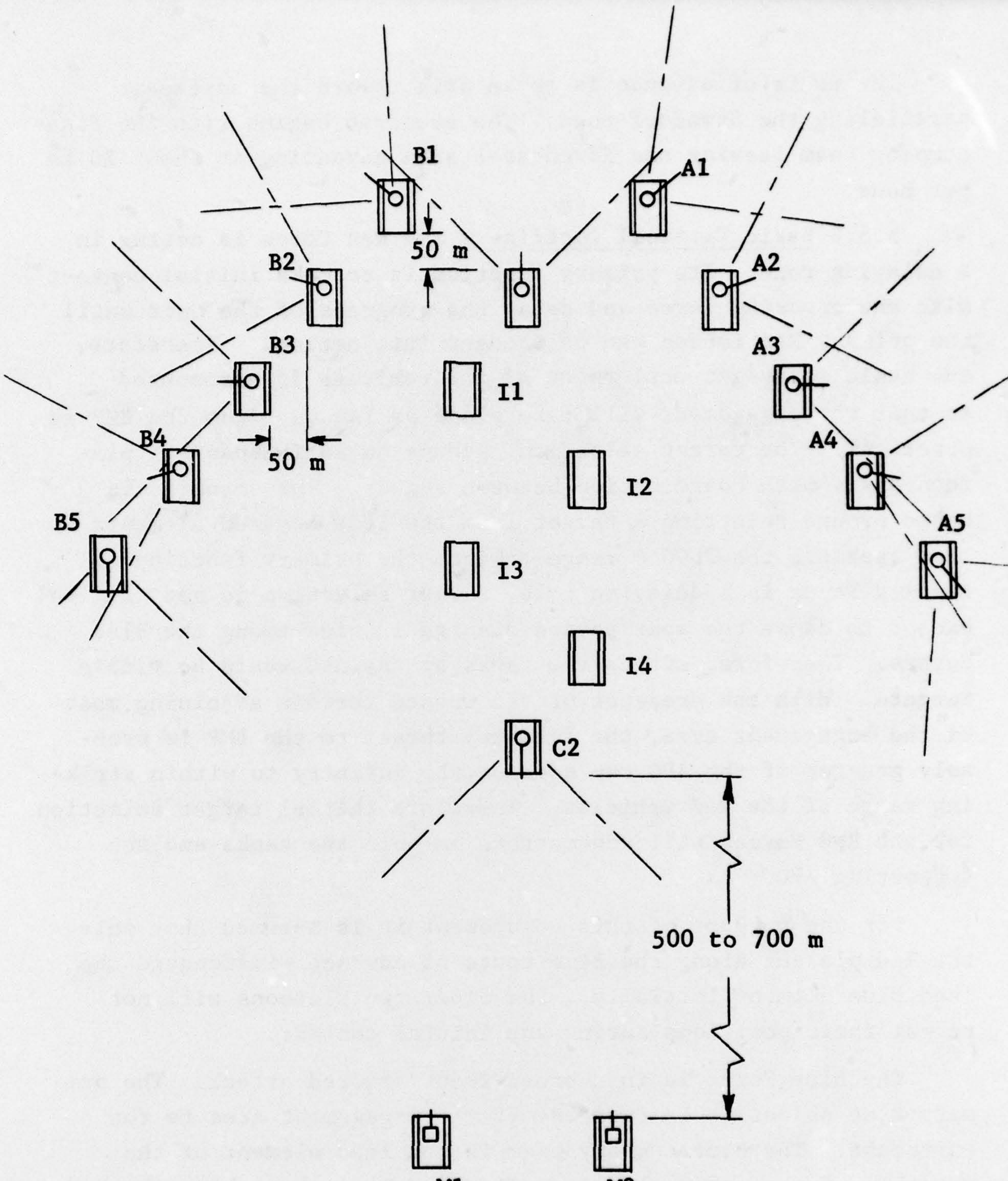

Figure 12. Blue initial formation of company team.

The route of advance is on an axis toward the northeast paralleling the Stendorf road. The scenario begins with the Blue company team leaving the Kirchhasel area advancing at about 20 km per hour.

5.5.2 Basic Tactical Doctrine - The Red Force is acting in a delaying role. Its primary function is to make initial contact with the opposing force and delay the progress of the unit until the primary Red forces can be brought into action. Therefore, the basic strategic deployment of the vehicles is structured so that the engagement will take place as far out from the BMP as practical. The target selection is done on an independent platoon basis with coordination between squads. The scenario is based around selecting a target from the lead armored elements as they approach the 2000 m range. Since the primary function of the Red Force is a delaying role, target selection is not critical except to cause the most severe disorganization among the Blue Forces. Therefore, either the tanks or the APC would be viable targets. With the presence of the wooded terrain adjoining most of the engagement area, the infantry threat to the BMP is probably greater if the APC can advance the infantry to within striking range of the Red vehicles. Therefore initial target selection for the Red Forces will concentrate on both the tanks and the supporting APC.

For the purpose of this engagement it is assumed that only the Red platoon along the Blue route of advance will engage the lead Blue element initially. The other two platoons will not reveal their positions during any initial contact.

The Blue Force is in a broad front armored attack. The primary Blue objective is located off the engagement area to the northeast. The Blue company team is the lead element of the attacking force, therefore its primary role is breaching the Red defenses as quickly as possible. Additionally it has a role of identifying and spotting any potential Red defense forces. The selected route of advance is such as to proceed between the two hills located at grid references 5820 and 5918. In the event of an attack by Red Forces the Blue tactics will be to stop the armored platoon coming under the most direct fire and return fire to the Red unit. The other Blue armored platoon along with the infantry support units will advance the nearest covered position. After the first armored platoon has returned fire they will then advance to covered positions. Then both armored platoons will attempt to advance toward the Red unit and neutralize the delaying force. As necessary the mechanized infantry may be called upon to attempt to outflank the RPG-7 defense units and neutralize the BMP. In either event, the primary objective for the Blue Force is to break through the Red defense as quickly as possible.

5.5.3 Opening Engagement - The engagement begins when the lead Blue vehicle is at a range of approximately 2000 m from the Red Force. At this range each BMP squad selects one target and launches a missile. The assumption is made that the Blue vehicles targeted consist of one of the lead tanks in each platoon and one of the infantry APC in the trailing column formation. Time of flight for the missiles at this range will be approximately 17 sec from launch. It is assumed that the only detection available to the Blue Force is visual and that the vehicles are not in a "buttoned up" condition. Therefore the vehicle commanders are exercising primary visual surveillance of the terrain. This surveillance will not assure detection of a launch and/or missile-in-flight at a range in excess of 2000/1500 m respectively.

It is assumed, for discussion purposes that two out of the three missiles hit and kill and the third misses. The disabled vehicles are a tank in the platoon on the left flank and an APC. This miss is correctly identified as a missile by the surviving tank commander.

The Blue response is as follows:

1. The tank platoon on the left flank comes to a halt. The four remaining M60s then fire in the general direction of the launch. Since at this point it is assumed that the specific point of launch is not known, the suppression of another launch is attempted.
2. The tank platoon on the right flank turns toward the wooded area on the immediate forward right. Following this armored platoon is the infantry support group.
3. After the initial firing by the Blue Force the platoon on the left flank then moves to take covered positions in the depressed area to the forward left of the initial route of advance.

It is highly probable that the Blue firing has no affect upon the Red Forces. Therefore it is assumed that the Red Force proceeds to reload and launch a second missile salvo. As the Blue Force is attempting to advance to covered positions, the Red Force selects targets from the armored infantry group and the armored platoon on the right flank. The Blue Force is now actively surveying the area of launch and visually detects the second launches. The vehicles selected as targets are not immediately determinable by the Blue Force, however, an appropriate maneuvering action is taken by all vehicles consisting of either a series of zigzag maneuvers during the missile flight, or sudden turn(s) and/or stop(s) during the last few seconds before impending impact.

The tank platoon on the right flank has now reached the wooded area. The APC proceed up paths in the woods to dismount the infantry within striking range of the defending BMP.

While the infantry is proceeding to attempt a flanking maneuver, the two M106-mortars advance and provide artillery cover fire. Both tank platoons now advance in bounds and overwatch toward the range (approximately 1200 m) at which point their main guns can be utilized effectively.

5.5.4 Countermeasures - The introduction of the various countermeasures to be employed in this scenario will take place at the logical point of occurrence. In addition to maneuvering, the available countermeasures will include the launching of smoke by the tanks, the return fire with main gun armament, or the use of HILV. Each of these active hardware countermeasures requires the definitive location of the Red vehicles with the possible exception of the smoke launch equipment. However, even with smoke it is essential that at least the quadrant in which the launch took place be identified.

Additional countermeasures available to the Blue Force include two types of radar detectors and two types of infrared detectors. Basically, the difference between the two types of each will be that the simpler will be only a warning device where as the other, or more advanced, will be able to track the missile.

5.5.5 Additional Considerations - The basic scenarios will be structured in such a manner as to prevent the Blue Force from overrunning the Red Force or from approaching to within the 1200 m range in a reasonable period of time without the use of ECM. This structuring will provide for a valid evaluation of each of the passive countermeasure systems.

6. PROJECT STATUS

6.1 Activity During Current Quarter

Effort during this first quarterly period, July, August, September 1976, has been directed toward:

- definition of the ATGM-ECM problem in the context of an integrated battlefield
- preliminary model modification of BREWS
- preparation of the data base for BREWS

It is anticipated that these areas will be completed during the next quarterly period. The following specific activities are currently in progress:

- preparing preliminary map and feature overlays; appropriate high resolution maps have been ordered and preliminary environmental data are being obtained from a large area map
- preparing input data for vehicles and weapons
- preliminary modeling of tactics, doctrine, and operations
- modification to the line-of-sight routines of BREWS
- formulation of routines for the ATGM threat; preliminary descriptions of the flight profiles are being estimated; It is anticipated that detailed path/time functions will be provided by EWL during the next reporting period.

6.2 Planned Activity for Next Quarter

- Completion of current activities above
- Debug BREWS/VER1
- Debug data base for BREWS/VER1
- Continue BREWS modeling refinements
- Continue preliminary analysis

6.3 Status of Project Effort

The work effort expended to date is 449 man-hours and 16.2 percent of the contract.

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