

NAVAL POSTGRADUATE SCHOOL Monterey, California



THESIS

**SITUATIONAL AWARENESS DATA REQUIREMENTS
FOR A COMBAT IDENTIFICATION NETWORK**

by

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September 2000

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IDENTIFICATION NETWORK**

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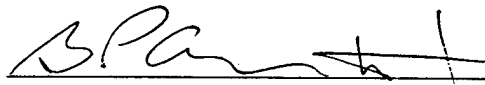
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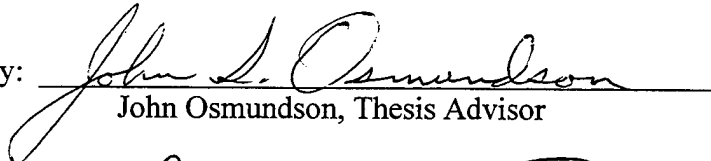
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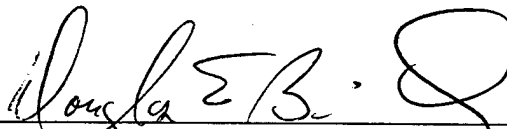


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ABSTRACT

The modern battlefield is extremely lethal. Many weapons systems provide the capability to engage a target far in excess of the range at which positive target identification can be made. This capability increases the likelihood of inadvertent engagement of friendly forces or, fratricide. Numerous initiatives have been undertaken to provide solutions to reduce fratricide. These solutions generally focus in one of two areas: target identification or situational awareness. Several situational awareness systems are under development. The Marine Corps has explored the concept of improving situational awareness through a mobile network application; however, the requirements for this system are not well understood.

One method of identifying the situational awareness requirements, which was used in this research, was through simulation. Three simulated combat environments were modeled (urban, mixed, and mountainous desert terrain) and the interaction of forces in the environments was observed. Based on the observations and the author's experience, conclusions were drawn about the requirements for a network situational awareness system. Principle findings of this research include system update rates, visual display resolution, and when situational awareness or target identification systems are preferred.

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EXECUTIVE SUMMARY

CID is the process of obtaining an accurate characterization of all potential targets in a combatant's area of the battlefield so that high confidence, real-time application of tactical options and weapons resources can occur [Ref. 1]. Numerous Combat Identification (CID) initiatives have been undertaken to reduce fratricide on the battlefield. One element of CID is situational awareness (SA). SA is the real-time, accurate knowledge of one's own location, the location of other friendly forces, the location of enemy forces, and the location of neutrals [Ref. 1]. To meet the SA portion of the CID requirement, the Marine Corps has initiated a series of advanced concept technology demonstrations (ACTDs) entitled, "Extending the Littoral Battle-space" (ELB). The ELB or a similar system, would ultimately provide Marines with a mobile, tactical network in which operational data, including SA information, could be exchanged. To date, the development process of the ELB has emphasized construction of the network over analysis of the data required to perform the SA function of CID. Consequently, the data that is required to provide SA, at the lowest unit levels in a network environment, is not well understood.

This thesis seeks to contribute to ongoing CID system research by determining requirements for providing SA through a network application using position location information (PLI).

A four-phase methodology was used in conducting this study of SA. In the first phase, a review of on-going initiatives in CID, future Marine force structure and doctrine, and the anticipated threat was conducted. The second phase entailed constructing a series

of detailed simulations modeling a range of environments and conditions in which Marines are expected to operate in the future. Three scenarios were modeled using the Janus simulation tool. The initial scenario modeled a Military Operation on Urban Terrain (MOUT) in which a small Marine infantry battalion cleared a town defended by a threat force. Next, a scenario was modeled in which a reinforced Marine infantry battalion attacked to open a route defended by a mechanized enemy force in an area of mixed open and close vegetation and terrain. The last scenario modeled a reinforced Marine Expeditionary Brigade size operation against a reinforced, heavy mechanized enemy force in a mountainous desert environment. Each model additionally contained a coalition force operating adjacent to the Marine force.

The three scenario models were run in the third phase of this research. Observations were made of the interaction among the forces in each scenario and results of the interactions were collected. In phase four, observations of the interaction of virtual forces were combined with Marine Corps doctrine; tactics techniques, and procedures; and the author's experience (as an infantry commander in the Fleet Marine Force, as a Weapons Tactics Instructor, and as a controller/instructor through 20 Combined Arms Exercises) to produce SA data requirements.

Several important findings result from this study. In MOUT, SA becomes more important than target identification. An update rate of one to two seconds is required to accurately reflect PLI. SA devices should be capable of aggregating and de-aggregating units and zooming to a level of resolution appropriate for the user's area of interest and required view. Additionally, SA devices should be deployed at the lowest level possible; equipping individuals with SA transmitters would provide the most accurate depiction of

the disposition of forces in an urban battle space. For mixed terrain, mountainous desert terrain, or situations in which large scale operations are conducted, resolvable distances, as stipulated by the Marine Corps CID operational requirements document (ORD), appear satisfactory. However, during dismounted trench-clearing operations, a resolution to 10m and an update rate of approximately three to five seconds is required.

To expand on the results of this study, additional simulations could be conducted in which Marines control the virtual forces employed in the Janus scenarios. Using Janus in this war-game like manner would allow a team of qualified Marines to evaluate the effect of human intuition and indecision on SA requirements, CID, and fratricide conditions.

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I. INTRODUCTION

Aleutian island of Kiska, 1942: The campaign on the island generated a fratricide toll of 28 killed and 50 wounded. As there were no enemy present, this was 100% of the casualties suffered by the well trained but inexperienced forces [Ref. 1].

Persian Gulf, 1990: U. S. forces were involved as victims in 22 reported fratricide events. Seven of these events (32%) involved the U. S. Marines and resulted in 21 casualties (14 killed and 7 wounded). The number of incidents in which Marines were victims was disproportionate to the size of the Marine force in theater. In almost half (43%) of the Marine Victim incidents, Marines were also the shooters [Ref. 1].

A. BACKGROUND

The modern battlefield is dynamic and chaotic. Combat operations are characterized by high tempo, fast closing speeds, long weapon ranges, first round kill capability, and quick firing decisions. The lethality of the combat environment has increased decision-makers demand for timely, accurate information to improve situational awareness, limit uncertainty, and reduce fratricide. A fundamental element of this information is Combat Identification.

Combat Identification (CID) is the process of obtaining an accurate characterization of all potential targets in a combatant's area of the battlefield so that high confidence, real-time application of tactical options and weapons resources can occur [Ref. 4].

It is generally accepted that three elements comprise the CID process: target identification (TI); situational awareness (SA); and tactics, techniques, and procedures (TTPs) [Ref. 1]. Situational awareness is the real-time, accurate knowledge of one's own location, the location of other friendly forces, the location of enemy forces, and the location of neutrals. Target identification is the ability to interrogate or recognize—as friend, enemy, or neutral—potential targets to aid weapons operators in shoot-no-shoot

decisions. TTPs are tools used by the war fighter to augment sensors and maximize the use of available resources. These three elements, SA, TI, and TTPs, provide war fighters with information and decision tools necessary to make engagement decisions during combat [Ref. 1]. SA and TI are facilitated by TTPs and other factors. SA is further amplified by accurate position location information (PLI). Position location information is data, self-reported or derived by active participation in a positioning network, which relates a friendly entity to a point on a map [Ref. 1]. Figure 1 depicts the relationship of the primary factors that influence CID.

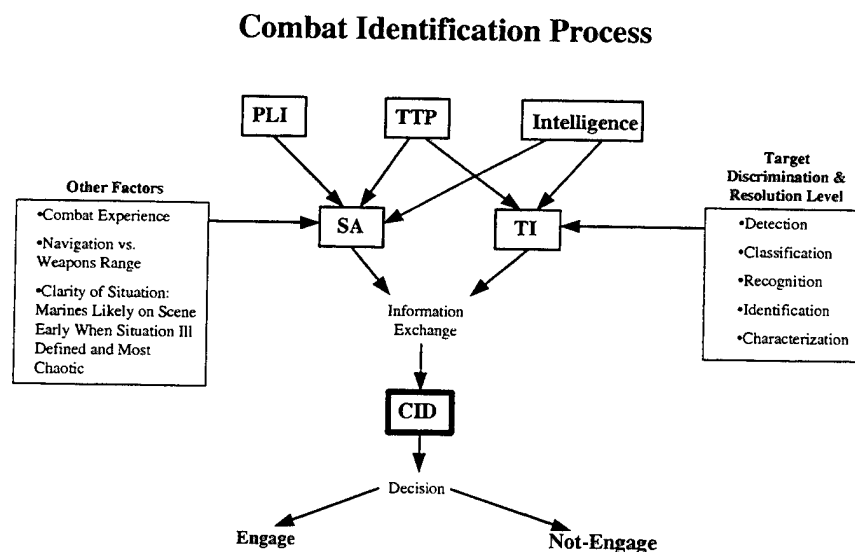


Figure 1. The Combat Identification Process

The Marine corps has determined the mission need for improved CID capability and has described the operational requirements for a CID system [Ref. 5]. The CID system, or system of systems, will be required to provide SA for commanders in near real

time and TI for shooters in real time under the full spectrum of battlefield conditions. Many existing devices are currently under evaluation to determine their suitability to meet the TI and SA portion of the CID system. Additionally, initiatives by the other military services are under consideration. To meet the SA portion of the CID requirement, the Marine Corps has initiated a series of experiments in new technology which include the use of a tactical, wireless network developed through commercial, off-the-shelf technology. The title of these wireless network experiments is Extending the Littoral Battle-space (ELB). It is envisioned that the ELB or a similar system, would ultimately provide Marines with a mobile, tactical network in which operational data could be exchanged. This data could include SA and possibly TI information. To date, the development process of the ELB has emphasized construction of the network over analysis of the data required to perform the SA function.

B. PURPOSE

This thesis will examine the situational awareness component of CID, to determine the data required to perform this fundamental battlefield function, when conducted as a network application using position location information.

C. SCOPE

This thesis will examine the situational awareness data required to conduct a network application of CID. The TI and TTP elements of CID will not be analyzed.

D. METHODOLOGY

A systems engineering approach was used to accomplish this research. An overview of the methodology follows. Modeling and simulation was used to observe the interactions of friendly and enemy forces operating in a variety of virtual environments.

Observations of the interaction of virtual forces was combined with Marine Corps doctrine, TTPs, and the author's experience (in the Fleet Marine Force, as a Weapons Tactics Instructor, and as a controller/instructor through 20 Combined Arms Exercises) to produce SA data requirements. The details of the process used follow. Initially, a literature search was conducted for background and amplifying information on the subjects of CID and SA. A review of the Marine Corps concept of employment for CID was conducted. A review of present and future threats, doctrine, force structures, equipment, and operational concepts was also conducted. Information gathered from this review was used to determine the possible Marine forces, threats, concept of operations, fire support, and operating environments likely in the future (each of these factors would then be modeled using a simulation tool). Upon completion of the review, simulation tools were evaluated and a tool selected. The tool was then used to construct the models and run the simulations. Finally, data generated by the simulations was compiled and reviewed.

E. RESEARCH QUESTIONS

1. Primary Research Questions

What situational awareness data is required to perform CID in a network application?

How do scenario variations affect situational awareness data?

2. Secondary Research Questions

In what physical environments should the simulations take place?

What are the appropriate size and composition of the simulated forces?

Which simulation tool should be used?

F. ORGANIZATION

This thesis consists of seven chapters. Chapter II describes the rationale for selection of the simulation tool used and details important aspects of Janus--the simulation tool selected. This chapter also discusses the selection of environments and forces modeled. Chapter III provides definitions of symbols and icons used throughout the remainder of the thesis. Chapters IV, V, and VI discuss the military operations on urban terrain (MOUT), mixed terrain, and mountainous desert simulation scenarios respectively. Chapter VII provides overall conclusions gathered from the simulations as well as recommended areas for further study.

G. BENEFITS OF THIS STUDY

Conclusions and recommendations of this study are expected provide initial requirements on which CID network architecture, design, and implementation decisions may be based.

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II. SELECTION OF SIMULATION, ENVIRONMENTS, AND FORCES

A. INTRODUCTION

The simulated scenarios used in this thesis needed to be reasonably accurate representations of future situations Marines might face. To ensure scenario accuracy, the appropriate physical operating environments, threat force composition, friendly force composition, and doctrine needed to be modeled. Additionally, a powerful, flexible simulation tool that could process this information was required. This chapter will discuss the selection of the simulation used to model force interactions, present an overview of important aspects of the selected simulation, and describe the selection of forces and environments implemented in the simulated scenarios.

B. SELECTION OF SIMULATION TOOL

1. Available Tools

Simulation tools reasonably available for use included Janus version 7.06dc, The Joint conflict and Tactical Simulation (JCATS), the High Level Architecture Warrior simulation (HLA Warrior), and the MAGTF Tactical Warfare System (MTWS).

The Janus simulation tool was locally available, UNIX based, and has been in use successfully for many years. Janus provides a high level of detail and functionality in its latest version, v7.06dc and is regarded as an accurate model. Contractor support for Janus was locally available.

The JCATS was not locally available but was accessible at other locations within one days travel to the Naval Postgraduate School (NPS). JCATS, a UNIX based tool, has been in use successfully for many years and is regarded as relatively accurate simulation.

JCATS provides greater detail than the other tools examined in its visual display of MOUT.

The UNIX based MTWS has been in use for many years throughout the Marine Corps, is well known, and viewed as reliable. The MTWS GUI is less user-friendly than the other tools examined. Although MTWS was installed and functional aboard NPS, no documentation or support was available.

PC based HLA Warrior was a new simulation tool developed by the TRADOC Analysis Center, Monterey, California. HLA Warrior was locally available and, although new, was regarded as reliable. Warrior is based upon the logic and algorithms of the Janus tool but improves on its performance by providing spreadsheet output. This output is then easily imported into common word processing and spreadsheet software for further analysis. However, because scenarios must be created in Janus, then executed in Warrior, operators must learn to use both systems. As a result, the length of the simulation learning curve is essentially doubled.

2. Simulation Selection

The Janus Simulation tool was selected for use in this thesis because of its history of reliability, local availability, and contractor support. Additionally, numerous terrain databases were available to support construction of varied scenarios.

C. THE JANUS SIMULATION TOOL

1. Overview

Janus is a high-resolution combat simulation tool, which allows users much flexibility in creating and executing scenarios. A wide variety of terrain databases and equipment templates are available to support scenario development from small unit

tactics through corps level operations. Weapons, personnel, vehicles, and aircraft are modeled in detail to appropriately represent combat system characteristics. These characteristics include primary and alternate weapon systems capability, sensor capability, mobility, survivability, and vulnerability. The tool also allows construction of new weapons systems and force templates. The interactions of the combat systems with each other, as well as the impact of the battlefield environment (i.e., weather, time of day, obscuration, and terrain features) on acquisition and engagement of targets, are represented at a high level of fidelity in Janus [Ref. 3].

2. Search-Detect-Engage (SDE) Algorithm

When a Janus scenario was run, all entities processed the search-detect-engage algorithm continuously. The algorithm is long, complex, and iterative. An overview of the algorithm:

During search, detection, and engagement the following are considered:

- Sensor Capability of the Observer
- Range From Observer to Target
- Target Posture (View Aspect, Defilade, Movement, Just Fired Signature)
- Weather Conditions
- Battlefield Obscurants
- Terrain and Vegetation
- Line of Sight
- Observer Field of View
- Observer Search Area Size
- Rules of Engagement

During engagement, the following are additionally considered:

- Weapon Range
- Ordnance Type and Characteristics
- Ammunition Load
- Probability of Hit (P_H)
- Probability of Kill (P_K)

Although this algorithm is thorough, it fails to consider the following important points that affect simulation performance:

- Entity Situational Awareness of Adjacent Entities, Units, and the Scheme of Maneuver
- Human Intuition
- Human Indecision

By omitting the capability for entities to maintain situational awareness of adjacent units and the scheme of maneuver, Janus increased the likelihood of fratricide among same-side forces. This occurred because Janus allowed entities to immediately engage targets recognized, where friendly forces were likely to be located, before fully resolving the target's identification as friend or foe. The value by which this process increased fratricide was unclear. An example of this situation follows. Two rifle squads occupy two adjacent building on the same side of a street. Both squad leaders know the others initial location and the concept of operations, which directs them both to simultaneously attack North across the street at 0800. At 0800 both squads leave their respective building and begin the attack North. As they cross the street the Marines know they can expect enemy in the buildings ahead and will immediately engage targets that become visible. The Marines also expect to see the adjacent squad on their flank and therefore, must identify targets on the flank as friend or foe before making an engagement decision. The same situation in Janus plays-out differently. The Marines leave the buildings at 0800. If they recognize a target ahead or to the flank, they immediately engage, unless the target is first identified as a friend. The shooter will

continue to engage until the target is resolved to the identification level and determined to be a friend.

3. Janus Entity Situational Awareness (SA)

In a Janus scenario, sides are the fundamental division of forces. Example sides are Marines, Army, coalition, or enemy. When constructing forces during the development of a Janus scenario, same-side forces must be placed into groups. For example, all the platoons, squads, teams, and individuals within a Marine rifle company could be grouped together. Any combination of same-side forces may be grouped. The implication of grouping during a simulation is that information Janus provides to entities within the same group allows them to seemingly possess perfect situational awareness. The high level of SA within a group results in group members never engaging each other. Within a group, no matter how chaotic and convoluted the situation may be, fratricide will never occur. To work around this situation, same-side entities must be divided into as many groups as possible. The ideal situation would be to assign an individual entity (individual rifleman, single crew served weapon, individual tank) to a group essentially creating one group per entity. Unfortunately, the number of groups is restricted to the number of workstations available to process simulation data. As workstations were a limited resource during this thesis work, grouping was restricted to the platoon level. The result of platoon simulation grouping was to artificially enhance platoon internal SA, eliminate platoon internal fratricide, and reduce the overall number of fratricide incidents. The value, by which grouping decreased fratricide, was unclear.

While fratricide internal to platoons was eliminated, near miss situations, many of which would in reality produce fratricide, did still occur in the simulations. An example

of a situation in which near miss might result in fratricide occurs when a squad fires through an adjacent squad at an approaching enemy. While these near miss situations were noted in the observations of each environmental scenario, near miss fratricidal kills were not inflicted by Janus.

4. Effect of SDE and SA on Simulation Results

The Janus search-detect-engage algorithm artificially increased fratricide by an unknown value while situational awareness among same-group forces in Janus artificially decreased fratricide by an unknown value. Careful observation of the Janus simulation runs conducted for this thesis suggests that the cumulative affect of the search-detect-engage algorithm and group SA is only a slight overall increase in fratricide. Accordingly, it is believed that the fratricidal interactions observed in the simulation may be used reasonably conclusively.

D. SELECTION OF SIMULATED ENVIRONMENTS

The Marine Corps is projected to operate in a broad spectrum of environments in the future [Ref. 6]; consequently, the diversity of these environments needed to be captured in the simulated scenarios modeled. Open desert, jungle, mountainous, arctic, wooded, urban, and ocean are some examples of possible operating environments. Janus provided a library of numerous virtual environments that were available off-the-shelf. This eliminated the time and difficulty of constructing new terrain databases, which was outside the scope of this thesis. In selecting the environments used in the scenarios, the following concepts were considered:

- Increasing Urbanization of the Global Population
- Location of Areas of Interest to the United States

- Likely Future Conflict Areas
- Balance in the Range of Scenario Environments
- Focus on Periods of Peak Interaction of Forces Over Lengthy Maneuver
- Availability of Terrain Databases

The rationale for the environments used in the simulated scenarios follows:

As the world's population shifts towards urban centers, they will become likely locations for operations [Ref. 6]; therefore, a military operations on urban terrain (MOUT) scenario was selected for evaluation in this thesis. The McKenna MOUT site at Fort Benning, Georgia provides the setting for the MOUT scenario.

A significant portion of the world's population and resources are located in desert regions. The United States maintains interests in many desert locations as well. Consequently, a desert scenario was selected for evaluation. Open desert tends to provide long line of sight between entities which, affords forces operating in open desert conditions with individual and unit SA higher than many other settings. To provide a more dynamic situation with shorter lines of sight, the mountainous desert environment of Fort Irwin, California was used as the setting for the desert scenario.

A scenario that contained varied terrain and vegetation was also desired to balance between the urban and desert environments. South central France was selected for this scenario environment because it provided a mix of open and close terrain and vegetation types with numerous small towns located along the mobility corridors.

The scenarios focus on high tempo, high intensity combat operations in which the enemy is directly engaged. Scenarios depicting humanitarian assistance operations, lengthy maneuver without contact, and bypass of enemy positions were omitted. A humanitarian assistance operation was omitted because no simulation tool available

provides adequate capability to model this scenario. The other types of operations were omitted because they were expected to put less stress on SA than situations in which friendly, enemy, and coalition forces engage in close proximity.

E. SELECTION OF FORCES TO MODEL

Marine forces, coalition forces, and threat forces were included in each simulated scenario.

1. Marine Forces

Marine forces operate as task organized units known as Marine Air Ground Task Forces (MAGTFs). These organizations range from Marine Expeditionary Unit (MEU), through Marine Expeditionary Brigade (MEB), to Marine Expeditionary Force (MEF) in size. MAGTFs are task organized for the specific mission and, in the future, are likely to be employed primarily as operational maneuver elements from a sea-base. When using the sea-basing concept, as much infrastructure as possible will remain at sea while only necessary combat forces are sent ashore [Refs. 6, 7, and 8]. The concepts of MAGTF task organization and sea basing were represented in the scenarios modeled. The scenarios cover a range of unit sizes through MEB level. Little information on the future force structure of the Marine Corps was available other than the introduction of new systems such as the Advanced Assault Amphibious Vehicle (AAAV), lightweight 155m howitzer, 120mm mortar, High Mobility Artillery Rocket System (HIMARS), Javelin, AH-1Z, UH-1Y, V-22, and joint strike fighter (JSF). These systems or their capability were represented in the scenarios modeled. Other aspects of the Marine force structure were based upon existing tables of organization and equipment.

Other capabilities included in the modeled scenarios:

- Infantry Operations
- Mechanized Operations
- Mounted and Dismounted Movement
- Light Armored Vehicle Operations
- Helicopter-borne Operations
- Military Operations on Urban Terrain
- Close Air Support, to Include Both Fixed and Rotary Wing Missions
- Unmanned Air Vehicle Reconnaissance
- Indirect Fire Support

2. Coalition Forces

In the future it is expected that U. S. forces will operate along-side forces from other nations [Ref. 6]; accordingly, a coalition force was included in each scenario to represent this condition. The coalition force for each scenario follows a model based upon a lightly mechanized, United Kingdom, Royal Army battalion equipped with Fox light armored reconnaissance vehicles.

3. Enemy Forces

The threat of the future may take many forms ranging from disorganized, lightly armed irregulars to organized, disciplined, armored and mechanized forces. For the purposes of the scenarios modeled for use in this thesis, the threat was structured as a well organized, armored, mechanized, and infantry force equipped with the latest generation of former Soviet Union (FSU) weapons systems and tactics. This type threat force was selected for use in the modeled scenarios because of its capabilities in the areas of survivability, mobility, firepower, sensors, and long weapon ranges. It was assumed that these factors would contribute to creating the most challenging CID environment for Marines. Additionally, FSU weapons and tactics are expected to remain in prevalent use throughout many nation states for the foreseeable future.

F. CHAPTER SUMMARY

Using the Janus simulation tool, scenarios were constructed in three terrain environments: urban, mixed, and mountainous desert. Various forms and elements of the MAGTF, U.K. Royal Army, and armored-mechanized-infantry threat comprise the forces interacting in the scenarios. The details of these scenarios are presented in later chapters.

III. GENERAL SCENARIO NOTES

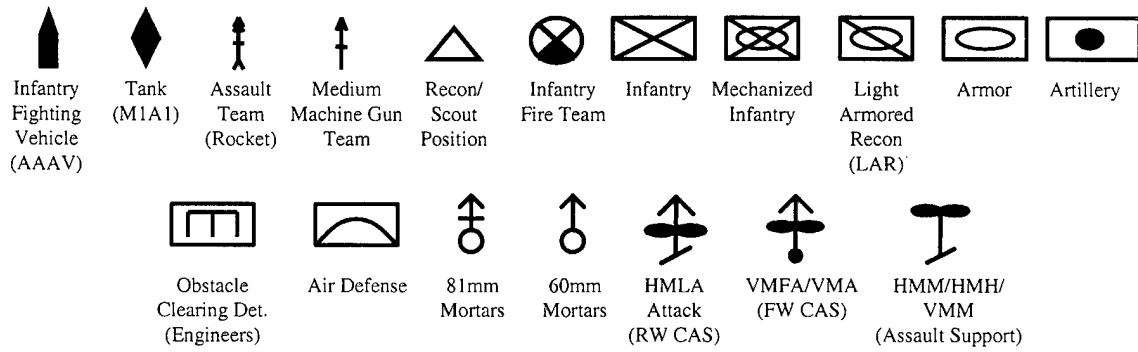
A. INTRODUCTION

Several issues are common to all the simulations conducted for this thesis. General military and Janus symbols, observed interaction types, and firing criteria are used throughout the discussion of the simulated scenarios. These common issues are described here, in detail, before presenting specific simulation results.

B. DEFINITION OF SCENARIO SYMBOLS

Before discussing and displaying important aspects of the simulated scenarios, common symbols used throughout Janus and this thesis must be defined. Common military and Janus specific symbols are provided. Figure 2 depicts common military symbols. Unit type symbols, unit size symbols, and example combinations of the two types is provided. Infantry fire-team and crew served weapons examples are also provided. Figures 3 through 5 depict entity symbols commonly observed in Janus. During a simulation run, Marine entities appear in blue, U.K. entities appear in purple, and enemy entities appear in red. Symbols used in Janus to represent most Marine equipment resemble the actual equipment. Notable exceptions are aircraft. In order to avoid creating drawings of Marine aircraft, existing drawings of Army and airforce aircraft were used in the simulations. The aircraft entities themselves were assigned the capabilities and weapons systems of the represented Marine aircraft.

Common Symbols for Entity and Unit Types



Symbols for Unit Size



Unit-Type Symbol Combinations

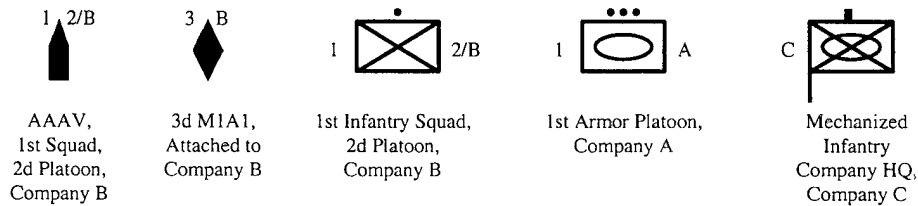


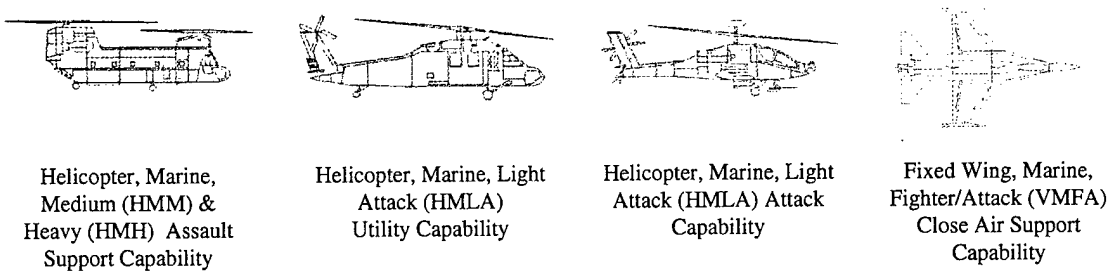
Figure 2. Common Military Unit Symbols

Example Janus Threat System Icons



Figure 3. Example Janus Threat Entity Symbols

Example Janus Marine Aircraft System Icons*



* Army and Airforce system icons assigned Marine aircraft capabilities in Janus simulations.

Figure 4. Example Janus Marine Aircraft Entity Symbols

Example Janus Marine and UK Ground System Icons

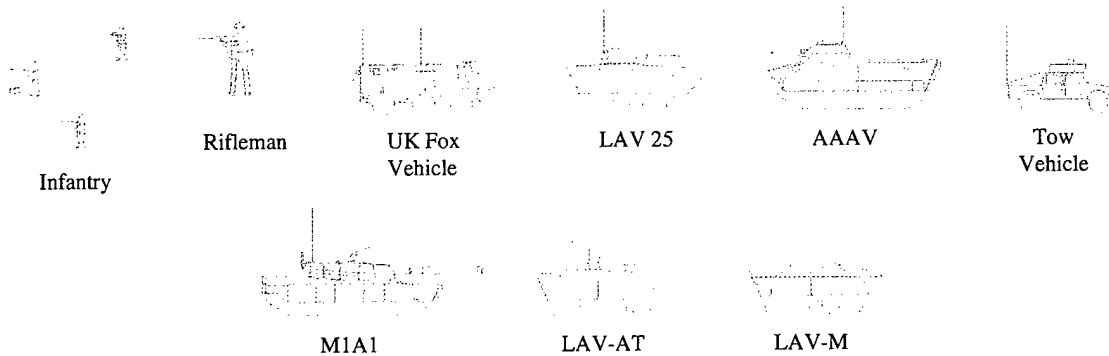


Figure 5. Example Janus Marine and UK Ground Entity Symbols

C. DESCRIPTION OF ENTITY INTERACTION

While the simulated scenarios ran, four types of interactions were observed among the entities. These interactions were classified as In Range, In Line of Sight, Near Miss, and Fratricide.

- In Range: Entities moved within range of each other's weapons systems.
- In Line of Sight: Entities move within visual range of each other and direct line of sight (LOS) exists between the entities.
- Near Miss: Entities are within range and LOS of each other and one of the following possibilities occurs. In the first possibility, a friendly shooter engages an enemy target while a friendly entity is present on the shooters

weapon-target line and within the shooter's weapon danger area. The friendly entity on the shooter's weapon-target line is unaffected by this engagement. In the second possibility, a friendly shooter intentionally engages another friendly entity mistaking it as an enemy. The shooter misses and the friendly target entity is unaffected.

- **Fratricide:** Entities are within range and LOS of each other and one of the following possibilities occurs. In the first possibility, a friendly shooter engages an enemy target while a friendly entity is present on the shooters weapon-target line and within the shooter's weapon danger area. The friendly entity on the shooter's weapon-target line is affected or killed by this engagement. In the second possibility, a friendly shooter intentionally engages another friendly entity mistaking it as an enemy. The friendly target entity is affected or killed by the shooter.

The interaction type, entities involved, and interaction time were recorded and presented in the results section for each scenario.

D. FIRING CRITERIA

Firing criteria must be established for forces in each Janus scenario. Janus firing criteria are roughly equivalent to rules of engagement (ROE) in that they prescribe the conditions under which an entity may engage a target. Three firing criteria selections are possible in Janus: aim-point, recognition, and identification. Using aim-point firing criterion, an entity detects a target and may engage it without resolving any detail about the target. An example of this firing criterion is a situation in which a shooter sees some movement ahead and engages the location of the movement without determining the type or identity of the target. This firing criterion would be used in situations where only enemy are likely to be encountered and the possibility of same-side forces interacting with each other is extremely low. Using recognition firing criteria, an entity observes a possible target and resolves the target to determine if it is a human, motor vehicle, armored vehicle, or, aircraft. The possible target may be engaged at this level of

resolution. An example of this firing criterion is a situation in which a shooter sees some movement ahead. The shooter observes the location of the movement and determines a human is the source of the movement. The shooter then engages the human without determining friend or foe. This firing criterion would be used in situations where hasty firing decisions are required. Using identification firing criteria, an entity observes a possible target and resolves the target to determine if it is a human, motor vehicle, armored vehicle, or, aircraft. The entity then further resolves the possible target to determine the specific type of entity observed, for example, human--Marine, tank--M1A1, armored vehicle--BMP. The possible target may be engaged at this level of resolution. An example of this firing criteria is a situation in which a shooter sees some movement ahead; the shooter observes the location of the movement and determines a human is the source of the movement; the human is determined to be an enemy; the shooter then engages the enemy. This firing criterion would be used in situations where time is available to make detailed firing decisions and absolute, positive target identification is required before engagement is authorized. In Janus, selection of identification firing criteria eliminates the possibility of fratricide among same-side forces.

E. CHAPTER SUMMARY

The symbols, entity interactions, and firing criterion described in this chapter are used throughout the following chapters. The chapters that follow discuss the MOUT, mixed terrain, and mountainous desert scenarios.

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IV. MILITARY OPERATIONS ON URBAN TERRAIN (MOUT) SCENARIO

A. INTRODUCTION

This chapter presents information about the MOUT scenario. Notes on the scenario terrain, forces, and concept of operation are outlined along with simulation parameters, and information describing the visual display of the scenario. Observations of the simulation are presented and conclusions are drawn from the observations.

B. SCENARIO NOTES

1. Terrain

The urban terrain constructed for this scenario consists of a small European style town containing 89 buildings of the following types:

Building Type	Number of Levels	Rooms Per Level	Construction	Height (m)	Number of Buildings of Type
House/ Apartment	2	4	Lumber/Siding/ Stucco	4	62
Commercial	3	8	Concrete/ Masonry	7	22
Warehouse/ Industrial	4	1	Lumber/Concrete/ Masonry	10	5

Table 1. Buildings in MOUT Scenario

The small town is located on a short, North-South oriented, ridge between two North-South running streams. To the Northwest and Southeast of the town are 500m x 250m swamps. High ground is located 500m West and 750m East. At its widest point, the town is 750m x 750m and covers an area of approximately 526,500m². The town is the

site of a junction between two primary roads and contains a rail line and siding. Figures 6 and 7 provide an overview and detail view of the layout of the town.



Figure 6. MOUT Scenario Terrain Map-Overview



Figure 7. MOUT Scenario Terrain Map-Detail

2. Forces

a. Friendly Force Composition

The Marine force in the MOUT scenario is made up of a reinforced mechanized company team, identified as Company B, and an adjacent reinforced mechanized infantry platoon, identified as 1st Platoon, Company A. Both units are reinforced by attached tank platoons and are supported by a single 81mm mortar platoon, engineers, one section of rotary wing CAS aircraft (HMLA-Attack), one section of assault support (HMLA-Utility) for casualty evacuation, an unmanned air vehicle for reconnaissance, and a Light Armored Reconnaissance (LAR) Company. Marine forces are organized and equipped according to Marine Corps doctrine.

b. Coalition Force Composition

An infantry company supported by Fox vehicles represents the coalition force. Platoons assigned to the company were organized smaller than their Marine counterparts and consist of 23 soldiers each.

c. Enemy Force Composition

The enemy force is organized as a mechanized company outfitted with standard FSU small arms and supported by BTR-70 vehicles. Enemy soldiers are deployed throughout. Specific positions were selected to establish fields of fire along streets, across open areas, and inside buildings.

3. Concept of Operations

The enemy force is deployed throughout the town to deny use of the railway and road junction. The general concept for employment of Marine and coalition forces:

- Company B: Clear enemy from the middle 50% of the town.

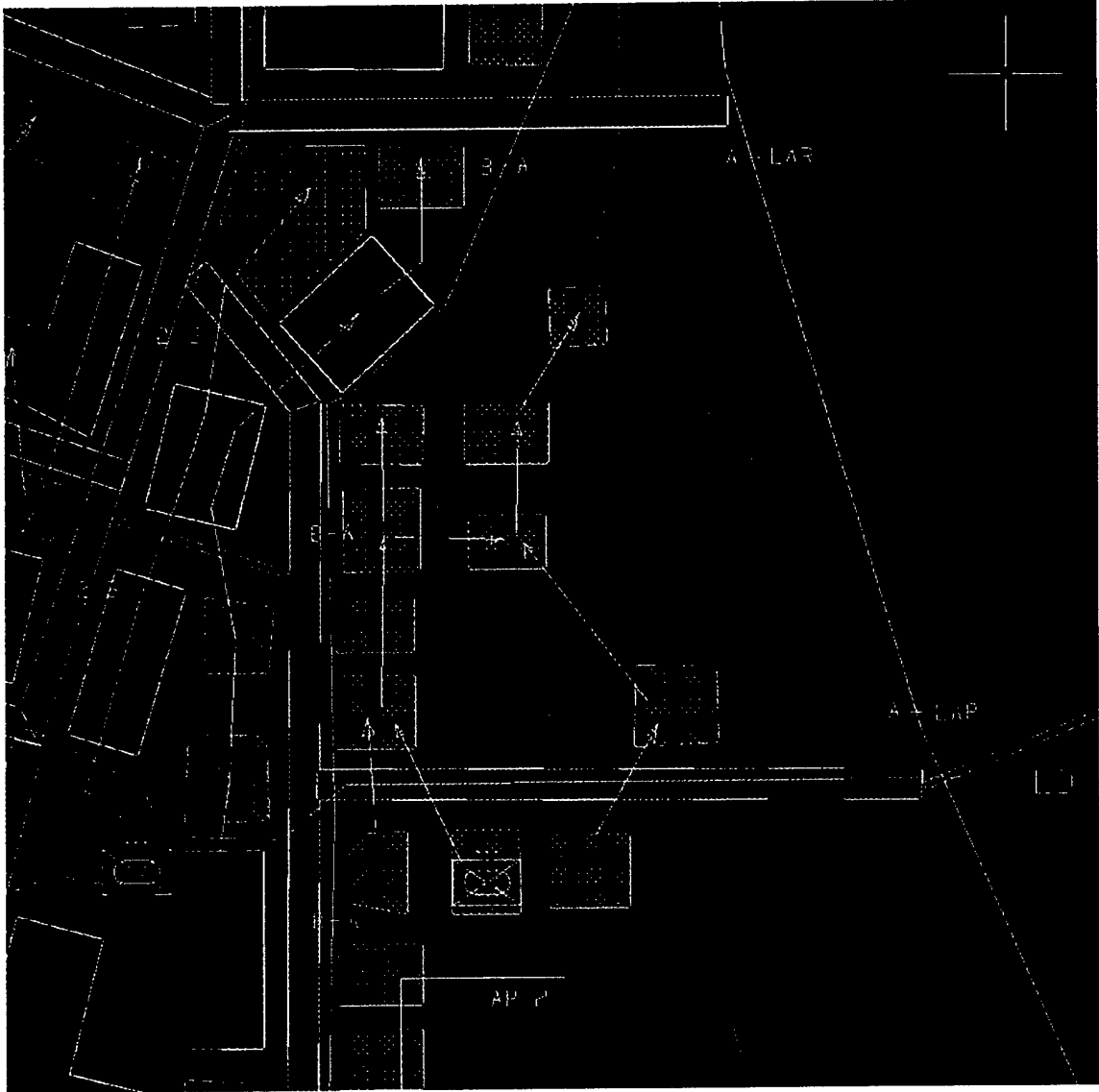


Figure 9. MOUT Concept of Operations Detail – 1st Platoon, Company A

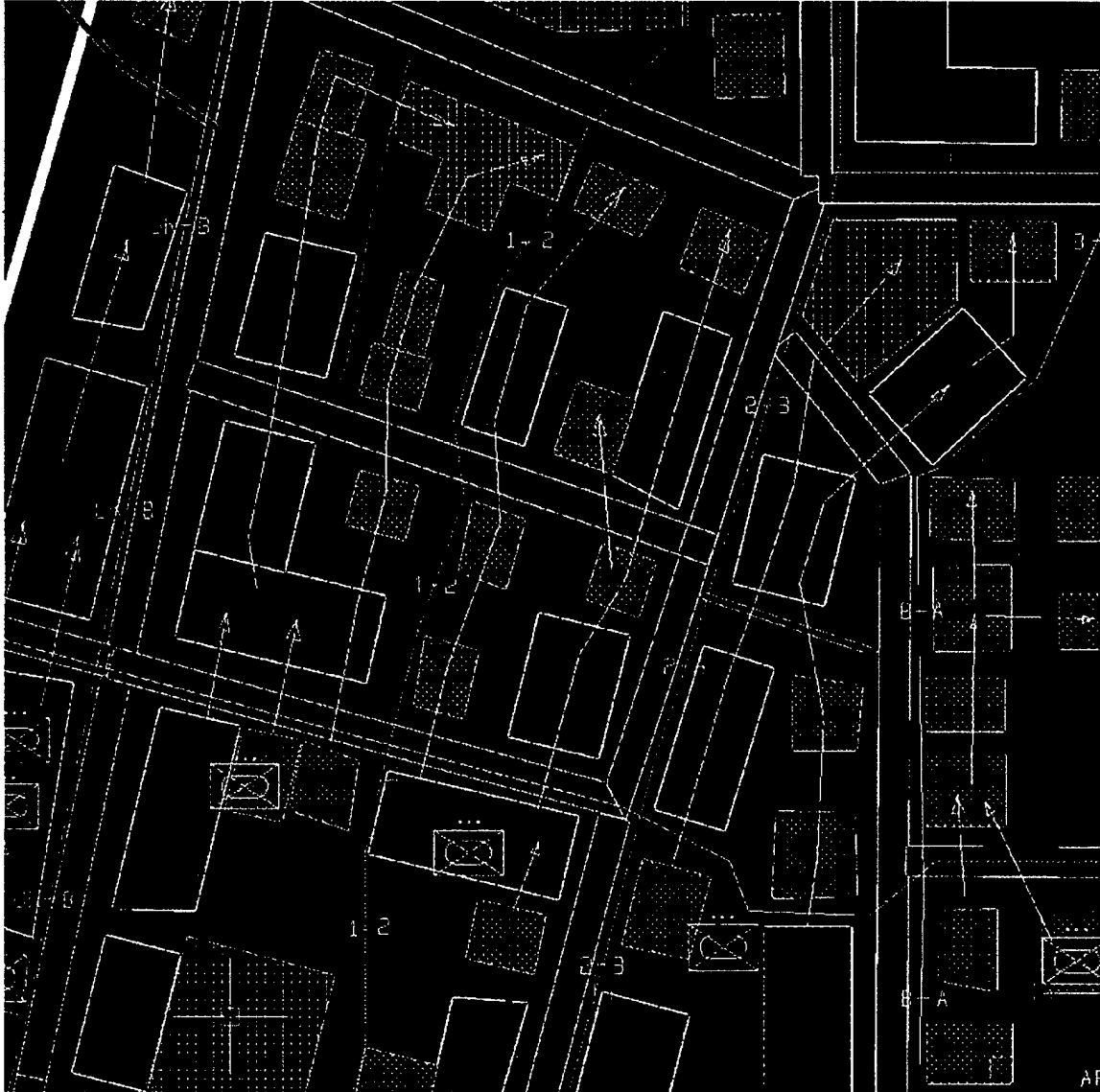


Figure 10. MOUT Concept of Operations Detail – Company B

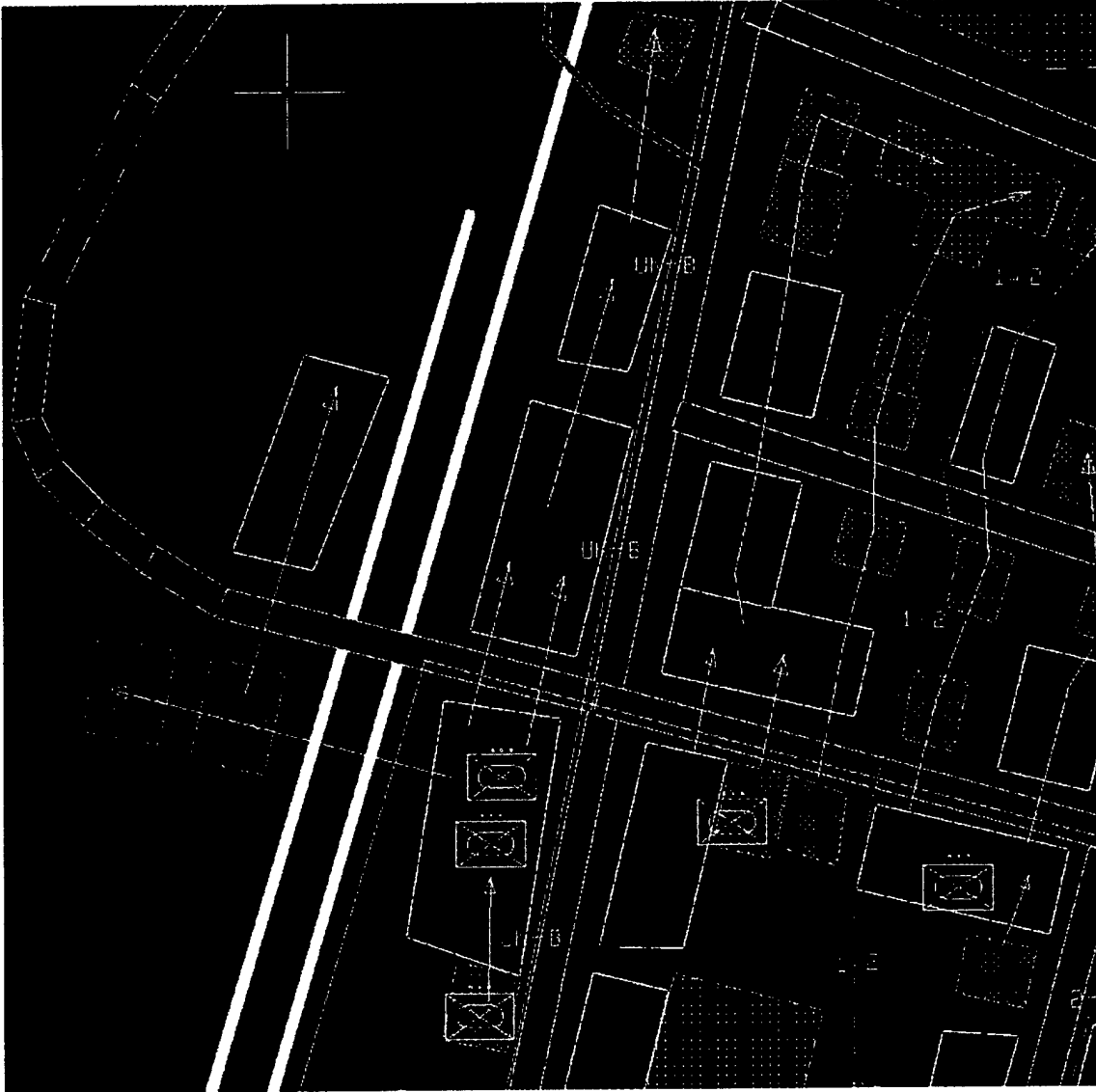


Figure 11. MOUT Concept of Operations Detail – UK

4. Simulation Parameters

Several parameters were set to establish baseline conditions for the MOUT scenario. The simulation was constructed to represent an attack commencing at 0800, on a clear, sunny day. Enemy, coalition, and Marine forces employed no battlefield obscuration. Obscuration was not employed in order to provide Marine forces with the highest opportunity to maintain SA, make positive target identification, and reduce

potential fratricide. The Janus fratricide capability was enabled for the scenario to allow misidentification and possible engagement of same-side forces. The firing criterion for all Marine and coalition forces was set to recognition. This setting was selected to represent the rapid shoot-no-shoot decisions required by the close range, short line of sight, of urban terrain and high intensity fight resulting from closing with a resolved enemy. Groups, which establish the extent of perfect situational awareness among entities, were set at the platoon level. Crew served weapons attached to and moving with platoons were not grouped with their respective platoon. Platoon size groups were established because the number of Janus workstations available was limited. As a result of this setting, no fratricide occurs between same-group entities. Again, it was assumed that the net effect of recognition firing criteria and platoon grouping, on total fratricidal interactions, was negligible.

5. Visual Display of Scenario

During the execution of a scenario run, entities are displayed in Janus as they move along their assigned routes into, out of, and between buildings. Janus does not present a visual representation of the interior floor plan of buildings. Consequently, room to room clearing and the inherent line of sight obstruction is not visually displayed. However, room to room line of sight obstruction is factored into the Janus search-detect-engage algorithm.

C. SCENARIO RESULTS

1. Fratricide Enabled vs. Disabled

For comparison, two runs of the scenario were conducted. In both runs, all parameters were set identically except the fratricide capability. A general comparison of

the interactions that occurred in the two runs is presented in Table 2. Comparison of the interactions within units and between adjacent units is presented. The number of occurrences and type of interaction is presented for each situation as well.

Comparison Between MOUT Fratricide Enabled and Disabled Simulation Runs

Unit	Fratricide Disabled Run	Fratricide Enabled Run
<i>Within Unit</i>		
1 st Pltn, Co., A (1/A)	N x 4	N x 2
3 rd Pltn, Co., B (3/B)		N x 2, F x 4
2 nd Pltn, Co., B (2/B)	N x 2	N x 1
1 st Pltn, Co., B (1/B)	N x 3	N x 5
Co. B, USMC (B)	N x 12	N x 11, F x 20
UK Co. (UK)		
LAR Co. (LAR)		
Aviation		
<i>Between Units</i>		
LAR - 1/A		
1/A - 3/B		N x 7, F x 13
3/B - 2/B		F x 9
2/B - 1/B	N x 7	N x 5, F x 14
B - UK	N x 7, F x 7	N x 1, F x 8
B - LAR		F x 2
Air - Ground	Note	Note
Total Interaction Incidents	USMC only: N x 28 USMC+UK: N x 35, F x 7	USMC only: N x 33, F x 60 USMC+UK: N x 34, F x 68

Note: Although no fratricide or near miss interactions occurred, CAS aircraft over-fired USMC and UK units on four occasions in both scenarios.

F = Fratricide Interaction

N = Near Miss Interaction

Table 2. Comparison of MOUT Fratricide Enabled and Disabled Simulations

Near miss incidents in the simulation do not produce the same effects on entities along the weapon-target line as would occur in reality. In Janus, no affect is produced. In real engagements, effects on entities on the weapon-target line range from no effect, through suppression, to catastrophic kill. Accordingly, it is assumed that in ether simulated scenario run, significant possibility of fratricide exists. The remainder of results presented in this chapter will cover the fratricide enabled scenario run.

2. General MOUT Observations

For the entire scenario, all entities remained within range of each other. As the Marine force advanced through the town, squads continually entered and exited line of sight windows to other squads. These periods of line of sight occurred between squads of the same platoon as well as across platoon boundaries. Line of sight windows that occurred within Marine platoons frequently resulted in near miss interactions. Line of sight windows that occurred between Marine platoons frequently resulted in both near miss and fratricide. This situation also occurred between the Marines and UK force.

State changes in MOUT occur when individual entities leave a room or building to enter an adjacent room, building, or open area between buildings. Marine and UK entity State changes occurred nearly instantaneously in the MOUT scenario as personnel moved through windows, doors, or other openings. While the condition of the currently occupied room or building was friendly when friendly forces were present and in control of the location, the adjacent room, building, or open area may be in a hostile (controlled by enemy) or an unknown condition. Marine and UK forces making a state transition into a hostile or unknown area were especially vulnerable to near miss and fratricide from

adjacent friendly entities that had line of sight and expected to see enemy forces in the area.

3. Entity Interaction Overview

Figures 12 through 20 chart the type of interaction (N = near miss, F = fratricide) and simulation time of each interaction within and between units. On all charts, shooters are plotted on the Y-axis, while targets are plotted on the X-axis. Where no interactions took place between units, no chart is provided.

Interactions Within 1st Platoon, Company A

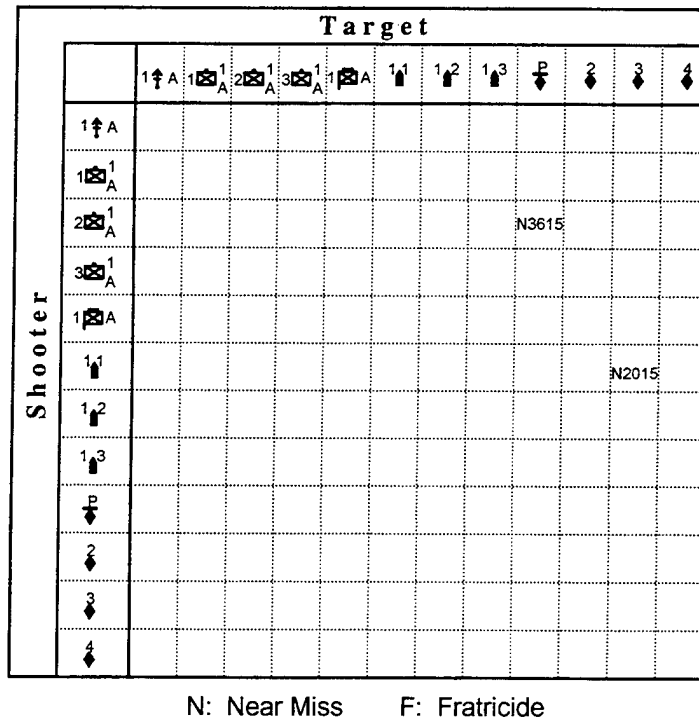


Figure 12. MOUT—Interactions within 1st Pltn., Co. A

Interactions Within 3d Platoon, Company B

		Target									
		3↑B	1☒ ³ _B	2☒ ³ _B	3☒ ³ _B	3☒ ³ _B	3☒ ³ _B	3↓	3↓ ²	3↓ ³	4
Shooter	3↑B		F1515								N2345
	1☒ ³ _B										
	2☒ ³ _B										
	3☒ ³ _B									N1145	
	3☒ _B										
	3↓										
	3↓ ²										
	3↓ ³										
	4										

N: Near Miss F: Fratricide

Figure 13. MOUT—Interactions within 3d Pltn., Co. B

Interactions Within 2d Platoon, Company B

		Target									
		2↑B	1☒ ² _B	2☒ ² _B	3☒ ² _B	3☒ ² _B	2↓	2↓ ²	2↓ ³	3	3
Shooter	2↑B										
	1☒ ² _B		N0000								
	2☒ ² _B										
	3☒ ² _B										
	2☒ _B										
	2↓										
	2↓ ²										
	2↓ ³										
	3										
	3										

N: Near Miss F: Fratricide

Figure 14. MOUT—Interactions within 2d Pltn., Co. B

Interactions Within 1st Platoon, Company B

		Target																			
		1↑B	1☒ _B ¹	2☒ _B ¹	3☒ _B ¹	1☒ _B ¹	1↓ ¹	1↓ ²	1↓ ³	↓ ^P											
Shooter	1↑B																				
	1☒ _B ¹				N2900																
	2☒ _B ¹				N1515																
	3☒ _B ¹		N3000	N1630							N3000										
	1☒ _B ¹																				
	1↓ ¹																				
	1↓ ²																				
	1↓ ³																				
	↓ ^P																				

N: Near Miss F: Fratricide

Figure 15. MOUT—Interactions within 1st Pltn., Co. B

Interactions Between 1st Platoon, Company A & 3d Platoon, Company B

		Target																							
		1↑ A	1☒ A	2☒ A	3☒ A	4☒ A	1↓	1↓	1↓	P	2	3	4	3↑ B	1☒ B	2☒ B	3☒ B	3☒ B	3↓	3↓	3↓	4			
Shooter	1↑ A																								
	1☒ A																								
	2☒ A																								
	3☒ A																								
	1☒ A																								
	1↓																								
	1↓																								
	1↓																								
	P																								
	2																								
	3																								
	4																								
	3↑ B																								
	1☒ B																								
	2☒ B																								
	3☒ B																								
3☒ B																									
3↓																									
3↓																									
3↓																									
4																									

N: Near Miss F: Fratricide

Figure 16. MOUT—Interactions between 1st Pltn., Co. A and 3d Pltn., Co. B

Interactions Between 3d Platoon, Company B & 2d Platoon, Company B

		Target																							
		3↑B	1⊠ ³ _B	2⊠ ³ _B	3⊠ ³ _B	3⊠ ³ _B	3⊠ ³ _B	3↓	3↓	3↓	4↓	2↑B	1⊠ ² _B	2⊠ ² _B	2⊠ ² _B	2⊠ ² _B	2⊠ ² _B	2↓	2↓	2↓	2↓	3↓			
Shooter	3↑B			F1515 F2345						N2345															
	1⊠ ³ _B													F2518											
	2⊠ ³ _B													F1120											
	3⊠ ³ _B									N1145															
	3⊠ ³ _B													F1115											
	3↓																								
	3↓																								
	3↓																								
	4↓																								
	2↑B																								
	1⊠ ² _B														F0000										
	2⊠ ² _B			F2518	F1115		F1115																		
	3⊠ ² _B																								
	2⊠ ² _B																								
	2↓																								
	2↓			F2245																					
	2↓																								
	2↓																								
3↓														F0900											

N: Near Miss F: Fratricide

Figure 17. MOUT—Interactions between 3d Pltn., Co. B and 2d Pltn., Co. B

Interactions Between 2d Platoon, Company B & 1st Platoon, Company B

		Target																				
		2↑B	1☒ _B ²	2☒ _B ²	3☒ _B ²	2☒ _B ²	2☒ _B ²	2↓ ₁	2↓ ₂	2↓ ₃	2↓	3↓	1↑B	1☒ _B ¹	2☒ _B ¹	3☒ _B ¹	1☒ _B ¹	1↓ ₁	2↓ ₁	3↓ ₁	P↓	
Shooter	2↑B																					
	1☒ _B ²		F0000										F2900		F2000	F2900						
	2☒ _B ²												F2900	F1500	F1500	F2815						
	3☒ _B ²																					
	2☒ _B ²															F1500						
	2↓ ₁																					
	2↓ ₂																					
	2↓ ₃																					
	2↓																					
	3↓		F0900																			
	1↑B																					
	1☒ _B ¹		F2900	F2900													N2900					
	2☒ _B ¹			F1515													N1515	N1630				
	3☒ _B ¹		F2015	F2815		F1500								N3000							N3000	
	1☒ _B ¹																					
1↓ ₁																						
1↓ ₂																						
1↓ ₃																						
P↓																						

N: Near Miss F: Fratricide

Figure 18. MOUT—Interactions between 2d Pltn., Co. B and 1st Pltn., Co. B

Interactions Between B, LAR, UK, and Snipers

		Target																																								
		1U	2U	3U	B	1B	1B	1 ₁	1 ₂	1 ₃	P	2B	2B	2 ₁	2 ₂	2 ₃	2	3	3B	3B	3 ₁	3 ₂	3 ₃	4	5	△																
Shooter	1U																										F3000															
	2U																																									
	3U																																									
	B	F1703	F3015				N1703	N3015				N3015																														
	1B	F1730	F2050																																							
	2B	F1630	F3000	F2316	F1630			N1515	N1815	N3000			N3000																													
	1 ₁																																									
	1 ₂																																									
	1 ₃																																									
	P																																									
	2B																																									
	2B	F1730			F1115	F1500	F1750	F2815																																		
	2 ₁				F2830	F2000																																				
	2 ₂																																									
	2 ₃																																									
	2																																									
	3																																									
	3B																																									
	3B																																									
	3 ₁																																									
3 ₂																																										
3 ₃																																										
4																																										
5																																										
△																																										

N: Near Miss F: Fratricide

Figure 19. MOUT—Interactions between Co. B, UK Co., LAR Co., and Snipers


Time of Air Engagement	Ground Entities in Open on Weapon-Target Line	Effect on Ground Entity
0:05:28	1 _{2/B} 2 _{2/B}	None
0:05:55	 2 _B 1 _{1/B} 2 _{1/B} 3 _{1/B} 1 _{2/B} 2 _{2/B} 3 _{2/B}	None
0:07:25	1 _{2/B} 2 _{2/B} 3 _{2/B}	None
0:20:29	1 _{2/B} 2 _B 3 _B 1 _{2/B} 2 _{2/B} 3 _{2/B}	None

Figure 20. MOUT—Interactions between Aviation and Ground Entities

Figures 12 through 20 show a significant number of near miss and fratricide interactions between entities (34 near miss, 68 fratricide). Although no actual air to ground interactions occurred in the simulation, the possibility of near miss and fratricide exists as a result of the 18 units over-fired by aviation ordnance.

Table 3 traces individual squad's movement through the town. The exposure time of each squad during movement in the line of sight windows between buildings is highlighted in this table. Table 4 summarizes the average exposure time for each squad.

USMC Squad Exposure Time When Moving Between Buildings

Unit	Time From	Time To	Time Interval	Bldg From	Bldg To	Distance (m)	Rmks
3/1/A	0:05:00	0:07:51	0:02:51	0	1	31	Begin Movement
3/1/A	0:19:36	0:21:57	0:02:21	1	2	8	
3/1/A	0:21:57	0:24:20	0:02:23	2	3	10	
3/1/A	0:38:00	0:40:00	0:02:00	3	4	9	End Movement
1/1/A	0:08:00	0:11:00	0:03:00	0	1	16	Begin Movement
1/1/A	0:11:15	0:14:15	0:03:00	1	2	31	
1/1/A	0:14:30	0:16:39	0:02:09	2	3	8	
1/1/A	0:24:55	0:26:33	0:01:38	3	4	10	
1/1/A	0:26:55	0:30:14	0:03:19	4	5	17	
1/1/A	0:38:00	0:40:07	0:02:07	5	6	17	End Movement
2/1/A	0:05:00	0:09:55	0:04:55	0	1	34	Begin Movement
2/1/A	0:32:00	0:38:27	0:06:27	1	2	63	
2/1/A	0:38:32	0:41:18	0:02:46	2	3	17	
2/1/A	0:40:51	0:45:01	0:04:10	3	4	21	End Movement
1/A Average			0:03:05			21	
3/3/B	0:01:55	0:04:23	0:02:28	0	1	11	Begin Movement
3/3/B	0:20:02	0:22:38	0:02:36	1	2	22	
3/3/B	0:22:58	0:27:10	0:04:12	2	3	24	
3/3/B	0:40:05	0:44:30	0:04:25	3	4	28	
3/3/B	0:46:08	0:48:46	0:02:38	4	5	13	End Movement
2/3/B	0:10:50	0:13:15	0:02:25	0	1	11	Begin Movement
2/3/B	0:13:50	0:16:36	0:02:46	1	2	22	
2/3/B	0:36:00	0:39:47	0:03:47	2	3	24	
2/3/B	0:41:27	0:44:30	0:03:03	3	4	30	End Movement
1/3/B	0:08:00	0:10:28	0:02:28	0	1	17	Begin Movement
1/3/B	0:22:00	0:24:54	0:02:54	1	2	24	
1/3/B	0:36:02	0:39:55	0:03:53	2	3	35	End Movement
3/B Average			0:03:08			22	
2/3/B	0:11:00	0:13:29	0:02:29	0	1	23	Begin Movement
2/3/B	0:25:02	0:27:10	0:02:08	1	2	8	
2/3/B	0:27:30	0:30:07	0:02:37	2	3	20	Squad Destroyed
3/2/B	0:11:00	0:12:57	0:01:57	0	1	7	Begin Movement
3/2/B	0:15:02	0:16:46	0:01:44	1	2	23	Squad Destroyed
3/2/B	NA	NA	NA	2	3	NA	Incomplete Route
3/2/B	NA	NA	NA	3	4	NA	Incomplete Route
1/2/B	0:12:00	0:14:57	0:02:57	0	1	29	Begin Movement
1/2/B	0:19:00	0:21:59	0:02:59	1	2	23	
1/2/B	0:27:02	0:30:25	0:03:23	2	3	14	Squad Destroyed
1/2/B	NA	NA	NA	3	4	NA	Incomplete Route
2/B Average			0:02:32			18	
3/1/B	0:15:01	0:17:54	0:02:53	0	1	26	Begin Movement
3/1/B	0:20:02	0:20:25	0:02:23	1	2	20	
3/1/B	0:28:00	0:31:00	0:03:00	2	3	24	
3/1/B	0:45:00	0:47:22	0:02:55	3	4	22	End Movement
2/1/B	0:15:01	0:17:59	0:02:58	0	1	26	Begin Movement
2/1/B	0:34:02	0:36:55	0:02:53	1	2	23	
2/1/B	0:38:30	0:40:38	0:02:08	2	3	12	End Movement
1/1/B	0:23:04	0:25:53	0:02:44	0	1	26	Begin Movement
1/1/B	0:29:01	0:32:14	0:03:13	1	2	23	
1/1/B	0:39:00	0:42:00	0:03:00	2	3	12	
1/1/B	0:44:10	0:47:24	0:03:14	3	4	13	End Movement
1/B Average			0:02:51			21	
Overall			0:02:56			21	

Table 3. MOUT Squad Exposure Time Between Buildings

Average Marine Squad Exposure

Unit	Average Time Interval	Average Distance (m)
1/A	0:03:05	21
3/B	0:03:08	22
2/B	0:02:32	18
1/B	0:02:51	21
Overall	0:02:56	21

Table 4. MOUT Average Marine Squad Exposure

At first glance, the overall average of 21m covered in 0:02:56 seems to be an excessive value considering the time it takes one Marine to run across a street may only be a few seconds, depending upon the width of the street. However, the overall average may be a relatively accurate representation of reality in measuring the total unit time to cross even a narrow street. This is because of the many factors that affect squads as they conduct exposed movement through open areas in the scenario. The squads may rush as a group across an open area, cross as teams, as pairs, or individuals. The smaller the aggregate that crosses, the longer the total time it takes the unit to cross the street. Additionally, many squads took fire while crossing open areas, pinning Marines down, sending them back into the starting building, and in general, lengthening the total time the unit spent in an exposed posture.

4. Example Interactions

Five typical interactions are presented as examples to provide a feel for how interactions between units operating in an urban environment might unfold over time.

a. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.

While tank 3 supports 2d Platoon's attack it observes and mistakenly engages 3d Platoon. Events unfold as follows. At 0817 3d Squad, 3d Platoon departs a building and moves toward the next building (Fig. 21).

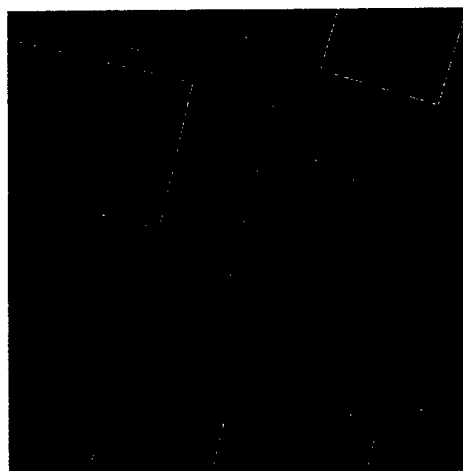


Figure 21. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.: 0817

Tank 3 has no line of sight to the squad. A line of sight fan is depicted in Figure 22.

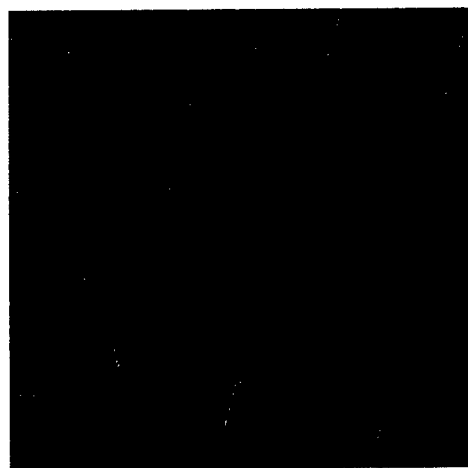


Figure 22. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.: 0817

At 0827, the squad enters the tank's line of sight (Figs. 23 and 24).

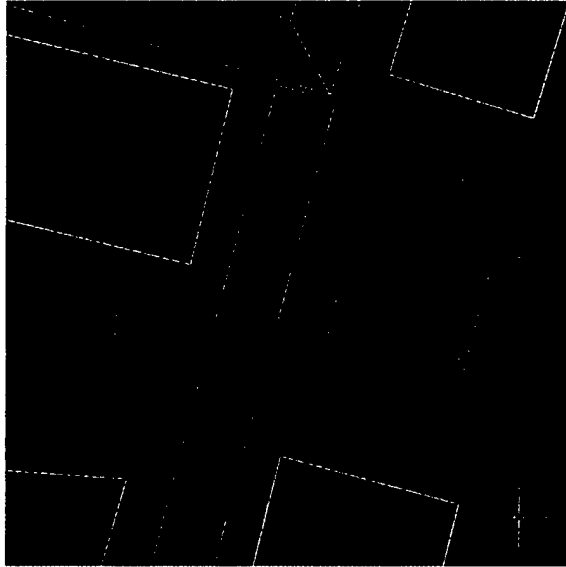


Figure 23. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.: 0827

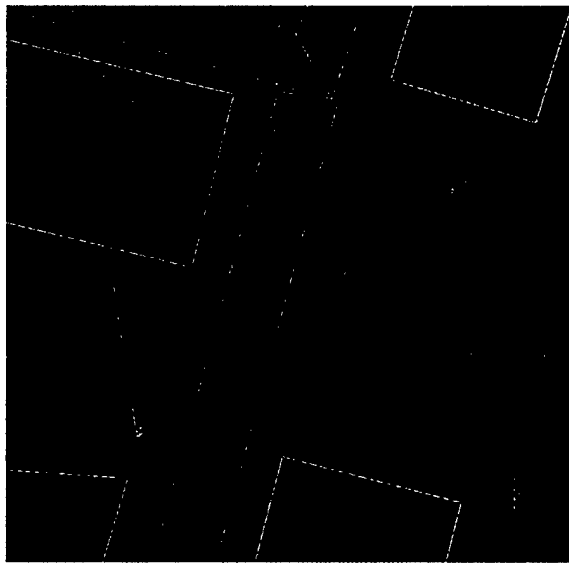


Figure 24. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.: 0827

Eight seconds elapse and at 0855 the tank engages the squad (Figs. 25 and 26).

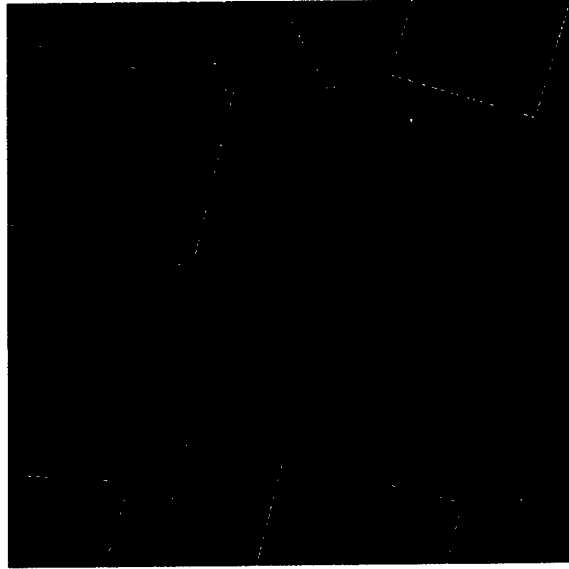


Figure 25. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.: 0855

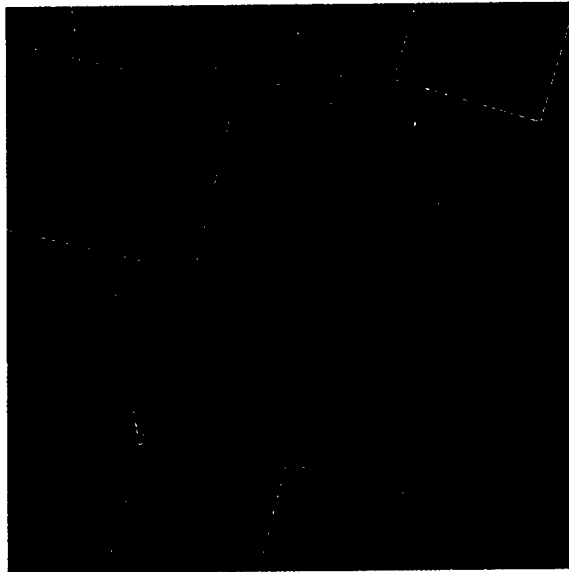


Figure 26. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.: 0855

The tank engages the squad for 7 seconds until it determines the squad is friendly at 0902 and ceases fire (Figs. 27 and 28).

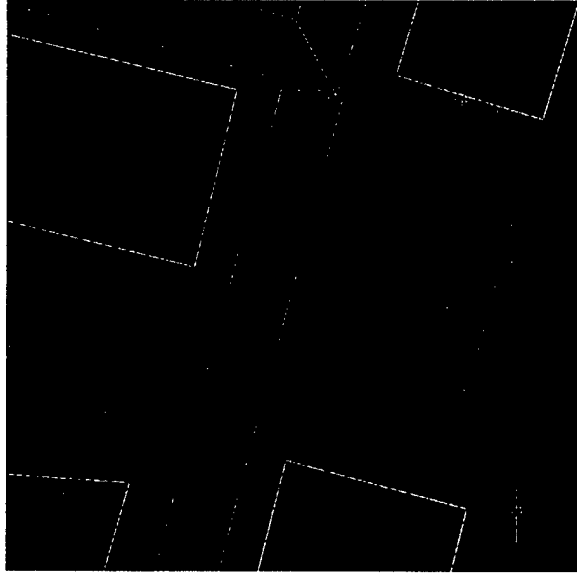


Figure 27. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.: 0902

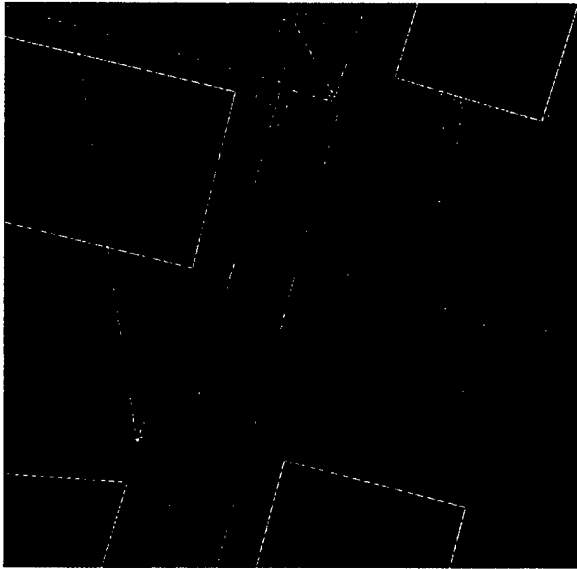


Figure 28. Co. B: Tank, 2d Pltn. vs. 1st Sqd., 3d Pltn.: 0902

The result of this interaction is one killed in 3d Squad, 3d Platoon.

b. Co. B: 1st Pltn. vs. 2d Pltn.

At 1457, 2d and 3d Squads of 1st Platoon and 3d Squad, 2d Platoon prepare to attack across the street (Fig. 29). There is no line of sight between the three units.

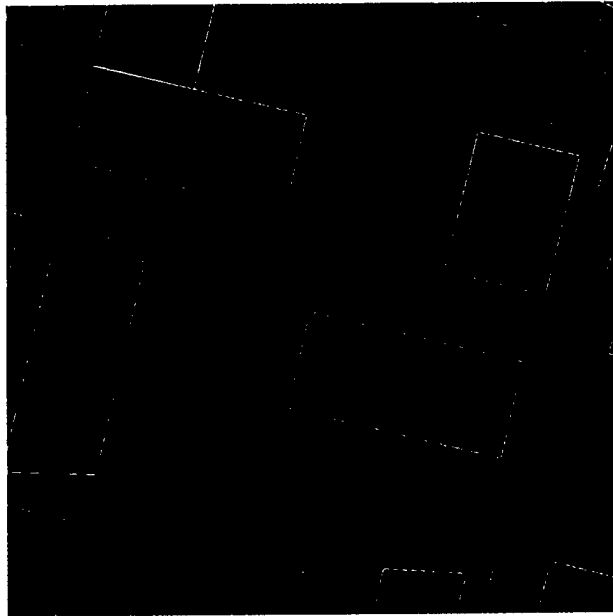


Figure 29. Co. B: 1st Pltn. vs. 2d Pltn.: 1457

At 1502, 1st Platoon exits its building and is observed by the platoon headquarters of 2d Platoon (Fig. 30).

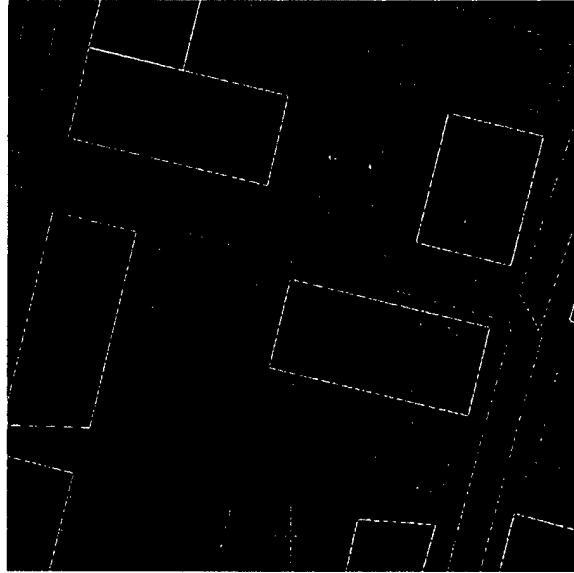


Figure 30. Co. B: 1st Pltn. vs. 2d Pltn.: 1502

At 1506, 2d Squad, 2d Platoon emerges from its building as the platoon headquarters engages 1st Platoon (Fig. 31).

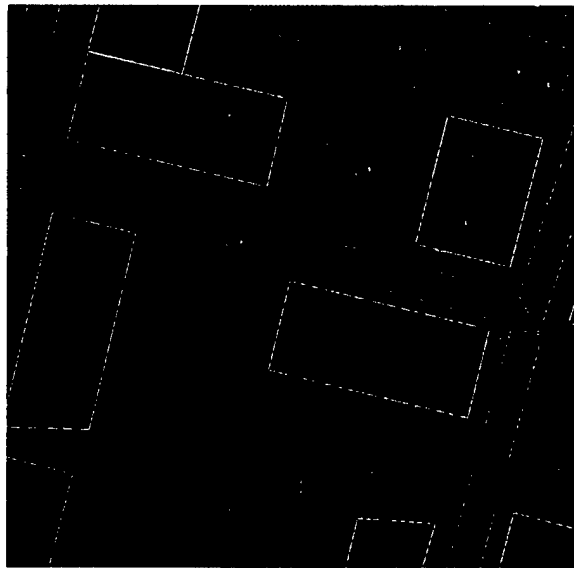


Figure 31. Co. B: 1st Pltn. vs. 2d Pltn.: 1506

Two seconds later, at 1508, fire is exchanged between the 2d Squad and platoon headquarters of 2d Platoon and 1st Platoon (Fig. 32).

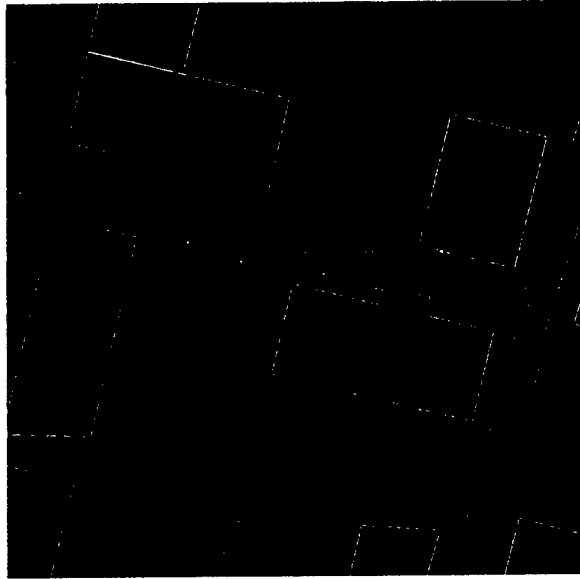


Figure 32. Co. B: 1st Pltn. vs. 2d Pltn.: 1508

By 1515, a full-scale, inter-unit engagement is underway (Fig. 33).

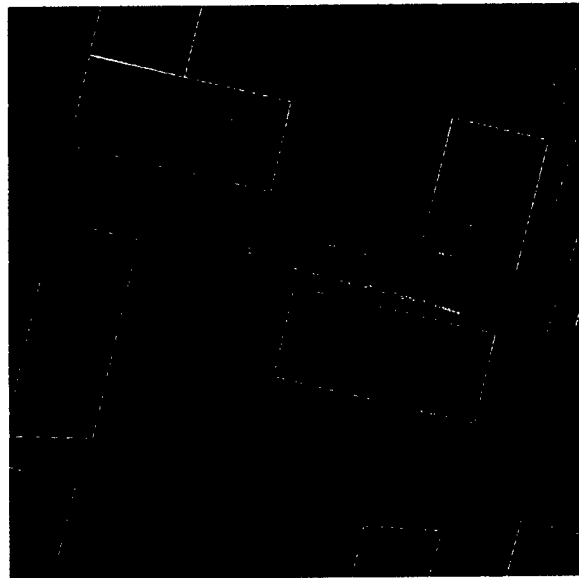


Figure 33. Co. B: 1st Pltn. vs. 2d Pltn.: 1515

At 1601, the firefight continues with numerous casualties inflicted on 2d Platoon (Fig. 34).

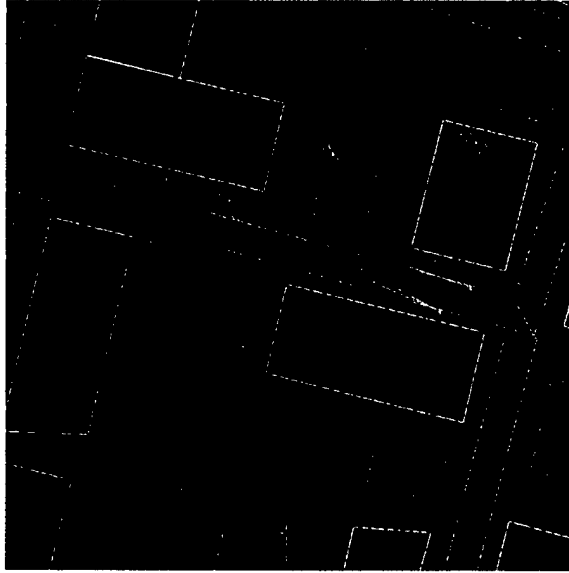


Figure 34. Co. B: 1st Pltn. vs. 2d Pltn.: 1601

By 1609, 1:06 later, the engagement ends with 1st Platoon destroying 2d Squad, 2d Platoon (Fig. 35).

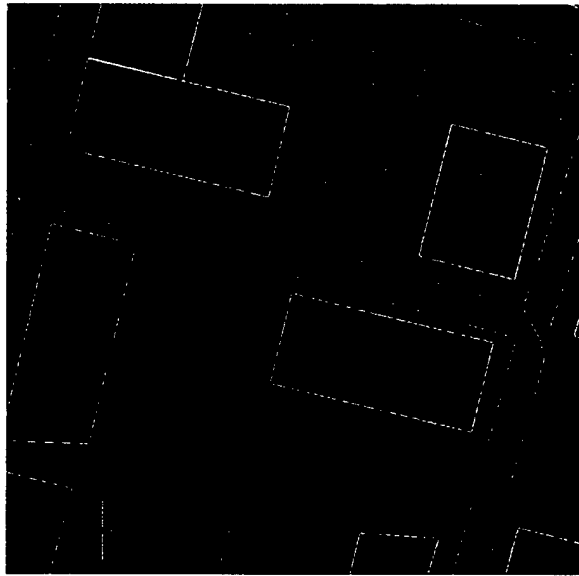


Figure 35. Co. B: 1st Pltn. vs. 2d Pltn.: 1609

c. *Co. B vs. 1st Pltn., UK Co.*

At 1624, 1st Platoon, UK Company prepares to attack across the street while 1st Platoon, Company B begins to enter a building (Fig. 36).

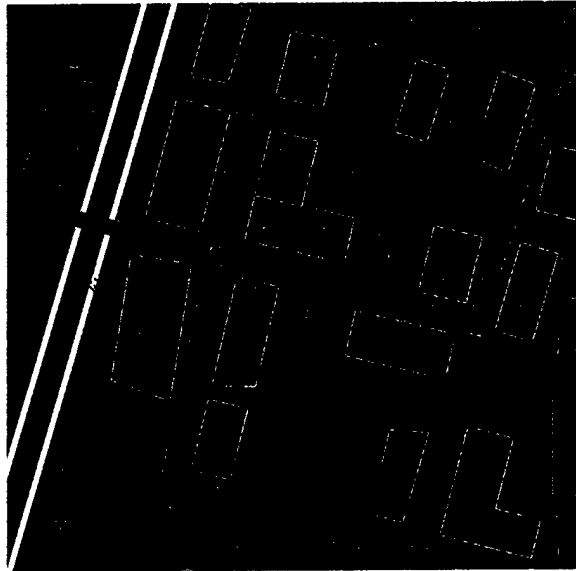


Figure 36. Co. B vs. 1st Pltn., UK Co.: 1624

Elements of Company B do not have line of sight to the UK force (Fig. 37).

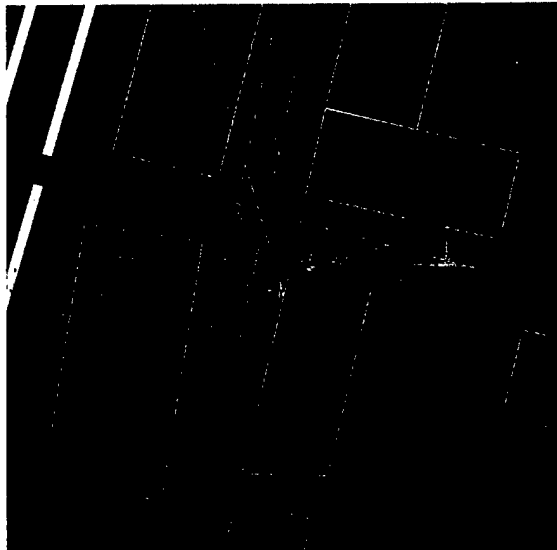


Figure 37. Co. B vs. 1st Pltn., UK Co.: 1624

At 1628, the UK platoon moves into the street and is exposed to Company B (Fig. 38).

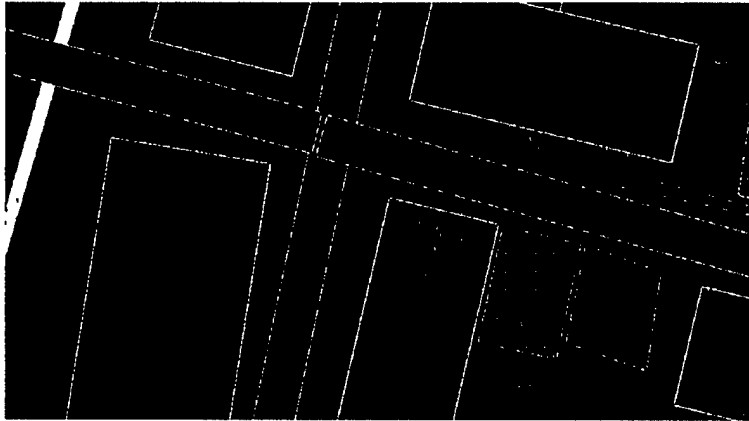


Figure 38. Co. B vs. 1st Pltn., UK Co.: 1628

Seven seconds later, at 1635, Company B acquires the UK force and engages (Fig. 39).

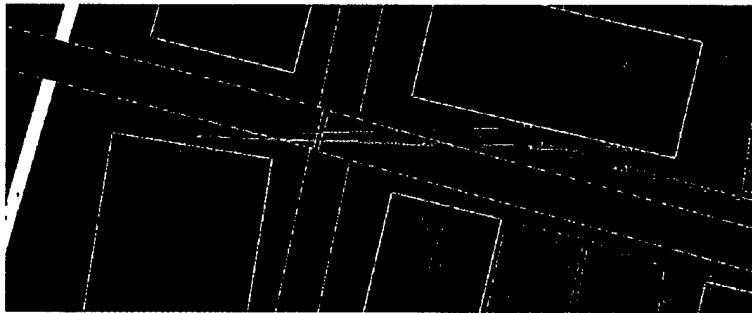


Figure 39. Co. B vs. 1st Pltn., UK Co.: 1635

By 1709, the B Company headquarters joins the engagement, creating a near miss situation as it fires through 1st Platoon, Company B at the UK force (Fig. 40).

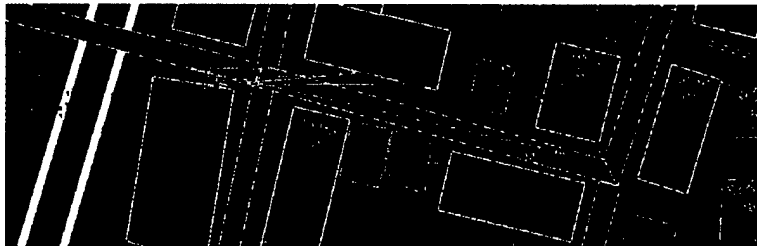


Figure 40. Co. B vs. 1st Pltn., UK Co.: 1709

By 1757, 1st Platoon, Company B has ceased fire and entered a building. The B Company headquarters continues to engage as the 1st Platoon headquarters enters the street and line of fire of the company headquarters creating another near miss condition (Fig. 41).

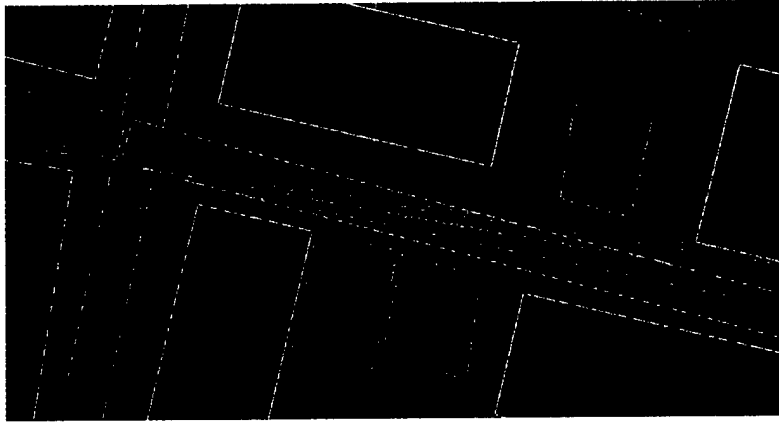


Figure 41. Co. B vs. 1st Pltn., UK Co.: 1757

By 1908 Company B has exited the street and most B Company entities have ceased fire on 1st Platoon, UK Company, which has been destroyed as a result of the 2:16 engagement. The B Company machine gun required 1:46 seconds to determine that the force it had engaged was friendly (Fig. 42).

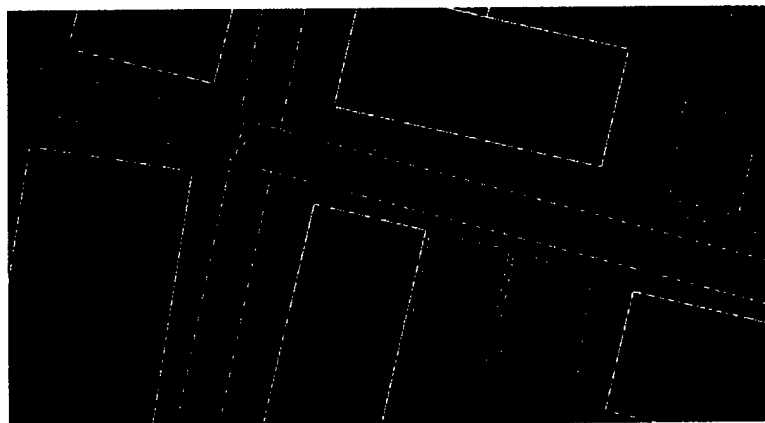


Figure 42. Co. B vs. 1st Pltn., UK Co.: 1908

d. Machinegun, 1st Pltn., Co. B vs. 2d Pltn., UK Co.

At 1951, a machinegun attached to 1st Platoon, Company B engages enemy to the front of the UK Company (Fig. 43).

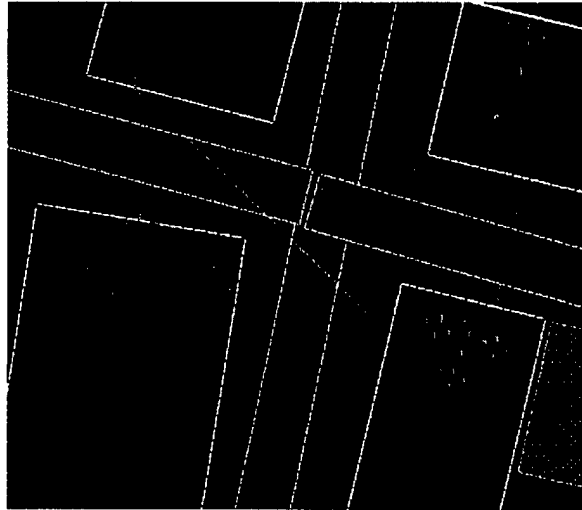


Figure 43. Machinegun, 1st Pltn., Co. B vs. 2d Pltn., UK Co.: 1951

The machinegun continues to engage as the UK Platoon advances into the open; the UK platoon is out of the machine gunner's line of sight (Fig. 44 and 45).

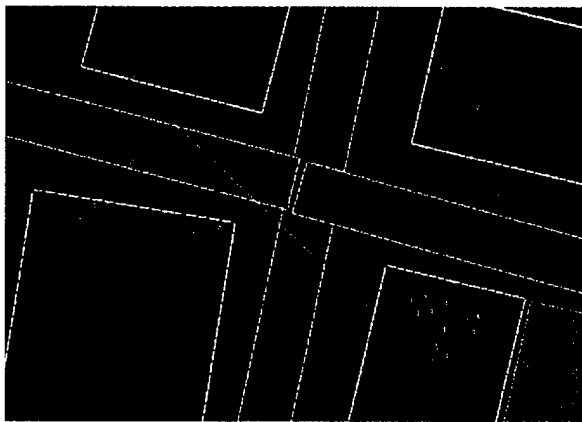


Figure 44. Machinegun, 1st Pltn., Co. B vs. 2d Pltn., UK Co.: 2019

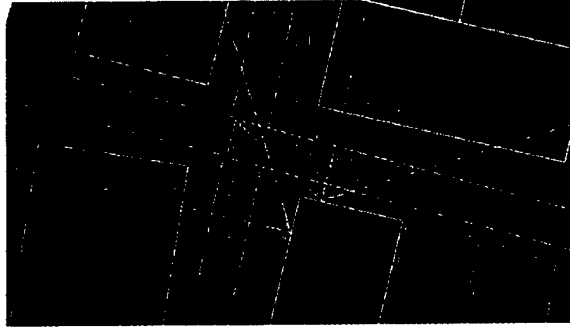


Figure 45. Machinegun, 1st Pltn., Co. B vs. 2d Pltn., UK Co.: 2024

At 2029 the UK platoon enters the line of sight of the machine gunner (Fig. 46).

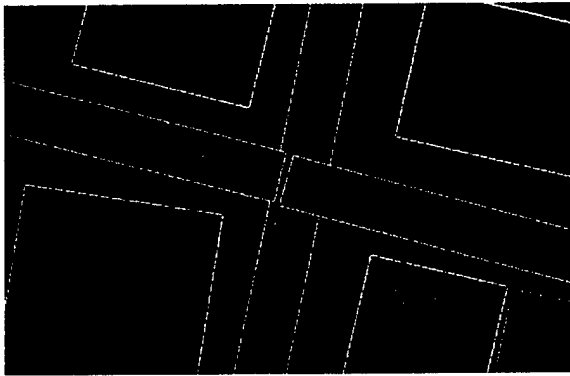


Figure 46. Machinegun, 1st Pltn., Co. B vs. 2d Pltn., UK Co.: 2029

At 2056 the machinegun fires through the UK platoon creating a near miss condition (Fig. 47).



Figure 47. Machinegun, 1st Pltn., Co. B vs. 2d Pltn., UK Co.: 2056

At 2102, after 32 seconds of line of sight to and six seconds of fire through the UK platoon, the machine gunner recognizes the near miss situation and ceases fire (Fig 48 and 49).

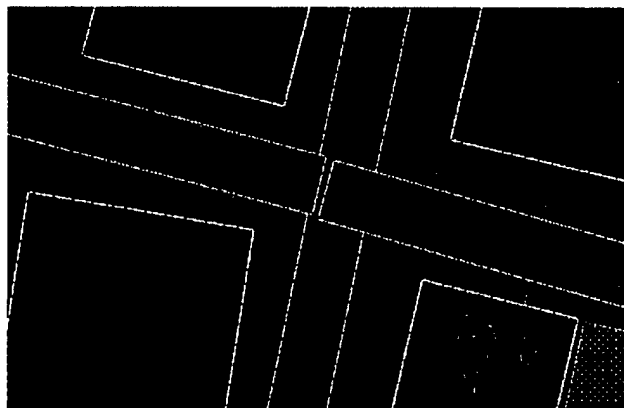


Figure 48. Machinegun, 1st Pltn., Co. B vs. 2d Pltn., UK Co.: 2102

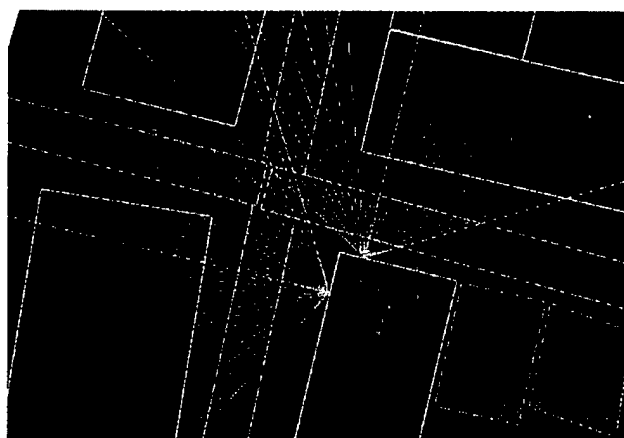


Figure 49. Machinegun, 1st Pltn., Co. B vs. 2d Pltn., UK Co.: 2102

e. Co. B: 1st Sqd., 2d Pltn. vs. 3d Sqd., 1st Pltn.

At 1900, 3d Squad, 1st Platoon has stopped in a building while adjacent 1st Squad, 2d Platoon attacks to seize a nearby building (Figs. 50 and 51).

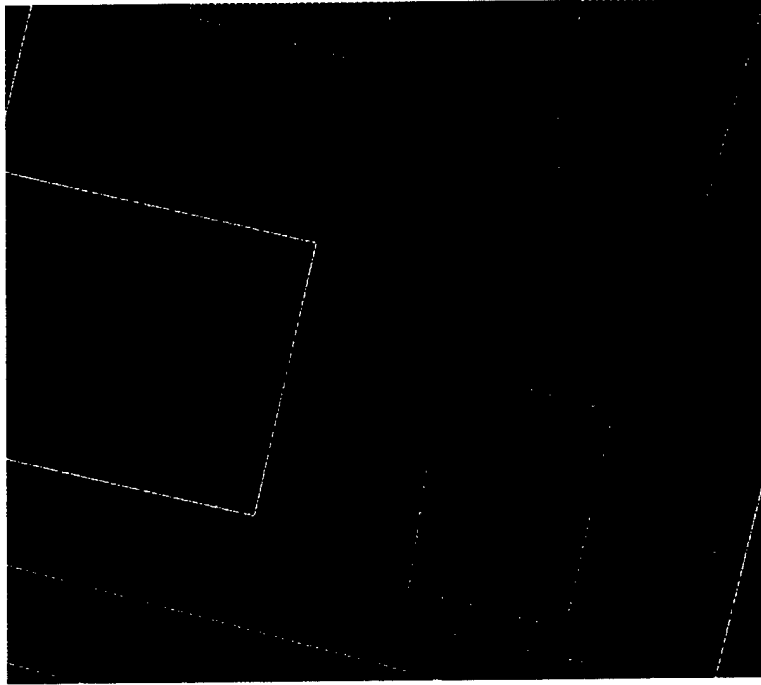


Figure 50. Co. B: 1st Sqd., 2d Pltn. vs. 3d Sqd., 1st Pltn.: 1900

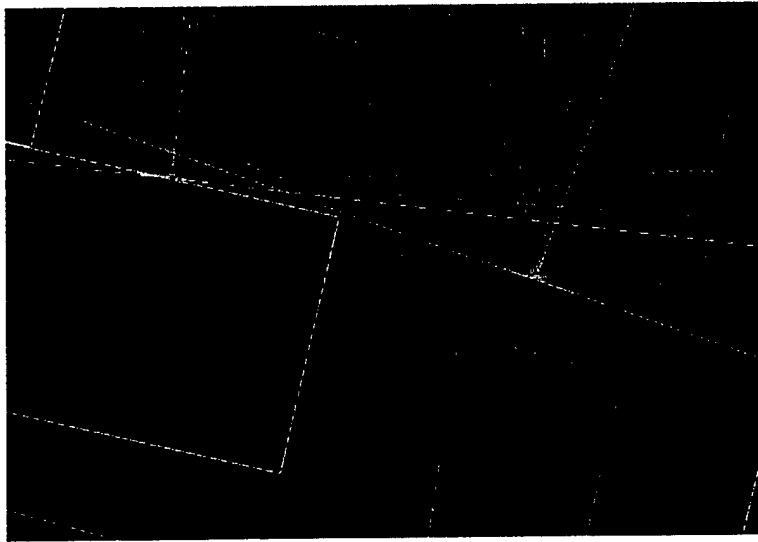


Figure 51. Co. B: 1st Sqd., 2d Pltn. vs. 3d Sqd., 1st Pltn.: 1900

By 1927, 1st Squad, 2d Platoon has entered line of sight to 1st Platoon (Fig. 52).

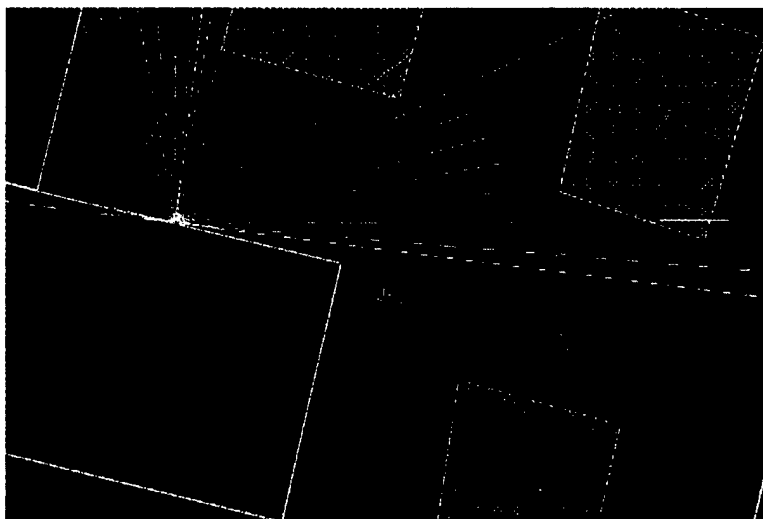


Figure 52. Co. B: 1st Sqd., 2d Pltn. vs. 3d Sqd., 1st Pltn.: 1927

At 1959, 1st Squad, 2d Platoon observes and engages 3d Squad, 1st Platoon creating a near miss condition (Fig. 53).

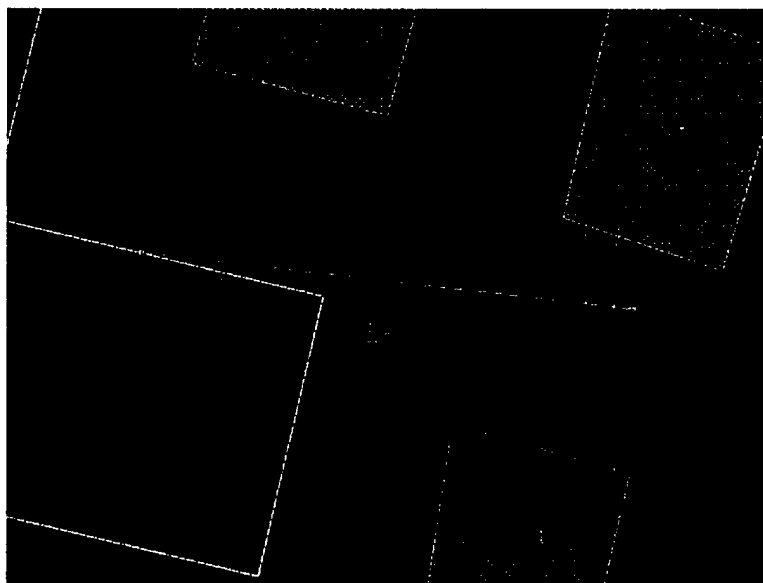


Figure 53. Co. B: 1st Sqd., 2d Pltn. vs. 3d Sqd., 1st Pltn.: 1959

At 2001, two seconds after engaging, 1st Squad, 2d Platoon determines the adjacent unit to be friendly and ceases fires (Fig. 54).

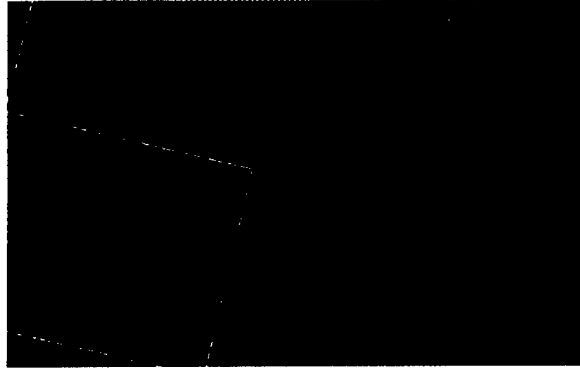


Figure 54. Co. B: 1st Sqd., 2d Pltn. vs. 3d Sqd., 1st Pltn.: 2001

D. MOUT CONCLUSIONS

1. Position-Location Information

Standard position-location information (PLI) data, consisting of unit identification, unit location, and time at location, appear to be satisfactory for maintaining situational awareness in an urban environment.

2. Situational Awareness over Target Identification

Foot mobile entities move through the three dimensional urban terrain of the MOUT scenario at normal and slower than normal infantry rate of movement. Although the entities move more slowly in MOUT, their state changes occur more rapidly than in the mixed and mountainous desert terrain scenarios. This is caused by personnel moving from inside buildings, through building openings, into open spaces between buildings or adjacent buildings in less than one second (the time it takes to walk or run through a doorway). This state transition time is significant for the following reason. While a building occupied by Marines is considered a friendly area, the streets, buildings, and open areas adjacent to the building may be considered hostile areas. Tanks, AAVs, crew served weapons, and individual Marines may have line of sight and fields of fire in these areas. The short duration windows of line of sight between entities occurring at

very close range in the urban environment tends to create rapid fire-no-fire decision situations. This short decision time may not be long enough for humans to wait for a response from a target identification device. The short fire-no-fire decision time combined with the rapid nature of entity state changes in an urban setting suggest a situational awareness device may be more effective than a target identification device. A situational awareness device would provide marines with warning of adjacent friendly positions prior to the occurrence of an interaction. Instead of reacting to the situation, Marines would be able to anticipate and intuit unfolding events.

3. Rate of Information Update

In order for a situational awareness device to provide adequate information, entity positions must be updated frequently enough to account for rapid entity state changes. An update rate of one to two seconds would be required to accurately reflect PLI for MOUT.

4. Situational Awareness System Architecture and Deployment

The number of SA devices distributed to the force and the unit level to which they are distributed will effect the system's architecture and the quality of SA information provided. In an urban environment, the natural dispersal of entities at the individual, single vehicle, crew served weapon, fire team, and squad level makes detail and high-resolution important features in a SA system. For example, devices are deployed at the squad level. A squad leader is equipped with a PLI transmit/receive device. His position represents the location of all the Marines in his squad; however, the squad leader has two fire teams in the building in which he is located and one fire team deployed across the street. Other squads operating close by observe the squad leader's PLI in their system

displays and treat his location as friendly. The area across the street is treated as hostile because the fire team located there has no PLI transmitter and is therefore invisible to the SA system. This idea is not trivial because it impacts the deployment and dispersal of SA devices throughout the force. The smaller the unit equipped with SA transmitters and receivers, the higher the detail and resolution of the system. The higher the detail and resolution, the higher the utility of information provided to users.

In most operations, Marines are employed as squads, platoons, and companies; however, individual Marines do occasionally separate from their unit, either on an assigned mission or inadvertently. Accordingly, in most situations, SA devices may be distributed to squad, platoon, or even company level and relatively accurately represent the PLI of the entire unit on a center of mass basis. In MOUT, however, the environment disperses units into small groups of teams and individuals. This dispersal can significantly decrease SA and increase fratricide as the MOUT scenario examples have displayed. To reduce this problem in MOUT, SA devices should be deployed at the lowest level possible.

Numerous architecture and deployment options exist ranging from equipping every Marine with a device to only equipping platoons and higher units with devices. One of the many other possibilities: deploy a mix of SA device types throughout the force -- some personnel and vehicles are be equipped with transmitters alone, while others are be equipped with transmit/receive devices. Regardless of which system architecture is deployed, some issues that should be considered in the deployment decision follow.

Equip every Marine with a SA device:

- Every individual entity's PLI is displayed in the SA system. Every individual will have access to a view of the battle space beyond their visual range. The location of other adjacent friendly forces will be clearer to all individuals. Marines SA will increase, individuals and units will possess an increased ability to self organize their activity, and fratricide will likely decrease.
- Individual rifleman will most likely be focussed on a weapon sight aperture view of the battle space. A separate SA display would take an individual's eyes away from his assigned sector of observation. Unless the two are integrated for the individual, deployment of separate SA and TI systems at the individual level will likely cause information overload of the rifleman and may ultimately be less effective than use of a TI device alone.
- In MOUT, Individuals will usually remain within verbal communication range of team leaders.
- Team leaders and higher unit leaders are more likely than individual riflemen to have the time to frequently view a SA device.
- Volume of data transmitted over the SA system network is large if every individual entity transmits and receives PLI.
- SA displays become cluttered with entity PLI and difficult to read because of the large number of entity PLI reports displayed.

Equip only unit leaders with SA devices:

- Unit leader's PLI is displayed in the SA system.
- SA displays are less cluttered with PLI reports and present a cleaner view to users.
- Volume of data transmitted over the SA system network is much smaller than a system in which every individual entity transmits and receives PLI.
- In MOUT, a large number of entity positions go unreported; as a result, the SA system is unreliable because it lacks detail and resolution.

Equip individuals with transmit devices and unit leaders with transmit/receive

SA devices:

- All individuals input data into the SA system; as a result, leader SA of his, and adjacent unit entities is high.
- Leaders verbally pass SA information to individuals within their unit. Individuals use the information received verbally to increase their personal SA, anticipate interactions, and augment TI devices.
- Redundancy is introduced into PLI reporting. If one individual's device fails, as long as he is in the vicinity of at least one other Marine, unit dispositions displayed in the system will remain accurate.
- Volume of data transmitted over the SA system network is much smaller than a system in which every individual entity transmits and receives PLI but larger than a system that equips only unit leaders.
- SA displays are cluttered and difficult to read because of the large number of entity PLI reports displayed.

Trade-offs between these possible system implementations must be balanced against the level of SA desired. Clearly in MOUT, higher detail is required for a SA system to be effective.

5. Resolution of Information

After observation of the MOUT simulation, it appears the capabilities required for CID SA system performance, as specified by the Marine Corps Operational Requirements Document (ORD) for CID, may be inadequate for urban terrain [Ref. 5]. The ORD requires a CID SA system component to resolve entities separated by 200m (threshold) and 100m (objective) with the requirement further specified for dismounted infantry to 100m (threshold) and 25m (objective). This resolution distance is acceptable for most operations. For MOUT, these distances are inadequate for the detail of the terrain. In the majority of European, Asian, and 3rd world nations, the dimensions of

most buildings are estimated to be less than 25m in size and most roads and streets less than 25m in width. Accuracy of 25m for personnel does not resolve if the Marine is standing in a building or out in the street. This could mean the difference between treatment as hostile or friendly in a CID SA system. Further, in MOUT Marines are likely to operate with armored and other vehicle support. Consequently, resolution for vehicles must be similar to that of personnel for a SA system to function effectively in MOUT.

A resolvable distance of less than 25m is of particular importance as digital-mapping technology improves in the near future. Present digital mapping capability allows high resolution to fine detail of building size and location. This capability is already in use in commercial rental cars equipped with navigational equipment. This equipment presents a digital route map display, written directions, audible instructions to alert drivers as they approach turns, and identification of arrival at a specific street address (a resolution less than 25m). Additional enhancements to digital mapping include rapid map update through the intelligence process and enhanced satellite imagery, improvements to the Global Positioning System (GPS) and construction of follow-on systems, and the ability to zoom between low resolution (large map scale) and extremely high resolution (small map scale). This zoom capability already exists as well in commercial software and web applications like Mapquest.com.

The resolvable distance for MOUT should, at a minimum, account for GPS (or other PLI system inherent accuracy and the size of buildings and width of roads in the most likely areas for future urban operations. Based on these factors and current technology, a more appropriate minimum resolvable distance to accurately provide SA

would be a threshold of 25m to 50m and objective of 5m to 15m. These distances apply to both personnel and vehicles.

6. Entity Display Aggregation

Entity display aggregation refers to the level of unit PLI detail displayed by a SA system. This aggregation could range from the display of all individuals within a unit to only the unit. De-aggregation accomplishes the opposite effect and allows a user to resolve unit PLI icons into finer levels of granularity for more detailed depiction of entity locations. Examples of unit aggregation and de-aggregation are provided in Figures 55 through 59. These examples show aggregated unit positions based on the unit leader's PLI.

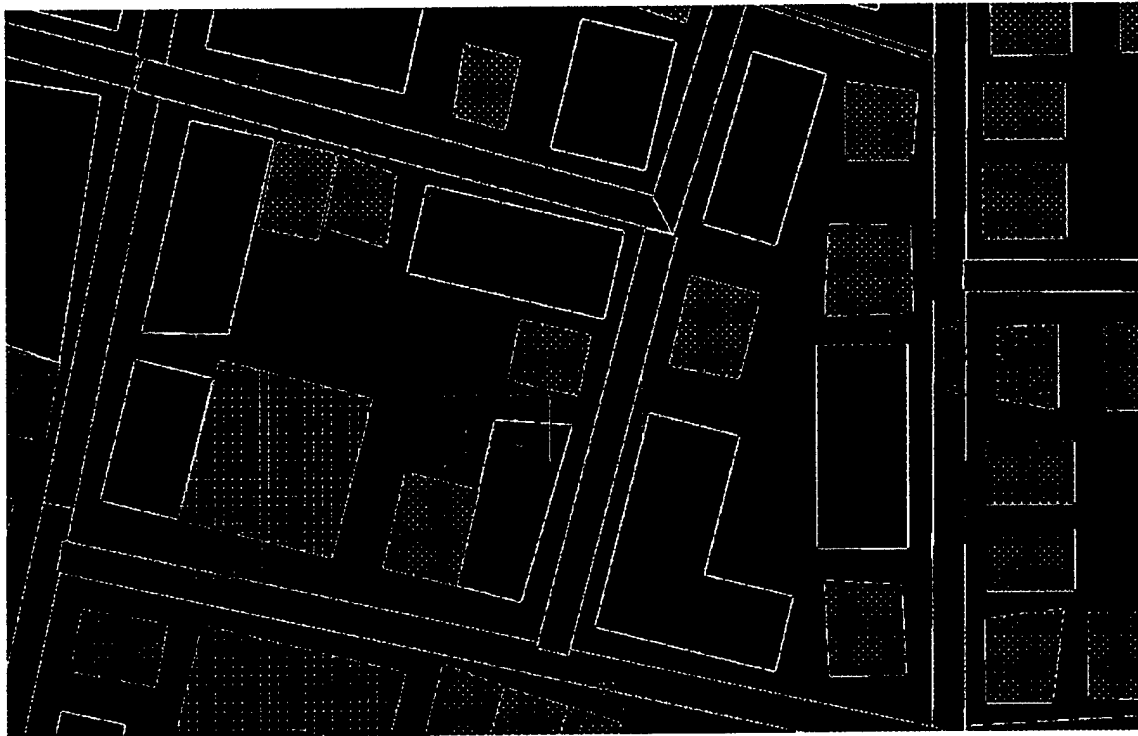


Figure 55. Company Aggregation of Entities

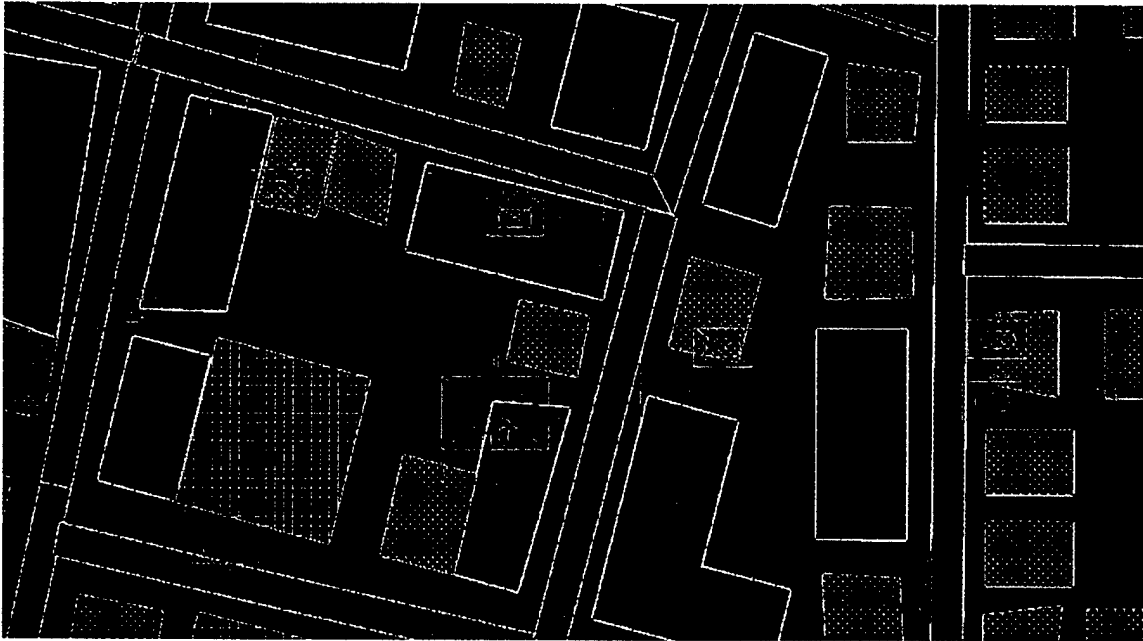


Figure 56. Platoon De-aggregation of Entities

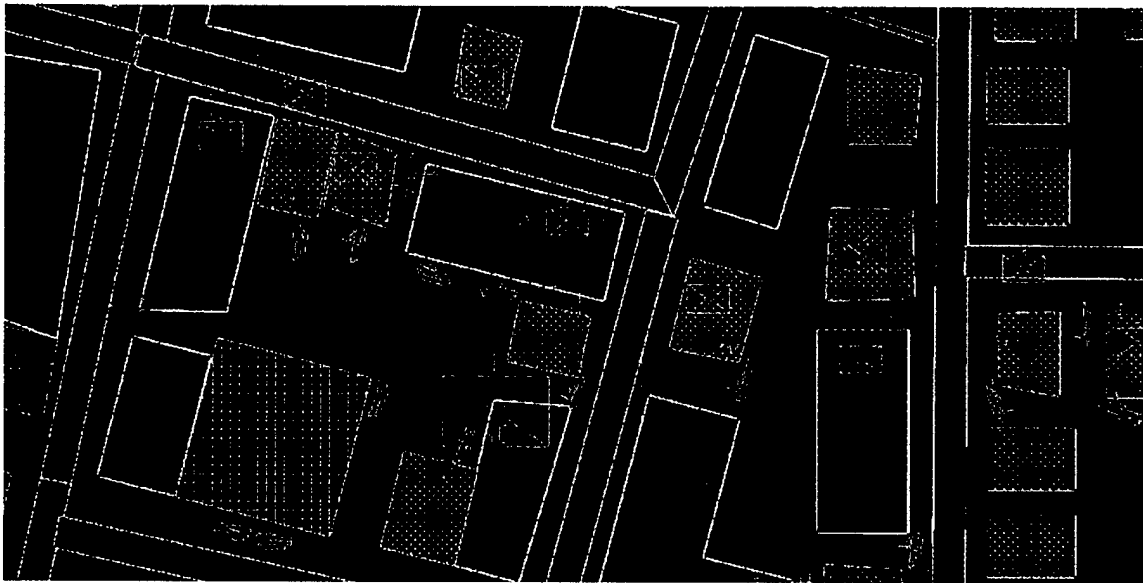


Figure 57. Squad De-aggregation of Entities

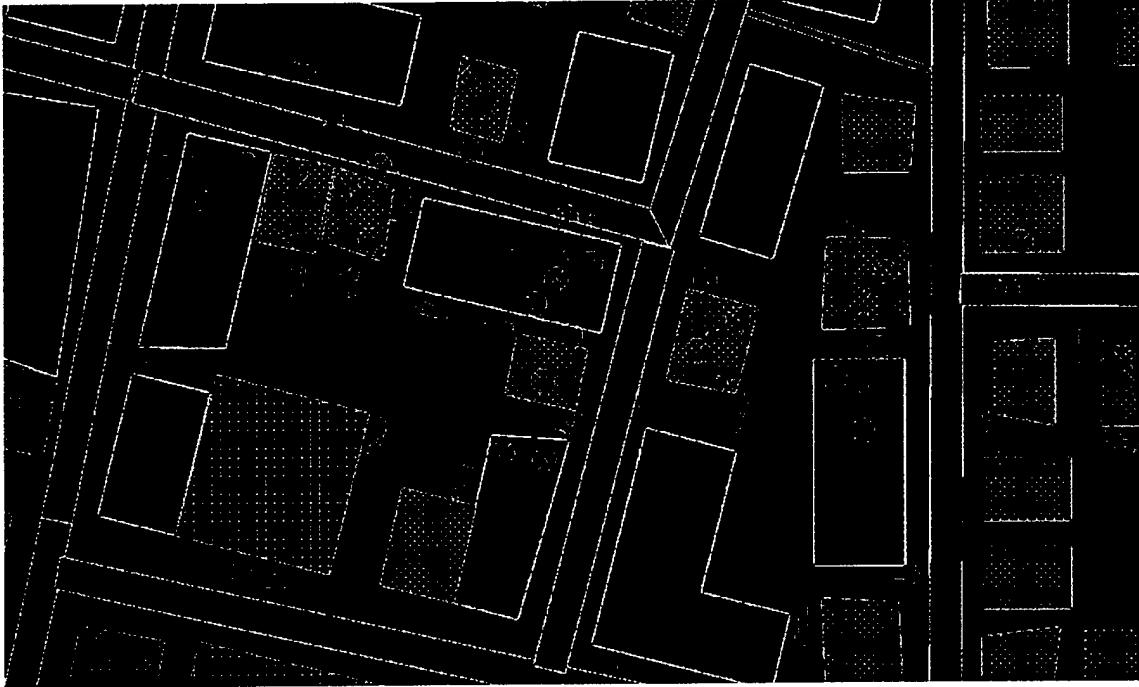


Figure 58. Team De-aggregation of Entities

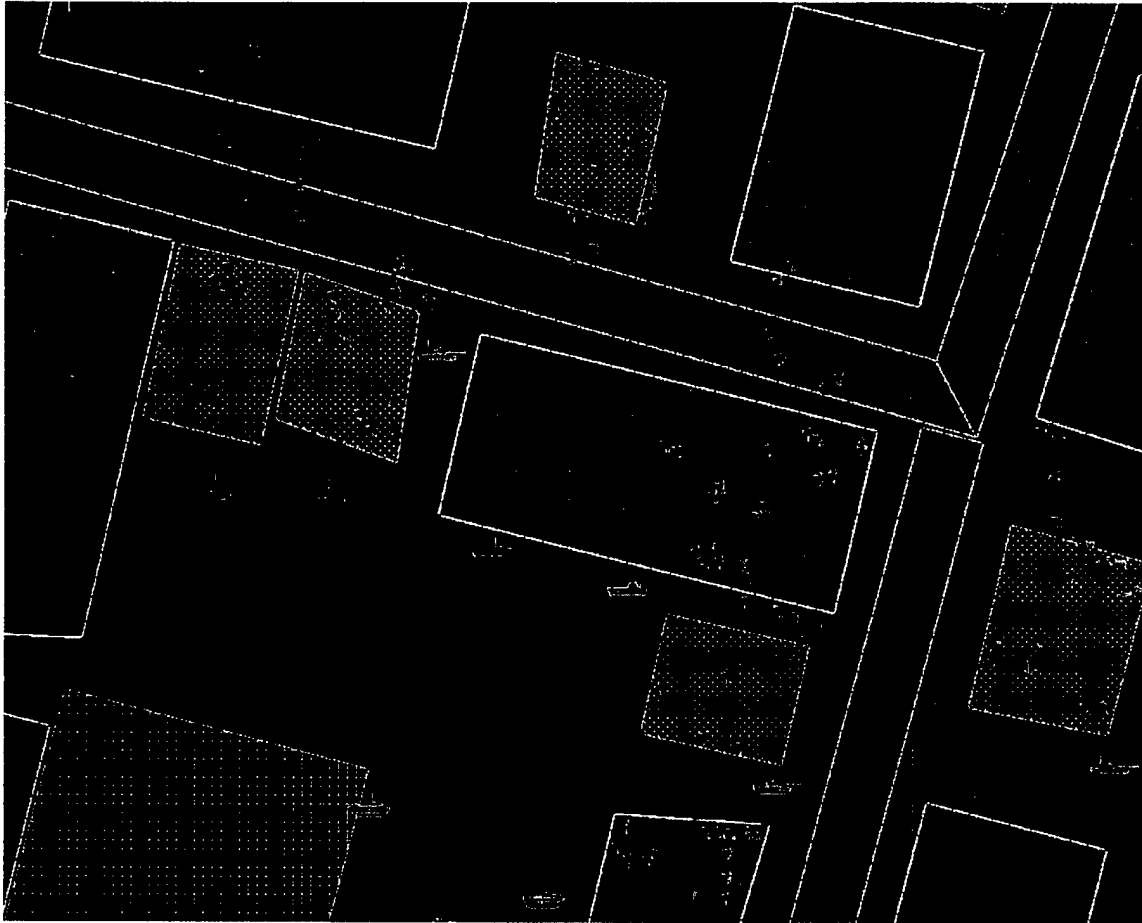


Figure 59. Individual De-aggregation of Entities

It is clear, from the series of images in figures 55 through 59, that the highest SA of accurate entity location in an urban setting is achieved by de-aggregation to the individual level. This level of detail is cumbersome however, when viewing higher scale maps and large areas. The ability to aggregate and de-aggregate units allow a SA device user to clean-up his display and, with the addition of a zoom capability, focus on that level of resolution appropriate for his area of interest and required view.

7. Aviation Information

Aviation caused no near miss or fratricide incidents in the MOUT scenario. However, the many friendly units in the scenario over-fired by aviation ordnance (Fig.

20), combined with the tendency for rotary wing CAS aircraft rounds to impact short and long along the weapon-target line, suggest that near miss and fratricide incidents are likely in real situations of CAS employment in MOUT. This suggests that a SA system depicting the accurate location of personnel in urban areas would be useful to aircrews. Additionally, PLI of rotary wing CAS aircraft would be valuable to ground entities to identify situations in which they are located on an aircraft's weapon-target line or in the aircraft's weapon hazard area.

E. CHAPTER SUMMARY

This chapter has discussed the MOUT scenario simulation, presented observations of the interaction of virtual forces, and drawn conclusions about the SA data requirements when operating in an urban environment. The following chapters will discuss the other simulated scenarios conducted for this thesis.

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V. MIXED TERRAIN SCENARIO

A. INTRODUCTION

This chapter presents information about the mixed terrain scenario. Notes on the scenario terrain, forces, and concept of operation are outlined along with simulation parameters. Observations of the simulation are presented and conclusions are drawn from the observations.

B. SCENARIO NOTES

1. Terrain

The scenario is centered along a main supply route (MSR) between urban areas. The MSR follows an avenue of approach that is oriented North-South, paralleling a small river. High ground with numerous tree lines, hilltops, and wooded areas overlooks the MSR. Several company and platoon size mobility corridors cross the terrain and provide small-unit access to bypass the MSR. Figure 60 provides a view of the terrain map used in the scenario.

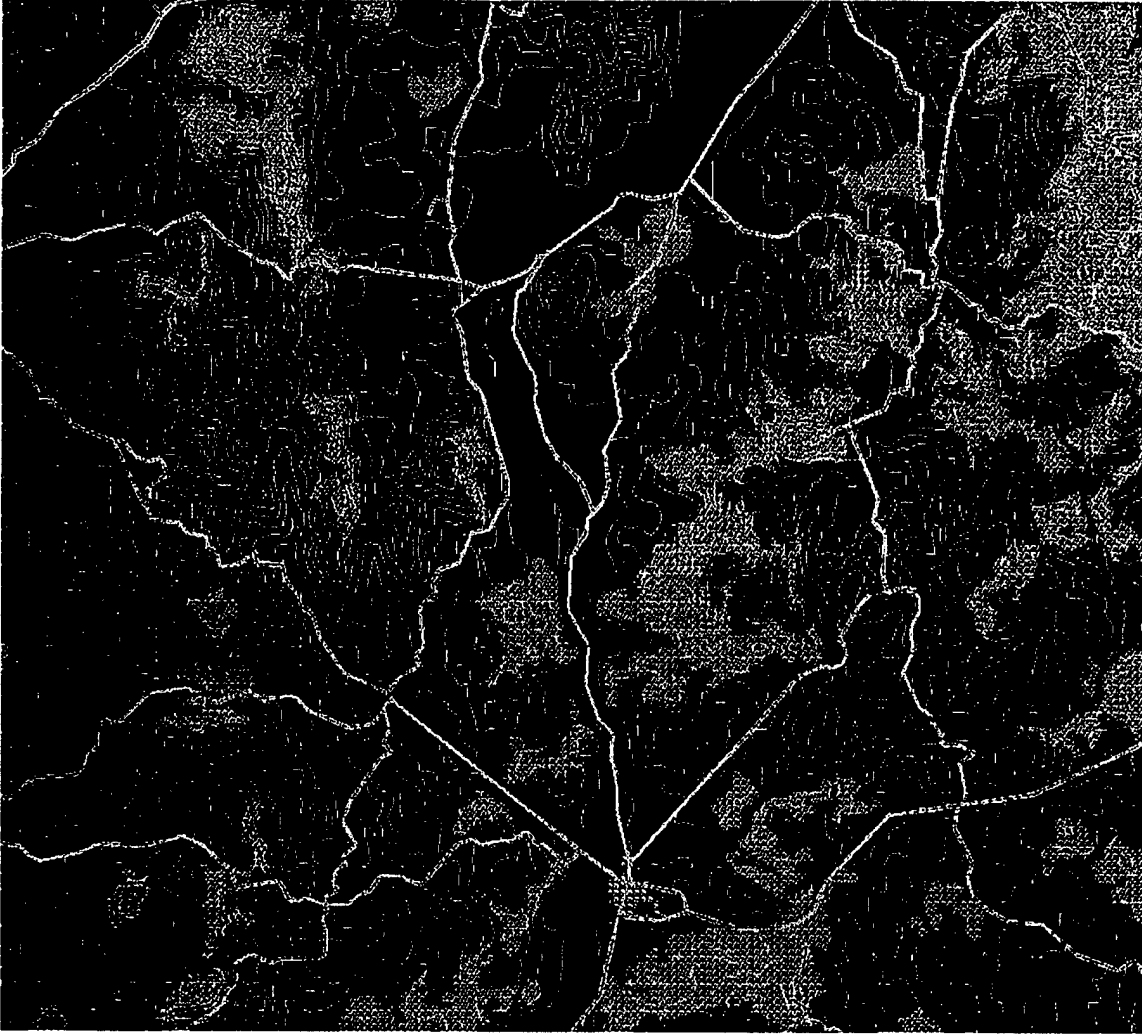


Figure 60. Mixed Terrain Scenario Map

2. Forces

a. Friendly Force Composition

The Marine force in the mixed terrain scenario is a task organized MAGTF. A standard table of organization and equipment was used to organize the force. Exceptions were made to force composition in cases where new equipment is expected to replace current systems. The following general task organization outlines the composition of Marine forces for this scenario.

Ground Combat Element:

- Reinforced Mechanized Infantry Battalion Team:
 - Battalion Forward Command Post
 - Combat Train
 - M1A1 Tank Company Team; Infantry Detached
 - AAV Equipped Mechanized Infantry Company Team; Infantry reattached from the Tank Team
 - Anti Armor Platoon
 - Heavy Machine Gun Platoon
 - Mortar Platoon
 - Obstacle Clearing Detachment (Combat Engineer Detachment)
 - Air Defense Detachment
- Helicopter-borne Task Force (HTF):
 - Rifle Company
 - Attached Crew-Served Weapons
- Light Armored Reconnaissance Company
- Artillery Battalion
 - Detachment, Battalion Fire Direction Center
 - Two Lightweight Howitzer Batteries
 - Detachment, Counter Battery Radar
 - Detachment, Survey Section
 - Combat Train

Aviation Combat Element:

- Three Sections Rotary Wing Close Air Support (RW CAS)
- Five Sections Fixed Wing CAS (FW CAS)
 - Three sections VMFA
 - Two Sections VMA

Marine forces are organized and equipped according to Marine Corps doctrine. The simulation begins with the Marine force across the line of departure, infantry elements closing on the final coordination line, and the helicopter-borne task force landing at L-hour.

b. Coalition Force Composition

An infantry company supported by Fox vehicles and a 60mm mortar section represents the coalition force. Platoons assigned to the company were organized smaller than their Marine counterparts and consist of 23 soldiers each. The coalition force begins the scenario at its line of departure.

c. Enemy Force Composition

A BMP-2 equipped mechanized infantry company, T-80 equipped tank platoon, BRDM-2 equipped reconnaissance platoon, BTR-70 equipped infantry platoon, and 2S1 equipped artillery battery comprise the enemy force.

3. Concept of Operations

The enemy force is deployed in a defensive posture along the avenue of approach in order to block Marine and coalition force movement South. The enemy defends with the mechanized infantry company, reinforced with tanks and the reconnaissance platoon. The separate infantry platoon defends a prominent mobility corridor East of the main

defense. An overview of the enemy positions is provided in Figure 61. Figure 62 shows the details of the enemy force positions.

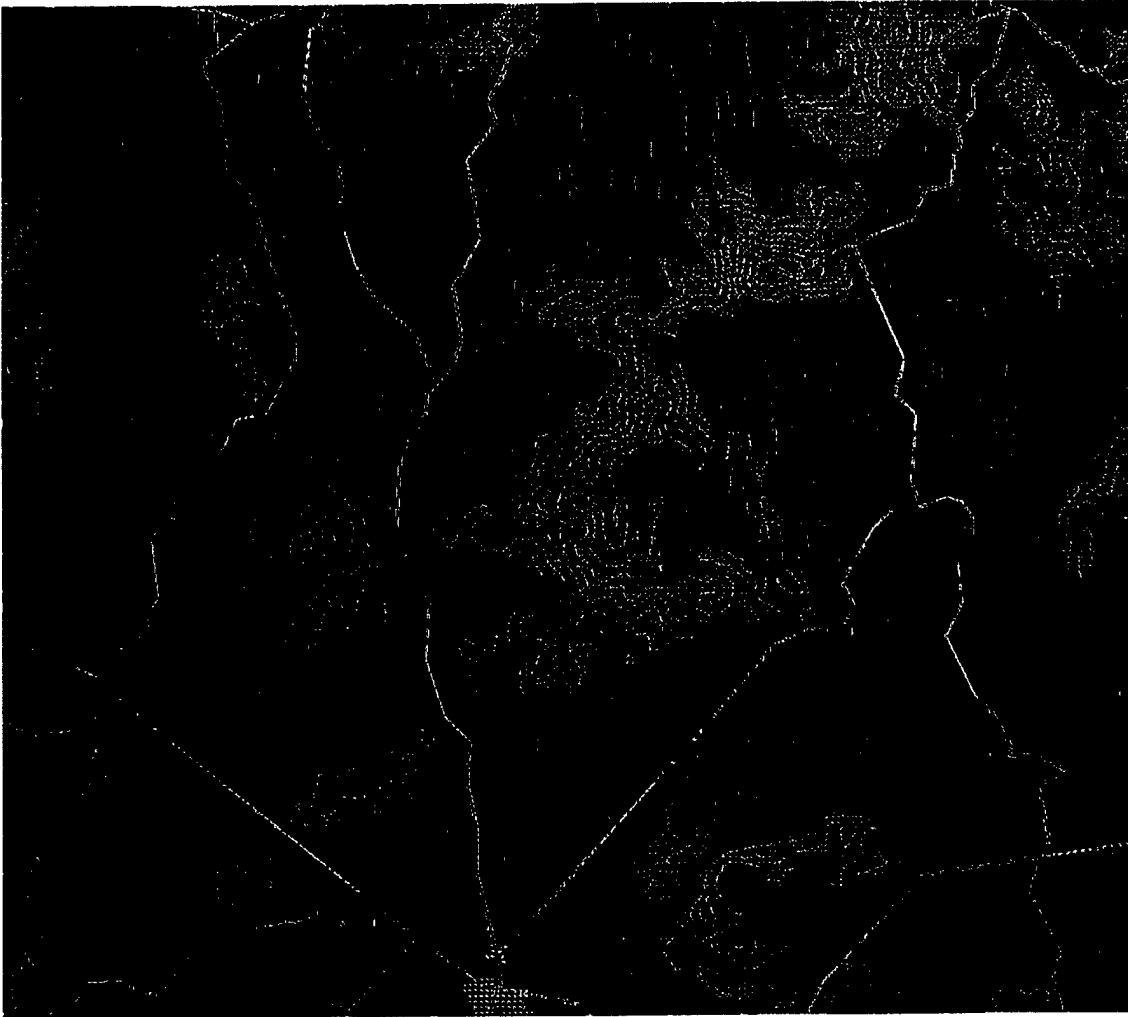


Figure 61. Mixed Terrain Enemy Overview

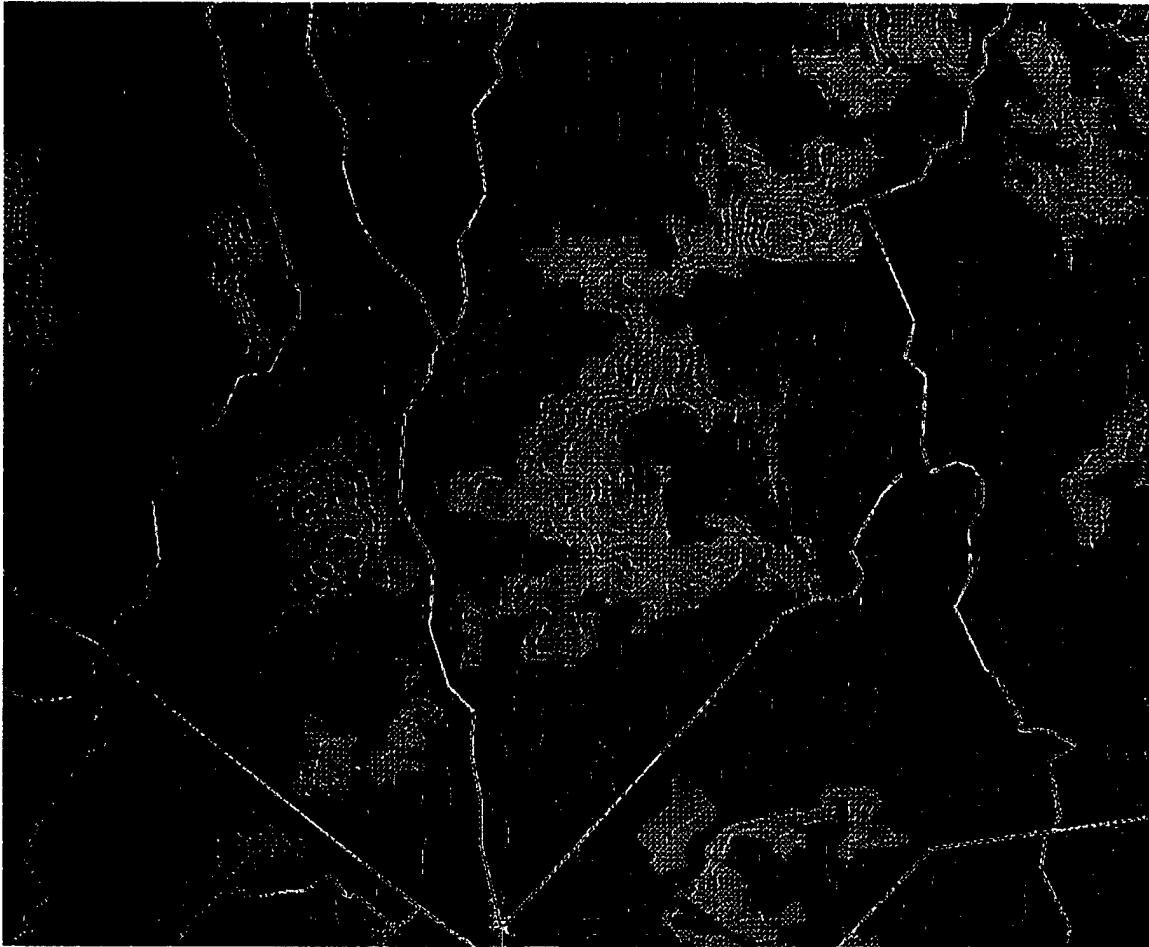


Figure 62. Mixed Terrain Enemy Defensive Positions

Figure 63 provides an overview of the entire concept of operations for both Marine and coalition forces.



Figure 64. Mixed Terrain LAR Concept of Operations

The HTF (Company L) attacks to clear the West side of the river and support the battalion's attack (Figs. 65 and 66).



Figure 65. Mixed Terrain HTF Concept of Operations

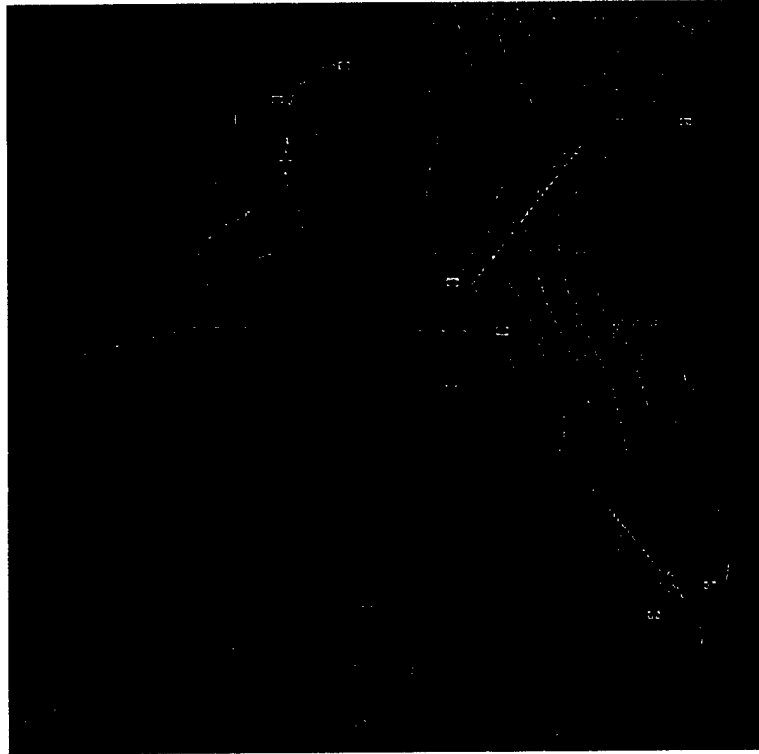


Figure 66. Mixed Terrain Detailed HTF Scheme of Maneuver

The Marine Battalion attacks to clear the enemy to the East of the river and open the MSR (Fig. 67).

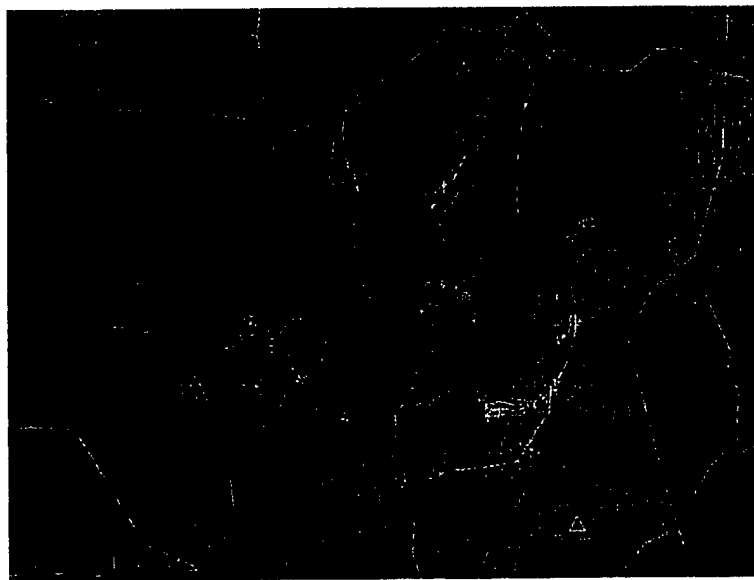


Figure 67. Mixed Terrain Battalion Concept of Operations

The battalion is task organized into support-force 1, support-force 2, and the main effort. Support-force 1 is made up of the tank company headquarters, one platoon of tanks, two sections of Tow missile systems, and two sections of heavy machine guns. Support-force 1 attacks by fire to allow support-force 2 to gain position. Support-force 2 is made up of two tank platoons, one section of Tow missile systems, and one section of heavy machine guns. Support-force 2 attacks by fire to support the main effort's attack to clear enemy from the East side of the river. Figure 68 provides an overview of the scheme of maneuver for support-forces 1 and 2.



Figure 68. Mixed Terrain Support-Force 1 and 2

The mechanized company (Company A) is the main effort. The main effort attacks to clear the enemy position East of the river and establishes a blocking position to the South (Figs. 69 and 70).

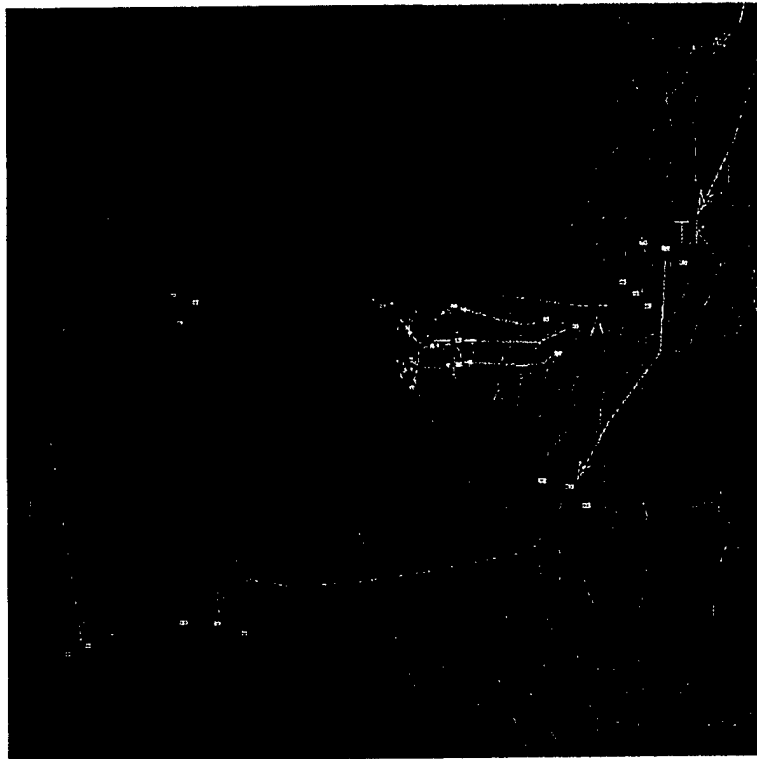


Figure 69. Mixed Terrain Main Effort, Overview

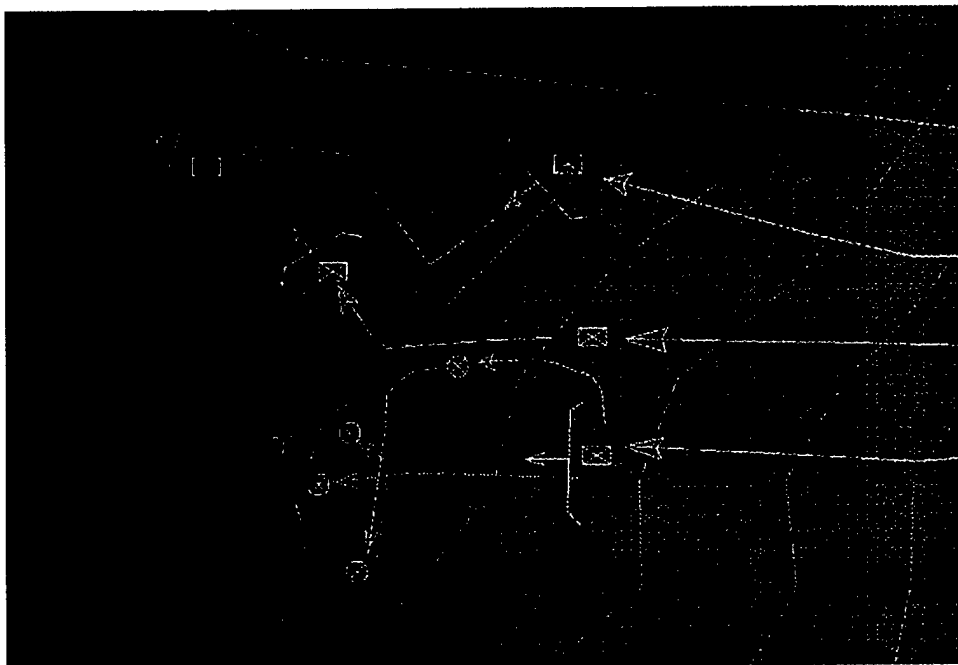


Figure 70. Mixed Terrain Main Effort, Detail

The coalition force attacks to clear a route to the East of the Marines (Figs. 71 and 72).



Figure 71. Mixed Terrain Coalition, Overview

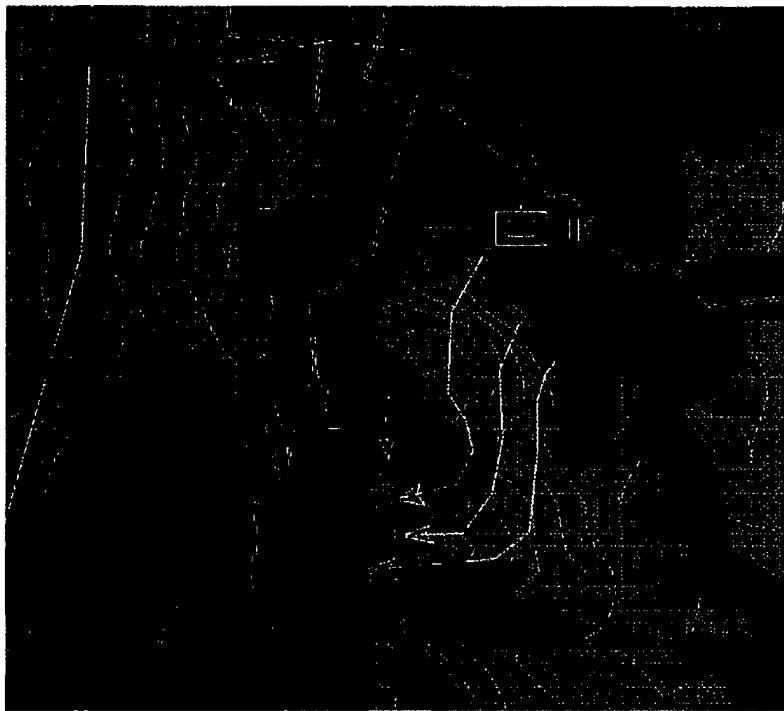


Figure 72. Mixed Terrain Coalition, Detail

4. Simulation Parameters

Parameters set to establish the baseline conditions for the scenario include the following. The simulation was constructed to represent an attack commencing at 0800, on a clear, sunny day. No battlefield obscuration was employed. The Janus fratricide capability was enabled and the firing criterion for all Marine and coalition forces was set to recognition. Groups were set at the platoon level. Again, it was assumed that the net effect, of recognition firing criteria and platoon grouping, on total fratricidal interactions was negligible.

C. SCENARIO RESULTS

1. Fratricide Enabled vs. Disabled

Again, for comparison, two runs of the scenario were conducted. In both runs, all parameters were set identically except the fratricide capability. A general comparison of the interactions that occurred in the two mixed terrain scenario runs is presented in Table 5. Comparison of the interactions within units and between adjacent units is presented. The number of occurrences and type of interaction is presented for each situation as well. As was evident from the previous MOUT scenario comparison, the number of near miss and fratricidal interactions suggest a significant possibility of fratricide exists in a mixed terrain situation. The remainder of results presented in this chapter will cover the fratricide enabled scenario run.

Comparison between Mixed Terrain Fratricide Enabled and Disabled Simulation Runs

Unit	Fratricide Disabled Run	Fratricide Enabled Run
<i>Within Unit</i>		
Support-Force 1 (SF 1)		N x 1
Support-Force 2 (SF 2)		N x 3
Helicopter-borne Task Force (HTF)	N x 6	N x 5
Obstacle Clearing Detachment (OCD)		
Battalion Mortars (81s)		
Main Effort, Co. A (A)		F x 6
Screening Force, LAR Co. (LAR)	N x 2	
UK Co. (UK)		N x 2
Aviation	N x 1	F x 1
<i>Between Units</i>		
SF 1 – HTF	N x 4	
SF 1 – SBF 2		N x 1, F x 7
SF 1 – A	N x 1	
SF 2 – OCD		F x 2
SF 2 – HTF	N x 2	
SF 2 – A		F x 2
SF 2 – 81s		F x 2
A – HTF	N x 2	N x 2
A – LAR		F x 1
USMC – UK		
LAR – HTF		F x 4
Air – Ground	N x 9	N x 4, F x 6
Total Interaction Incidents	USMC: Nx27 USMC+UK: Nx27	USMC: Nx16, Fx31 USMC+UK: Nx18, Fx31

F = Fratricide Interaction

N = Near Miss Interaction

Table 5. Comparison of Mixed Fratricide Enabled and Disabled Simulations

2. General Observations

During the attack on the enemy positions East of the river, units of the main effort were not able to maintain a high level of SA of adjacent Marine units. Apparently, this condition occurred because the wooded terrain over which the attack was conducted afforded little line of sight of adjacent units and enemy positions. Nine incidents of fratricide and one near miss incident occurred as a result.

The rolling terrain that units of support-force 2 attacked across led to their disorientation and engagement of support-force 1. The result was seven fratricidal and one near miss interaction.

The restrictive line of sight windows through the hills and vegetation impacted air defense units' ability to correctly identify rotary wing aircraft. Two aircraft were engaged and destroyed as a result.

The close proximity of friendly and enemy ground forces created a situation in which aviation directly attacked ground entities, or placed them well within aviation ordnance hazard areas, on four near miss and six fratricidal occasions.

The avenue of approach in which the enemy defended was four Kilometers across at its widest point. The terrain slopes upward relatively steeply on both sides of the corridor at this point. The relatively steep slope of the terrain along the sides of the corridor allowed FW CAS aircrews only a very short period of observation in which to acquire specific enemy entities and release bombs before the target area was over-flown. Laser-guided, precision munitions (PGMs) could reduce this problem; however, PGMs are expected to continue to be a limited resource. This difficulty to acquire targets

combined with the close nature of the vegetation and terrain created a situation, in which a FW CAS aircraft engaged and destroyed a RW CAS aircraft.

3. Entity Interaction Overview

Figures 73 through 80 chart the type of interaction (N = near miss, F = fratricide) and simulation time of each interaction within and between units. On all charts, shooters are plotted on the Y-axis, while targets are plotted on the X-axis. Where no interactions took place between units, no chart is provided.

Interactions Within Company L (Helicopter-borne Task Force)

		Target														
		☒ _L	1☒ _L ¹	2☒ _L ¹	3☒ _L ¹	1☒ _L ²	2☒ _L ²	3☒ _L ²	1☒ _L ³	2☒ _L ³	3☒ _L ³	☒ _L [↑]	☒ _L ³	☒ _L ¹³	☒ _L ²	☒ _L [↑]
Shooter	☒ _L															
	1☒ _L ¹															
	2☒ _L ¹															
	3☒ _L ¹		N2020 N3045N2435 N3045													
	1☒ _L ²															
	2☒ _L ²		N3045													
	3☒ _L ²															
	1☒ _L ³															
	2☒ _L ³															
	3☒ _L ³															
	☒ _L [↑]															
	☒ _L ³															
	☒ _L ¹³															
	☒ _L ²															

N: Near Miss F: Fratricide

Figure 73. Mixed—Interactions within Company L (HTF)

Interactions Within Support-Force 1 Units

		Target																
		CO	XO	B1	2A1	3A1	4A1	1A1	2A1	3A1	4A1	1A2	2A2	3A2	4A2	☒	1A1	2A1
Shooter	CO																	
	XO																	
	B1																	
	2A1																	
	3A1																	
	4A1																	
	1A1																	
	2A1																	
	3A1																	
	4A1																	
	1A2																	
	2A2																	
	3A2																	
	4A2																	
	☒																	
	1A1																	
	2A1																	

N: Near Miss F: Fratricide

Figure 74. Mixed—Interactions within Support-Force 1

Interactions Within Support-Force 2 Units

		Target													
		P ₂	2 ₂	3 ₂	4 ₂	P ₃	2 ₃	3 ₃	4 ₃	1 ₃	2 ₃	3 ₃	4 ₃	2 ₁	1 ₁
Shooter	P ₂														
	2 ₂														
	3 ₂									N2023	N2023				
	4 ₂														
	P ₃														
	2 ₃				N1541										
	3 ₃														
	4 ₃														
	1 ₃														
	2 ₃														
	3 ₃	N1339	N1339	N1339	N1339	N1339									
	4 ₃	N1452	N1452	N1452	N1452	N1452									
	2 ₁														
	1 ₁														

N: Near Miss F: Fratricide

Figure 75. Mixed—Interactions within Support-Force 2

Interactions Within Company A (Main Effort)

		Target																		
		1 _A	2 _A	3 _A	1 _A	2 _A	3 _A	2 _A	3 _A	2 _A	3 _A	1 _A	2 _A	3 _A	3 _A	↑ _A	⊗ _A	1 _A	2 _A	3 _A
Shooter	1 _A																			
	2 _A																			
	3 _A																			
	1 _A																			
	2 _A																			
	3 _A																			
	↑ _A																			
	⊗ _A																			
	1 _A																			
	2 _A																			
	3 _A																			

N: Near Miss F: Fratricide

Figure 76. Mixed—Interactions within Company A (Main Effort)

Interactions Among Aircraft

		Target												
		✈ ¹	✈ ²	✈ ³	✈ ¹	✈ ²	✈ ³	✈ ⁴	✈ ⁵	✈				
Shooter	✈ ¹													
	✈ ²													
	✈ ³													
	✈ ¹													
	✈ ²													
	✈ ³													
	✈ ⁴													
	✈ ⁵													
	✈													

N: Near Miss F: Fratricide

Figure 77. Mixed—Interactions among Aircraft

Interactions Within UK Company

		Target												
		1 U	2 U	3 U	U	U	1 U	2 U	3 U					
Shooter	1 U													
	2 U			N11617			N11617							
	3 U													
	U													
	U													
	1 U													
	2 U													
	3 U													

N: Near Miss F: Fratricide

Figure 78. Mixed—Interactions within UK Company

Interactions Between Units

Shooter		Target																											
		HTF					SF 1					SF 2				ME													
		1L	2L	3L	4L	5L	1S	2S	3S	4S	5S	1F	2F	3F	4F	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A				
HTF	1L																												
	2L																												
	3L																												
	4L																												
	5L																												
	6L																												
	7L																												
	8L																												
	9L																												
	10L																												
SF 1	1S																												
	2S																												
	3S																												
	4S																												
	5S																												
SF 2	2F																												
	3F																												
	4F																												
	5F																												
	6F																												
ME	1A																												
	2A																												
	3A																												
	4A																												
	5A																												
	6A																												
	7A																												
	8A																												
	9A																												
	10A																												
LAR	1L																												
	2L																												
	3L																												
	4L																												
UAV	1U																												
	2U																												
	3U																												
T	1T																												
	2T																												
	3T																												

N: Near Miss F: Fratricide

Figure 79. Mixed—Interactions between Units

The previous figures show a significant number of near miss and fratricide interactions between entities (18 near miss, 31 fratricide). Two fratricidal ground to air interactions occurred resulting in two lost aircraft. Four fratricidal and four near miss air to ground interactions occurred. The air to ground interactions resulted in three LAVs and one AAV destroyed and an uncounted number of Marines killed.

4. Example Interactions

Seven typical interactions are presented as examples to provide a feel for how interactions between units in mixed terrain might unfold over time.

a. RW CAS vs. Air Defense

At simulation time 0006, a section of RW CAS aircraft proceed along their route to attack position 1 (AP 1) (Fig. 81).

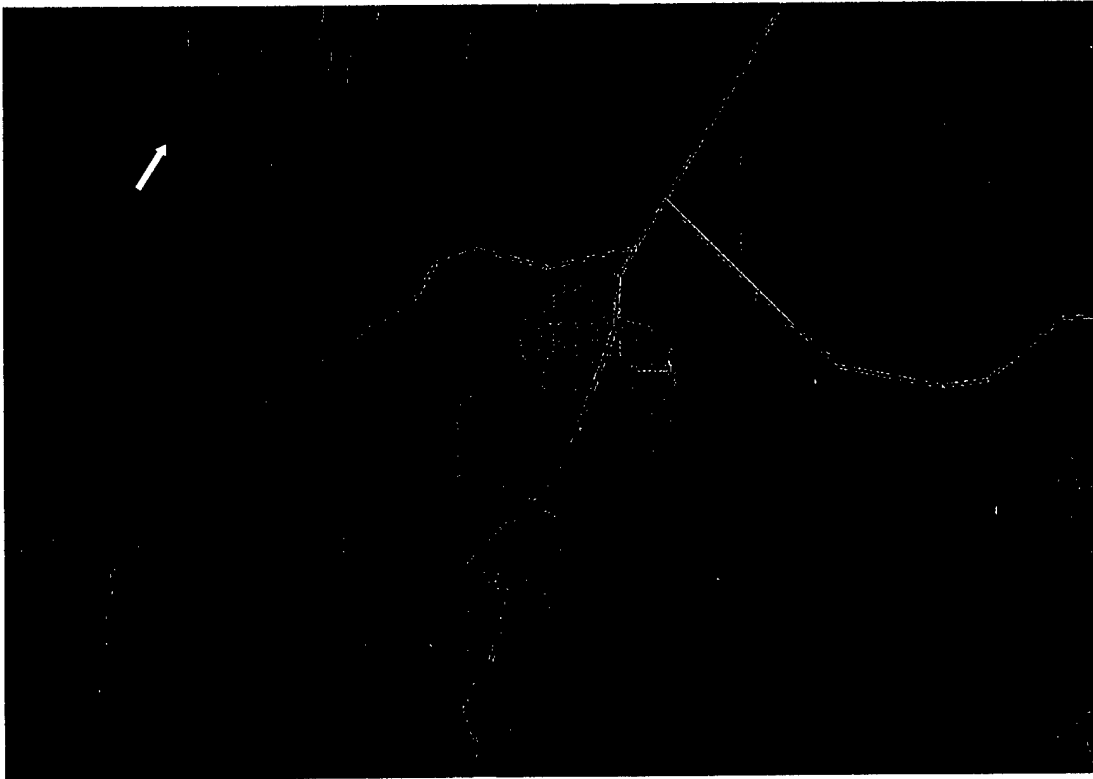


Figure 81. RW CAS vs. Air Defense: 0006

The aircraft are terrain masked from the air defense unit (Fig. 82).



Figure 82. RW CAS vs. Air Defense: 0006

The aircraft move through intermittent line of sight with the Avenger air defense system for 50 seconds, between 0010 and 0100 (Fig. 83), at which time they arrive at their AP.

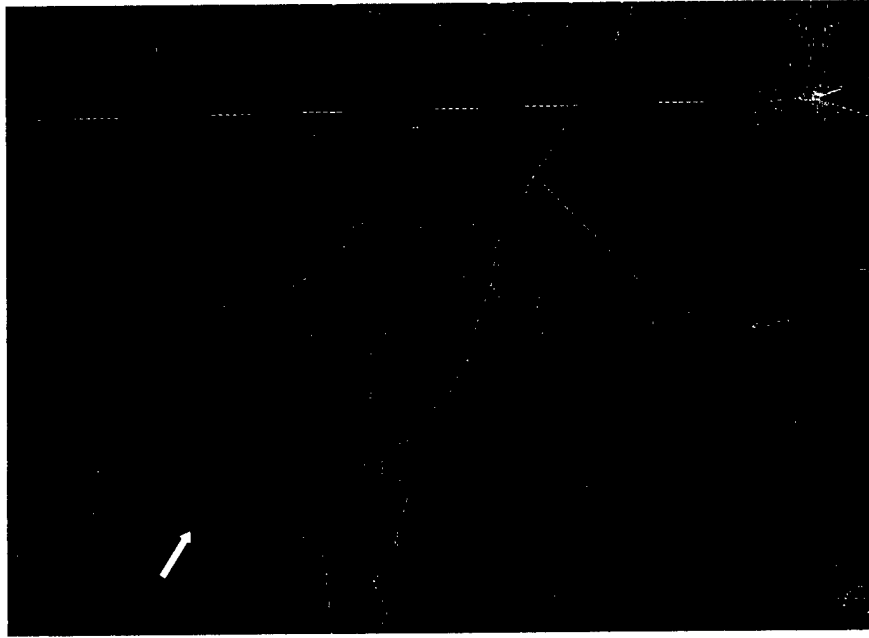


Figure 83. RW CAS vs. Air Defense: 0100

The aircraft remain in their AP from 0100 until 0203 (1:03 elapsed) when they are acquired and engaged by the Avenger (Fig. 84). One aircraft is destroyed.

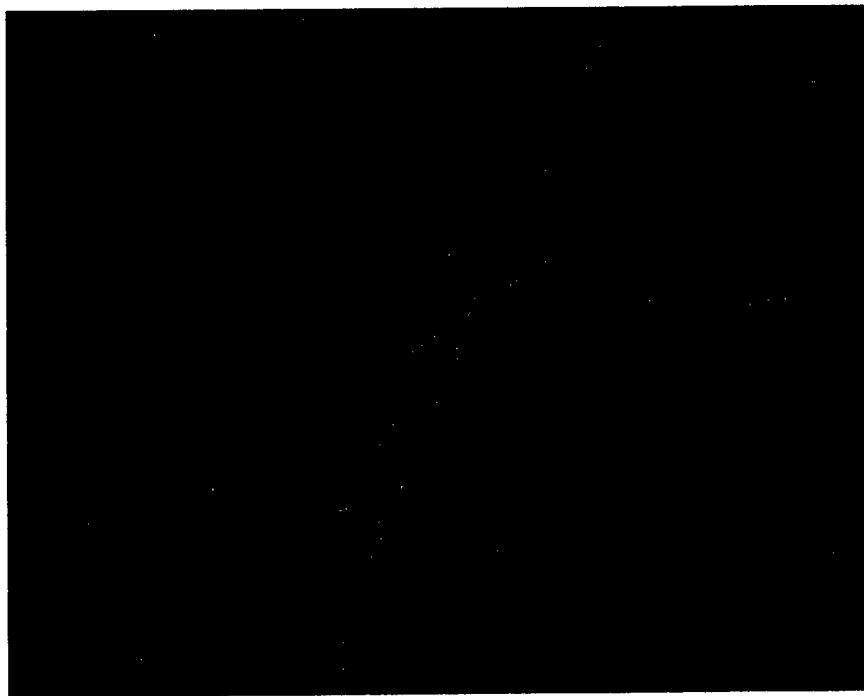


Figure 84. RW CAS vs. Air Defense: 0203

b. FW CAS vs. Co. A

A section of VMFA, FW CAS aircraft are inbound on an attack of an enemy position East of the river (Fig. 85).

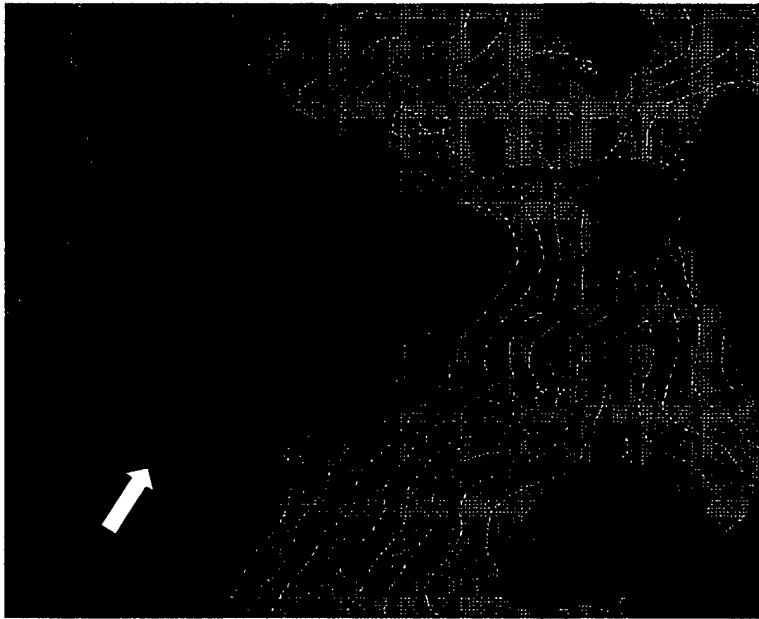


Figure 85. FW CAS vs. Co. A: 0136

The aircraft acquire Company A instead of the enemy and drop ordnance in the vicinity of the company command post. One AAV is destroyed (Fig. 86).

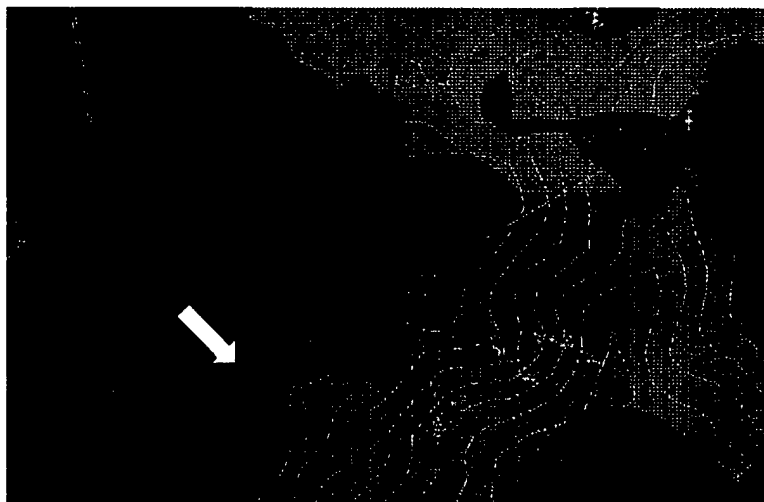


Figure 86. FW CAS vs. Co. A: 0140

c. Tow, SF 2 vs. Tank, SF 2

During the unit movement to support by fire position 1, The 3d Tow Section observes a target. The Tows have no line of sight to the 2d Tank Platoon advancing on their right (Fig. 87).

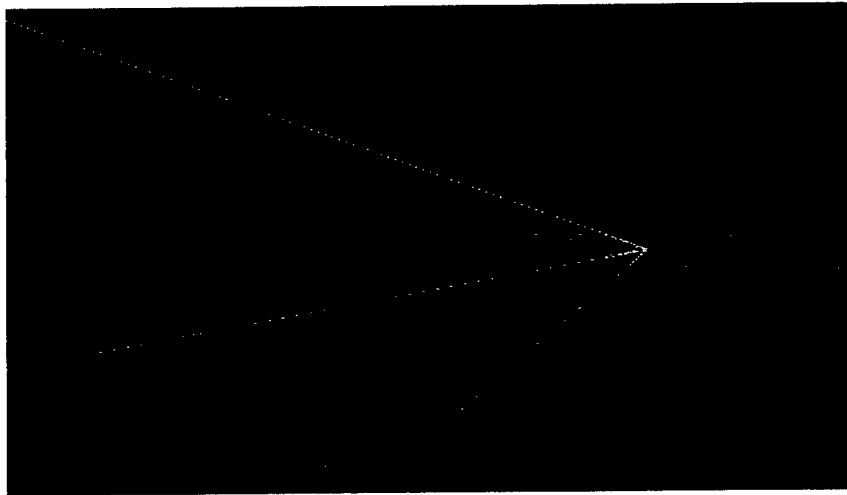


Figure 87. Tow, SF 2 vs. Tank, SF 2: 1450

At 1451, the Tow section engages a target to its right and over-fires the tank platoon (Fig. 88).

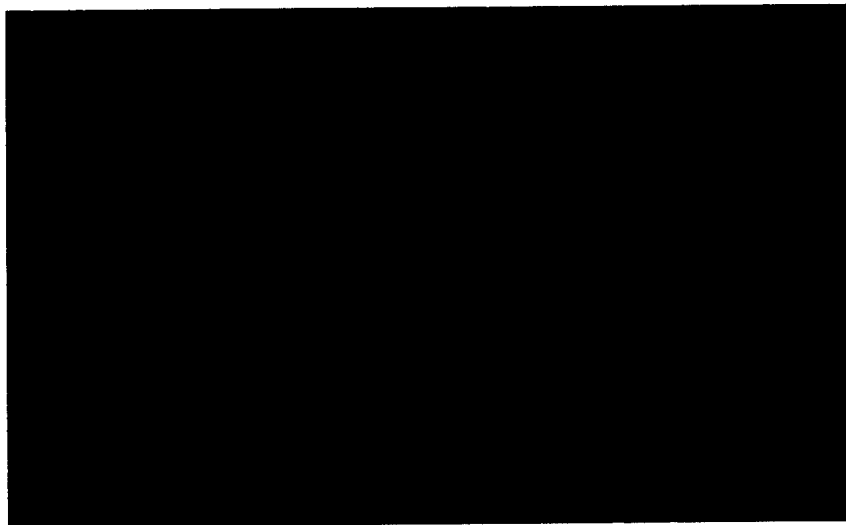


Figure 88. Tow, SF 2 vs. Tank, SF 2: 1451

d. Mortar Sec., Co. A vs. VMFA

At 1600, as Company A conducts an attack on enemy positions East of the river, a section of FW CAS aircraft are inbound to a target in the vicinity of Company A (Fig. 89).



Figure 89. Mortar Sec., Co. A vs. VMFA: 1600

The aircraft are unaware of the active mortar mission Company A is conducting on the enemy positions along the route of flight (note the mortar weapon-target line) (Fig. 90).

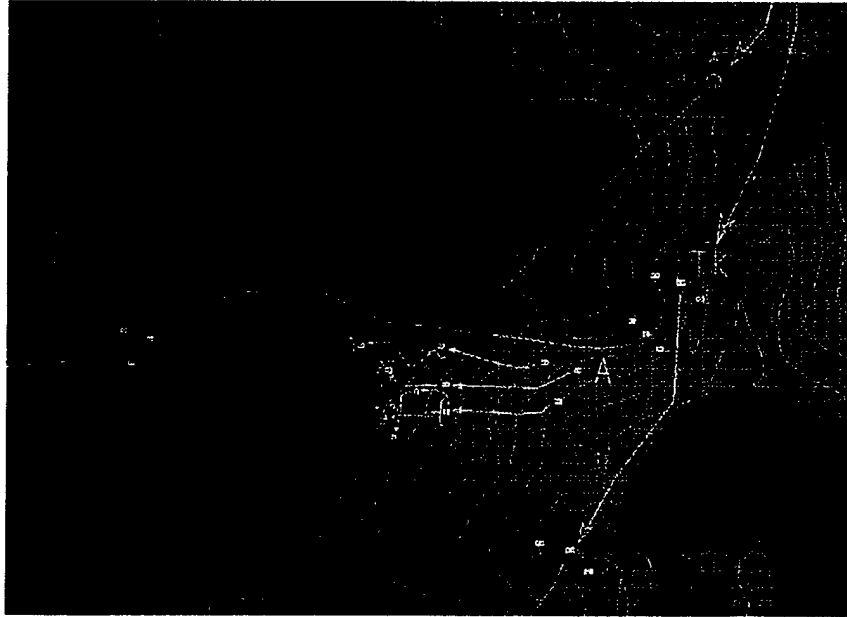


Figure 90. Mortar Sec., Co. A vs. VMFA: 1600

The aircraft make their attack run on the target at 1657 and hazard Company A by the attack heading (Fig. 91). Mortar impacts can be observed in the target area at the same time (Fig. 92).

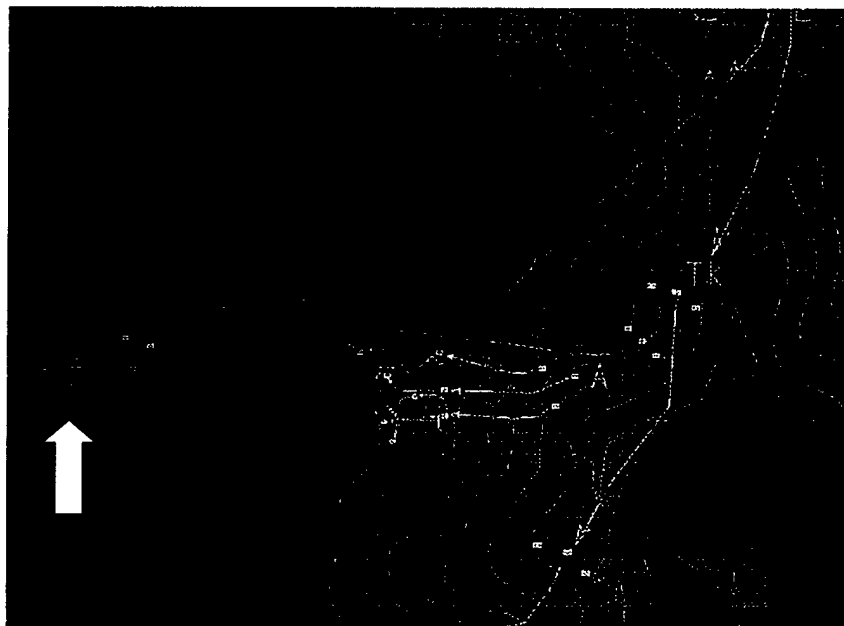


Figure 91. Mortar Sec., Co. A vs. VMFA: 1657

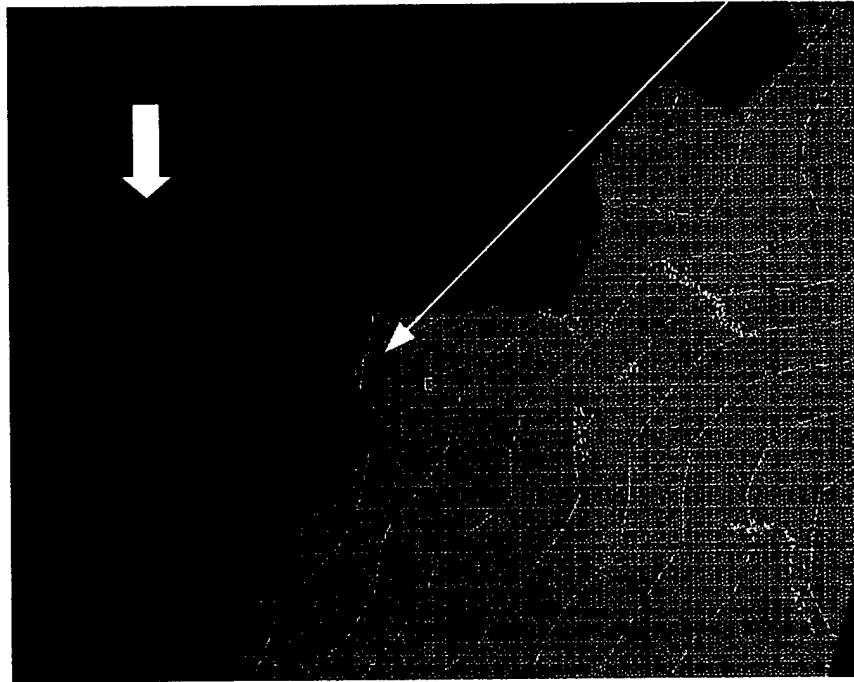


Figure 92. Mortar Sec., Co. A vs. VMFA: 1708

At 1720, the aircraft cross the trajectory and weapon-target line of the active mortar mission; mortar rounds are in the same airspace as the aircraft (Fig. 93).

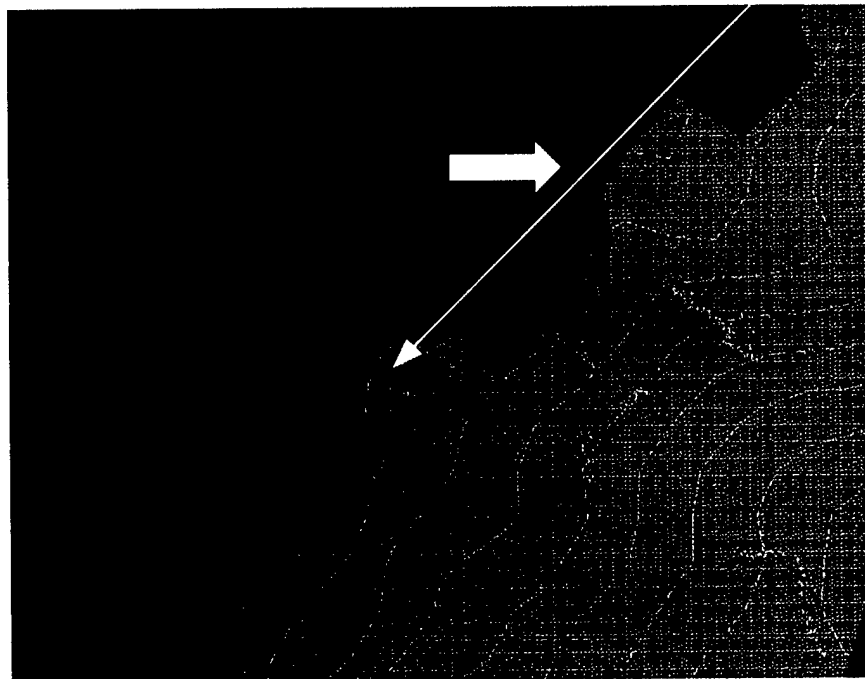


Figure 93. Mortar Sec., Co. A vs. VMFA: 1720

e. *2d Pltn., Co. A vs. 1st Pltn., Co. A*

1st and 2d Platoons, Company A attack toward enemy positions at 2115.

The platoons do not have line of sight to each other (Fig. 94).

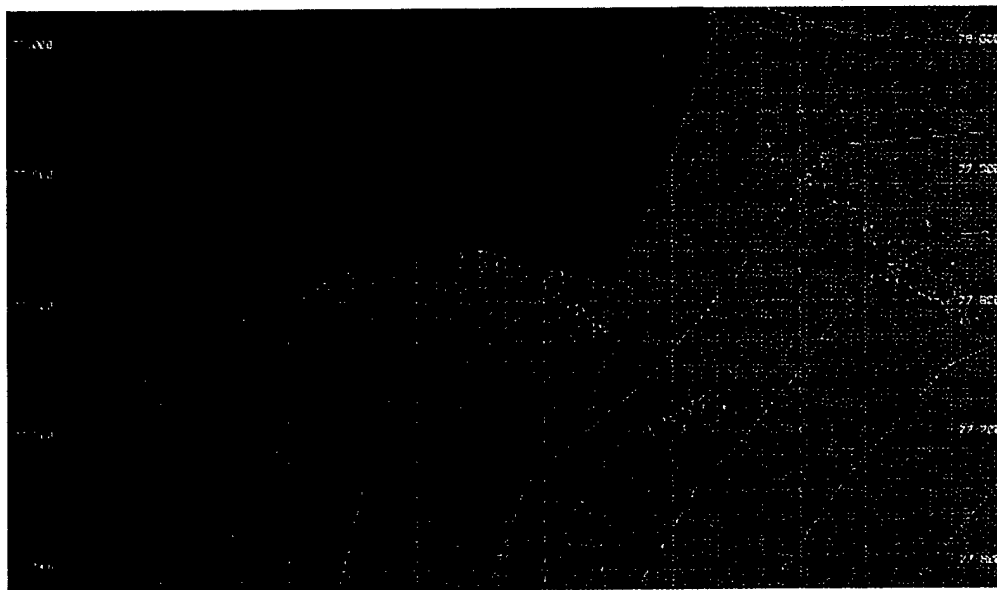


Figure 94. *2d Pltn., Co. A vs. 1st Pltn., Co. A: 2115*

At 2214 the 1st platoon leaves the trees and is engaged by the enemy (Fig. 95).

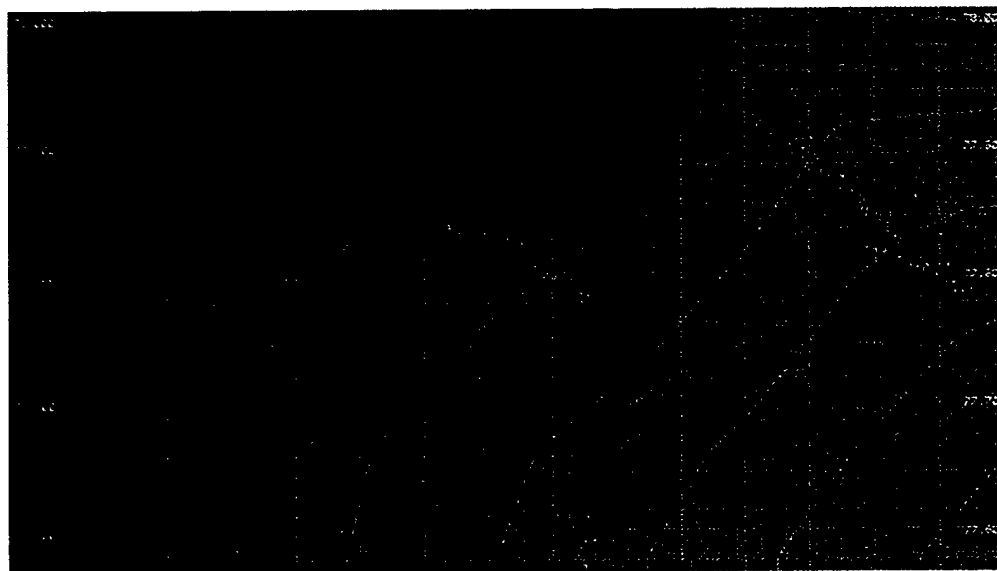


Figure 95. *2d Pltn., Co. A vs. 1st Pltn., Co. A: 2214*

At 2222, 2d Platoon, Company A exits the trees, observes both the enemy and 1st Platoon, misidentifies 1st Platoon as enemy, and engages (Fig. 96).

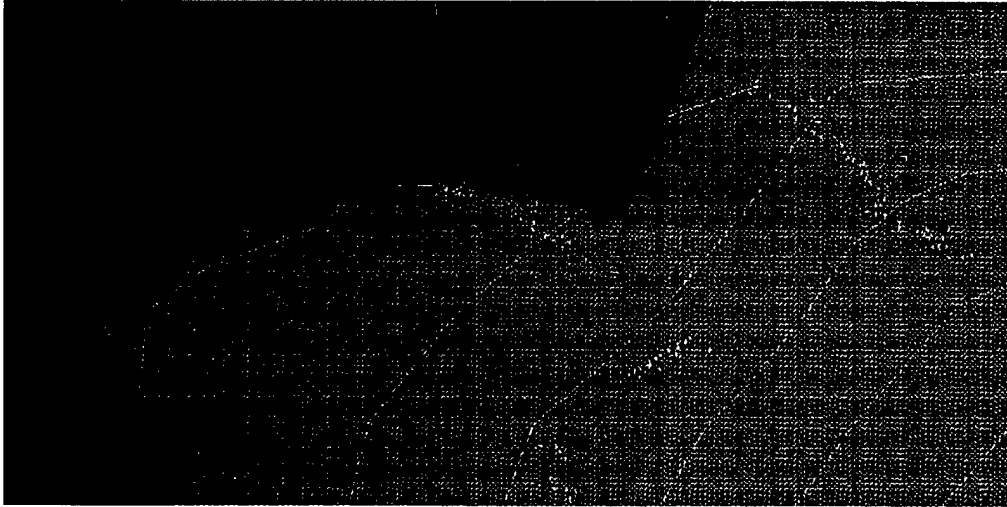


Figure 96. 2d Pltn., Co. A vs. 1st Pltn., Co. A: 2222

Two minutes pass while a fight between the enemy, 1st Platoon, and 2d Platoon develops. Throughout this fight, both the enemy and 2d Platoon engage 1st Platoon (Fig. 97).

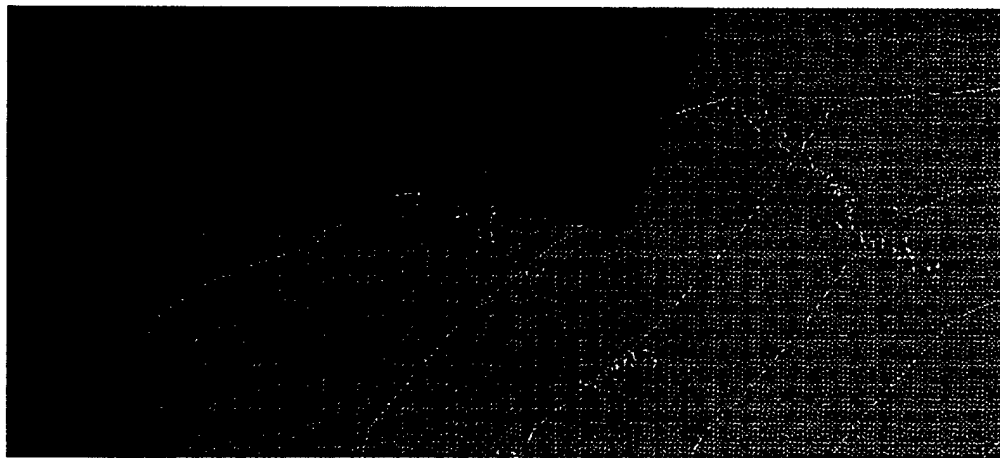


Figure 97. 2d Pltn., Co. A vs. 1st Pltn., Co. A: 2422

Entities in 1st Platoon return fire at 2d Platoon at 2540 (Fig. 98).

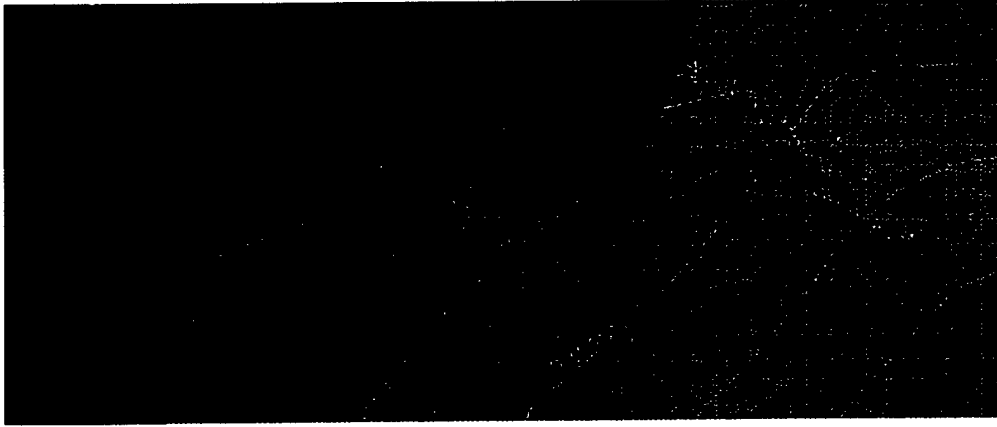


Figure 98. 2d Pltn., Co. A vs. 1st Pltn., Co. A: 2540

Sporadic fire continues to be exchanged between 1st and 2d Platoons, resulting in several casualties (Fig. 99).



Figure 99. 2d Pltn., Co. A vs. 1st Pltn., Co. A: 2916

The fire between the Marine platoons ceases at 3200, after 9:38 of fire between the two Marine platoons (Fig. 100).



Figure 100. 2d Pltn., Co. A vs. 1st Pltn., Co. A: 3200

f. 2d Pltn., LAR Co. vs. 3d Pltn., Co. A

By 10500, 3d Platoon, Company A has established a blocking position along the East side of the river, overlooking the MSR. To the Southwest, the 2d Platoon, LAR Company advances toward its next over-watch position (Fig. 101).

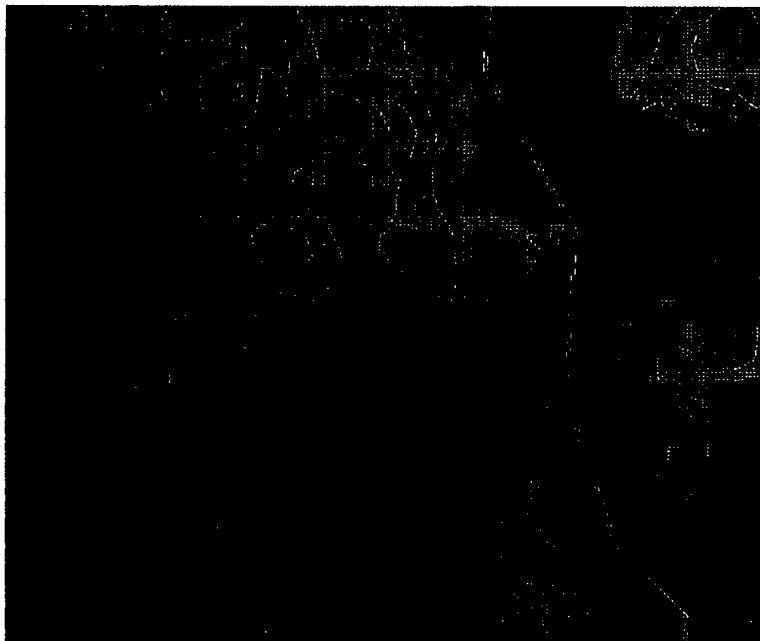


Figure 101. 2d Pltn., LAR Co. vs. 3d Pltn., Co. A: 10500

At 10543, the LAR platoon arrives at its position. From this position, line of sight exists to 3d Platoon, Company A (Fig. 102).

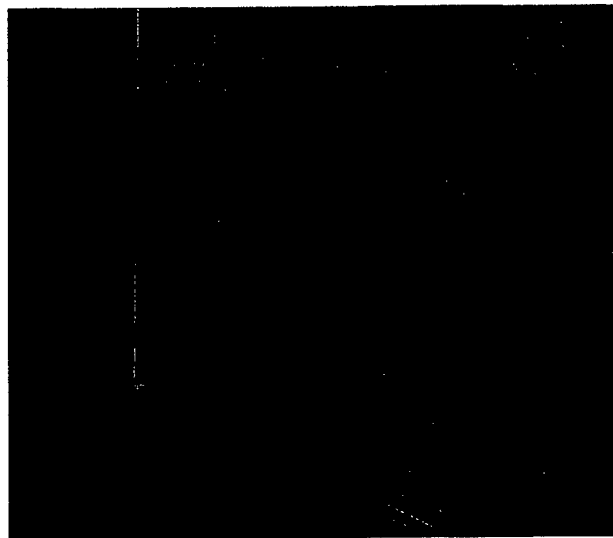


Figure 102. 2d Pltn., LAR Co. vs. 3d Pltn., Co. A: 10543

After 2:24 of observation, LAR detects the infantry platoon, determines it to be hostile, and engages. The LAR continue engaging for 2:06 before determining the infantry to be friendly and ceasing fire (Fig. 103).



Figure 103. 2d Pltn., LAR Co. vs. 3d Pltn., Co. A: 10807

D. MIXED TERRAIN SCENARIO CONCLUSIONS

1. Aircrew Situational Awareness

FW aircraft in the scenario were particularly lethal to ground and RW entities. Unlike the MOUT scenario, entities were not protected by buildings and other man made features from aviation observation, targeting, and weapons effects. Consequently, SA displays for FW and RW aircrews that contain accurate ground entity and RW aircraft PLI would be required to reduce air to ground fratricidal interactions. The PLI displayed to the aircrews would not prevent misidentification of friendly as enemy: however, it would alert the aircrews to the presence, disposition, and proximity to the target of friendly personnel. Aircrews then would be better able to orient their attack to prevent the effects of their ordnance from affecting adjacent friendly entities.

2. Resolution of Information

Resolvable distances, as stipulated by Reference 5, appear satisfactory for a SA device used in a mixed terrain environment.

3. Aircrew Artillery and Mortar Situational Awareness

FW CAS aircraft flew through the Company A mortar weapon-target line during the scenario. Indirect fire support forward observers, forward air controllers, and fire support coordination personnel establish control measures and coordinating instructions for combined arms fire support employment. However, the high speed of aircraft, high pilot workload in the cockpit, and difficulty of acquiring the correct target in the target area make following all control and coordinating measures difficult. A display of the active indirect fire mission weapon-target lines on aircrew SA devices would enhance

pilots ability to avoid the danger of crossing the flight path of ordnance, especially rifle company mortars.

E. CHAPTER SUMMARY

This chapter has discussed the mixed terrain scenario simulation, presented observations of the interaction of virtual forces, and drawn conclusions about the SA data requirements when operating in this type environment. The following chapter will discuss the final simulation, the mountainous desert scenario.

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VI. MOUNTAINOUS DESERT TERRAIN SCENARIO

A. INTRODUCTION

This chapter presents information about the mountainous desert terrain scenario. Notes on the scenario terrain, forces, and concept of operation are outlined along with simulation parameters. Observations of the simulation are presented and conclusions are drawn from the observations.

B. SCENARIO NOTES

1. Terrain

This scenario is set in a high desert environment with little vegetation. The area of operations is crossed West to East by three large avenues of approach. The northern and Southern avenues average four kilometers in width while the middle avenue averages six kilometers in width. North-South mobility corridors interconnect the three West-East corridors at the edges of the area of operations. The three corridors are separated by mountain ranges. The most prominent terrain in the area is a mountain peak in the center of the scenario terrain map. Figure 104 provides an overview of the terrain map used in this scenario.



Figure 104. Mountainous Desert Terrain Overview

2. Forces

a. Friendly Force Composition

The Marine force in the mountainous desert scenario is a task organized MAGTF of MEB strength. The MEB was organized for employment as an operational maneuver element, operating from a sea-base of amphibious shipping. A standard table of organization and equipment was used to organize the force. Exceptions were made to

force composition in cases where new equipment is expected to replace current systems. All systems that would be required to conduct sustained operations ashore are included in the task organization of the MEB; however, the size and composition of logistics units has been reduced to account for future improved ship to shore logistics delivery methods. The following general task organization outlines the composition of MEB used for this scenario.

Command Element:

- MEB "Jump" Command Post (Commander, Operations Officer)
- MEB Forward Command Post (Main Command Post Remains Shipboard)
- Three Communications Retransmission Sections
- MEB Combat Train (Small, to Support the Command Element)

Aviation Combat Element:

- Fighter-Attack (VMFA) Squadron (12 Aircraft)
- Detachment, Fighter-Attack, All Weather (VMFA-AW) Squadron (6 Aircraft)
- Attack (VMA) Squadron (12 Aircraft)
- Unmanned Air Reconnaissance (VMU) Squadron (6 Unmanned Air Reconnaissance Aircraft)
- Light Attack (HMLA) Squadron (12 AH1Y Attack Helicopters and 12 UH1Z Utility Helicopters)
- Two Medium Assault Support (HMM and VMM) Squadrons (12 Medium Assault Support Helicopters and 12 Tilt Rotor Aircraft)
- Heavy Assault Support (HMH) Squadron (12 Heavy Assault Support Helicopters)

Combat Service Support Element:

- Logistics Train, Including Armor Maintenance and Support Equipment
- Logistics Train, Direct Support of Ground Combat Element
- Logistics Train, General Support of MEB

Ground Combat Element:

- Regimental Forward Command Post (7th Mar.)
- Regimental Main Command Post
- Tow Anti Tank Missile Platoon
- Regimental Combat Train
- Three Communications Retransmission Sections
- Mechanized Battalion Task Force (1st Bn., 7th Mar.):
 - Forward Command Post
 - Main Command Post
 - Tank Company Team (M1A1 and AAV)
 - Mechanized Company Team (Co. A) (AAAV and M1A1)
 - Mechanized Company (Co. B) (AAAV)
 - Anti Armor Platoon (TOW Missiles and Heavy Machine Guns)
 - Mortar Platoon
 - Engineer Platoon
 - Mine Clearing Platoon (AAAV)
 - Two Combat Trains
 - Two Communications Retransmission Sections
- Mechanized Infantry Battalion (3d Bn., 7th Mar.):
 - Forward Command Post
 - Main Command Post
 - Two Mechanized Companies (Co. I and Co. K) (AAAV)
 - Anti Armor Platoon (TOW Missiles and Heavy Machine Guns)
 - Mortar Platoon
 - Two Combat Trains
 - Two Communications Retransmission Sections
- Helicopter-borne Task Force (Co. L, 3d Bn., 7th Mar.):
 - Rifle Company, Reinforced
 - Mortar Section
 - Engineer Squad
 - TOW Missile Squad

- Heavy Machine Gun Squad
- Two Sections FW CAS
- Two Sections RW CAS
- VMU Sortie
- Squadron VMM
- Squadron HMM
- Section HMLA Utility
- Two Communications Retransmission Sections

- Artillery Battalion, Reinforced (3d Bn., 11th Mar.):
 - Main Command Post
 - Fire Direction Center
 - Three Lightweight Howitzer Batteries (155mm)
 - Rocket Artillery Battery (MLRS)
 - Three Survey Parties
 - Three Counter-Battery Radar Teams
 - Two Combat Trains

- Light Armored Reconnaissance Company

- Engineer Company

- Reconnaissance Company

b. Coalition Force Composition

A U.K. mechanized infantry battalion is the coalition force used in the Mountainous Desert Scenario. The battalion's composition follows:

- Main Command Post
- Anti Tank Platoon
- Heavy Mortar Platoon
- Three Infantry Companies (Equipped with FOX Vehicles)
- Combat Train

c. Enemy Force Composition

The Enemy force used on the scenario is composed of the following elements:

Mechanized Infantry Battalion, Reinforced:

- Main Command Post
- Forward Command Post
- Mortar Platoon
- Anti Armor Platoon (BRDM-AT)
- Heavy Machine Gun Platoon
- Reconnaissance Platoon (BRDM-2)
- Engineer Company
- Tank Company (T-80)
- Three Mechanized Infantry Companies (BMP-2)
- Air Defense Company (SA-9, ZSU, and 2S6)
- Logistics Train

Artillery Battalion, Reinforced:

- Main Command Post
- Fire Direction Center
- Three Self-propelled Howitzer Batteries (2S1)
- Two Rocket Artillery Batteries (BM-21)
- One Counter-Battery Radar Team
- Two Logistics Trains

Separate Tank Company (T-80)

Separate Mechanized Infantry Platoon (BTR-70)

Separate Reconnaissance Platoon, Reinforced (BRDM-2 and T-80)

Separate Reconnaissance Company (BRDM-2 and BRDM-AT)

3. Concept of Operations

The enemy force defends along the central avenue of approach with tanks and mechanized infantry, reinforced with artillery and the separate tank company in reserve (Figs. 105, 106 and 107).

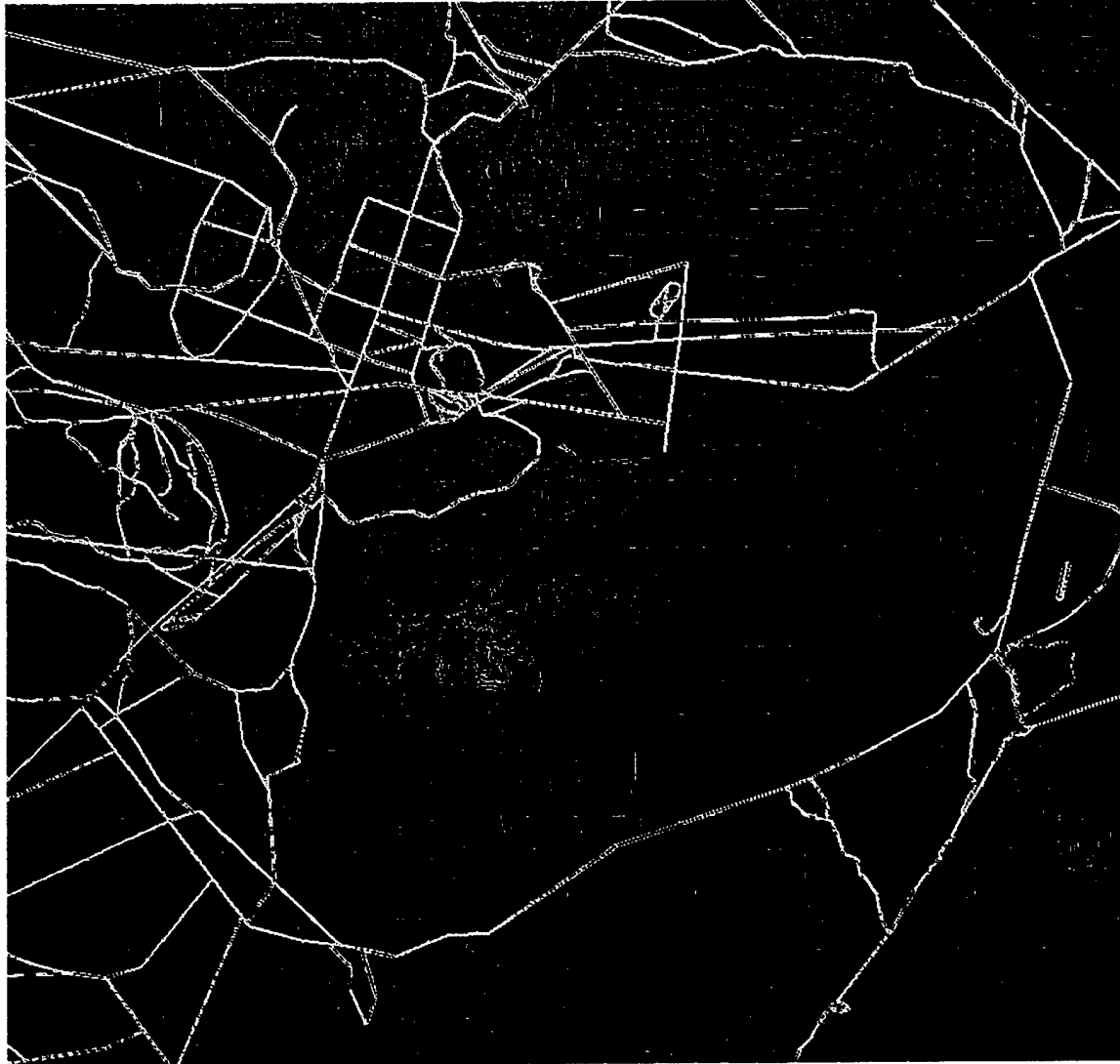


Figure 105. Desert Terrain Enemy Situation Overview

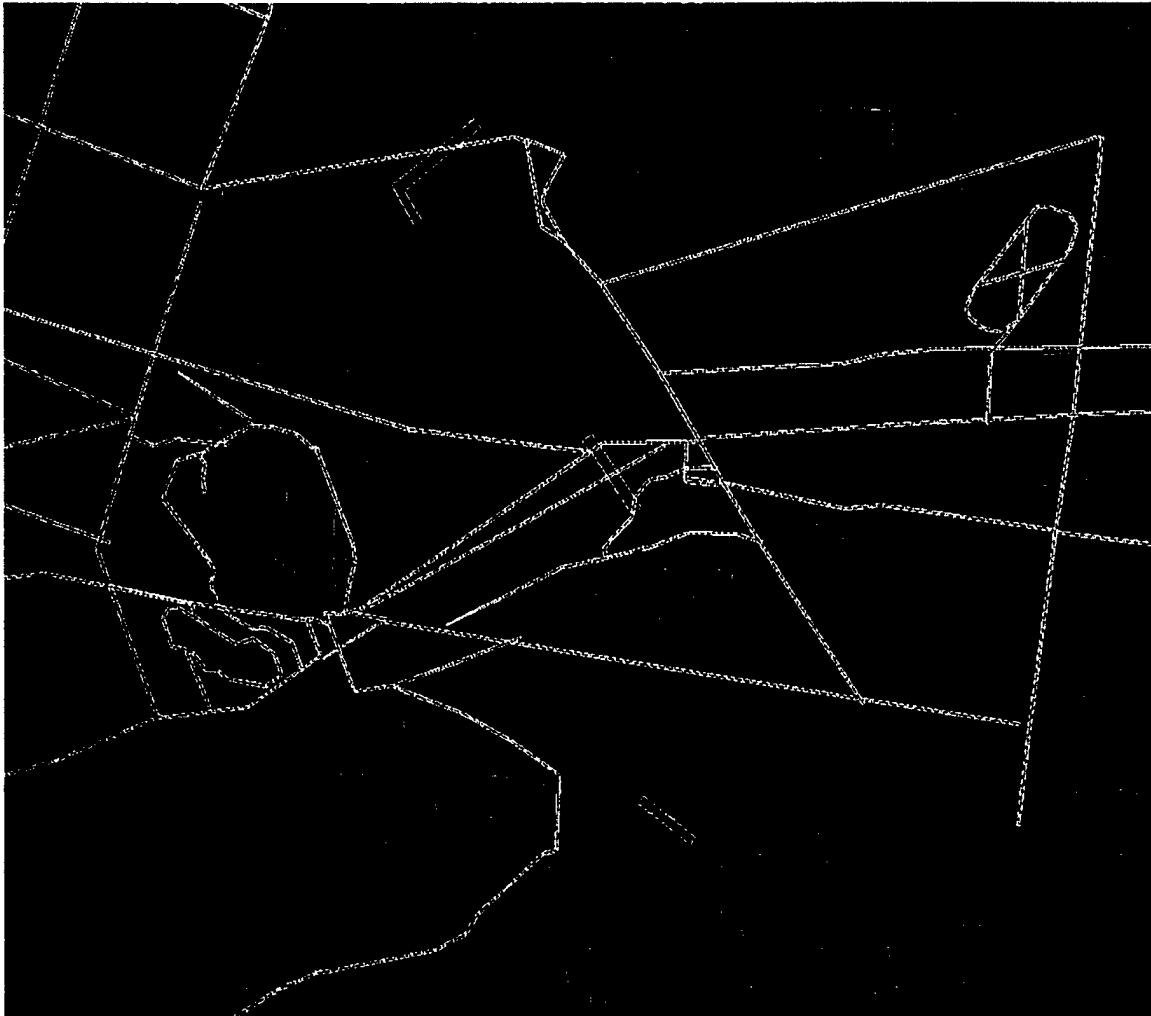


Figure 106. Desert Terrain Enemy Main Defense

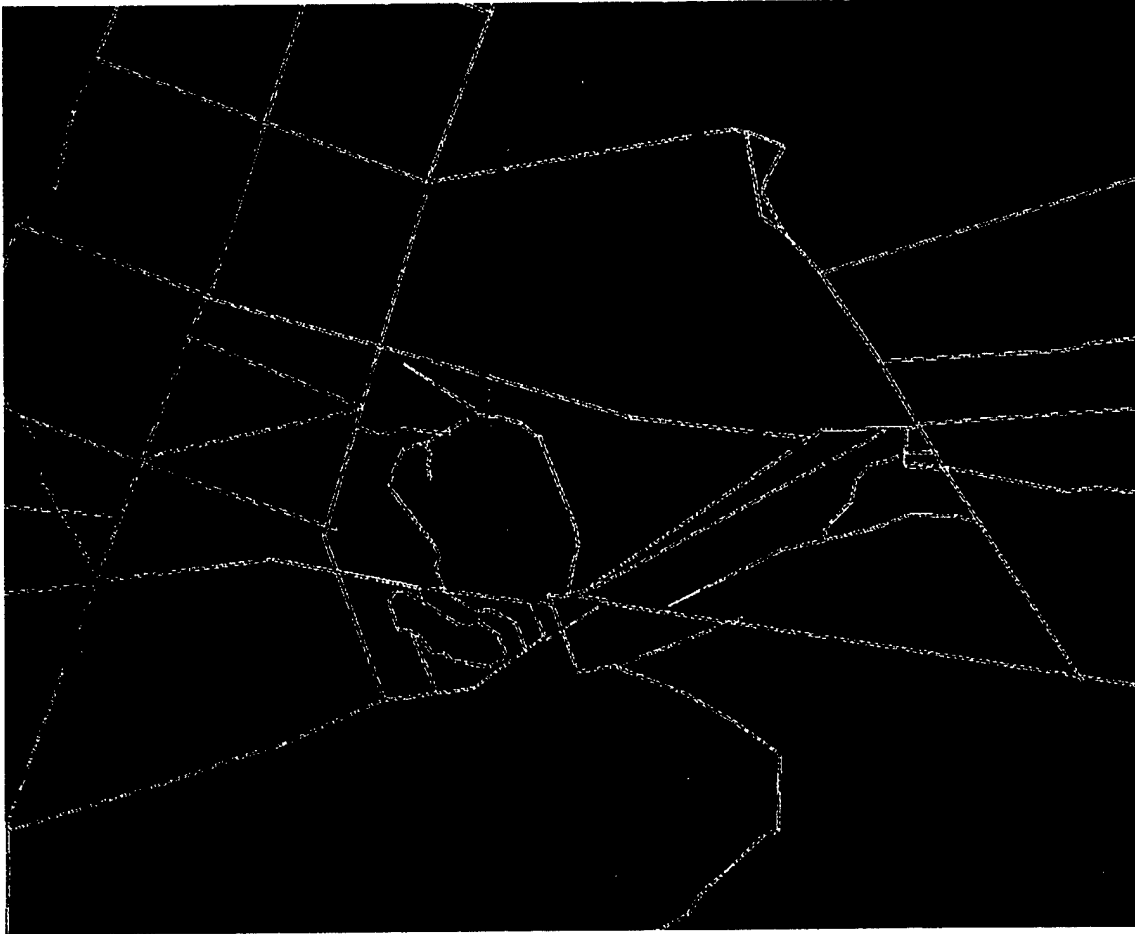


Figure 107. Desert Terrain Enemy Main Defense Detail

The Northern avenue of approach and flank of the enemy battalion is defended by the separate reconnaissance platoon and a tank platoon (Figs. 108 and 109).

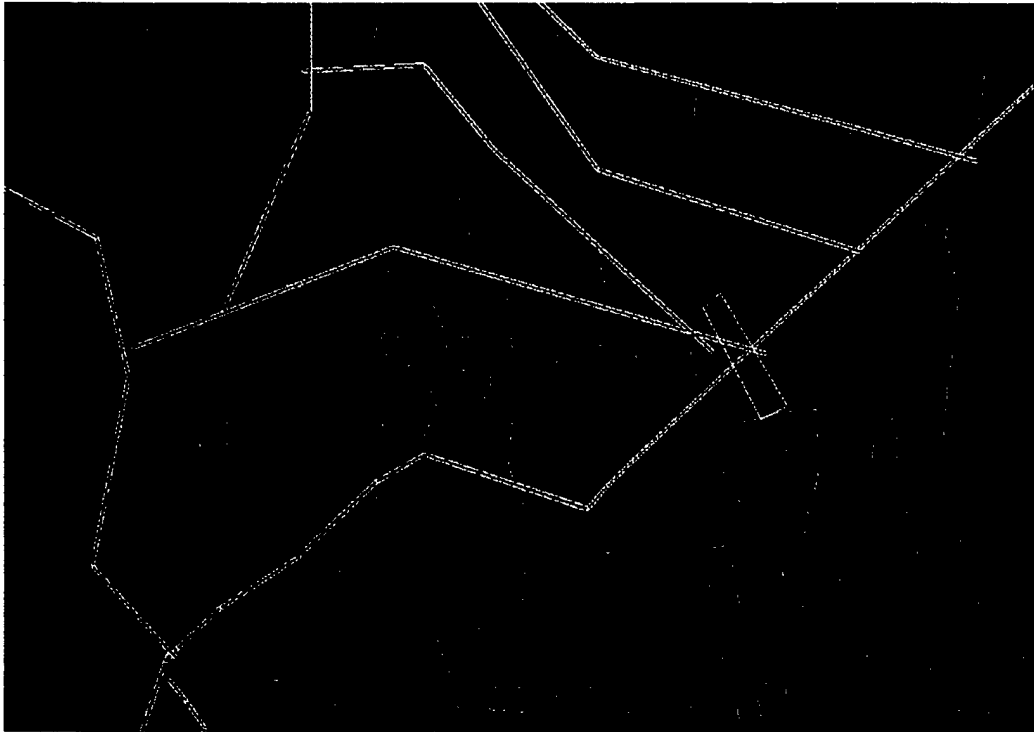


Figure 108. Desert Terrain Enemy North Defense

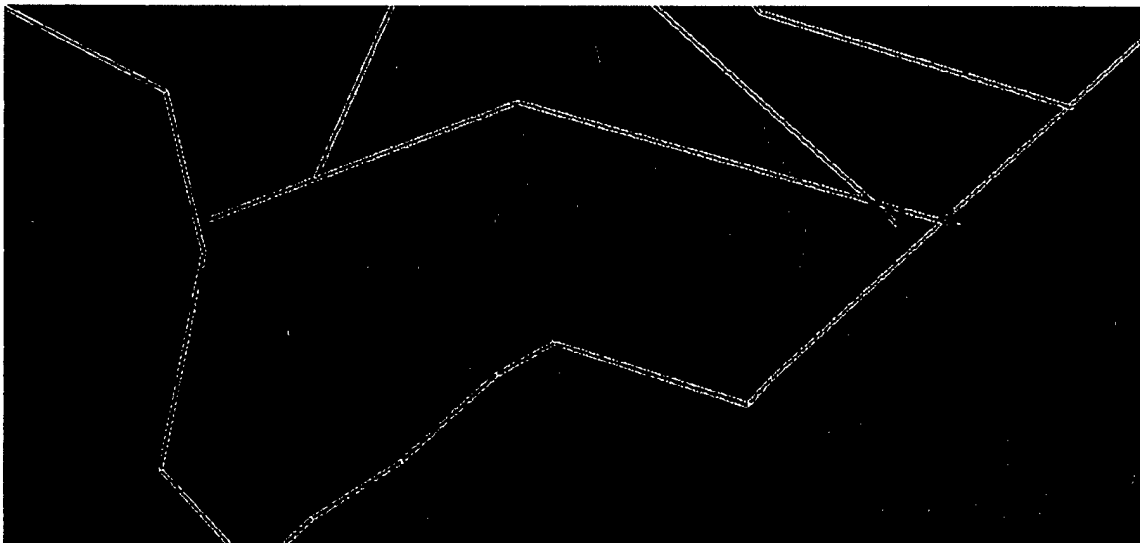


Figure 109. Desert Terrain Enemy North Defense Detail

The Southern avenue and flank of the battalion is defended by the separate infantry platoon (Fig. 110).



Figure 110. Desert Terrain Enemy South Defense

To the East of the separate infantry platoon, the reconnaissance company screens in zone (Fig. 111).

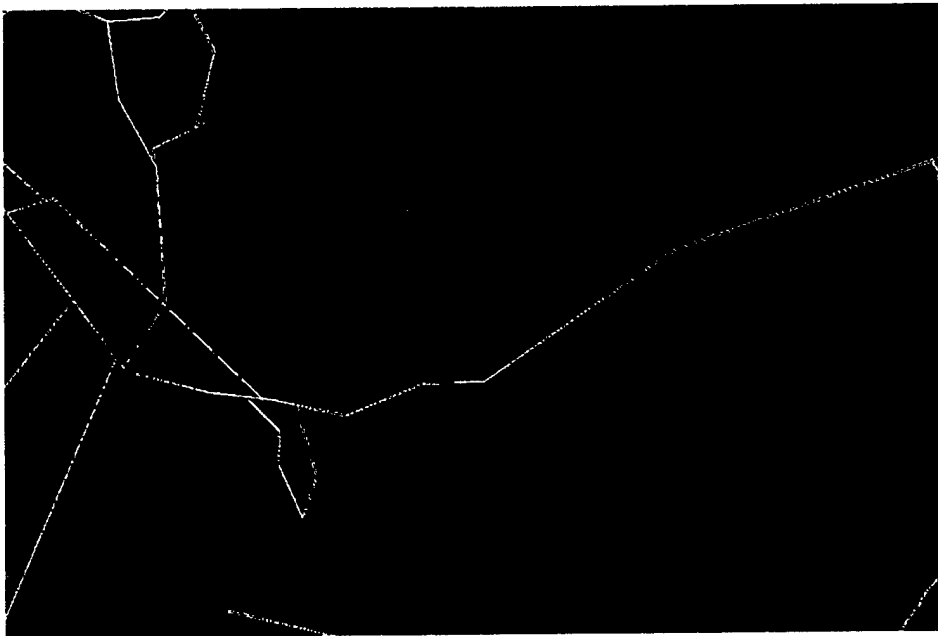


Figure 111. Desert Terrain Enemy Reconnaissance Company

The U. K. coalition force attacks to clear the Northern avenue of approach by a two company dismounted attack (Figs. 112 and 113).

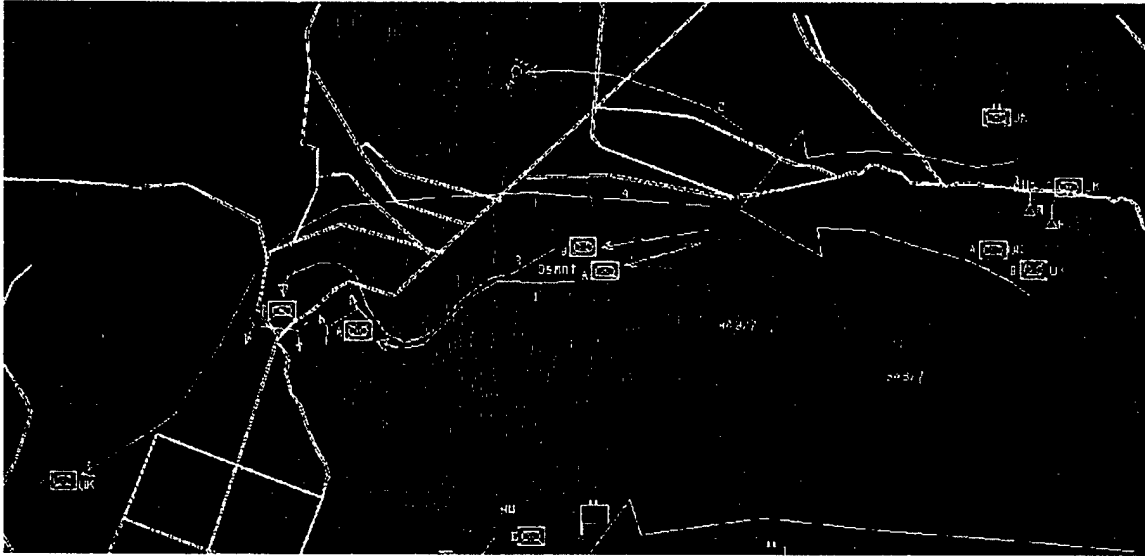


Figure 112. Desert Terrain UK Battalion Attack Overview

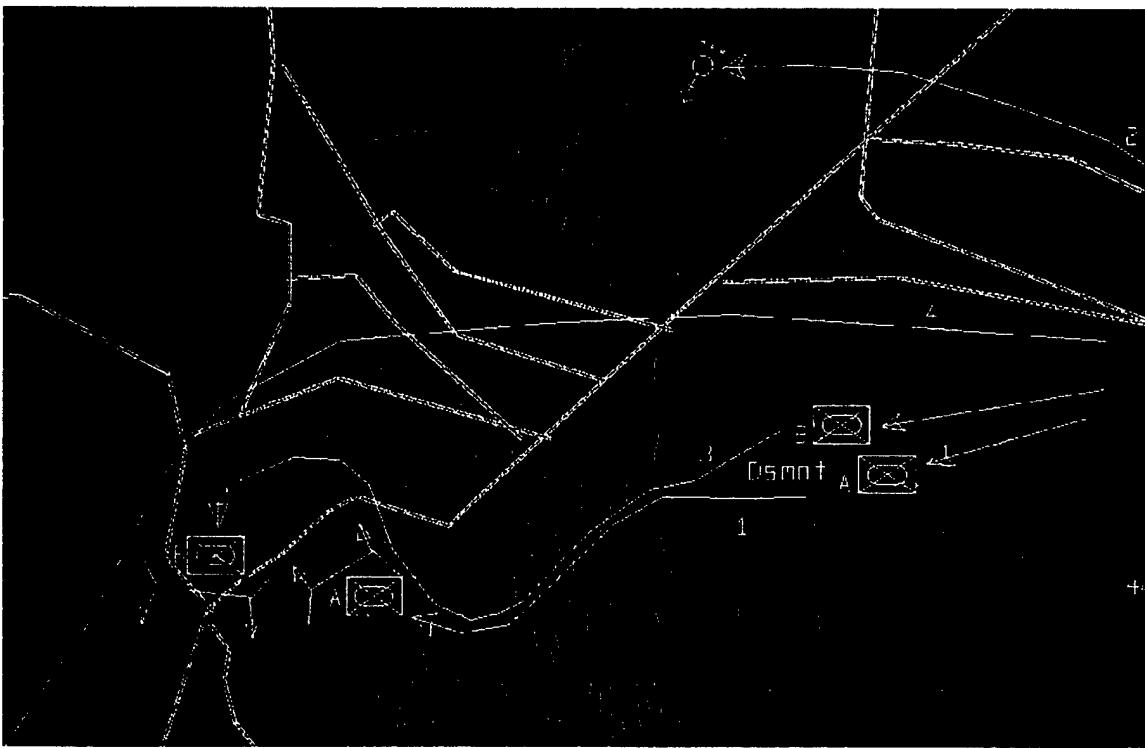


Figure 113. Desert Terrain UK Battalion Attack Detail

The Marine forces attack to destroy the enemy reserve tank company, clear the separate infantry platoon defensive position and screening force in the South avenue of approach, and destroy the enemy in the central avenue of approach. Specific unit tasks include:

- The helicopter-borne task force (HTF) clears the enemy platoon defending the Southern avenue of approach (Figs. 114 and 115).



Figure 114. Desert Terrain HTF Attack Overview



Figure 115. Desert Terrain HTF Attack Detail

- LAR screens to the in the Southern avenue and links-up with the helicopter-borne force (Fig 116).

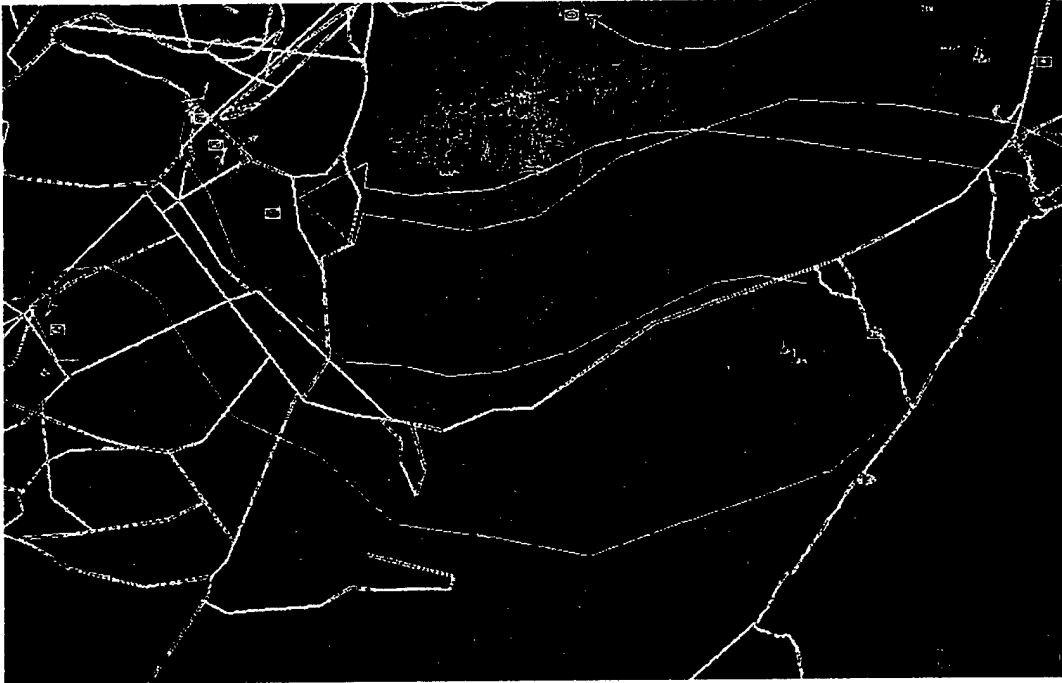


Figure 116. Desert Terrain LAR Screen

- The mechanized battalion task force attacks to clear the Southern half of the main enemy defensive position (Figs. 117 and 118).

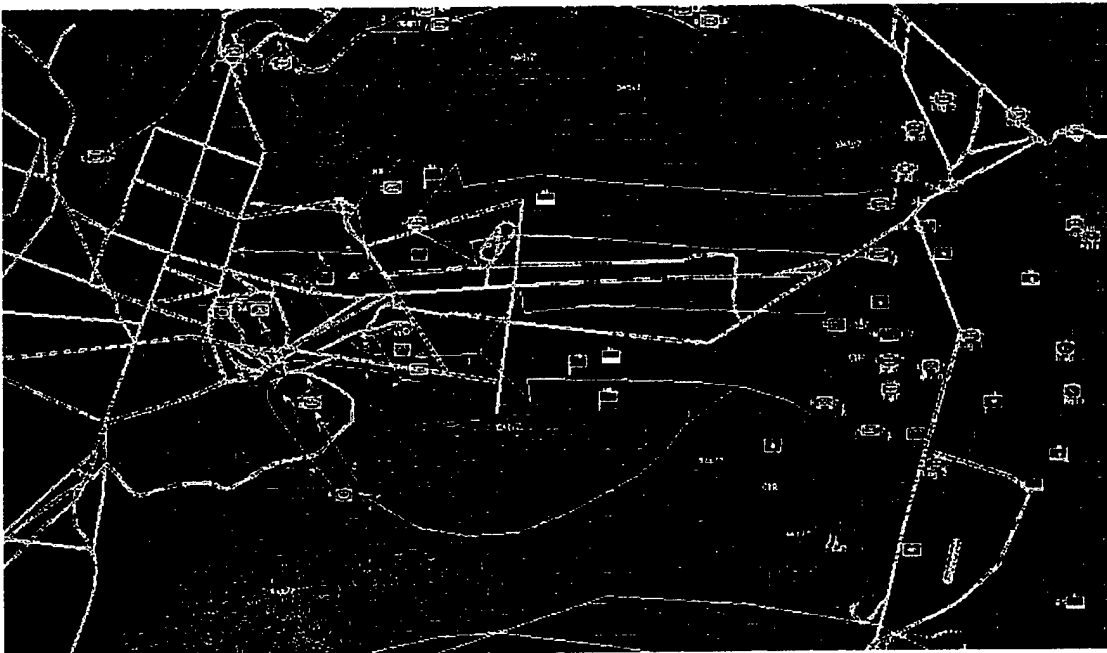


Figure 117. Desert Terrain USMC Main Attack Overview

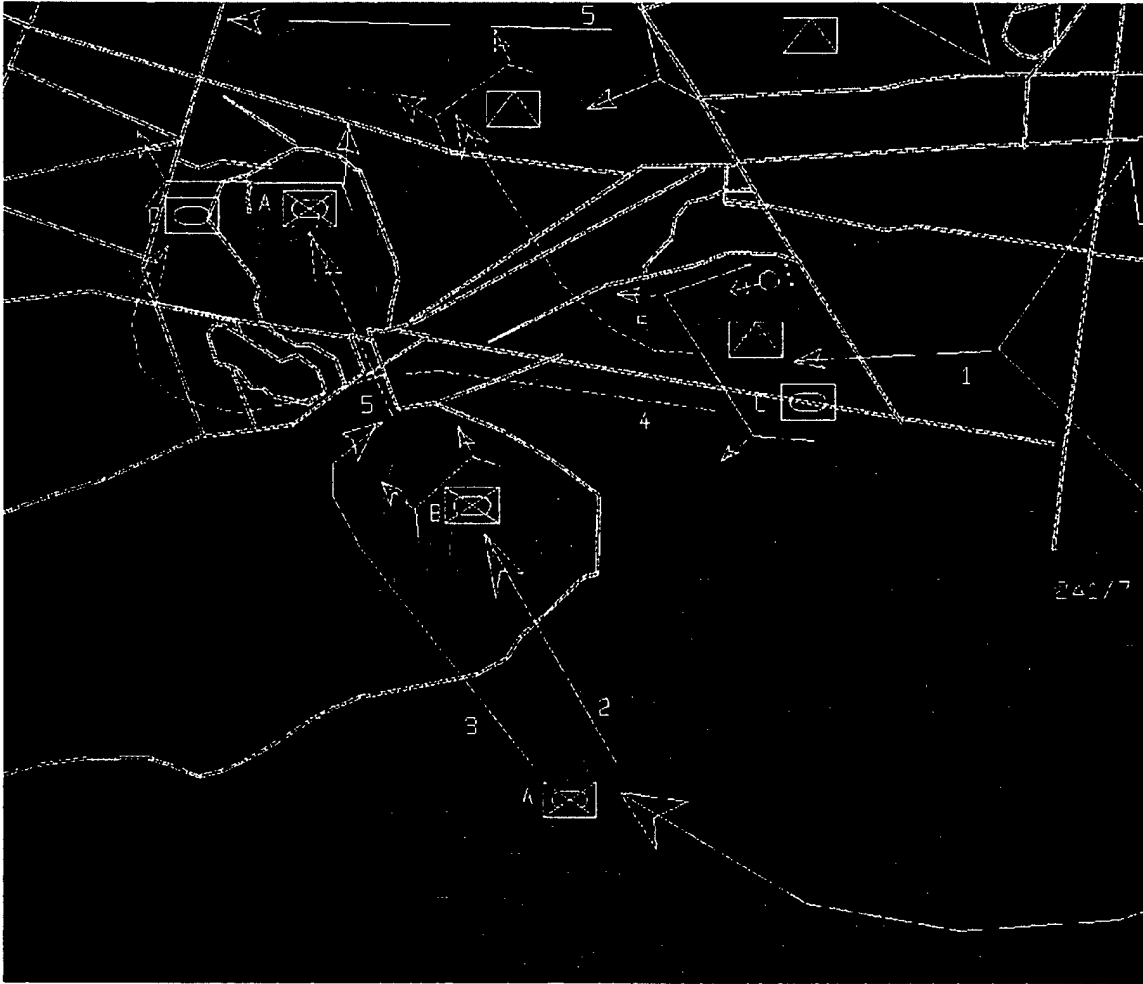


Figure 118. Desert Terrain Mechanized Battalion Task Force (1/7) Attack

- The mechanized infantry battalion attacks to clear the Northern half of the main enemy defensive position (Figs. 117 and 119).

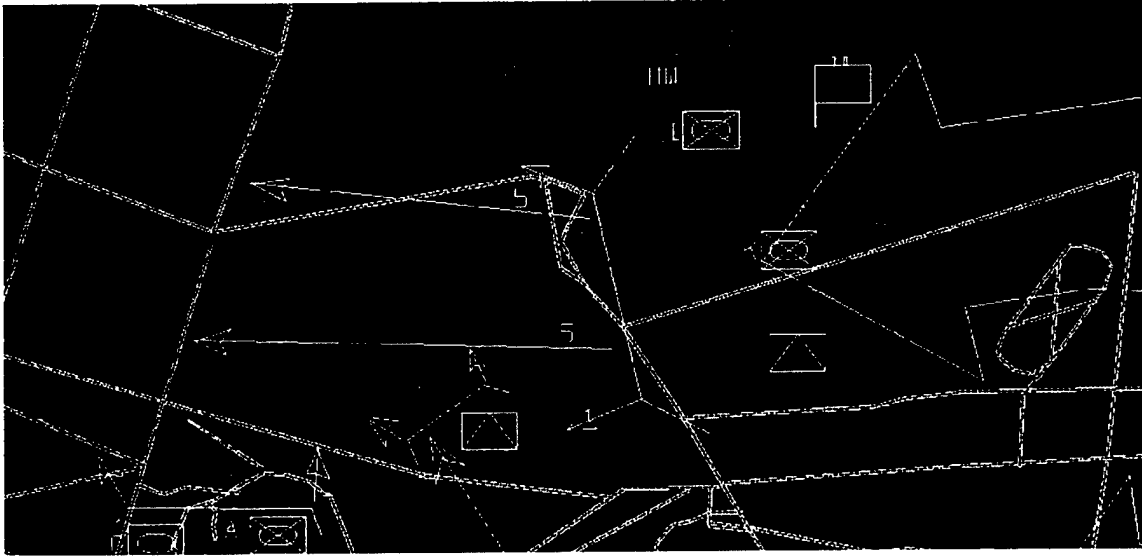


Figure 119. Desert Terrain Mechanized Battalion (3/7) Attack

4. Simulation Parameters

Parameters set to establish the baseline conditions for the scenario include the following. The simulation was constructed to represent an attack commencing at 0800, on a clear, sunny day. No battlefield obscuration was employed; however, to more accurately simulate desert conditions, vehicle, aircraft, and personnel movement generated dust was enabled. Fratricide was disabled. All entities were required to identify targets prior to engagement.

5. Fratricide Disabled Constraint

The mountainous desert scenario models a large scale, high intensity, brigade size operation. As a result of the size and scope of the scenario, the model contains over 3000 entities. The number of workstations available was not sufficient to adequately run this large scenario in a fratricide-enabled mode. Consequently, fratricide was disabled and no scenario generated, direct fratricidal interactions occurred. All observations were made from this fratricide-disabled scenario model. No comparison of fratricide enabled versus

fratricide disabled results could be made; however, many near miss interactions were observed in the scenario and used as the basis for conclusions.

C. SCENARIO RESULTS

1. General Mountainous Desert Observations

The Mountains that separated the corridors generally blocked cross-corridor line of sight between units. This reduced the potential for cross-corridor interaction between units and near miss or fratricide. In the few windows of visibility that permitted cross-corridor line of sight, the potential for and occurrence of near miss (and likely fratricide) increased. Within corridors, there was a tendency for entities to focus on the nearest targets and fire across or through adjacent units during target engagement. This type of cross-unit engagement would likely result in near miss and fratricide incidents in a real battlefield situation. A total of 48 near miss incidents were observed during the scenario.

2. Entity Interaction Overview

Figures 120 through 132 chart the type of interaction (N = near miss) and simulation time of each interaction within and between units. On all charts, shooters are plotted on the Y-axis, while targets are plotted on the X-axis. Where no interactions took place between units, no chart is provided.

Interactions Within LAR Company

		Target																			
		F	1	2	3	↑	↑	LOG													
Shooter	F																				
	1																				
	2																				
	3																				
	↑																				
	↑																				
	LOG																				

N: Near Miss F: Fratricide

Figure 121. Desert—Interactions Within LAR Co.

Interactions Between Company L, 3/7 & LAR Company

		Target																
		L	1L	2L	3L	A	3A		1	2	3	LAR	LOG					
Shooter	L																	
	1L								N11700									
	2L																	
	3L																	
	A																	
	3A																	
	1								N10250	N11422								
	2	N11755		N11755					N10335									
	3								N10003									
									N12450									
	LAR																	
	LOG																	

N: Near Miss F: Fratricide

Figure 122. Desert—Interactions Between HTF and LAR Co.

Interactions Within Company B, 1/7

		Target																												
		☒ B	☒ _B ¹	☒ _B ²	☒ _B ³	☒ _B ¹	☒ _B ²	☒ _B ³	☒ _B ¹	☒ _B ²	☒ _B ³	☒ _B ¹	☒ _B ²	☒ _B ³	☒ _B ¹	☒ _B ²	☒ _B ³													
Shooter	☒ B																	N10513												
	1☒ _B ¹																	N12802	N10513											
	2☒ _B ¹																													
	3☒ _B ¹																													
	1☒ _B ²																	N10921												
	2☒ _B ²																													
	3☒ _B ²																	N10914												
	1☒ _B ³																													
	2☒ _B ³																													
	3☒ _B ³																													
	↑ ☒ _B																													
	1☒ _B ¹																													
	1☒ _B ²																													
	1☒ _B ³																	N10740												
	2☒ _B ¹	N10355																	N10744	N10744										
	2☒ _B ²																		N10355											
2☒ _B ³																	N13711	N10424												
3☒ _B ¹																		N10424								N13711				
3☒ _B ²																														
3☒ _B ³																		N10602	N10538											

N: Near Miss F: Fratricide

Figure 123. Desert—Interactions Within Co. B

Interactions Within Heavy Weapons Pltn, 1/7

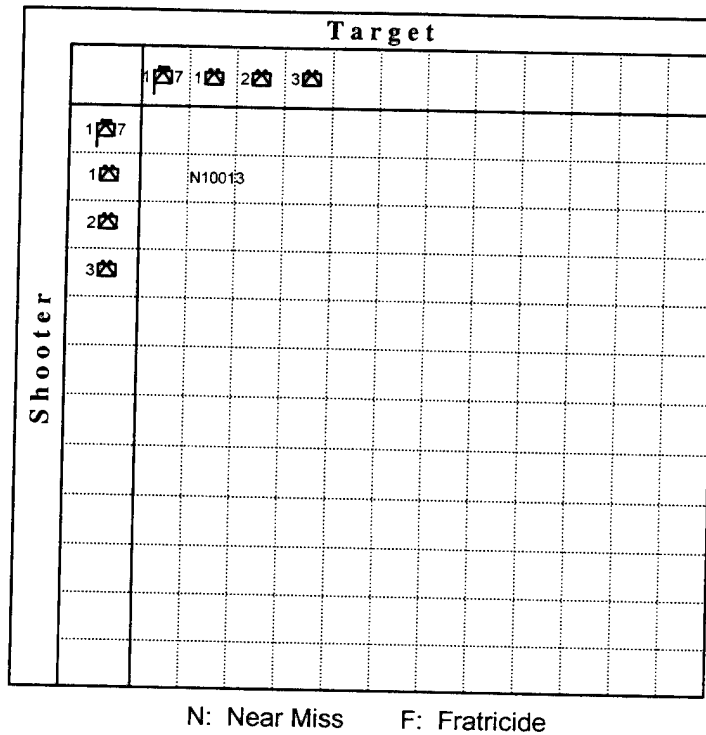


Figure 125. Desert—Interactions Within Heavy Weapons Pltn., 1/7

Time	Interaction
0:11:10	VMFA Section Re-attacks Enemy BM-21 Battery on a Final Attack Heading Along the Weapon Target Line Of the MLRS Battery During an Active Fire Mission; Aircraft Occupy the Same Air Space as Ordnance Trajectory.
0:56:55	HMLA Section Engages Dismounted Infantry From the 1 st UK Company with 20 mm Gun.
1:49:34	HMLA Section Engages Enemy, Over-firing Elements of Companies A and B; Approximately 5 Missiles Fired.
1:56:05	HMLA Section Engages Enemy, Over-firing Elements of Company B; Approximately, 10 Missiles Fired.

Figure 126. Desert—Air-ground Interactions

Interactions Between Units

		← Continued Target Continued →																
		7th Mar			Co K/7				Co I/7				3d Bn, 7th Mar					
Shooter	Co I/7	3 K																
		I																
		1 I																
		2 I																
		3 I																
		4 I																
		5 I																
		6 I																
	3d Bn, 7th Mar	7																
		8																
		9																
		10																
		11																
		12																
		13																
UK Bn	14																	
	15																	
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99																		
100																		

N: Near Miss F: Fratricide

Figure 131. Desert—Interactions Between Units, Part 5

Interactions Between Units

Continued ←		Target	
		UK Bn	UAV
Shooter ↑	Continued	3, K	UAV
	Co I/7	1, I	
		2, I	
		3, I	
		1, I	
		2, I	
		3, I	
		1, I	
		2, I	
		3, I	
		3d Bn, 7th Mar	
		3, 7	
		3, 7	
		UK Bn	
		1, U	
		2, U	
		3, U	
		1, U	
		2, U	
		UK	
	N5655		
	UAV	N1110	

N: Near Miss F: Fratricide

Figure 132. Desert—Interactions Between Units, Part 6

3. Example Interactions

a. 1st Sqd. vs. 2d Sqd., Co. L (HTF)

Attacking squads advance on enemy positions while blocked from line of sight of each other by the terrain (Fig. 133). A line of sight fan of the squads is superimposed in Figure 134.

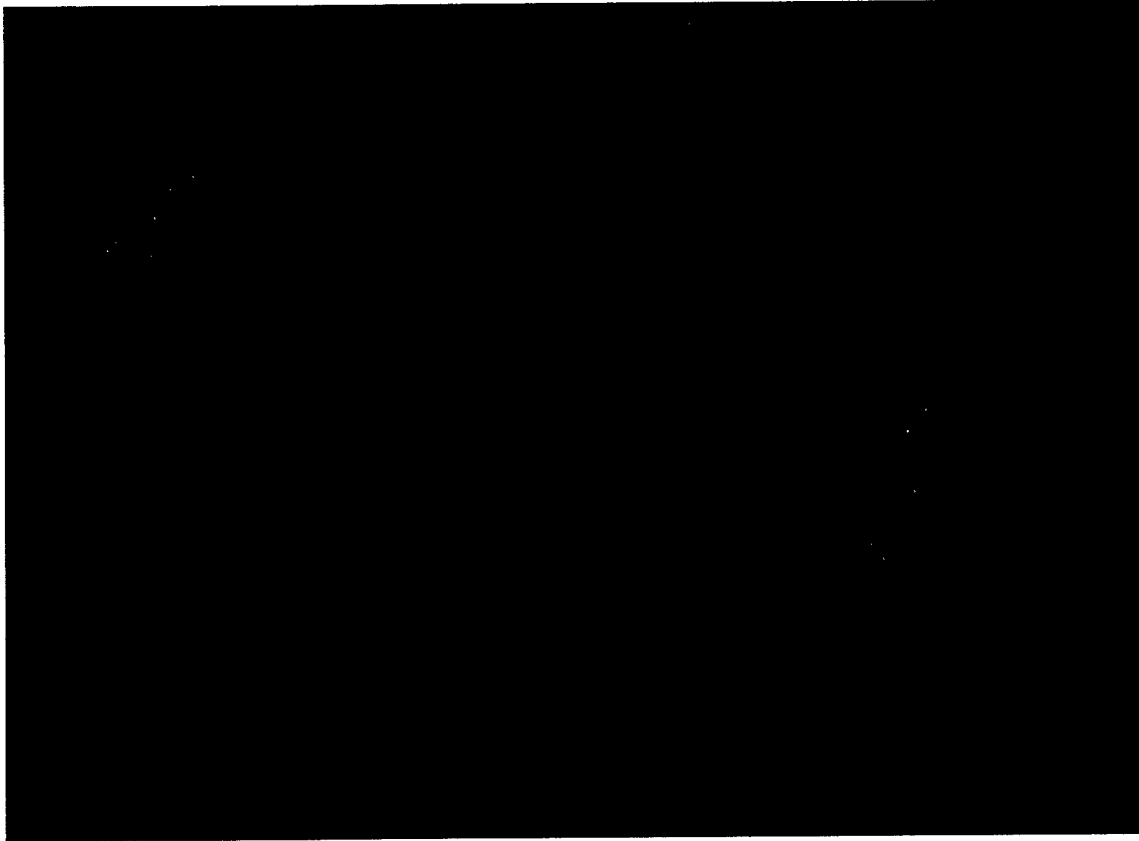


Figure 133. 1st Sqd. vs. 2d Sqd., Co. L (HTF): 12944

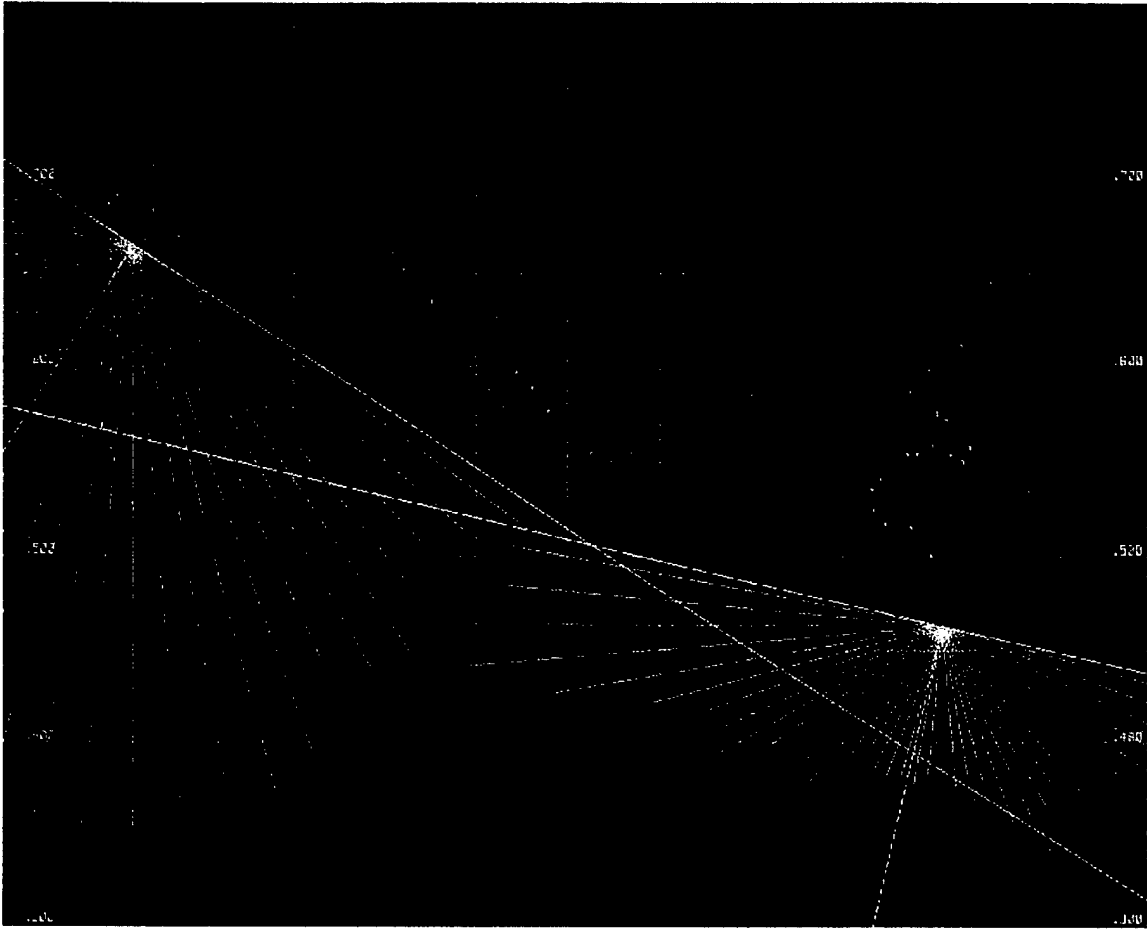


Figure 134. 1st Sqd. vs. 2d Sqd., Co. L (HTF): 12944

As the engagement of the enemy position on the hilltop between the two squads unfolds, the squads continue to advance with no line of sight of each other (Fig. 135).



Figure 135. 1st Sqd. vs. 2d Sqd., Co. L (HTF): 13101

If the squads continue to advance they will enter each other's fields of fire.

b. 3d Pltn. vs. AT Sec., LAR Co.

As the LAR platoon advances across the ridgeline, it has no line of sight of the enemy vehicle or the LAR company logistics train to the North (Figs. 136 and 137).

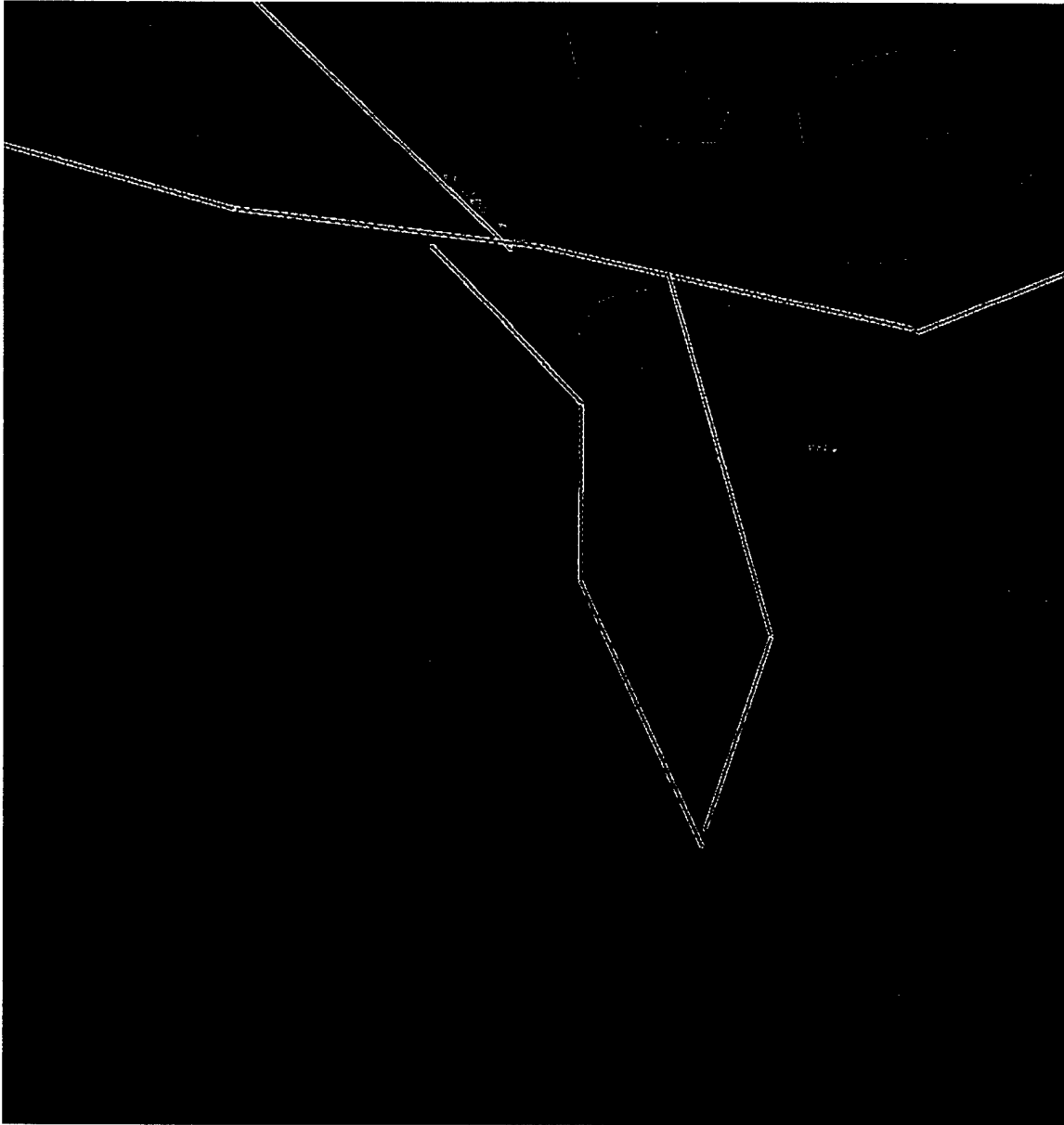


Figure 136. 3d Pltn. vs. AT Sec., LAR Co.: 11212

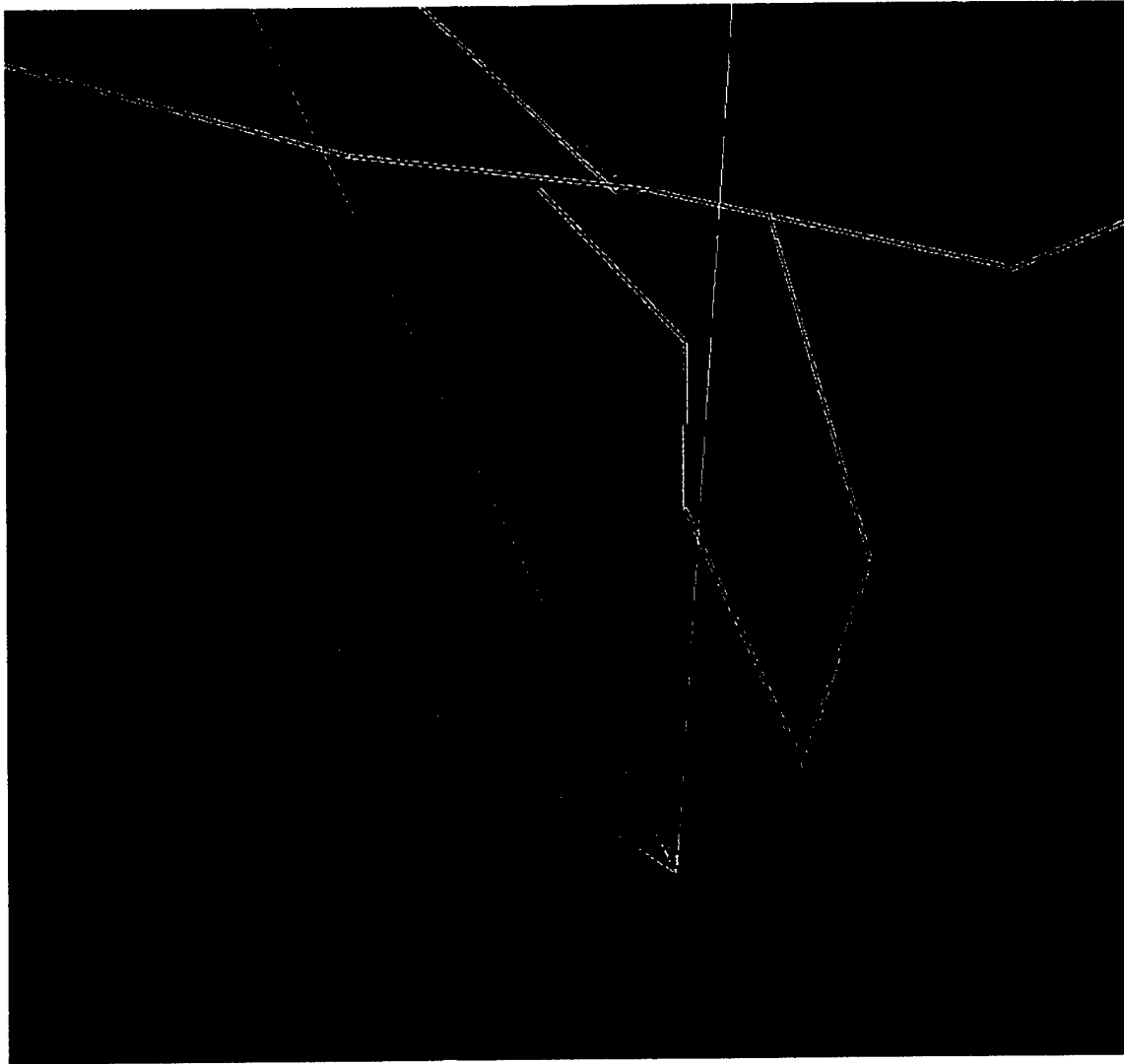


Figure 137. 3d Pltn. vs. AT Sec., LAR Co.: 11212

The LAR platoon engages the enemy vehicle as soon as line of sight to the enemy vehicle is established. The logistics train is in the danger area of the LAR platoon's fires (Fig. 138).

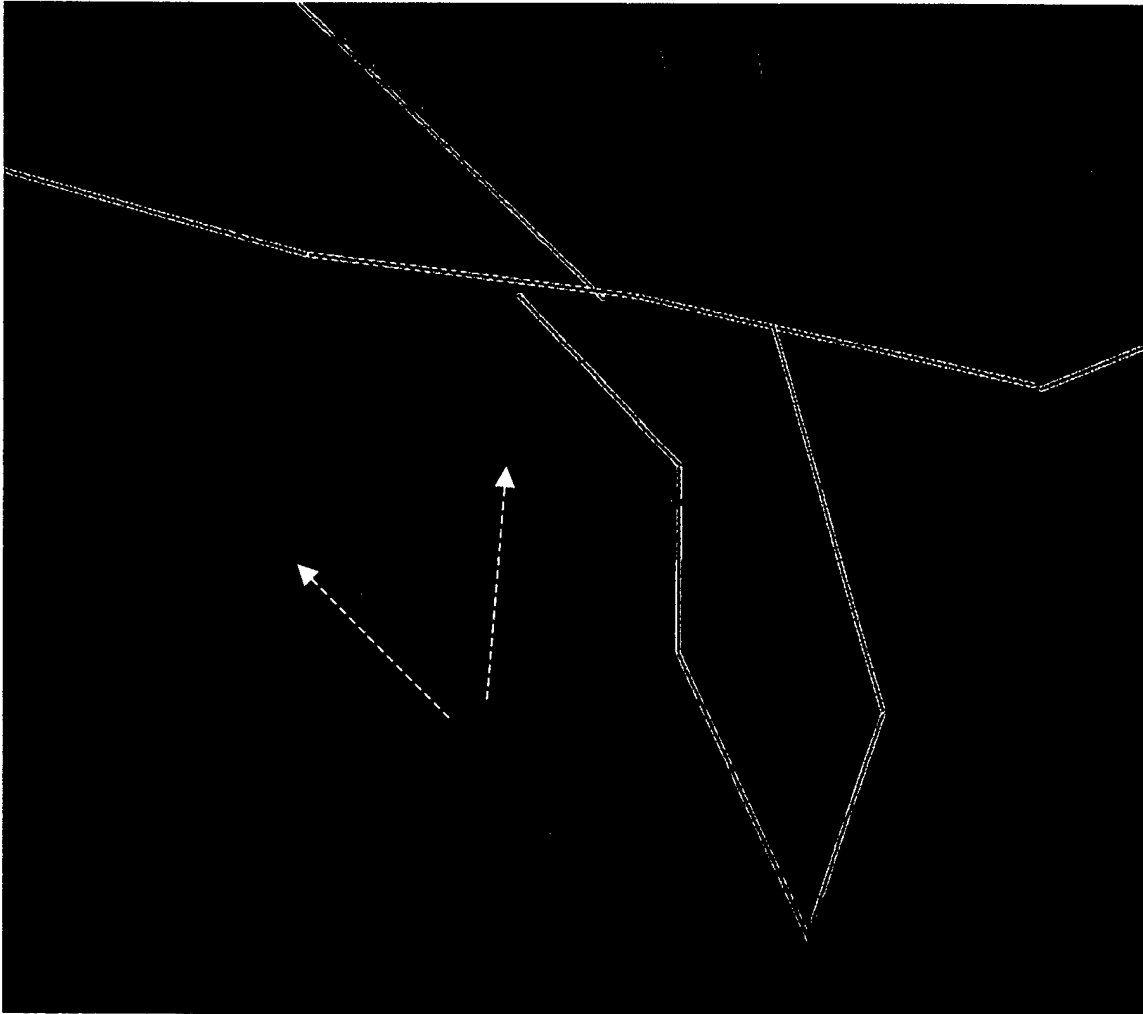


Figure 138. 3d Pltn. vs. AT Sec., LAR Co.: 11441

c. LAR Co. vs. 2d Pltn., Co. L

The LAR platoon observes the enemy position and engages as the 2d Platoon, Company L assaults the same position from the opposite direction. 2d Platoon is in the target area of the LAR platoon's fires (Fig. 139).



Figure 139. LAR Co. vs. 2d Pltn., Co. L: 11707

d. RW CAS vs. 1st U.K. Co.

As a section of RW CAS aircraft move along their route to an attack position, an infantry unit in the vicinity of a known enemy position is observed and engaged. The unit is the 1st U.K. Company (Fig. 140).



Figure 140. RW CAS vs. 1st U.K. Co.: 05633

e. Co. B Hdqts. vs. 1st Pltn., Co. B

The Company Headquarters AAV engages an enemy position by firing across the AAVs of 1st Platoon. The fire hazards 1st Platoon (Fig. 141).

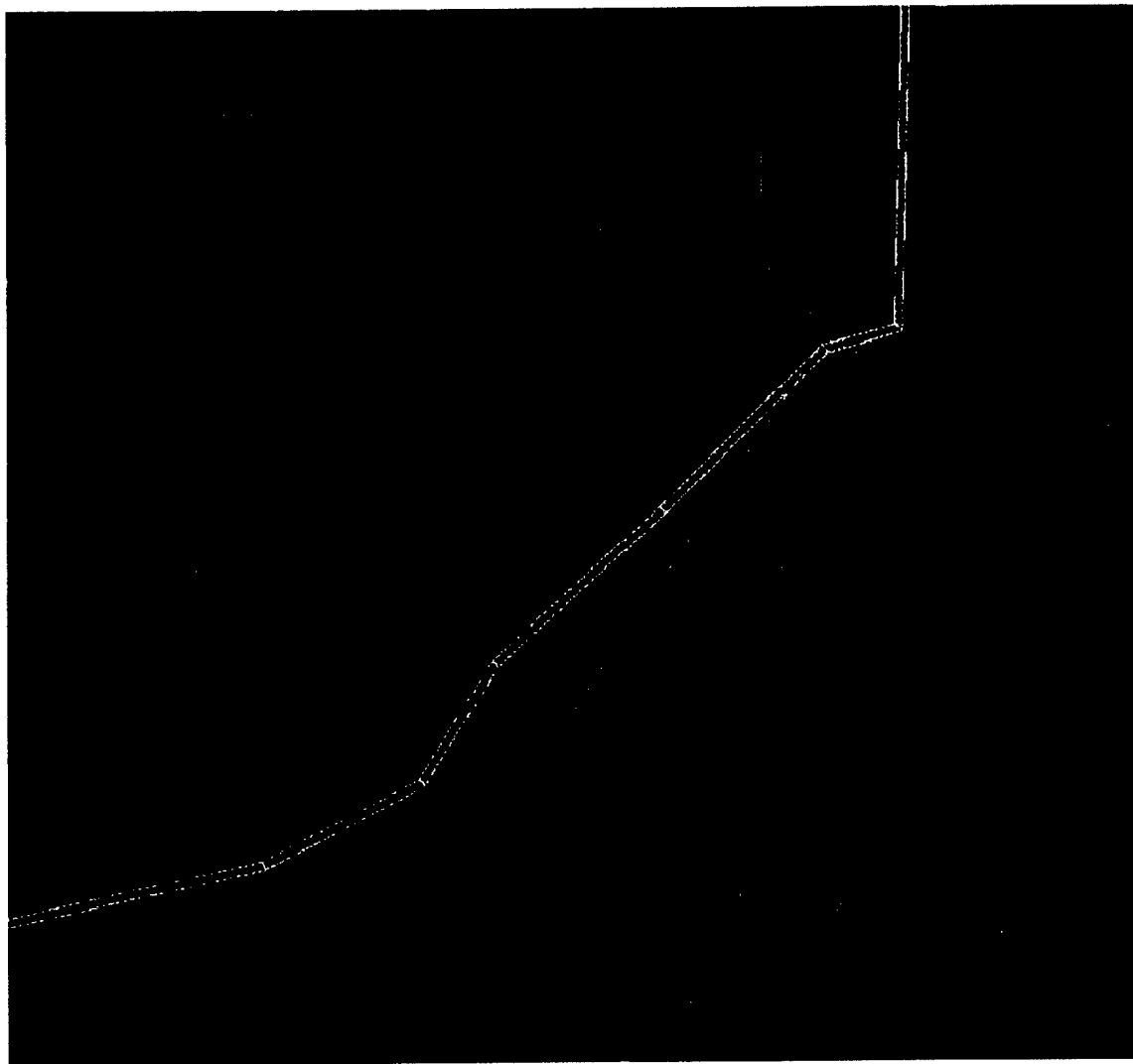


Figure 141. Co. B Hdqts. vs. 1st Pltn., Co. B: 10527

f. AAV vs. Infantry and 2d Pltn., Co. B

The 2d Squad, 1st Platoon, Company B AAV engages an enemy position by firing through dismounted infantry in the area. The fires are oriented toward the 3d Platoon's AAVs. This fire endangers both the dismounted infantry and AAVs (Fig. 142).

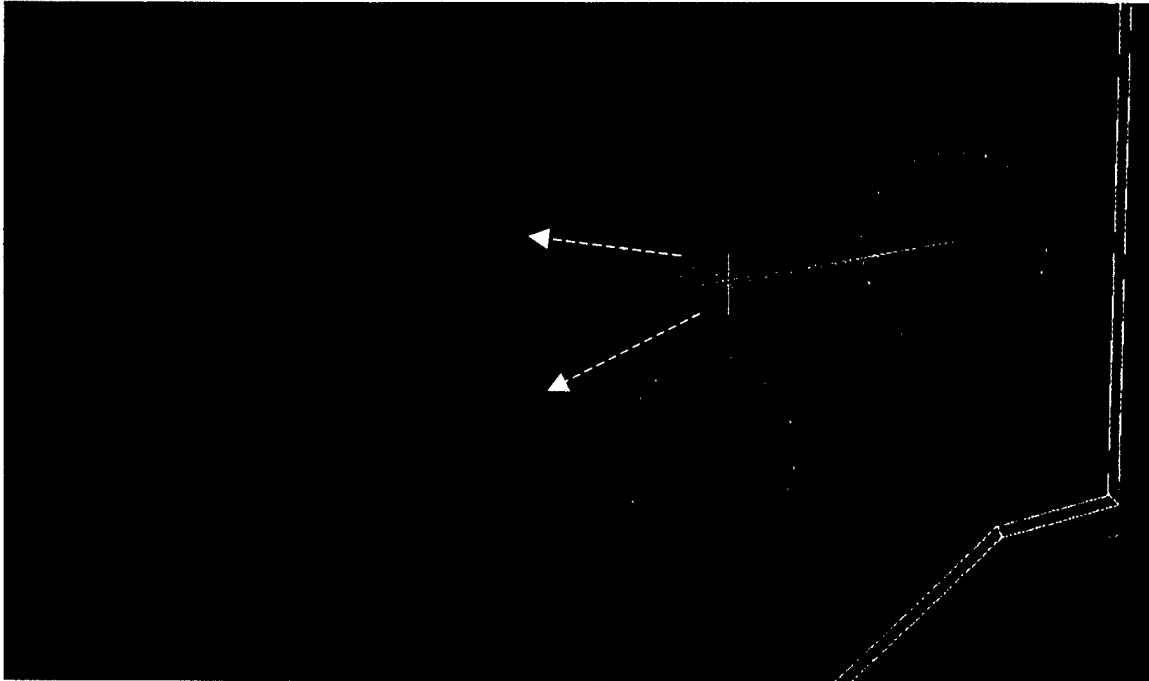


Figure 142. AAV vs. Infantry and 2d Pltn., Co. B: 10744

g. Converging Fires and 1st Pltn., Co. B

Elements of Company B converge fires on an enemy position. This fire endangers numerous AAVs and dismounted infantry in the area (Fig. 143).

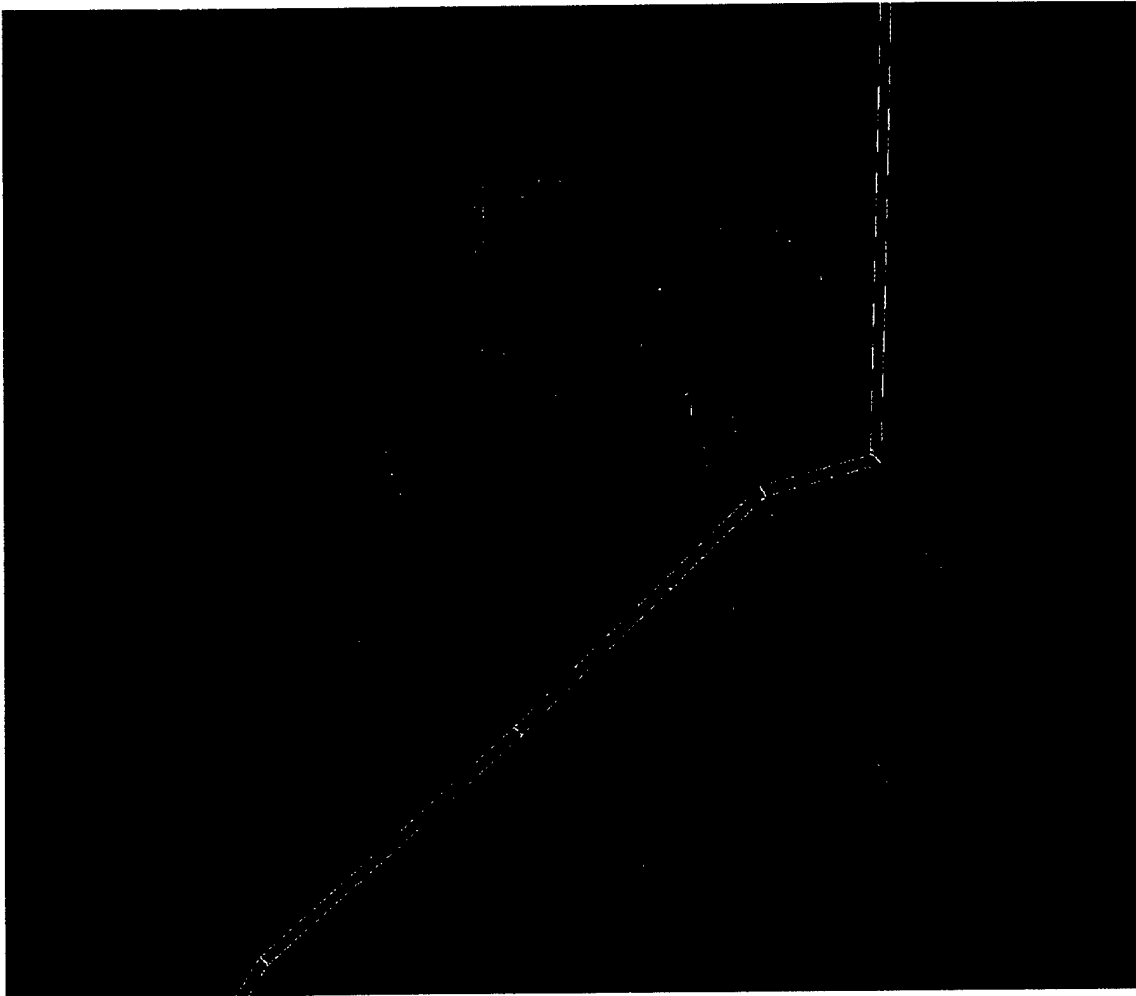


Figure 143. Converging Fires and 1st Pltn., Co. B: 10648

h. RW CAS vs. Co. B

RW CAS aircraft fire several missiles over Company B while engaging enemy. This fire hazards the company (Fig. 144).

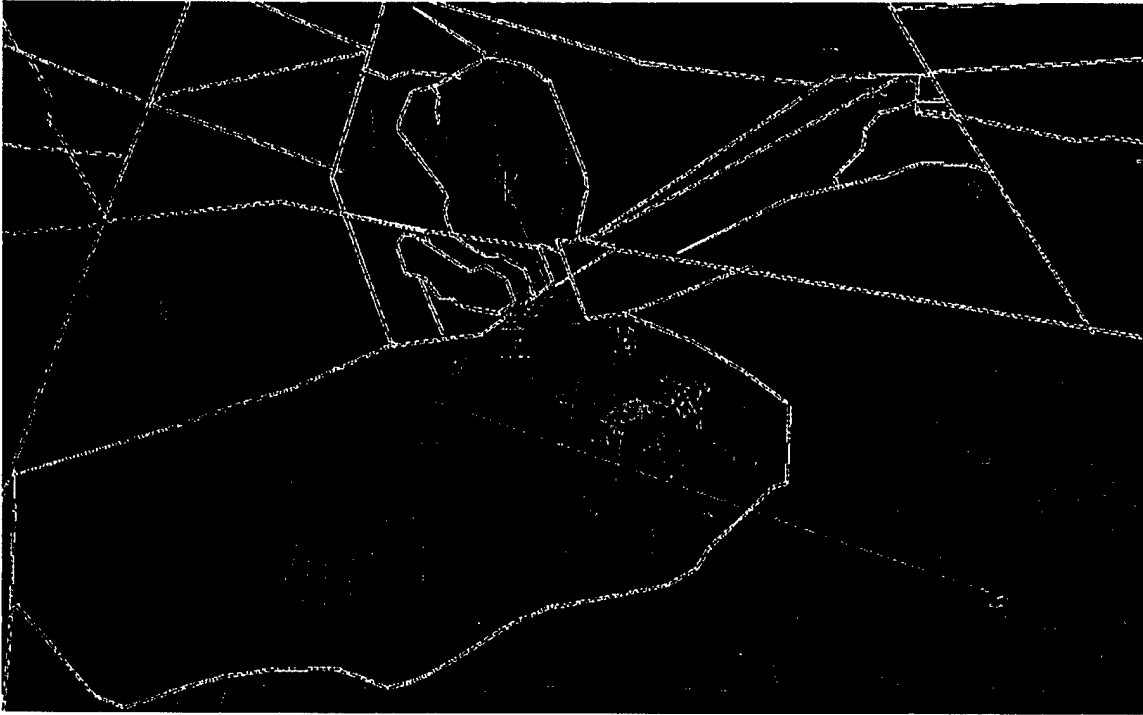


Figure 144. RW CAS vs. Co. B: 14934

i. Trench Clearing and Co. A

During trench clearing operations, the conditions become nearly as dynamic as those in a MOUT environment. Friendly and enemy infantry and infantry fighting vehicles move in close proximity to one another. Infantry clearing enemy trenches are not visible to adjacent and supporting friendly elements. Fires tend to converge and the situation becomes extremely unclear (Fig. 145).

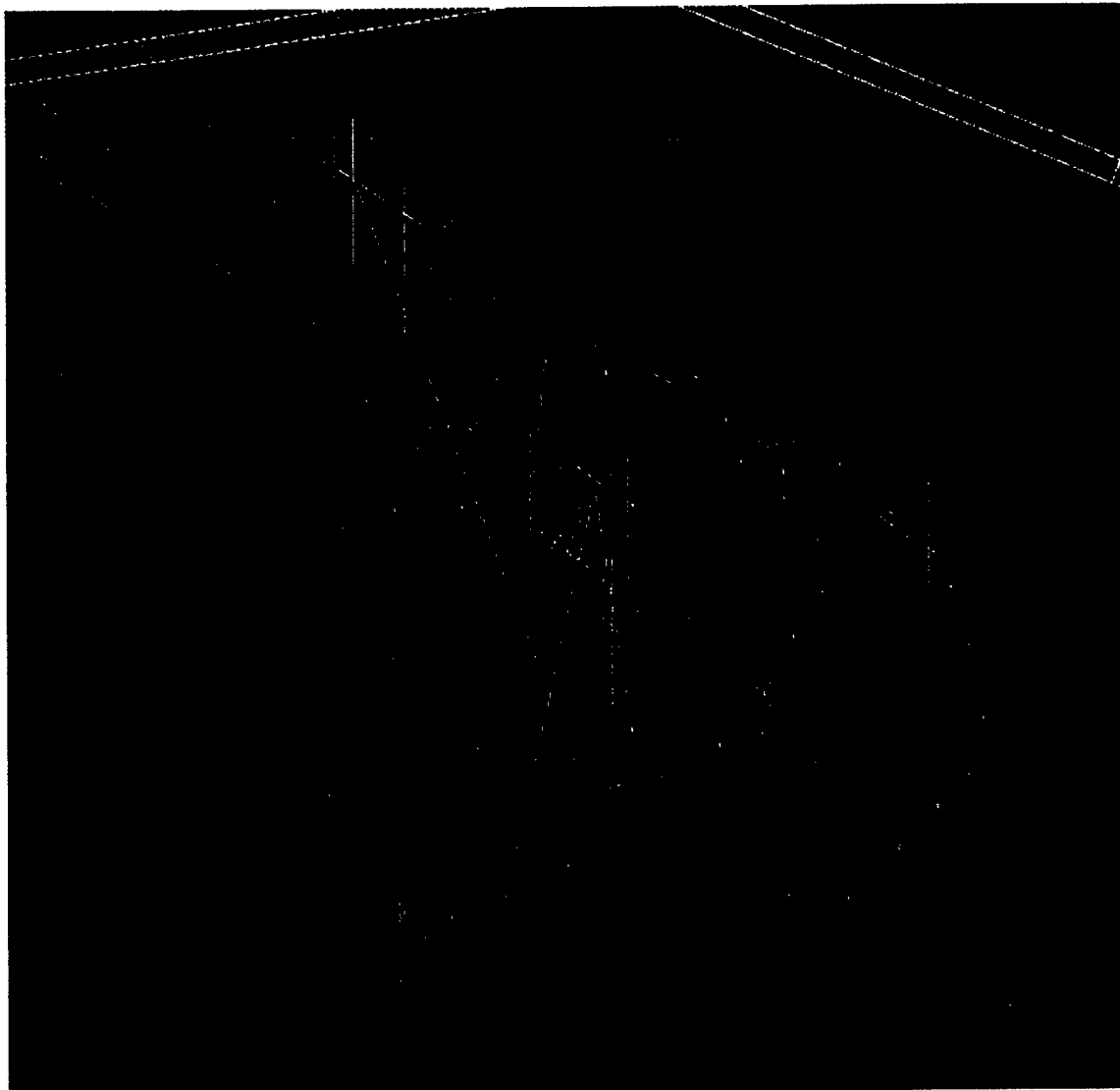


Figure 145. Trench Clearing and Co. A: 14305

j. 1st Pltn., Co. A vs. 1st Pltn., Co. K

1st Platoon, Company A engages enemy from its support-by-fire position to neutralize enemy positions and allow Company K to assault across open terrain. 1st Platoon's fires are oriented in a manner that endangers 1st Platoon, Company K (Fig. 146).

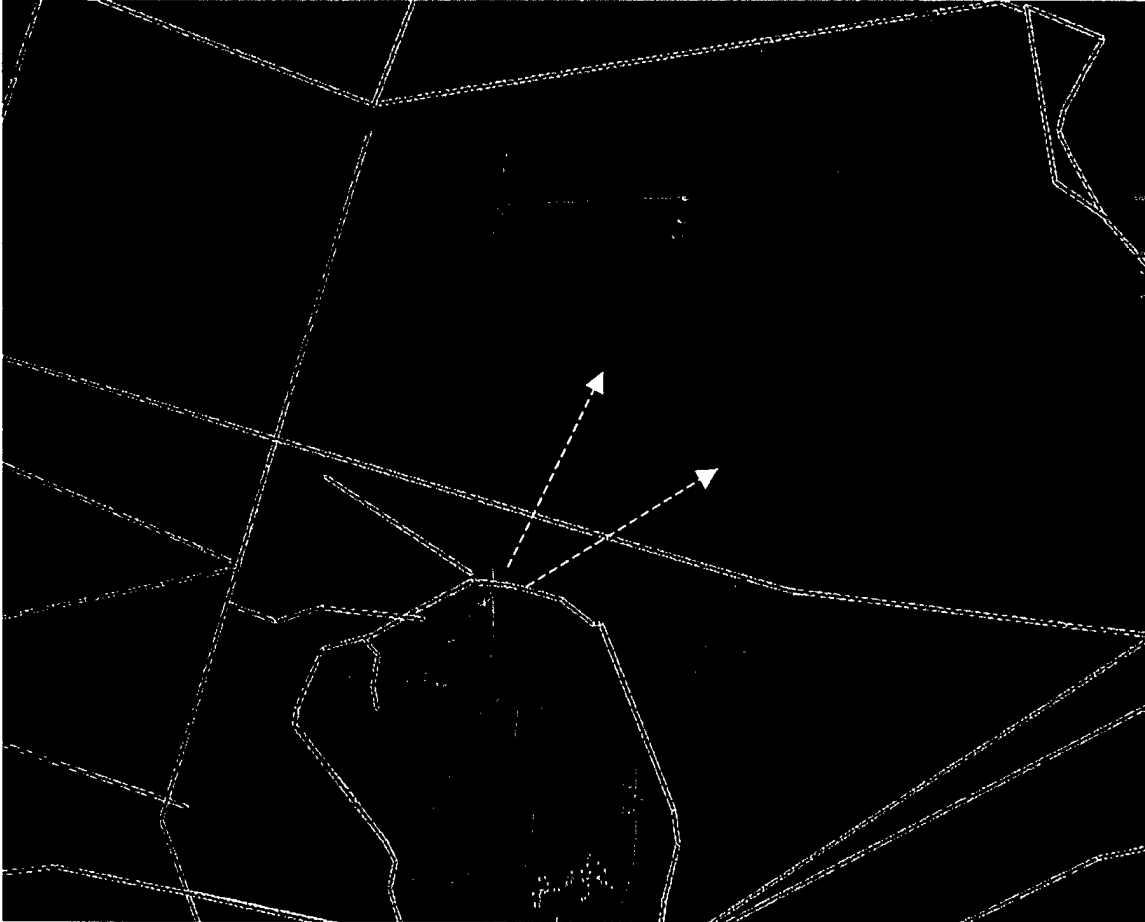


Figure 146. 1st Pltn., Co. A vs. 1st Pltn., Co. K: 20854

D. MOUNTAINOUS DESERT CONCLUSIONS

1. Resolution of Information

Resolvable distances, as stipulated by Reference 5, appear satisfactory for a SA device used in a mountainous desert environment or situation in which large scale operations are conducted.

2. Association of Actual Entity Location to PLI

While SA allows entities to anticipate upcoming interactions, the sheer number of adjacent entities in an observer's field of view make associating an entities PLI on a SA display, with an observed entity position on the ground, extremely difficult. This process

can occur in situations where dozens of friendly vehicles and personnel are moving while interspersed with enemy forces. Sorting the entities observed into friend (as identified by PLI in a SA device), enemy as identified by visual identification, and unknown is a difficult process that is prone to human error. This problem is reduced if terrain features facilitate the association of PLI with an entity position on the ground. In a flat, featureless desert, associating entities to PLI could be extremely difficult. A weapon sight mounted target identification (TI) system could significantly mitigate the entity location-PLI association problem by identifying targets as weapon operators sight them. TI information, in this situation, would significantly enhance SA information.

3. Converging Fires and Maneuver

As units approached enemy fortifications, they tended to converge on the positions. As units continued to advance, fires oriented on the enemy began to encompass adjacent units. Many near miss incidents (and likely fratricide on an actual battlefield) were observed in the scenario as a result of this trend. A SA device could alert unit leaders to the development of this situation and allow them to prevent their unit's fires from converging onto adjacent units.

4. Clearing Enemy Fortifications

The activity observed in this scenario was fast paced. Units covered much distance in a short period of time. Although the tempo was high, entity state changes unfolded much more slowly than in a MOUT environment. Accordingly, PLI update at 100m intervals and entity resolution as stipulated in Reference 5 would be satisfactory to maintain an accurate depiction of the disposition of forces in the battle space. The slower rate of state change holds true in this scenario until infantry dismounts to clear enemy

positions. During dismounted trench clearing operations, conditions approach those of MOUT. In order to maintain an accurate depiction of the battle space while enemy fortifications are cleared, PLI update and resolution must increase to nearly that described for MOUT. A resolution to 10m and approximately three to five second update rate would be needed to account for the close quarter, subterranean battle in the fortified enemy positions.

E. CHAPTER SUMMARY

This chapter has discussed the mountainous desert scenario simulation, presented observations of the interaction of virtual forces, and drawn conclusions about the SA data requirements when operating in this type environment. The following chapter will discuss conclusions and recommendations based upon the three simulations conducted.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The following conclusions were synthesized from the observations of the MOUT, mixed terrain, and mountainous desert terrain scenario simulations:

- Standard position-location information (PLI) data appears to be satisfactory for maintaining situational awareness in urban, mixed terrain, and mountainous desert environments.
- An update rate of one to two seconds would be required to accurately reflect PLI for MOUT.
- SA information is more important than TI information in MOUT.
- In MOUT, a high level of detail and resolution is required for a SA system to be effective. SA devices should be deployed at the lowest level possible; equipping individuals with SA transmitters would provide the most accurate depiction of the disposition of forces in an urban battle space.
- In order to most accurately provide SA in an urban environment and capitalize on current and developing technology, a minimum resolvable distance threshold of 25m to 50m and objective of 5m to 15m should be sought. These distances apply for both personnel and vehicles.
- SA devices used in MOUT should have the ability to aggregate and de-aggregate units and zoom to a level of resolution appropriate for the user's area of interest and required view.

- Resolvable distances, as stipulated by Reference 5, appear satisfactory for a SA device used in mixed terrain, mountainous desert terrain, or situations in which large scale operations are conducted.
- During dismounted trench-clearing operations, a resolution to 10m and an update rate of approximately three to five seconds is required.
- SA devices could alert unit leaders to the development of converging fire and cross-fire situations.
- In conditions in which an observer's FOV is filled with many friendly and enemy entities who are intermixed, moving quickly, and not located on obvious terrain, TI is required to assist the observer in sorting friend from enemy.
- A SA system depicting the accurate location of personnel in urban areas would be useful to aircrews. Additionally, PLI of rotary wing CAS aircraft would be valuable to ground entities to identify situations in which they are located on an aircraft's weapon-target line or in the aircraft's weapon hazard area.
- PLI displayed to aircrews would not prevent misidentification of friendly entities as enemy: however, it would alert the aircrews to the presence, disposition, and proximity to the target of friendly personnel. Aircrews then would be better able to orient their attack to prevent the effects of their ordnance from affecting adjacent friendly entities.

- A display of the active indirect fire mission weapon-target lines on aircrew SA devices would enhance pilots ability to avoid the danger of crossing the flight path of ordnance, especially rifle company mortars.

B. RECOMMENDATIONS FOR FURTHER STUDY

Four areas for further study exist, which could add to the conclusions made in this study.

First, increase the number and type of environments modeled to include winter conditions in Norway; jungle conditions in Africa, Asia, and South America; and large metropolitan area urban conditions. The project would require the construction of these terrain databases before research could begin.

Second, increasing the number of workstations and re-running the scenarios would validate the results of this thesis. The number of workstations should be increased to allow only members of small teams (weapon crews and infantry fire-teams) to possess perfect knowledge of each other's position; this would more accurately represent real battlefield conditions, especially during MOUT. With enough workstations, the simulations could be further enhanced to allow evaluation of the effect of human intuition and indecision. Each small unit could be assigned to a workstation and controlled by a Marine of the appropriate rank and experience. The simulation would unfold as a war game played by actual Marines who make the fire no-fire decisions. The results of the scenarios would be recorded by Janus and replayed for an analyst to evaluate in much the same manner as was done in this thesis.

Third, model the interaction of forces in an operation other than war. Ensure combatants and noncombatants are intermingled in the scenario.

Fourth, via simulation, evaluate the aviation specific SA data requirements for CID focussing on air-ground interactions as viewed from the aircrew perspective.

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