AD NUMBER

AD-B034 309

NEW LIMITATION CHANGE

TO **DISTRIBUTION STATEMENT - A**

Approved for Public Release; Distribution Unlimited.

LIMITATION CODE: 1

FROM **DISTRIBUTION STATEMENT - B**

Distribution limited to U.S. Gov't. agencies only.

LIMITATION CODE: 3

AUTHORITY

Army Science Board, Office of the Assistant Secretary of the Army (RDA), Washington, DC 20310.

19991014037

FINAL REPORT

Army Science Board

Ad Hoc Group on

Military Operations in Built-Up Areas (MOBA)

Date: Jan. 1979

Source: Army Science Board
Office Assistant Secretary of the Army (RDA)
Washington, DC 20310

Dr. James J. Renier (Chairman)
Dr. Albert B. Bishop, III
LTG James M. Gavin, USA (Ret)
Mr. David R. Heebner
Dr. Robert L. Hess
Dr. Paul W. Kruse, Jr.
Dr. Russell D. O'Neal
Mr. Charles L. Poor
Dean Ralph E. Fadum
Dr. John D. Weisz (Special Consultant)
LTC Daryl Jaschen (Military Staff Assistant)

79 40

TABLE OF CONTENTS

INTRODUCTION

Background

During World War II in Western Europe, 40% of the combat between Allied and Axis forces was in urban areas as the front lines moved through the numerous cities of France, the Low Countries and Germany. This combat was carried out on the small unit level, usually by infantrymen, or at best by dismounted troops. Fighting was door to door, room to room, building to building; progress was slow and the enemy was ousted from the cover and protection of the buildings grudgingly. Although tactically the Army preferred to bypass cities in order to destroy the larger enemy forces, it was always necessary to clear out the forces remaining in the bypassed cities using techniques of urban combat. The Army expected this type of combat and trained for it in mock cities erected at training centers throughout the world. Since World War II the Army doctrine has continued to shun combat in cities and concentrate on the battle of firepower and maneuver in the open. As a consequence, there has been little training for urban warfare, except perhaps in the Berlin Brigade, and facilities to conduct this training are virtually nonexistent in the Continental U.S. Materiel has been developed without special consideration for its performance in the unique conditions of city fighting; some weapons and other materiel now in the hands of troops are unsuitable for use in built-up areas. In all three areas -- doctrine, training and materiel -- the Army's capability to fight effectively in cities is less than it needs to be.

This deficiency in combat capability has become increasingly clear to Army planners over the past few years, and with the realization has come a recognition that some degree of urban combat, particularly in Europe, is a certainty if war should occur. There are now 567 cities in Europe having population greater than 100,000; one of these cities would be encountered in combat every 40-60 kilometers. Urbanization is proceeding at such a pace in Europe that an Army would encounter a village or town of some size every 3-4 kilometers. It seems evident that combat in cities is unavoidable even if the preferable tactic is to bypass.

For the tactical defender, forcing the attacker to fight in towns and cities may be a viable way to conduct the war. It is generally conceded that cities are an effective force multiplier for the defender; that is, the attacker must commit more than three times the strength of a defender in order to successfully defeat the defending force in a city. If, as most experts agree, the NATO Armies are badly outnumbered in men and weapons in a war with the Warsaw Pact Armies, forcing the battle into cities may effectively reduce the imbalance of forces. We recognize that the leaders of the FRG and the civil population may not readily accept the idea that the battle for Europe will be fought in their cities, with the attendant destruction and civilian casualties. However, realistically, we believe that the cities will inevitably become part of the campaign and consideration should be given to using them.

Since combat in cities is likely in the event of a war in Europe, the Army has realized the need to revitalize their efforts to prepare for Military Operations in Built-up Areas (MOBA). This Ad Hoc Study Group was chartered by the Army Scientific Advisory Panel (now Army Science Board) to recommend ways that technology can contribute to an improved MOBA capability for the U.S. Army.

Some of the conditions which make MOBA different from combat outside of cities and require special consideration are these:

- Fighting is at close range, often face-to-face and seldom exceeding 50 meters. Some weapons, particularly large caliber, are unsuitable at these very short ranges, because fuzes do not arm quickly enough.

- Rockets and recoilless rifles generally should not be fired from the confinement of small rooms because backblast and overpressure are harmful to weapon crews.

- Weapons for breaching concrete walls are required. These walls furnish concealment and cover not generally available to the foot soldier outside of cities.

- Communication, particularly by radio, is difficult and sometimes impossible. RF ranges are unpredictable but usually much shorter than in the open because of the shielding of large buildings and structures.

- Multi-storied buildings add the vertical dimension to the battle. Basements, sub basements and upper floors become part of the battle scene. Combat vehicle vulnerability is increased because of the increased likelihood of attack from above.

- Sewers, subways and utility tunnels provide covered passageways for movement of troops of both sides, and for concealment. A detailed knowledge of the location and status of these tunnels is needed to successfully wage the battle.

- The map and chart data needed by the commander far exceed those needed for combat in the open. For example, he should know telephone, electric, gas , water and sewer locations, connections, substations, generating and pumping stations. Communications in place can help him maintain his own communication links.

- Command and control presents an entirely different problem than in the open. Although distances are short, difficult communications and interrupted lines of sight make control of the battle by higher echelon commanders a very problematical thing. Small unit commanders must be prepared to act on their own initiative to accomplish their mission. Data regarding positions and movement of friendly and enemy forces is needed by the small unit commander in this environment. From the tactical standpoint, it may be worthwhile to deliberately locate C^2 centers in cities because of the inherent protection afforded by tall buildings constructed of steel and concrete. The cost to the enemy of destroying such a C^2 center would be very high.

- Intelligence will probably be spotty. Location of the enemy is increasingly difficult because of the multitude of cover and concealment available. The enemy can move rapidly by multiple paths without being observed by friendly forces. The collection and analysis of information is made more difficult by the limitations on communications.

- Target location is difficult because of the ready availability of concealed firing positions. Snipers can move from room to room, appearing for only very brief times and then changing position. Limited visibility makes observation beyond 50 meters practically impossible. Visibility is usually limited by dust and smoke and in some cases by urban pollution.

- Movement by vehicle is difficult in MOBA. Streets will be littered by rubble and cratered if the city has been bombed or subjected to artillery attack. Bridges and overpasses are likely to be down. The availability of cover afforded by buildings, rubble and tunnels makes vehicles in the streets more vulnerable to sudden, unexpected attack. Evacuation of the dead and wounded and resupply are slowed because of the difficult vehicle movement.

- The urban battle is psychologically more debilitating to the soldier. Battle is at close ranges and danger exists in all directions -- above and below as well as on every side. Safe areas may be non-existent. Actual fighting may be brief but intense, with little warning. Periods of exposure to possible enemy encounters may extend continuously over days or weeks, perhaps even months. The noises and smells of battle are intensified by the confinement of streets and buildings.

All of the above factors contribute to a combat environment which is definitely different from battle outside of the urban areas. Special tactics and techniques are needed and the soldiers need to be properly trained in the employment of these tactics and techniques. In some cases special equipment is needed, or existing equipment needs to be modified to make it suitable for MOBA.

Report Format

The report is a compendium of separate reports prepared by the Ad Hoc Group members which examine in detail nine functional areas of Military Operations in Built-Up Areas:

Modeling, Simulation & Training;
Mapping;
Location & Identification of Forces;
Command & Control;
Communications;
Non-Chemical Weapons & Ammunition;
Chemical Weapons & Defense; Radiological Defense;
Mobility;
Psychological Factors.

These separate sections are preceded by an Executive Summary which presents the Terms of Reference and which contains the General Findings of the Group and summarizes the Specific Findings contained in the separate sections of the report.

FINAL REPORT

Army Science Board

Ad Hoc Group on

Military Operations in Built-Up Areas (MOBA)

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. Terms of Reference

The Terms of Reference for the Ad Hoc Group on MOBA were established by memorandum dated 1 April 1977. They are as follows:

a. Help TRADOC translate the results of the U.S.-FRG joint study in terms that are meaningful to the developer. Consider the modelling techniques that have been employed and recommend improvements.

b. Examine the unique technical problems arising from operating in a MOBA environment which affect the ability of the Army to (1) determine the location of and identify enemy, neutral, and friendly forces; (2) exercise command and control; (3) move from point to point; (4) engage all types of targets with effective weapons. Identify the critical technical problem areas and recommend appropriate technical solutions having high payoff possibilities.

In responding to these Terms of Reference, the Ad Hoc Study Group used the U.S.-FRG joint study to develop the special conditions for MOBA which are listed in paragraph 1. There are many references in the joint study to materiel limitations and needs; each of these is addressed in the separate sections of this report and materiel developments recommended herein are in consonance with the specified needs and recommendations of the U.S.-FRG study.

The requirement of the TOR to consider modelling techniques is addressed in Section 1 of the report, "Modeling and Training". The examination and identification of unique technical problem areas and recommended technical solutions are addressed in the remaining section of the report as follows:

TOR Operational Area	Study Report Response
Location and identification of enemy, neutral, and friendly forces	Section 3, Location and Identification of Forces
Exercise of Command and Control	Section 4, Command and Control Section 5, Communications
Engagement of all types of targets with effective weapons	Section 6, Non-chemical Weapons & Ammunition Section 7, Chemical Weapons and Defense
Movement from point to point	Section 8, Mobility

An additional section, Psychological Factors in MOBA has been added because the Ad Hoc Study Group believed this to be an important consideration in urban combat.

2. General Findings

Overall, the Study Group believes that, although there is an increasing awareness in the Army of the importance of MOBA, it has not received sufficient emphasis by the Army's combat development, training and materiel development organizations.

- The need for materiel to be operational in a MOBA environment has not been included in most materiel requirements documents, (MENS, ROCs, LOAs, etc.) with the result that some items of materiel now in the hands of troops are unsuitable or inoperable in MOBA. These materiel deficiencies are noted in the appropriate sections of this report.

- The extent to which materiel is or is not useful in MOBA has not been determined in all cases, although DARCOM is working this problem in specific areas. Further testing is needed to find out which weapons and other materiel are suitable and what new developments are needed. Because of the hiatus which has existed in consideration of MOBA, the manner in which weapons and other materiel should be used in MOBA is not completely understood. Training, games and maneuvers can help determine these factors. The need to expand the data base of weapon and materiel effectiveness is included in the separate sections of this report.

- The MOBA environment, in the past, has not been considered an integral characteristic of normal combat operations. As a result, during the development cycle testing by both the materiel developer and the combat developer, data has not been collected or evaluated to adequately address this spectrum of system performance. Testing within the MOBA environment should be institutionalized for all systems as a standard, routine requirement.

- Training for MOBA has been cursory at best. Individuals and units do not receive sufficient training to insure operational readiness. Training facilities worldwide are inadequate.

- The Ad Hoc Study Group agrees with the position stated in the U.S.-FRG joint study that "Forces which are to be engaged to conduct military operations in built-up areas cannot be equipped with special weapons for this purpose ... it must be possible to use them in any other terrain and they must be capable of carrying out the entire scope of missions and combat. Nevertheless it must be required that special types of ammunition are developed for the available weapons which are optimum with regard to carrying out military operations in built-up areas"* Today's technology can in most cases support needed modifications or new developments.

- As a minimum, the proposed MOBA-related tasks for FY78 and FY79 developed and recommended by the Second DARCOM-TRADOC Coordination Conference on MOBA, 19-20 July 1977, should be funded and performed. Specific references to some of these tasks are included in the separate sections of this report.

---

* Draft U.S.-FRG Joint Study on MOBA, June 1977, paragraph B3 (c), pg. 29

3. Specific Findings

a. Each section of the report includes a complete set of conclusions and specific recommendations. For a full understanding of the background and reasoning supporting these findings, the entire section should be read.

b. From among the many different recommendations contained in the body of the report, the Ad Hoc Study Group has selected the following as technical solutions to MOBA-related materiel problems which have the highest payoff possibilities:

- The investigation of modeling and training for MOBA resulted in 16 recommendations. These can be summarized as follows:

  - MOBA modeling, simulation, and training plans and activities should consider the broad range of MOBA, namely: combat in cities, operations involving the combination of man-made towns and the surrounding natural terrain, and military operations in urban terrain. In addition, field and simulation studies should proceed simultaneously so that each can benefit from the findings of the other.

  - Specific consideration should be given in training and simulation efforts to the use of cities in the tactical planning and development of defenses. MOBA as a force multiplier should be considered in the modeling and training exercises.

  - Develop a comprehensive CIC model of sufficient resolution to investigate such factors as squad-level tactics, the details of weapon usage, interrelationships among the environment, tactics, and weapons, individual detection and firing capability, and psychological factors. This investigation should include examinations of the MOBACS Unit Operations Level Game to check the feasibility of increasing its resolution to the level required and of DYNTACS and perhaps other high resolution simulations to see if they can be adapted to MOBA. MOBACS offers the interactive feature, a decided advantage but some difficulty may be experienced in getting it running on a production basis. DYNTACS has the resolution, a relatively sophisticated tactical decision-making capability, and is operational at Ft. Leavenworth, but is a completely closed simulation.

  - A MOBA training facility should be planned for construction and modification on a continuing basis as knowledge of MOBA operations and training requirements increases. An immediate capability should, however, be provided that will enable field exercises to be performed which enact in real life items which the URBWAR model simulates. This involves a single attack on a defended multi-room building starting either from the street or another building, with platoon-size forces on both sides. Results of the field

exercises could then be used to update URBWAR and URBWAR study results used to organize and equip offensive and defensive forces in CIC. A logical next step, as information becomes available, is to provide for a comprehensive company-level CIC operation, eventually with combined arms.

- Mapping for MOBA will probably always depend chiefly on data obtained on site and in advance. Maps for MOBA must therefore be prepared before the fact. If MOBA is important more of this work should be done (technology will probably never significantly simplify the problem). In spite of this fact, areas for research that may provide a meaningful return are as follows:

  - The Army Terrain Information System (ARTINS) should be designed to include intelligence concerning the nature of built-up areas that are of military significance. In such a system, the data bank would include, in addition to terrain intelligence, features such as underground installations, types and configuration of buildings, power and communication centers and lines, piers, railroads, roadways, bridges, etc.

  - Developments in remote sensing technology offer the possibility in the near future of obtaining much of the useful information needed for MOBA in enemy territory or elsewhere not easily accessible for on-site intelligence and of updating existing maps on a near real-time basis. Continued strong emphasis should be applied to assure that a system to incorporate remote sensor outputs on a near real-time basis in combat intelligence is in place to exploit a rapidly developing technology.

- The most promising technologies for detecting, locating and identifying forces in a MOBA environment are radar, night vision/IR, and unattended ground sensors. Thorough and comprehensive tests in a MOBA environment of inventory equipment and that under development in these categories must be carried out to determine their suitability. The equipment to be tested should include, as a minimum:

  - AN/PPS-15

  - AN/GSQ-160

  - Second generation starlight scope

- Army common modular FLIR
- REMBASS sensors
- METRRA

- Proper design and development of radar, night vision/IR and UGS systems requires both signal propagation information and target and background signature data bases. The lack of such data in a MOBA environment makes it impossible to design future generations of equipment suitable for use both in open terrain and in MOBA. Army laboratories responsible for the development of this equipment should be tasked to collect the needed information appropriate to each technology, and to incorporate it into the design of future equipment.

- Among the most promising new systems under development for detecting, locating, and identifying forces are a) active (radar) and passive (radiometric) millimeter wave systems operating at 35 or 94 GHz, and b) second generation lightweight FLIR systems operating in the 3-5 or 8-12 micron spectral interval. Army laboratories responsible for these developments should ensure that the equipment designs are compatible with use in MOBA.

- A strong C^2 Architecture and Systems Engineering group should be established within the Army, supported and supplemented by industry, as recommended by the ASB Ad Hoc Group on C^2 in their interim report.

- Derive the requirements to be placed on a command and control system in order for it to be effective in MOBA and MOBA-related environments.

- Develop a MOBA battlefield simulator for command training and expand the MOBA C^2 Training program to include simulated battle exercises.

- The Army should make certain that requirements for systematic quantitative data collection for COBA are clearly recognized and stated, and are given sufficient priority in the commands responsible for doing the work. Such data provides information to help in the training for better communications in built-up areas, for fixes that may be made in present equipment, and for taking COBA properly into account in future communication systems and equipment development.

- As data becomes available from systematic testing and data collection, it should be made available for introduction into training programs. The results of the Signatron contract have already analyzed the existing data base and suggestions of points to be emphasized in training can come from this report.

- The program that has been recommended by Signatron, i.e. a polarization diversity and space diversity measurement program that will provide a diversity data base for COBA radio communication should be carried out. It may well be that COBA radio communications can best be improved by use of diversity. Space and polarization diversity require neither transmitter modification nor extra frequency allocation. If tests indicate that significant improvements in communication capability can be achieved by either or both of these techniques, then product improvement programs should be initiated and the fixes implemented.

- As new communication equipment becomes available it should be tested in a COBA-like environment in all of its various modes. The new SINCGAR family of radios is a good example. It offers several features which should be helpful in a COBA environment, not the least of which is security.

- New communication equipment specifications should consider the COBA environment. An example of where this might be first applied is the proposed mobile subscriber system.

- Electro-optical communication, particularly by way of fiber optics, should be well supported. The advances that have been made in the recent past have been outstanding and it offers opportunities for communication over large bandwidths and with good security and freedom from jamming.

- The non-chemical weaponry section of this report contains detailed sections dealing with nine specific classes of weapons and their application to military operations in built-up areas. Each detailed section presents a set of conclusions and recommendations related to the weapon category with which it deals. In all, 31 recommendations are made. In addition, two general findings serve to summarize the overall effort and are as follows:

  - Steps must be taken to define the technical opportunities for a real improvement in our MOBA weaponry posture, not just to a few high level people in TRADOC and on the Army Staff, but also to the Army laboratories and development agencies and their contractors — the people who will do the actual development if it is to be done. This can best be accomplished by conducting battalion scale exercises in representative built-up areas to test our doctrine, communication and weapon systems working together as a system. Such exercises, adequately supported and studied by participating weapons designers could do more to define the opportunities for innovation and to uncover the current operational deficiencies of our Army in MOBA than any single other step.

- several promising weaponry ideas were found within the development community, but lack funding support for further exploration. Every effort should be taken to enhance feasible MOBA-related ideas and innovative programs. To this end, a MOBA directors fund should be established. A moderate level of funding assigned to the Laboratory Directors and Program Managers concerned with MOBA weaponry would permit early start feasibility investigations and demonstration of systems which the designers believe in and should go far toward making the developers believe that the Army is serious in its desire to improve its capability in MOBA. In addition, a program to encourage joint Army/DARPA advanced development projects for MOBA may be a useful stimulant to bring forth new ideas. Specific funding recommendations are contained in Section 2 of the non-chemical weapons section of this report.

- Chemical operations in MOBA were examined primarily from two aspects: Offensive chemical operations and protection against chemical weapons. Four recommendations for each area have been developed. Due to the fact that chemical offensive R&D efforts are constrained by Congressional funding support, as well as other considerations, future chemical initiatives should focus predominantly on plans for defensive use. Highlights of the study report are as follows:

  - The systems analysis of the use of chemical agents in MOBA proposed by the 2nd DARCOM-TRADOC Coordination Conference on MOBA should be executed. Output of the study should include: Data base information on dissemination, dispersal, persistency and effectiveness of toxic and non-toxic chemicals in built-up areas; weapon concepts for individual, crew-served, artillery, rocket, tank and air delivery of toxic and non-toxic chemicals in MOBA; recommendations for development of new chemical agents if required for MOBA.

  - If there is the least hope of developing the prophylaxis antidote protective system of STOG 78-7.2.1 b, the Army should launch a major effort to bring this system to fruition. Research has been conducted on the mechanism by which nerve agents attack the nervous system and development of a prophylaxis system may be possible as a result of continued investigation.

  - Remote detection of chemical agents and an alarm system to alert small units should be developed. An infrared spectral analysis detector currently is being developed.

- The mobility of the Army's current forces is as adequately developed for MOBA as is reasonable and no new vehicle classes or severe modifications of current classes is called for. There appears to be no need for developing a new item of automotive equipment for MOBA.

- Psychological factors are considered much more important in MOUT than in other types of warfare. Whereas they may be neglected without dire results normally, in MOUT they may be crucial factors. The psychological section of this report recommends research efforts be undertaken to provide a data base and a system of technology for designing MOUT equipments. One particular effort is felt to be of critical importance and is highlighted as follows:

  - Every effort should be taken to define the variables which control or limit individual and unit performance in MOUT and obtain empirical data on their functional relationships, including physical and psychological factors.

SECTION I

Modeling, Simulation & Training

SECTION I

Modeling, Simulation & Training

Introduction

The nature of Military Operations in Built-Up Areas (MOBA) has been thoroughly described in a number of documents including FM 90-10, the CAC report of November 1976, and the 30 September 1973 report by GTE Sylvania. All of these stress the impact of urbanized terrain on all levels of military planning and operations. Thus, considerations of modeling, simulation, and training for MOBA must include:

1. Combat in cities (CIC),

2. Operations involving the combination of man-made towns and the surrounding natural terrain, and

3. The synergistic effect many actions of types (1) and (2) have on the overall conduct of military operations on urbanized terrain (MOUT).

These three levels correspond generally to the traditional responsibilities of the captains, colonels, and generals, respectively; although it is apparent that CIC will require specific consideration of sergeants and perhaps corporals as well as captains, as platoons and squads are forced to fight essentially on their own. The colonels, as battalion or brigade commanders, must consider the optimal use of the natural and man-made environmental features in accomplishing assigned objectives. The generals, commanding divisions or corps, besides trying to capitalize on the overall environment to enhance their available resources, must also take into account the political and religious effects, as well as the military advantages of defending, attacking, or bypassing a particular city or town.

The presence of significant numbers of non-combatants and constraint on collateral damage must be dealt with at all levels in addition to the more traditional problems of combined-arms strategies and tactics.

General Requirements

U.S. military personnel must be equipped, organized, and trained for all apsects of MOBA. However, there is only a moderate amount of experience and data upon which to base equipment developments, organizational structures, and training programs. The immediacy of the MOBA problem dictates that appropriate additional information be obtained as expeditiously as possible.

The existing CAC and GTE Sylvania studies have basically defined the overall problem and identified specific areas needing examination. They also have provided important insights concerning potential solutions. This material indicates a need for both field studies and modeling/simulation efforts. These two approaches should proceed simultaneously so that each can benefit from the results of the other. All currently available material can be used for initial designs.

Models/Simulations

There are two simulation models that have been designed and used especially for the study of MOBA. One is URBWAR, developed by Rodman Laboratory, Rock Island Arsenal, and described in an ARMCOM report dated 15 October 1975. The other is MOBACS, developed by George Schecter at Ketron, and described in a four-volume report published in early 1977. A SCORES type of evaluation procedure has also been used by CAC to study MOBA. Other simulation models, designed for other uses, could also be of potential value in MOBA.

URBWAR

URBWAR is a stochastic, event-sequenced, small-unit (platoon and below) urban combat simulation. It is currently limited to a single attack by one force against a building or buildings occupied by the other force. There is considerable flexibility in the layout and material of the buildings and the size, weapons, starting positions, and tactics of both forces. Elements all move, detect, and fire individually within the constraints of the roles assigned to them. Movements include moves to assault, obtain a more favorable search position, and those caused by suppressive fires. Reasonably sophisticated models are used for detection, hit, and casualty probabilities and times for these events, although a need has been expressed for better detection parameter values. Furthermore, these probabilities are weapon dependent. The output provides (1) a summary of which elements were killed, by whom, the weapon used, and the rounds fired, and (2) an event-by-event account of the engagement. Engagement times are a matter of 10 to 20 seconds.

Planned modifications include (1) a more precise probability-of-hit and probability-of-incapacitation subroutine which will account for the part of a human body hit, and mobility and fire-power kills, and (2) a dynamic route-selection routine for each element similar to those used in DYNTACS and ASARS.

In summary, URBWAR appears to provide a reasonable first effort at a platoon-vs-platoon CIC action. With the proposed modifications in place, it will be quite representative of the concepts of such actions as currently held by military tacticians. URBWAR cannot, however, in its present form, play CBR factors or non-human sensors, although it would seem these factors could be introduced without too much difficulty once the effects of such items on the personnel involved are known.

URBWAR is also not capable of testing the effects of combined arms actions including armor, artillery, or air support, intra- or inter-platoon command and control, the psychological and physical effects of isolation from other units over long periods of time, the fighting of a small-unit delaying action, or a retreat. Although it is conceivable that these features could also be included, it is not clear that sufficient information is available at this point in time to permit a reliable description of these items to be formulated. Additional field experience is needed for this to take place.

Even if all the desired modeling and parameter information were available, the question still remains as to the best role, if any, for URBWAR. Should URBWAR, perhaps modified slightly to represent by input parameters the effects of some of the features just discussed, remain a relatively simple platoon-vs-platoon, single assault, short-time duration, shot-by-shot model, or used as the basis for expansion into a large, general-purpose CIC model? In the former role, it could serve as a generator of statistical inputs to a higher level CIC or MOBA simulation; in the latter, it would become the basic CIC simulation itself.

MOBACS

The Military Operations in Built-up Areas Combat Simulation is a product of a research project entitled Gaming Models for Military Operations in Built-up Areas. It addresses combined-arms actions from the division down to fire-team levels in a three-part process in which battle orders are input by military personnel and can be changed within the course of the battle to test alternative approaches to various strategic and tactical situations.

The three steps in this process are:

1. A planning map exercise intended to simulate division/brigade planning operations. Here military planners produce detailed operations plans which are used to construct the input for the second level of simulation, the Force Operations Level Game.

2. The Force Operations Level Game simulates brigade sized combat operations with a unit resolution level of approximately platoon-sized units. It is fully team interactive (both forces) wherein players input unit orders which govern the simulated combat action for that period. The results are fed back to the players who then formulate unit orders for the next period. Each period corresponds to approximately 15 minutes of combat time. The combat history generated is analyzed to isolate critical unit action sequences which then form the basis for a detailed scenario for the lowest, most detailed level of simulation, the Unit Operations Level Game.

3. The Unit Operations Level Game simulates approximately company level operations with resolution to the squad or fire-team level. This game can be operated either (1) as a closed simulation of combat sequences with player-analysts providing complete input scenarios and having the capability of automatic parametric replication of game play or (2) in the cyclic mode as is used with the Force Operations Level Game.

According to the descriptions provided in the Ketron report, the representations of terrain, command and control, communication, combined arms operations, movement, structure hardness, target effects, target acquisition, and fire control are well conceived and reasonably realistic for division, brigade, and company level actions. However, since there has been a minimal amount of recorded experience or analysis, it is difficult to evaluate the realism or the efficiency of the three simulation levels individually or the gaming operation as a whole.

The positive features of MOBACS are: (1) it includes all levels of MOBA operations; (2) military player/analysts can participate on-line and can both guide and learn from the play of the game; (3) a wide range of unit sizes can be studied; (4) combined arms forces can be played at all levels; and (5) considerable flexibility in force structure, tactics, weapons, and the general military situation is afforded.

Shortcomings appear to be: (1) a lack of operational experience with the simulation and, hence, no real tests of the efficiency or effectivensss of MOBACS or its parts; (2) insufficient resolution in the Unit Operations Level Game to investigate such factors as squad-level tactics, the details of weapon usage (and, hence, effectiveness), and the interrelationships among the environment, tactics, and weapons; and (3) problems in adequately representing the "terrain" in built-up areas, particularly in cities where street networks are involved.

SCORES

The Scenario Oriented Recurring Evaluation System is a corps-level general evaluation procedure based on a set of standard scenarios. It includes Air Force as well as Army Operations. Although SCORES currently does not play MOBA, the Combined Arms Center used a SCORES type of evaluation based on the Europe-I scenario to gain insights concerning current force capabilities and MOBA shortfalls in its 1975-1976 MOBA study. The success of this effort would seem to indicate the feasibility of modifying SCORES to include MOBA type activity on a regular basis. The CAC personnel involved with this effort are in an excellent position to guide such efforts.

The JIFFY War Game

JIFFY is an interactive computer played war game in which the participants make decisions regarding tactical objectives and the computer serves primarily as a firepower score board. It has been used in conjunction with SCORES evaluations and could prove useful in this role when SCORES is modified to play MOBA. JIFFY, or a similar interactive game, might also be of use in prescreening tactics for the Force Operations Level Game portion of MOBACS.

DYNTACS

DYNTACS is a high-resolution, company-level simulation capable of playing combined arms actions on a 5 km-by-10 km battlefield. It was originally built in the middle 1960's to evaluate tank and anti-tank weapon systems (with no thought of MOBA). It is similar to a relatively large number of small-unit-action type simulations constructed about that time such as Carmonette and TATAWS.

These DYNTACS-type simulations have many attributes which could be very valuable in studying the CIC phases of MOBA if they could be modified to do so. They should be particularly valuable in modeling sustained company-level operations where the actions of individual elements must be accounted for throughout a battle made up of multiple engagements over a significant area of a city. This phase is basic to a real understanding of CIC operations. Currently, however, this phase cannot be simulated with existing models since URBWAR involves only a single action and the MOBACS Unit Operations Level Game lacks the resolution.

The DYNTACS type simulation could be used in one or both of two ways. One would be to modify it to play CIC itself. The other would be to incorporate some of its capabilities into URBWAR and MOBACS. Recall that it has already been decided to use the DYNTACS route-selection model in the next modification of URBWAR.

Training

Although there is much about MOBA which is similar to other types of military operations, MOBA obviously contains many significant features which are new and different from traditional operations. It is essential that training programs be evolved to cover these features and that these programs be fully coordinated with existing programs so that MOBA training is treated as an integral operation.

The subject of training was given careful attention in the CAC study, and was on the agenda of the 19-20 July 1977 DARCOM-TRADOC Coordination Conference on MOBA.

General Concepts

The characteristics of MOBA dictate that training must include the following:

1. For the Generals and Colonels:

   a. The use of urbanized terrain as a force multiplier (for economy of forces), to gain time, and/or attrit the enemy.

   b. Make best use of combined arms at the corps and division levels in urbanized terrain. This includes air reconnaissance and support, armor, artillery, air mobile operations, and service support.

   c. Consideration of political, religious, and humanitarian factors in accomplishing items (a) and (b). These factors could have important bearings on whether to defend, attack, by-pass, or abandon a given city or area.

   d. The administration of non-combatants in occupied areas, particularly when actual fighting is involved. This includes providing protection, food, health care, and other services, preventing interference with military operations, and planning evacuation procedures.

2. For the Captains, Sergeants, and Troops:

   a. Tactics developed for MOBA, particularly CIC, where small units must operate in relative isolation. This includes use of the vertical dimension and coping with the potential of harassment and fires from all directions.

   b. Use of weapons and equipment, both traditional and those newly developed for CIC.

   c. Communicating and navigating during CIC.

   d. Creating and dealing with rubble.

   e. The psychological stresses inherent in CIC.

   f. Dealing on the personal level with non-combatants.

   g. The tactics and weapons that will be used against them by the enemy.

A detailed list of training needs is presented in Appendix S of the CAC report categorized under the headings Navigation, Engineer (building classification, demolitions, obstacles), Communications, Weapons, and Tactics (offense, defense). The major importance of effective tactics is stressed.

Training Program Needs

Training program needs include both materials and facilities. A necessary first step is the incorporation of current doctrine and weapon-system information into appropriate documents and manuals. The doctrine aspects are beginning to be accomplished with the publication of the new FM 90-10 and the section on MOBA in FM 100-5. However, the CAC study indicates an immediate need to also incorporate MOBA doctrine in FM 7-10 and FM 7-20. In addition, current infantry and combined arms Army Training Evaluation Programs (ARTEPs) are being revised to include MOBA missions, but an immediate need is recognized for the development of a training and evaluation scenario for ARTEPs 7-15 and 7-45 involving delaying actions, in-depth defense, route withdrawal planning, counter-attack, movement down a street under fire, building entry and clearing, and a live fire exercise. These efforts should be continued and plans made for periodic updates as training exercises and simulation studies yield new and better information. It is assumed that information concerning new weapon-system and equipment developments will be incorporated in appropriate field manuals and training documents as quickly as possible.

Training for the Generals and Colonels will require, in addition to the availability of current doctrine and weapon-system capability information, appropriate scenarios and simulation war games through which experience can be gained. MOBA-type field training facilities would obviously be highly desirable, but will of necessity have to be limited due to the cost and lack of availability of extensive areas or urban type settings in which to run exercises. The most that could be hoped for, from a practical point of view, are facilities capable of providing field training in CIC operations of the type specified by CAC for inclusion in ARTEPs 7-15 and 7-45. Results would then have to be extrapolated for inclusion in higher level simulations and war games. Because of the inter-active format of MOBACS, its map exercise and Force Operations Level Game could serve as MOBA training devices for corps and division commanders.

Training for the Captains, Sergeants, and Troops will have to include the latest information on weapons, communication devices, and tactics. It should also include instructions in dealing with non-English speaking non-combatants. Some role-playing exercises could be extremely valuable in this context. Map reading and experience in maintaining one's bearings should also be present. Of great importance, however, is field training in CIC operations including both the single attacks and the more involved operations recommended for inclusion in ARTEPs 7-15 and 7-45. The exercise should be long enough and realistic enough to fully bring out the psychological effects of both hig intensity, close-range fire fights and the isolated operations of small units in streets and buildings.

Training Facilities

Provision of field training facilities poses the greatest problem in MOBA training. Existing facilities are extremely rare. There is a small facility next to the wall in West Berlin which the Berlin Brigade uses for training and an additional facility is planned at Grafenwoehr in West Germany. The Federal Republic of Germany maintains a MOBA training site at Hammelburg.

There is currently essentially no suitable facility for MOBA training in the United States. The XVIII Airborne Corps has plans for a MOBA facility at Ft. Bragg and the FY 79 DARCOM list of MOBA tasks includes renovation of a three-story building in the Edgewood Area of Aberdeen Proving Ground as a test facility.

With reference to the proposed Ft. Bragg facility, some concern was expressed during the July 1977 DARCOM-TRADOC meeting about proceeding to an expensive facility without some assurance that it will provide a valid MOBA training situation. Although the point is well taken, it appears that enough is already known about the general MOBA, and more specifically CIC, environment to proceed with certain parts of such a facility with the rest to be added later as knowledge accrues. For example, a single one-block long street lined only with facades of buildings supporting firing platforms would provide at least some minimal aspects of a movement down a street and being fired upon from many directions and altitudes. A pair of cross streets would increase the realism. A few of the facades could later be replaced by actual buildings for use in defending, entering, and clearing operations. Relatively few actual buildings would be needed. Additional facilities, including tunnels, deep buildings, utility stations, and even rivers and bridges could come later. It is essential, however, that a sufficient set of structures be in place at an early date to parallel in the field what URBWAR attempts to simulate, including a live fire capability. Then, simulation studies using URBWAR could be checked in the field and field experience built into URBWAR. In this way, understanding of what is required for a comprehensive MOBA training facility could be gained. It could further be enhanced if the results of both the initial field tests and the URBWAR studies could be incorporated into a higher level simulation and the resulting outputs used to help with the advanced designs of the MOBA training facility. In any case, some elements of such a facility are needed now so that the desired level of understanding of MOBA can be gained as soon as possible.

Conclusions

1. Recent studies of MOBA have produced a good foundation upon which to formulate a first-cut MOBA doctrine and identify problem areas which need study.

2. Several simulation models exist which have the potential of playing significant roles in the continued development of MOBA doctrine and the evolution and evaluation of appropriate tactics, weapons, equipment, and training programs.

3. A hierarchy of simulation models is needed both to study and to train personnel for the various levels of MOBA activities.

4. MOBA training facilities are a necessity in gaining experience with MOBA, and particularly CIC, both to train personnel and gain additional knowledge to further develop doctrine, tactics, and weapons. Live fire capability is extremely important.

5. The newness of MOBA interest and the resulting lack of detailed operational knowledge coupled with the high cost of urban type training facilities, dictates an evolutionary approach to the designing of such facilities. There is, however, an immediate need for a facility in which to engage in a single attack on a defended building and to experience fires from many heights and directions as an advance is made through a street.

Recommendations

1. MOBA modeling, simulation, and training plans and activities should consider the broad range of MOBA; namely, CIC, operations involving the combination of man-made towns and the surrounding natural terrain, and MOUT.

2. Field and simulation studies should proceed simultaneously so that each can benefit from the findings of the other.

3. Continue the development of URBWAR as a platoon-vs-platoon, single assault, short time duration, shot-by-shot model, incorporating into it those features of other small-unit-action simulations felt beneficial and the capability for at least parametric treatment of other factors such as CBR. Some of this development will have to wait for the results of field tests or additional changes made as new knowledge becomes available.

4. Use URBWAR to develop appropriate distributions and statistics for higher level simulations, models, and war games.

5. Continue to develop MOBACS as new information becomes available from field tests and new subroutines are developed or adopted from other simulation models.

6. Investigate the use of intercorrelations in the development of the statistical battlefield in the MOBACS terrain model as a means of increasing the realism in representing street networks and building complexes.

7. Develop a comprehensive CIC model of sufficient resolution to investigate such factors as squad-level tactics, the details of weapon usage, interrelationships among the environment, tactics, and weapons, individual detection and firing capability, and psychological factors. This investigation should include examinations of the MOBACS Unit Operations Level Game to check the feasibility of increasing its resolution to the level required and of DYNTACS and perhaps other high resolution simulations to see if they can be adapted to MOBA. MOBACS offers the interactive feature, a decided advantage, but some difficulty may be experienced in getting it running on a production basis. DYNTACS has the resolution, a relatively sophisticated tactical decision making capability, and is operational at Ft. Leavenworth, but is a completely closed simulation.

8. Using the expertise gained by CAC in their MOBA study, modify (expand) SCORES to include MOBA.

9. Investigate the appropriateness of modifying JIFFY or perhaps other interactive corps level simulations for use as a MOBA MOUT model and as a high level training device.

10. Continue the dissemination of current MOBA doctrine and related material in field manuals and training documents and provide for the rapid update of these publications as new and improved information becomes available.

Investigate the use of the MOBACS map exercise and Force Operations Le· Game as MOBA training devices for corps and division commanders. Its :eractive nature should make it well suited for this purpose. Should t'· ot prove feasible, JIFFY and other high level models would have to .onsidered. If no existing high-level model can be adapted to do the ,ob, a new game would have to be developed from scratch.

12. Appropriate training materials and inputs to the high level MOBA game should be prepared for use by corps and division commanders. The following subjects should be included: (1) the use or urbanized terrain as a force multiplier, (2) the use of combined arms at the corps level in urbanized terrain, (3) consideration of political, religious, and humanitarian factors, including the effects of collateral damage, in planning military operations, and (4) the administration of non-combatants in occupied areas, in particular where actual fighting is taking place.

13. Appropriate training materials and programs should be prepared for use at company level and below. The following subjects should be included: (1) MOBA tactics, especially CIC tactics, (2) traditional and newly developed weapons and equipment, (3) communication and navigation during CIC, (4) creating and dealing with rubble, (5) psychological stresses inherent in CIC, (6) dealing on a personal level with non-English speaking non-combatants, and (7) the tactics and weapons that are used by the enemy.

14. A MOBA training facility should be planned for construction and modification on a continuing basis as knowledge of MOBA operations and training requirements increases. An immediate capability should, however, be provided that will enable field exercises to be performed which enact in real life items which the URBWAR model simulates. This involves a single attack on a defended multi-room building starting either from the street or another building, with platoon-size forces on both sides. Results of the field exercises could then be used to update URBWAR and URBWAR study results used to organize and equip offensive and defensive forces in CIC. A logical next step, as information becomes available, is to provide for a comprehensive company level CIC operation, eventually with combined arms.

15. Study the use of the absorption walk, frangible bullets, etc., to minimize injuries during live fire exercises.

16. Study the use of electronic, laser, and other devices to determine and record hits and damage caused by the weapons employed in training exercises.

SECTION 2

Mapping

SECTION 2

Mapping

Earlier studies[1] of MOBA have directed attention to the fact that in previous operations involving U.S. forces in urban areas, up-to-date information on urban features of military significance was not available. It is projected that future operations in such areas will generate needs for a great variety of information including routes of transportation, communication systems, underground installations, key governmental centers, structures, etc. To avoid problems of the past, large scale maps showing such features will be essential. Indeed, it has been said that planning and preparations for MOBA would appear to be more important to an effective city defense than new and original concepts.

With these requirements in mind, the committee sought to determine the state-of-the-art of mapping of urban areas that show all features of military significance related to ground operations and then to offer some recommendations with respect to efforts that should be initiated to ensure that the mapping needs for built-up areas for the future will be met. To this end, a member of the committee met with representatives of the Defense Mapping Agency (DMA)* and the U.S. Army Topographic Laboratories (ETL)** to review the extent of their efforts directed to meeting MOBA requirements.

The Defense Mapping Agency

Of particular interest to MOBA and the matter on which discussions were focused at the DMA were the activities of the Topographic Center. This Center is concerned with the production of tactical topographic maps. It was reported that the Office for Plans and Requirements of the DMA had not received a definitive statement concerning services specifically designed to support MOBA. There is a requirement to provide city maps but it was reported that there has not been a serious undertaking to produce a map or topographic product specifically desighed to meet MOBA requirements. There have been discussions concerning the various characteristics of urban areas that may affect military operations but it was reported that DMA had not received any specific requirements from the Army to prepare maps specifically designed to show such features. In response to a question as to whether or not, if requested, the DMA could develop maps to meet MOBA requirements, it was reported that they did have the capability to produce such maps but that the current workload would make it impossible to undertake such a responsibility without a significant increase in budget. With respect to budget, it was further reported that the level had more or less stabilized and it was perceived that if any new activity were to be undertaken, it would have to be done by trading off on-going activities.

---

[1] GTE Sylvania Final Report dated 9/3/73

*, ** - See notes appended hereto.

With respect to products now being produced that would provide some information for MOBA, the DMA produces three types of city maps characterized as follows: 1. City Route Graphic Maps, which simply show the lines of travel through urban areas, 2. City Graphic Maps, which show an intermediate level of information, and 3. Military City Maps at a scale of 1 to 12,500 that contain the greatest amount of information including topographic features. These maps are prepared in large part from air photographs.

The following additional facts emerged from discussions with representatives from the DMA.

1. The DMA does not collect intelligence; it depends on other agencies such as the DIA, the CIA, etc., for such information.

2. With respect to our NATO allies, there is an agreement that each country will prepare its own maps in accordance with an agreed-upon set of specifications.

3. Finally, it was reported that if the DMA should become involved in any mapping exercise in Europe, this would have to be agreed upon by our NATO allies.

In later discussions with the ETL, it was reported that the DMA serves primarily as a production agency with respect to mapping and that it depends in large part on the research efforts of the ETL to support these activities.

The U.S. Army Engineer Topographic Laboratories

The U.S. Army Engineer Topographic Laboratories (ETL) has a prime responsibility of engaging in research related to mapping. Among its elements is the Terrain Analysis Center (TAC).*** This Center is concerned with the development of a "compendium of available data on pertinent natural and man-made features of (an area) and an evaluation of their effects on tactical military operations." A Terrain analysis report contains maps showing surface configurations, surface drainage, surface water, ground water, engineering soils, engineering geology, vegetation, climate, cross country movement, lines of communication, etc. Although the efforts of the Center have not been focused on built-up areas, it would appear that it has the competence to treat such areas. At present, it is doing state-of-the-art studies of terrain in general.

Among activities related to mapping of significance to MOBA are the development of three maps that have been prepared by ETL. The first of these is a map at a scale of 1 to 750,000 that includes the whole of Europe; it shows all urban areas having an area greater than 0.25 sq. km. This map clearly demonstrates why it is becoming important to give consideration to MOBA. The second map shows the Fulda corridor at a scale of 1 to 250,000. It also shows all urban areas larger than 0.25 sq. km. and clearly demonstrates how built-up areas block traditional lines of movement. The third map shows the projected increase in urbanization of the Fulda corridor for the year 2,000. It demonstrates the increasing importance of MOBA in the years ahead.

*** See notes appended hereto.

Of particular relevance to MOBA is the development of a mapping system that is intended to supplant the current DMA City Route Graphic, City Graphic, and Military City Maps previously described. The new system will consist of a combination of the City Route Graphic and the City Graphic Maps of the DMA system. A map similar to the old Military City Map and one that represents an effort to stretch the current state-of-the-art is also under development. Experimental examples of each of these three types of maps are available. These maps are referred to by the ETL as level I, II, and III maps, respectively. The level III type map shows much of the information that is required for MOBA. This includes types of buildings depicting story heights as well as types of construction; that is, steel frame, concrete, masonry, etc. It shows the widths of city streets, bridge data including horizontal and overhead clearances as well as types of bridge structures. It shows railroads, power transmission lines with voltage and tower heights, subway routes and stations, pipelines, spires and chimneys, open areas, and land use. In addition, the map folio includes a three dimensional oblique stereo pictorial of a three dimensional view of a city. Although some of the information necessary to prepare a level III map can be obtained from remote sensing techniques, it is obvious that much of it must be obtained on location. It was reported that the preparation of a level III map is very time consuming; thus, it would need to be prepared well in advance of any anticipated need for it.

Another development at the ETL of significance to MOBA is the Army Terrain Information System (ARTINS). This system is designed to provide terrain intelligence to field armies. When fully developed, the system will be designed to "embody automated processing, production, storage, retrieval, dissemination, and up-dating of terrain intelligence." The data bank will include vegetation and surface configuration, hydrology and natural resources, electric power, solid fuels, petroleum and natural gas lines, air terminals, water terminals, lines of communication logistic facilities, underground installations and defenses and data related to climatology and meteorology.

Conclusions

1. As populations continue to become more and more concentrated, MOBA will become more and more unavoidable.

2. In order to conduct MOBA, it will become highly important to provide intelligence concerning the physical features of an urban area such as those now being included in the level III experimental map being developed by the ETL.

3. Although a significant amount of mapping intelligence can be obtained from remote sensing, a substantial amount of essential information will need to be obtained on location. Furthermore, the task of obtaining the essential information and depicting it in useful form is time consuming; thus, if the required information is to be available when needed, it will have to be obtained well in advance of military operations.

4. The ETL does have the resources to process mapping information required for MOBA but more attention must be focused on the mapping of information required specifically for MOBA.

Recommendations

Mapping for MOBA will probably always depend chiefly on data obtained on-site and in advance. Maps for MOBA must therefore be prepared before the fact. If MOBA is important more of this work should be done (technology will probably never significantly simplify the problem). In spite of this recognized shortcoming several efforts appear likely to provide meaningful return. They are as follows:

1. Appropriate agencies be tasked to obtain the intelligence that cannot be obtained by remote sensing on a continuing and sustained basis. Some important urban features that will affect military operations that cannot be disclosed by remote sensing are continually changing. Accordingly, it will be necessary systematically to up-date this information and keep it current.

2. It is also recommended that we seek to reach agreement with our allies with respect to the information required as well as the format for depicting it for the purpose of conducting MOBA. The division of responsibility for performing this task should also be agreed upon.

3. It is recommended the Army Terrain Information System (ARTINS) be designed to include intelligence concerning features of built-up areas that are of military significance. In such a system the data bank would include, in addition to terrain intelligence, features such as underground installations, types and configuration of buildings, power and communication centers and line, piers, railroads, roadways, bridges, etc.

4. Developments in remote sensing technology offers the possibility in the near future of obtaining much of the most useful information needed for MOBA in enemy territory or elsewhere not easily accessible for on-site intelligence and of updating existing maps on a near real-time basis. We recommend continuing strong emphasis to assure that a system to incorporate remote sensor outputs on a near real-time basis in the combat intelligence is in place to exploit a rapidly developing technology.

NOTES

*DMA: The DMA is comprised of Aerospace, Hydrographic, & Topographic Centers. It is also responsible for the Defense Mapping School, the Inter-American Geodetic Survey and DMA Depots. "It serves the land, sea, and aerospace requirements of all the U. S. Defense forces by providing management of all mapping, charting and geodesy activities common to those forces. The Director of DMA reports to the Secretary of Defense through the JCS. It has an authorized strength of 7600 civilians and 725 military personnel. Its products fall into three categories - maps for land maneuvers and operations, charts for nautical and aerial navigation and operations, and geodetic data on the size and shape of the earth, the precise position of points on its surface, and the variations in the pull of gravity and magnetic force at points all over the world." The Office for Plans and Requirements for DMA is concerned with operational and contingency plans. Its current operational budget is approximately 240 million dollars per year.

Discussions concerning DMA activities were held with Brigadier General Ames Albro, Jr., Deputy Director, and Mr. Yates Dameron, Assistant Deputy Director, both of the Office for Plans and Requirements for DMA.

**ETL: The ETL is a field operating agency of the Office of the Chief of Engineers. Its major R&D missions include automated mapping, point positioning, and military geographic information. It is organized into five prime R&D elements: The Research Institute, the Computer Sciences Lab., Geographic Sciences Lab., Topographic Developments Lab. and the Terrain Analysis Center. These elements employ 78% of ETL's work force which is comprised of approximately 280 civilian and military personnel. The remaining 22% provides the necessary administrative staff services. At the ETL discussions were held with Colonel Philip Hoge, Commander/Director, and Lt. Col. William Stockhausen, Deputy Director. Meetings were also held with the Chief of the Terrain Analysis Center (TAC), the Chief of the Topographic Design and Development Group as well as the Director of the Geographic Sciences Lab.

***TAC: The Terrain Analysis Center reports directly to the Technical Director of the ETL. It has an operational rather than an R&D mission. Established by the Chief of Engineers in 1975, it provides a terrain analysis capability at Department of Army level. TAC prepares specific terrain studies and analyses in support of contingency plans in war scenarios. It assists and complements civilian users for terrain intelligence. It is developing a capability to provide military geographic information and terrain data from all sources worldwide needed for military and civilian contingency planning, training and engineering. TAC's location within the ETL enables it to test new methodologies, techniques and systems resulting from R&D to represent the user in these areas. When tasked to perform its mission, TAC is divided into two teams of analysts - one, a Data and Acquisitions Management Team; the other, the Data Analysis Team. TAC includes among its representative projects the development of special terrain studies in support of MOBA by the Defense Advanced Research Projects Agency (DARPA).

From discussions at the ETL, it was learned that this Laboratory has the responsibility not only to support the Army but also to conduct R&D for DMA. At the ETL, it was reported that the DMA is primarily a production agency though it is not precluded from engaging in R&D in support of its own activities. As a final item, it was reported that the ETL must rely on the DIA, the CIA, etc. for intelligence just as does the DMA. It should also be noted that the Army does have a capability to produce maps in field units to support Army needs.

SECTION 3

Location & Identification of Forces

SECTION 3

Location & Identification of Forces

Table of Contents

3-1.0 BACKGROUND

As it does in other mission areas, MOBA introduces unique problems to the conventional methods for detecting, locating and identifying forces. Many surveillance technologies, e.g., night vision systems, require line of sight between friendly and enemy forces. In built-up areas, whether intact or in rubble, open areas are few and the enemy is readily concealed. Even those technologies not requiring line of sight, e.g., unattended ground sensors, suffer from unique problems associated with background clutter not present in urban areas. As an initial step in determining the magnitude of these problems, it is necessary to evaluate present surveillance and target acquisition equipments in the TOE in a MOBA environment. The list of tasks in the prepared FY79 MOBA program, developed at the Second DARCOM-TRADOC Coordination Conference on MOBA, 19-20 July 1977, defines only one surveillance task, namely, "Surveillance Techniques in MOBA (Night Vision)". No money has been provided to Night Vision Laboratory specifically for this task; however, some tests have been run by NVL at the Marine Corps Combat Village, Quantico using other funds. No other surveillance and target acquisition tasks have been defined or carried out. Thus the utility of such technologies as radar, unattended ground sensors, RPV's, acoustics, photography, lasers/electro-optics, mine/booby trap detection, and IFF in a MOBA environment remains undetermined.

In the pages which follow, the above nine technologies are discussed in light of MOBA needs, and inclusions and recommendations are drawn. The statements reflect a consensus between the ad hoc committee and the individual laboratories responsible for the development of each of the technologies.

3-2.0 RADAR TECHNOLOGY

Personnel and Vehicle Detection

A number of airborne and ground based radars for detection of moving personnel and vehicles are in the Army inventory. Several new systems will be fielded over the next few years.

The AN/APS-94 side looking radar has been operational for many years in the OV-1 aircraft. This radar can detect vehicles out to ranges well in excess of 50 km. By the early 1980's, the SOTAS will be operational. This system consists of a modified AN/APS-94 radar in a helicopter and a ground station with a real time display. The rotating antenna in the SOTAS provides rapid wide area surveillance. Both systems have been extensively tested in Europe. It is likely that some indication of their effectiveness in a MOBA environment can be obtained by analysis of available data. The SOTAS tests are well documented with accurate ground truth data.

The ground based AN/PPS-4 radar is fielded in large quantities. This radar has a range of 1.5 km on personnel and 3 km on vehicles. It may be replaced in a few years by the AN/PPS-15 radar. Both radars detect targets by presenting doppler frequency signals to the operator through an audio headset. The AN/PPS-5 radar was extensively used in Viet Nam. It can detect personnel and vehicles out to 10 km. The radar has a "B" type (azimuth vs range) display in addition to a headset. Target acquisition for the Artillery is provided by the AN/TPS-25 and AN/TPS-58 radars. These radars can detect vehicles to 20 km and personnel to 10 km. They are operated with standard military maps so that target locations can be correlated with map features such as roads. The AN/TPS-58 can also detect and adjust artillery bursts.

A MOBA environment could present a number of problems to these radars, e.g., loss of line-of-sight due to buildings; a high false alarm rate caused by detection of civilian personnel, animals and rotating machinery; large echoes from buildings may overload the clutter cancellation circuits.

Evaluation of these existing radars in a MOBA environment requires an instrumented test facility (see IFF technology discussion). In addition to evaluating existing radars the testing should be structured to provide a clear indication of new radar developments required to provide reliable detection of personnel and vehicles in a MOBA environment.

Some New Radar Capabilities

The lightest of the radars discussed above is the AN/PPS-15, which weighs 20 lbs. and operates from a tripod mount. Technology now permits development of a handheld radar weighing less than 5 lbs. The CS&TA Laboratory is initiating a program with RCA to apply microwave FET technology and CCD processing to lightweight radar.

Remotely Piloted Vehicles (RPV), such as the AQUILA, offer a number of attractive possibilities as a platform for sensors in a MOBA environment. Their low cost and low vulnerability should allow them to be used for penetration missions. In cooperation with AVRADCOM, the CS&TA Lab is pursuing a major program to develop a radar for use in an RPV. The main emphasis is on a radar capability to automatically detect and recognize military targets such as tanks, trucks and artillery in the presence of echoes from terrain and foliage. The approach is based upon the use of millimeter waves for high angular resolution and signal processing of radar signatures. A brassboard 95 GHz radar has been developed by Norden. Basic characteristics of this radar are attached. A number of promising signal processing techniques have been developed by the Georgia Institute of Technology. Preliminary tests of the Norden radar utilizing these processing techniques have been very encouraging. This radar should be evaluated in a MOBA environment to determine if modifications of its signal processor are required. The evaluation can be best accomplished through flight tests in a helicopter.

Weapon Location

A major weapon for MOBA is the mortar. The AN/TPQ-36 mortar locator of the FIREFINDER system will be fielded by the early 1980's. This radar is an extremely effective mortar locator, but may be too expensive for many situations. Several lightweight low cost mortar locating systems are under development. An IR system has been successfully tested by Lincoln Laboratory under the HOWLS program. A combined radar/acoustic system has been developed by the CS&TA Lab. These developments show that it is feasible to produce a mortar locator, weighing under 200 lbs. at a unit cost below 100K, which can reliably locate mortars at a range of 5 km. The best configuration for MOBA can be most efficiently determined through analysis and simulation. The simulation approach has been very successful in previous weapon location programs.

Direct fire weapons are also heavily employed in MOBA situations. The problem of detecting direct fire weapons was investigated a number of years ago. It is feasible to develop a radar weighing under 100 lbs. which can detect and locate direct fire weapons at a range of at least 1 km. Its utility can also be evaluated through simulation by increasing the scope of the above mentioned mortar locating study.

Detection of Personnel Within Buildings

None of the fielded radars or those under development can penetrate buildings to any significant extent. During the SEA period a number of developments in the areas of foliage penetration and intrusion detection occurred which were applicable to the problem of detecting moving personnel in buildings. A 30 MHz bistatic radar detected personnel at a range of a few hundred meters through heavy foliage. The electromagnetic intrusion detector AN/GSQ-160, EMID, detected moving personnel through walls. A VHF pulse radar (GEODAR) was developed which detected tunnels more than 10 feet below the surface.

The utility of the AN/GSQ-160 in its present configuration can be readily evaluated by means of a 3 months test. It is likely that more sophisticated equipment will be required. A potential problem is false alarms caused by RF interference.

There is a strong possibility that an appropriate extrapolation of the bistatic foliage penetration radar and tunnel detection radar technology can provide an effective system for detection of personnel in buildings.

Conclusions - Radar

1. Radar is one of the most important surveillance technologies and should be adapted to MOBA.

2. There is no radar task identified in either the letter of General Hunt or the DARCOM-TRADOC MOBA Conference proceedings. No funds have been allocated for radar in MOBA.

3. SOTAS and MOHAWK SLAR have been employed in REFORGER Exercises, including urban areas.

4. A 95GHz stationary target detecting radar is under development for Aquila. Its utility in built-up areas has not been explored.

5. There is need for a lightweight mortar locating system appropriate to use in urban areas. An IR fence/laser rangefinder is under development for HOWLS. There is no radar system under development. A system employing both radar and accoustics has been explored at CS&TA Laboratory.

6. Technology today permits the development of a handheld (flashlight) MTI radar.

7. The AN/GSQ-160 EMID can detect moving personnel within a room from outside the room. It is in the SEAOPS inventory.

Recommendations - Radar

1. Evaluate the utility of TOE radar systems including the AN/PPS-15 in a MOBA environment for personnel and vehicle detection.

2. Determine the technical feasibility of developing radar and radiometric systems for use in a MOBA environment to: a) detect vehicles on roads; b) detect personnel outdoors; c) detect personnel within buildings; d) detect and locate weapon firings, including small caliber and mortar.

3. Review the SLAR and SOTAS REFORGER data to determine the utility of these systems in urban areas.

4. Test the utility of the AN/GSQ-160 to detect personnel within buildings from outside the buildings.

5. Evaluate the utility of the AQUILA radar as development continues in detecting personnel and vehicles in an urban environment.

3-3.0 NIGHT VISION/INFRARED TECHNOLOGY

The important issues for Target Acquisition systems' use within a MOBA environment involve all aspects of the fighting team's utilization of these aids. At the present time the only systems which are or are planned to be deployed in large quantities are binoculars and night vision systems. The aspects to be considered include the basic design parameters of the system such as: weight, operability, cost, performance, EMI suppression and noise output. The mix of various types of these systems within the unit of interest must be addressed as there are many differing tasks required to be carried out. Finally the tactics of units in combat must be addressed to insure maximum utilization of existing assets.

The immediate problem is to assess the capabilities of the presently available night vision systems within the built-up areas. At present not enough information is available to predict system performance in this environment. The major concern here is the target signature in the MOBA situation. The assessment must be performed for both the defensive and offensive postures in order that predictions can be made for both cases. Preliminary tests have been carried out with various systems to assess the detection capability using military observers within a dead town using man targets at doors and windows of the buildings. These were static tests which would duplicate reconnaissance within the built-up area. These tests did not have significant statistical replications and did not include testing for the target signatures which were widely varying over the period of the test. These variations occurred both in the contrast and light level for the image intensifiers and in the temperature differential utilized in the thermal viewers. These tests did not include the issues of squad or platoon size groups, vehicles, mines or booby traps, weapon detection, motion, building occupancy and fire detection. Some of these items must be addressed to obtain any realistic results from a test.

The test which must be carried out would be to quantify the amount of intelligence that can be obtained both from inside and outside a town with various acquisition aides during a realistic assault on a town. These tests must be implemented with careful measurement of target signatures.

Fighting within the MOBA environment will occur much more frequently than previously experienced and because of the desire for continuous action many night operations will be carried out. These operations will require a varied capability in the sensors' abilities. The normal reconnaissance task of searching for targets such as vehicles, people or weapons systems is the major function. This will be fulfilled at many levels including intelligence gathering for overall operation planning down to individual soldier finding targets and directing fire at them. Many other tasks such as resupply and regrouping for attack must also be considered. These are very important missions which would be logical to carry out under the cover of darkness and would be facilitated by the use of night vision systems. Included in this second grouping would also be equipment repair which could be accomplished in the dark. The major point is that for all the tasks outlined above there

can be no assessment of the payoffs for making the investment in development or choosing the proper mix of systems for field issue without obtaining a realization of the systems' capabilities in the MOBA environment.

Test Outline

This program involves four weeks of testing with full target signature support for the total period of the test. It would be possible to save some small portion by taking target signature data for just one week of the test. The savings would be about 12% of the total cost of the test. The price also assumes support of the test by military personnel. Presumably the test sight is used for training and the trainees would be utilized as the observers for NVL experiments. Some of the cadre would also have to be available to act as referees and traffic controllers.

Utilizing night vision systems in a MOBA environment, tests will be of three types: (1) static surveillance by the individual soldier, (2) realistic defensive and offensive maneuvers by squads and (3) the mobility of the soldier wearing night vision goggles for such tasks as room clearing, resupply, vehicle repair and map reading. The measures of performance will be acquisition ranges, performance times and casualty rates.

This test should be carried out during at least two seasons of the year, winter and summer.

During the test period a helicopter test should be carried out which includes aerial observation of the town with a thermograph.

Conclusions

Image Intensifiers (Goggles, Starlight Scopes)

1. Quantico tests demonstrated detections of personnel in windows and doorways at ranges out to 175 yds., depending upon natural light level. Overall probability of detection 50% of the time occurred at 100 yds. Limitation was S/N not resolution. Third generation systems, which might be available by early 1980's will have increased detection range perhaps doubled.

2. They will reveal building activity only if lights (visible, near IR) are used by occupants.

3. Unlikely that they can be used to identify friendly forces unless friendlies were equipped with "optical transponder."

4. Goggles are useful aides for:

    a. Moving rapidly through buildings
    b. Driving vehicles
    c. Resupply
    d. Detecting enemy IR searchlights
    e. Map reading and vehicle repair

5. Can detect enemy use of NdYag laser rangefinders or target designators.

Thermal Imaging Systems (HHTV, NODLR-IR, TOW Night Sight, Dragon Night Sight, Tank Thermal Sight, PNVS, TADS)

1. Quantico tests revealed that high resolution (.25mr) systems can detect personnel in windows 100% of the time at ranges up to 175 yds. (limited by line of sight in the test) independent of ambient light level, if there is no heavy fog. Low resolution (2mr) systems are limited by resolution not S/N to 50% detection probability range of 150 yards.

2. In general the high resolution systems should reveal personnel in windows at ranges of at least 1Km.

3. Glass in windows will make it impossible to see personnel within room.

4. Other field tests have revealed that thermal imaging systems can determine which buildings are heated and which are not, thereby providing a clue to occupancy. This is by temperature distribution on outside walls, so doesn't depend upon open windows or doorways.

5. With a high resolution system at close range, 100 yards, it may be possible to identify personnel from enemy or neutral.

6. Enemy weapons which have been fired recently can be detected by thermal signature.

7. Vehicle thermal signatures uniquely identify enemy versus friendlies.

Recommendations

1. The Quantico tests, which were preliminary, need to be followed up by one or more tests of larger scope in which the following issues need to be addressed.

   a. Building occupancy as revealed by thermal signatures from the sides and from above (RPV, Mohawk, AAH TADS).

   b. Weapon detection as revealed by Thermal Signature (rifles, machine guns, anti-tank missiles (Sagger, RPG-7), artillery, recoilless rifles, tank main gun.)

   c. Mines, booby traps detection.

   d. Vehicle identification.

   e. Personnel identification.

   f. Detection of Nd-Yag laser rangefinder (designators by image intensifiers, and perhaps a CO_2 laser detection by thermal (8-14 μ) systems.

g. Effect of smoke on target observation and ability to see through it with thermal systems.

h. Squad level tests using TOE night vision equipment.

i. Detection of enemy resupply efforts.

Target and background signature data need to be collected while the above tests are underway.

An excellent test site for the above is Hammelberg FRG.

2. Determine requirement and technical approach for new night vision/optical equipment for NOBA environment, such as:

Corner Sight
- Optical
- Image Intensifier
- Infra-Red

Surveillance Drone

Cheap IR NIGHT SIGHT

Covert Search Light

Optical Augmentation

Laser Designator

Searchlights

Lighting Activity Detectors

Optical Communicators

3-4.0 ACOUSTIC TECHNOLOGY

1. Short Base Acoustic Array - The sound ranging technique currently used by the Army employs a linear array of up to six microphones to detect and locate firing artillery weapons, mortars and other sources of explosions. The use of Short Baseline Acoustic Array has been proposed and investigated to overcome some of the limitations of the conventional sound ranging approach. Some potential advantages of a system employing the SBA are reduced system response time, increased target handling capacity, and enhanced signal to background noise capability. The advantages are derived, in large measure, from the capability of the SBA to measure angle of arrival, as well as time of arrival, of the acoustic wave. The best use of this technique in a MOBA environment would probably be the deployment of the system outside the built-up area to monitor and locate activity within. No data is currently available regarding the performance of sound ranging systems in a MOBA environment. First steps in any investigation along these lines should include a better definition of the MOBA environment and the obtaining of acoustic propagation data relative to this environment. Subsequently, acoustic data would be evaluated using SBA processing, either on line, or off line by computer simulation, to determine and optimize SBA processing parameters and determine potential system effectiveness.

2. Clandestine Methods for Listening - A variety of potential techniques may be used to implement the requirement to listen to sounds within buildings and rooms from outside in a MOBA environment. Microphones and microphone-like transducers are available in extremely small sizes. They have low power consumption and are very rugged. These may be unobtrusively planted together with a suitable transmitter as a leave behind system. In open spaces, highly directional microphone systems may be used to monitor conversation from a distance. The effectiveness of this technique is limited by background noise and wind noise at the microphone. Conversations on the other side of walls may be monitored by contact microphones which utilize the wall as a vibrating membrane, activated by acoustic energy. These may be fired into place from a distance. A major consideration for remote listening systems is the requirement for the transmission system. This includes distance to be transmitted, duty cycle, method of turn-on, etc. Another method of remotely monitoring the acoustics within a room employs detection of the vibration of a structural membrane such as a window by detection of the modulation of the reflected energy from an active optical source (e.g. IR) which is directed at the window. In order to evaluate the relative suitability of these techniques, it is necessary to define specific requirements for operation in the MOBA environment. It is expected that evaluation hardware can be obtained off-the-shelf.

Conclusions - Acoustics

1. There is no acoustics task identified in either the letter of General Hunt or the DARCOM-TRADOC MOBA Conference proceedings. No funds have been allocated to acoustics in MOBA.

2. It may be possible to locate hostile mortars firing within an urban area by a short baseline acoustic locating system. However, multipath may be a problem.

3. Conversations can be overheard at ranges up to about 100m by using directional acoustic systems employing parabolic reflectors.

4. It is probable that a microphone and RF transmitter can be developed which can be fired from across the street into the wall of a building so as to overhear conversations within that building.

5. Conversations within a room can be overheard remotely by active IR means.

6. Leave behind microphone/transmitters can be pre-implaced in urban areas before withdrawal.

Recommendations - Acoustics

1. Determine the feasibility of utilizing short baseline acoustic locating systems for detection of mortars in an urban environment.

2. Investigate clandestine methods for listening to conversations within rooms by parabolic reflector/microphone systems, microphone/transmitters fired into place, active IR systems. Determine the limitations imposed by background noise.

3. Determine the utility of leave behind microphone/transmitter systems for urban warfare.

3-5.0 LASER/ELECTRO-OPTICS TECHNOLOGY

The general capability of detection of effluent emanations from a variety of man-made activities, principally weapon firings and vehicle exhausts, by CO_2 laser doppler techniques, has been demonstrated at considerable ranges. In addition, the narrow-band induced resonance characteristics of the laser beam permits identification, via the return, of specific gaseous constituents of the effluent (LOPAIR). By variation of the laser wavelength, it is possible to detect and identify the presence (or absence) of gases related to military targets and their ratio to a common background effluent. (λ_T/λ_B)

For MOBA utilization a system employing this technique will be mounted on a rooftop and scan above the local area. The concentration of target effluent above a firing weapon, or operating vehicle, will be considerably higher in its immediate vicinity, possibly enhanced by ducting along vertical walls, such that a maximum ratio of λ_T/λ_B return will indicate a target below that point. Ranging can be accomplished directly off the effluent to a reasonable degree or accuracy.

A program is proposed which will consist of three phases:

(1) Analysis of effluent returns from various targets at selected CO_2 Laser wavelengths and determination of return ratios against a normal urban background. Identification of specific targets may prove possible, e.g., Soviet Vehicles, Mortars, etc.

(2) Design and development of an exploratory development model.

(3) Test and evaluation in a simulated MOBA environment.

Conclusions - Laser/Electro-Optics

1. There is no lasers/electro-optics task identified in either the letter of General Hunt or the DARCOM-TRADOC MOBA Conference proceedings. No funds have been allocated to lasers/electro-optics in MOBA.

2. Artillery location by means of laser backscattering from muzzle blast effluents is under investigation. It is not clear whether this method would be useful for mortar location.

3. A Passive Artillery Location System based upon gunflash detection can locate artillery when firing provided there is line of sight between the PALS and the artillery.

4. Obscuration of the line of sight between laser and target, or between target and weapon, will render laser target designators inoperable. Laser rangefinder's operation will not be as affected, since only the line of sight between operator and target is important.

5. Flash and sound techniques used together will be effective a higher percentage of the time than each separately.

Recommendations - Laser/Electro-Optics

1. Based upon the results of the laser effluent detection study, determine whether these results are appropriate to solving the problem of locating mortars in urban areas.

2. A study of line of sight limitations in urban environments is needed to determine the utility of flash ranging, laser designators, and laser rangefinding systems.

3. Determine the increase in effectiveness of combination flash/sound ranging system for mortar location in urban areas.

3-6.0 PHOTOGRAPHY/PHOTO-OPTICS TECHNOLOGY

1. The Photo Optics Technical Area has initiated two (2) ILIR programs that would have application to target detection in a MOBA environment. One of these involves the use of photographic color signatures for automatic target detection. The concept involves aerial or ground photography with in-flight or immediate rapid processing of color film. A sensor will view the processed film and respond to the color densities corresponding to the color signatures of interest. For example, in a MOBA environment, the sensor could be set to respond only to olive-drab vehicles, or camouflaged vehicles. The frames containing the targets of interest could subsequently be studied or scanned for transmittance to the ground. Feasibility for developing such a system has been shown, but additional development work is required.

2. Another R&D effort was started in FY-77 under an ILIR program. The objective is to devise a passive long focal length photographic surveillance system utilizing long exposure times so that artificial illumination at night can be eliminated and the resolution of daylight photography maintained. At present, the study is being made for a stabilization device suitable for use in an aircraft. A computer analysis of such a system showed that at a stand-off range of 50 kilometers a target as small as 3 meters could be detected at full moon. At 200 kilometers a 10 meter target could be detected. The incorporation of such a stand-off system on fixed platforms, helicopters, AQUILA or commercial airliners would have application in a MOBA environment for high resolution passive surveillance. It is estimated that 100K would be required for the first and second year to study the servo mechanisms required for various aerial platforms and photographic conditions.

Conclusions - Photography

1. There is no photography task identified in either the letter of General Hunt or the DARCOM-TRADOC MOBA Conference proceedings. No funds have been allocated for photography in MOBA.

2. There is a photo package on MOHAWK. There is currently no intent to have a photo package on the AQUILA RPV, although work was done on one.

3. The present fielded systems do not provide a near real time capability.

4. Active line scanners used with retro-reflectors offer a means for locating friendly forces.

Recommendations - Photography

1. Determine the need for photographic systems in a MOBA environment, to include ground based and aerial platforms (MOHAWK, AQUILA, helicopter).

2. Should investigate the use of active line scanners (visible, IR) with retro-reflectors to locate friendly forces.

3-7.0 UNATTENDED GROUND SENSORS/REMBASS TECHNOLOGY

Unattended Ground Sensors

1. Remote unattended ground sensors and sensor systems, such as REMBASS and PEWS, appear to have unique potential for MOBA use working either alone or in concert with other kinds of combat-surveillance target-acquisition components and systems.

   a. Unattended ground sensors can detect intrusions into the area under their surveillance, and can distinguish true intrusions from the ambient environmental background. Certain of these sensors also can classify intruders into various categories based upon the "signature" characteristics of the disturbances they create.

   b. All of these sensors are capable of reliable continuous covert operation, without attention and for extended periods of time, and can transmit their findings to centrally located monitors over arbitrary but extensive distances.

   c. The physical phenomena, whose disruption by intrusions are sensed, differ with each of the various available sensing devices, and are different from the phenomena upon which other types of surveillance systems are based. Accordingly, unattended ground sensor systems have capabilities which are different from those of other surveillance systems and suffer from different limitations; they complement the other classes of system.

   d. The differences in sensed phenomena also contribute flexibility to the deployed unattended ground sensor system. A system can be tailored to suit the needs of a specific operational situation by proper selection of components to emphasize required capability and minimize the impact of the limitations imposed by the environment. Since the sensors and the monitors are compatible, regardless of the phenomena being measured, the system configuration is a reasonably arbitrary matter.

2. In spite of this apparent potential, emphasis in tactical sensor systems so far has been on open-area utilization rather than on the urban environment (although, in the Additional Comments Section, the REMBASS Materiel Need states urban warfare applications as one source of justification in identifying the need for an audio sensor to be used in conjunction with seismic detection). There are three reasons for this emphasis in the REMBASS Programs:

   a. The REMBASS Materiel Need, which is the REMBASS requirements document and the fundamental source of criteria to which REMBASS is being built, emphasizes direct support of tactical operations at the battalion to division level and speaks of the document need for early warning in a rapidly moving mobile force environment in its discussion of the REMBASS threat.

b. The existing history of unattended sensor utilization (in Vietnam) is predominantly exurban, and little is known as to exactly what use can or should be made of sensors in some other environment.

c. Sensor technology has not fully evolved, and certain of the capabilities considered appropriate to urban utilization are not yet within the state of the art. REMBASS-I, now in full scale Engineering Development, is first stage of the full capability REMBASS which is ultimately desired. It will be a complete usable sensor system but will not, for example, be able to distinguish civilian from military vehicles in a mixed column such as might be expected in an urban environment.

3. There are a number of unknowns which should be addressed, and a number of apparent inconsistencies which need resolution, before the true potential of unattended ground sensors in a MOBA role can be evaluated. And, there are a number of indications that these questions are appropriately ready for answer at this time.

a. An urban environment is presumed to be a seismically noisy one in which conventional seismic sensing will not work well; it is also thought to be rich in the kind of electromagnetic ambience which can degrade the data transmission aspects of sensor system operation. These presumptions need to be quantitatively confirmed before their effect can be evaluated.

b. Operation in an urban environment appears to require capabilities which are completely the opposite of those needed in an exurban situation. The necessarily large detection range of the REMBASS sensor, when used in an open field, seems to be an invitation to signal saturation when used to monitor a single city street. The real operational needs of an urban situation need to be examined and defined in the framework of what modern sensor technology can accomplish. Three particular facets of sensor technology appear to offer promise in this context: first, the inherent flexibility of a sensor system in which different kinds of compatible sensors are available for the tailoring; second, the self-adaptive (the automatic feature of adjusting detection sensitivity to compensate for actual background noise variation) capability which has now been achieved in the PEWS sensor system; and third, the low-cost imaging sensor now being built as part of the REMBASS Advanced Development program.

4. It would appear that the potential of unattended ground sensors for MOBA use could be examined properly now that modern sensor systems are approaching maturity and, coincidentally, that a meaningful study/test bed (AVID GUARDIAN) is available for the purpose.

REMBASS

Tactical sensors currently under development for Project Manager, REMBASS and other users can provide considerable information on the movement and location of forces in built-up areas. Existing sensors, for example, have the capability to identify by class (i.e., personnel, wheeled, tracked, fixed and rotary wing aircraft) and, therefore, can identify potential countermeasures to be deployed against these threats. The sensors are currently configured for tactical usage, therefore, are not immediately capable of use in MOBA. However, the concepts are proven and can be adapted with engineering development. In regard to the problem of locating forces housed in structures, previous programs for the Drug Enforcement Administration have indicated the possibility of detecting the presence of personnel in vehicles using seismic techniques. These same techniques appear to be feasible when applied to detecting the presence of forces in structures utilizing structural members as a major source of signal for these detectors. Again, development would be necessary, but the concept has proven to be feasible already.

Milestones:

1st Qtr FY78	2nd Qtr FY78	3rd Qtr FY78	4th Qtr FY78
Assess sensors modifications and required design changes.	Prepare feasibility models using existing assets.	Conduct tests of feasibility items.	Prepare report on results and recommendations for program continuation.

Remarks:

It should be noted that the above-mentioned application of sensors to MOBA can be significantly enhanced by utilizing on-going sensor data collection programs such as Project AVID GUARDIAN which can provide a wealth of information in a European environment. Prior to the initiation of this task, this type of source and others should be thoroughly investigated to prevent duplication of data collection efforts.

Conclusions

1. Unattended ground sensors (UGS), e.g., those used in REMBASS and others under development, are potentially a useful technology for surveillance in MOBA.

2. There is no UGS task specified in the DARCOM-TRADOC conference list. There was a MERADCOM sensors task in the original list from MG Hunt. No funds were received.

3. The REMBASS (UGS) background data base in urban environments is lacking. There is none from urban areas, including FRG and CONUS.

4. UGS have not been field tested in German urban areas. A natural vehicle for doing so is AVID GUARDIAN.

5. The sensor heads (transducers) themselves are probably suitable for urban areas, but new processors must be developed, or current processing concepts expanded.

6. Appropriate targets for UGS in urban areas are personnel, wheeled vehicles and tracked vehicles (both stationary and moving), fixed wing a/c, rotary wing a/c.

7. The Hidden Alien Detector (seismic detector) may be suitable to detect personnel in buildings through vibrations in the building structure.

8. The gun flash locator task was listed in the DARCOM-TRADOC conference proceedings but no funds were received. No work is underway. It is capable of detecting .30 cal rifle fire up to 1000 ft. It was developed under the Protection of Key Public Figures program and was tested in New York City and Stamford, Connecticut.

9. FRG propagation problems in urban environments may affect transmission of sensor data adversely. Tests have not been run.

Recommendations

1. Unattended ground sensors are potentially very useful in MOBA and should be recognized as such. The evaluation of their utility should be part of the DARCOM test plan.

2. Expand mission of AVID GUARDIAN so as to include sensor evaluation in an urban environment.

3. Obtain sensor background data (seismic, acoustic, magnetic, IR) in urban environments appropriate to FRG.

4. Designate an urban test site in the U.S. in order to test UGS under development. Coordinate this with the MOBA village development in U.S.

5. Fund the gunfire locator test listed in the TRADOC-DARCOM conference proceedings.

6. Evaluate REMBASS sensors in MOBA in FRG. This would determine utility of them and provide background data base.

7. The investigation of the unit identification concept of AVID GUARDIAN (BAZILE) should be expanded to consider an urban environment.

3-8.0 IFF TECHNOLOGY

The Army is in the process of determining if there is a need for cooperative IFF in conventional battlefield situations. During the period October to December 1977, TRADOC will be conducting tests at the CDEC, Ft. Ord, California, with the objective of determining at what range operators, utilizing electro-optical sights for weapons such as TOW, can distinguish between U.S. and Soviet targets such as tanks and armored personnel carriers. The TRADOC concern is that many of the new anti-armor weapons can kill targets at ranges beyond that needed for reliable identification. They are also interested in defining new training and operational procedures to improve identification capabilities. The terrain is open with no line-of-sight obstructions. Only one target at a time will be under observation. It should be noted that these tests were not designed to simulate tactical situations. They are intended to determine operator capabilities under near ideal conditions. It is doubtful that much can be inferred from the results of the CDEC tests concerning the need for IFF in a MOBA environment where visibility will be obscured and multiple targets will be present.

The CS&TA Laboratory has developed a cooperative IFF system for vehicle identification with common processor/controller and interrogation by microwave or laser transmission. Reply is either by the secure vehicle radio net, or a dedicated VHF Transponder. It is planned to demonstrate these systems at CDEC during December 1977. The CDEC demonstration will not address problems that could be encountered in a MOBA environment such as line-of-sight limitations and interference of VHF propagation caused by large buildings.

The TRADOC tests and demonstration of cooperative battlefield IFF need to be expanded to include a MOBA environment. We know of no instrumented MOBA test facility, nor can we make a reasonable estimate at this time of its cost. However, the facility can easily require a multi-million dollar expenditure.

The problem of IFF for personnel in a MOBA environment is unique. A major requirement could be identification of personnel in buildings. This application will require new approaches. A secure radio link is a possibility. The first tasks in a personnel IFF program should be a TRADOC sponsored study to determine the tactical requirements followed by an analytical and experimental investigation of applicable technical approaches.

Specific approaches, which can be initiated immediately for evaluation since the technology is well in-hand, deal with laser/electro-optics systems for IFF and training purposes. A brief description of these approaches is attached.

IFF and Laser/Electro-Optics for MOBA

Rapid identification of all friendly troops battlefield participants in a high stress, close proximity environment is mandatory in a MOBA scenario. Low cost laser interrogators, with a 1 to 3 mr beamwidth,

have been developed for tactical IFF purposes and for training systems (MILES). Solar cell receiving detectors, also very inexpensive, have been demonstrated at ranges in excess of 500 meters.

2. A system can be developed which will incorporate a laser interrogator emitting at 0.8 μ (GaAs) and a co-axial silicon receiver operating at 0.9 μ with the radiation split by a dichroic. The target will wear a group of solar cell buttons, filtered to 0.8 μ , and an LED emitter at 0.9 μ with each button. Both ends can be readily coded as required. In operation, the laser will be weapon mounted and boresighted. Upon interrogation the target will emit an IR response which can be converted to a flashing light on the rear of the battlesight to indicate a response.

3. Recommend a program be initiated along these lines and several (10) experimental models be built for evaluation.

Conclusions - IFF

1. There is no IFF task identified in either the letter of General Hunt or the DARCOM-TRADOC MOBA Conference proceedings. No funds have been allocated for IFF in MOBA.

2. CACDA is examining the need for Battlefield IFF. Tests being run 4 October - 9 October 1977 are not MOBA related. They are designed to determine the need for IFF associated with long range weapons like TOW, laser designators, etc.

3. Two funded approaches to Battlefield IFF are underway at CS&TA Laboratory. One employs a microwave interrogator; the other, a laser interrogator. Both employ an omnidirectional VHF transponder, either dedicated or the tank radio. They are to be evaluated in CDEC tests beginning in December 1977.

4. Conceptual approaches to Battlefield IFF include: noncooperative laser methods, aerial color photography spectral analysis and a variation of the MILES training simulator.

5. Almost all of the BIFF approaches are oriented toward vehicles. There is a need also for personnel systems.

Recommendations - IFF

1. Identify IFF as a key MOBA need.

2. CACDA should determine the value of BIFF in MOBA scenarios. To what degree is line of sight operation a practical limitation on the utility of those microwave and laser approaches currently being explored for vehicular IFF.

3. Test the current vehicular IFF systems in a MOBA environment to determine their technical limitations, such as propagation in cities of the VHF link. If necessary, redesign the interrogator and transponder.

4. Explore the need for a personnel system to determine the presence of friendly forces in buildings.

3-9.0 RPV TECHNOLOGY

The U.S. Army's current fixed wing RPV program is directed toward reconnaissance and target acquisition. The AQUILA, RPV system technology demonstrator, is flown typically at altitudes of 1000 to 2000 feet AGL with a TV and Laser Ranger/Designator sensor. It can cruise between 50 and 100 knots at ranges of 20 KM from a ground control station (GCS) with an endurance of 3 hours. The stabilized TV system can detect, identify and track tank size targets on a road at ranges of approximately 2000 meters from the RPV. Men in the open can be detected at perhaps half this range. Shadows make detection and tracking more difficult.

RPVs which can hover may be more suitable for military operations in built-up areas (MOBA) because they can operate at lower altitudes, enter enclosed areas and remain near a point of interest for a longer period of time. Using day or night sensors, they can observe through windows or other areas of interest. Fixed wing RPV could be flown in streets following patterns above buildings and towers based on video observed in the GCS. No estimate is available for the relative probability for survival between fixed wing and VTOL RPVs in a MOBA environment.

The operational fixed wing RPV will operate at 30 to 40 KM from the GCS and utilize a data link which requires that the RPV remain within radar line of sight from the GCS. For the short ranges envisioned in MOBA, it may be possible to maintain the required line of sight at low altitudes using simpler equipment with VTOL RPVs. DOD RPV efforts are concentrated on fixed wing RPVs. Several U.S. contractors have done limited work on rotary wing and ducted fan VTOL RPVs on their own initiative. These efforts are limited primarily to RPV design but have not included system integration. The governments of Canada and the U.K. are sponsoring technology development of rotary wing RPVs. With the possible exception of the Canadian CL-227, none of the VTOL RPVs is big enough to carry the current fixed wing sensor.

The RPV will be used in applications where the probability of survival of a manned system is unacceptable. The RPV has application for MOBA missions; however, analysis and test will be necessary to evaluate the application and to compare the capabilities of fixed wing vs VTOL concepts.

MM Surveillance Radar for R.P.V.

Frequency	95 GHz
Modes of Operation:	
- High Resolution Ground Mapping	20 Nano Sec Pulse
- Fixed Target Enhancement	20 Nano Sec Pulse Pulse to Pulse Polarization Agility Processor
- Moving Target Indication	50 Nano Sec Pulse (Single Delay-Line Canceller)

Azimuth H.P. Beam Width	2.5 mr
Elevation Coverage	25^{0}
$(CSC^{2} \theta \cos^{3} \theta)$	
Mech. Azimuth Scan Range	$\pm 20^{0}$
Range Coverage	1 Km - 3 Km
Single-Frame Azimuth Coverage	.7 Km at Near 2.1 Km at Far Range

Conclusions

1. The ability to view from above will cause RPVs to be of much utility in a MOBA environment.

2. RPVs which can hover will be of greater use than fixed wing (AQUILA) RPVs in MOBA.

3. RPV payloads of interest include surveillance and target acquisition systems (FLIR's, MTI radar, millimeter wave radiometers) and target designators (laser, millimeter wave).

4. There is no U.S. Army program to develop a hovering RPV. Canada and the U.K. are sponsoring technology development of rotary wing RPVs.

Recommendations

1. Determine the utility of fixed wing RPVs by testing AQUILA with surveillance, target acquisition, and target designation payloads in a MOBA environment such as that at Quantico.

2. PM - RPV should obtain one of the Canada or U.K. rotary wing RPVs to test its utility in MOBA for surveillance, target acquisition, and target designation payloads.

3-10.0 MINE/BOOBY TRAP DETECTION TECHNOLOGY

Program for Research Development and Analysis

Explosives detection is a continuing problem for both the civilian and the public sectors of this and other countries. The military need lies in the area of mine and booby trap detection in a variety of environments ranging from operations in relatively pristine areas to MOBA. Every conceivable discipline of science has been searched for technology which could be pertinent to the military need. The current results of this long endeavor are a great narrowing of the areas of interest to a few promising approaches. One of the fields showing great promise is the general area of biosensors which, in turn, is currently narrowed to include only enzymatic and animal research. Of the animals, the most promising are dogs; and their merit as mine detectors has been clearly established by MERADCOM through a series of four field tests in 1975/76. Some work, however, remains to be done in this area. Initially, dogs must be trained and evaluated as remote-controlled sensors, thus eliminating any human hazards incident to a minefield search. (During the four tests of 1975/76, handlers maintained control of the dog by means of a six-foot leash.) The remote control system would require some development wherein existing NASA or other systems were adapted to this purpose, but it is certain that the existing training protocols are adequate as a foundation for the advanced training needed for optimum remote control.

It should be noted that marking of individual mine locations is as pertinent a feature of a remote control system as is accurate command guidance. Finally, the animals should be evaluated, both on leash and with remote control, in a test environment which closely duplicates intense combat activities.

At least a two-year effort is necessary to achieve the goals of this program.

Remarks

It is obvious that any success in the area of explosives detection will serve not only the military sponsor but also civilian agencies with similar problems. Terrorist activities against civil aircraft, buildings, etc., lead to civil police activities not unlike MOBA scenarios. Success in this particular effort could be of great value to the civilian sector.

Harmonic Radar for Close In Detection

Harmonic radar is currently in use for locating electronic eavesdropping equipment and hidden military equipment caches in room search scenarios. Low power systems have the capability to penetrate typical construction materials and assist trained personnel to locate threat items. A measure of discrimination between electronic threat items and metallic assemblies is afforded by comparing the even and odd (Normally the second and third) harmonic return. The principle limitation for MOBA application lies in the lack of specificity. Many non-threat items are capable of generating returns, and some threat items do not. In room search, the system operating

range is intentionally limited so that each detection may be unambiguously investigated by physical means. The efficacy of harmonic radar in house, or street search, implying greater power and range, has not been demonstrated. Low power systems are commercially available, while high power systems are under development at MERADCOM.

A one-year study of the applicability of harmonic radar for close in detection for MOBA is recommended. The principle elements of this study are:

a. A detailed evaluation of foreign experience in MOBA with deployed harmonic radar systems.

b. A more precise definition of the MOBA scenario anticipated.

c. An evaluation of the probable utility of harmonic radar in the MOBA scenario using existing equipment.

Airborne Harmonic Radar

The application of synthetic aperture techniques to harmonic radar systems has been successfully demonstrated. Harmonic images obtained from an airborne system are characterized by an order of magnitude increase in target to background clutter ratios. The impetus behind system development has been the need to detect passive, stationary military targets, (weapons, vehicles, troops, etc.) intentionally obscured by natural cover. In this scenario, virtually all harmonic returns are potential threats and the manner of deployment apparent in the image suggests the threat type. Application to MOBA has not been addressed due to the lack of a requirement and the increase in the density of non-threat returns anticipated. The utility of such a system would be determined by the relative density of non-threat items at the time of search.

A two-year program to evaluate the utility of Airborne Harmonic Radar for MOBA is recommended. The likely harmonic clutter environment is first determined and, if warranted, a demonstration/evaluation test program is accomplished using existing equipment. Harmonic images in a realistic environment would be obtained.

Conclusions

1. Detection and clearing of mines/booby traps will be an extremely serious problem in MOBA.

2. There is no provision for mine/booby trap detection in the letter from General Hunt and the DARCOM-TRADOC conference proceedings.

3. Conventional metallic and nonmetallic mine detectors suffer from a severe false alarm problem in MOBA environments due to the presence of shrapnel and the inhomogeneous nature of medium magnetometers and gradiometers suffer from the same problem.

4. Dogs are proven valuable for the detection of mines and booby traps in a MOBA environment and are probably best detectors.

5. METRRA (Portable) has been demonstrated to be of value in detecting arms-caches and armed personnel in building (room to room search) utilizing both second and third harmonics.

Recommendations

1. Re-examine the decision to discontinue the dog program and, in particular, the use of leash and remote building search.

2. In light of the proven utility of METRRA elsewhere for building search, test the utility of the handled METRRA, second and third harmonics in a MOBA scenario.

3. Evaluate the utility of airborne METRRA to detect enemy forces in villages.

SECTION 4

Command & Control

SECTION 4

Command & Control

General

Military Operations in Built-up Areas will be a part of tactical warfare in the European theater. Built-up areas will most likely be employed to provide force multiplication in the defense by judicious employment of forces and tactics in the combination or urban, suburban, and open terrain existing in Europe. Employment of division level forces in urban terrain would be expected relatively rarely (only in a few large cities) while battalion or brigade employment could be the rule (many areas eixst with population under 50,000) rather than the exception. The command and control problem thus becomes one of coordinating the actions of forces across the entire scope of anticipated terrain. This is feasible only when the anticipated problems in command and control have been dealt with in each type of terrain.

The primary functions of command and control systems are, according to Gen. Jack Welch,* "preservation of the order and cohesiveness of our forces, avoiding blunders and insuring freedom of action, and insuring non-zero effectiveness". The Command and Control System may be considered as a Management Information System whose objectives are to perform the functions stated above and additionally to insure the effectiveness and optimal employment of forces. The first group of objectives must be met by the system even in a significantly deteriorated condition if the objectives are to be met at all. The cost of not having an adequate command and control system capable of coping with the European environment would be extremely high. In this environment a command and control system is a management information system that is an aid to the manager. In the field the Army manages operations by exception, which requires early identification of the exceptions. Identification and prioritization of those indicators critical to defining the exceptions, together with digestion and presentation of the data to the appropriate command level for decision, are critical to development of coordinated command and control systems.

The problems of command and control are exacerbated in urban areas by the interrupted lines of sight coupled with the tendency of urban combat to be reduced to face to face combat at the fire team level. The communication problem is made more difficult and simultaneously its solution more significant to meeting the demands of an effective command and control system by the need to extend communications (probably radio) to the fire team and possibly individual level.

COMMAND AND CONTROL STATUS

Command and control is discussed here as it exists specifically for the MOBA environment and as the generic form influences MOBA and MOBA related operations.

MOBA - Command and Control

Examination of the present and in-process doctrinal literature indicates that objective functional requirements on a MOBA command and control system have not been prepared for any level of command.

---

* MG Jasper A. Welch, USAF, Assistant Chief of Staff for Studies and Analysis, from an address, C^3 Systems - the Efficiency Connections, at the 39th MORS Symposium, 29 June 1977.

Command and Control Training for MOBA at the squad and platoon leader level is limited to 7-10 hours during the normal training cycle. At the company, battalion, and brigade commander level, the total time allocated to MOBA training amounts to one 2-hour lecture.

Little if any attention has been given to the definition of the command and control needs in MOBA and MOBA related operations. The 2nd DARCOM-TRADOC MOBA conference proceedings do not cite any needed action with respect to C^2.

Command and Control for Tactical Warfare

The Army Scientific Advisory Panel Ad Hoc group on Army Command and Control is investigating and preparing recommendations with respect to technology applications and systems developments in this area. The central conclusion and recommendation of this group at the approximate mid point of their investigation is as follows: (quoted from the interim report dated 18 April 1977) "the most fundamental problem with Army C^2 is the lack of an enforced Systems Architecture/Systems Engineering discipline". The report goes on to recommend - "that the army give first priority to establishing strong C^2 Architecture and Systems Engineering group(s) with complete authority to negotiate with users and developers and to make decisions stick on requirements".

It is observed that a large number of Command and Control and related systems exist and are planned for existence. These subsystems often have duplicative data bases. The problems of ensuring currency in the results across these subsystems together with the attendant increased communications load and storage requirements confirm the need for a strong Architecture and Systems Engineering office to enable development of a command and control system capable of supporting the needs of the army.

Development of a command and control system applicable to coordinated attack and defense across multiple types of terrain (Built-up, Suburban, Open Country, etc.) must be included within the activities of an Architecture and Systems Engineering office.

ADDED COMMENTS REGARDING C^2 AND MOBA

- The present C^2 philosophy appears to be reactive rather than projective or pre-emptive. This results in a marked increase in the data to be assimilated by the command and control system and further places a very severe timeliness requirement on the analysis, presentation, decision, and command sequence. The requirement here is for an all-wise decision maker to make the perfect decision on the basis of absolutely complete and timely input data.

- Command and Control training could be significantly upgraded through the incorporation of objective representation and evaluation of the situation data as presented by a competent simulation.

- Development of a set of objective prioritized requirements for manual and semi-automated C^2 approaches will go a long way toward minimization of duplicated subsystems and communications requirements.

- The present situation in command and control appears to result from technology push in which the technology is applied because it is available rather than from technology pull where technology application is governed by identified and defined capability needs.

- It appears that development of a reasonably firm specification for the data priorities in the C^2 system would enable development of an objective specification for the tactical communications system and an evaluation of the capabilities of the system in being and planned.

Data Sources

The above paragraphs are based on consideration of the How to Fight manuals apropos of command and control and MOBA, the examination of about 50 documents, visits to knowledgeable individuals at Fort Benning, TRADOC CACDA, the FBI Academy, the Marine Corps headquarters, the consideration of the interim report of the ASAP Ad Hoc group on C^2, and the second DARCOM-TRADOC coordination conference on MOBA.

POTENTIAL TECHNOLOGY CONTRIBUTIONS TO COMMAND AND CONTROL IN MOBA

System architecture development (operations research/operations analysis), systems engineering, and display development (human factors) are the primary areas where technology can contribute to development of an effective C^2 system for use in MOBA and related environments. Data input device development and upgrading of some command and control functional subsystem performances would also be helpful.

The continuing monitor function for system Architecture and System Engineering development, as proposed by the ASAP Ad Hoc group on C^2, should be implemented.

Recommendation

The C^2 Ad Hoc group be expanded to include MOBA input and to insure MOBA consideration in the System Architecture and System Engineering Office.

Functional Requirements Definition

Findings - Current objective definitions for the required capabilities and characteristics of Army C^2 systems (manual and/or automated) at company, battalion, brigade and division levels of command do not appear to exist. Prioritized input and output information requirements for these command levels have not been found. These data should form the basis for development of a C^2 System Architecture and subsequent system specification and development. The operations research/operations analysis community could significantly assist the Army in development of this data.

It seems unlikely that such a development could be completed without use of a battlefield simulation incorporating open, suburban, and urban terrain in several scenarios to exercise the decision maker's role at the several levels of command. This type of approach could be used to prioritize the input data and to develop presentation

techniques enabling a decision maker to best utilize the available data without compromise of his style of command and control. There is no intent in such a study to impose either an automated or a manual system at any level. The intent is to objectively determine the data items needed to enable successful C^2 at each level of command, to prioritize these items, and to define the most satisfactory means of presenting this data to the commander.

Recommendation

Derive the requirements to be placed on a command and control system in order for it to be effective in MOBA and MOBA-related environments.

Architecture Development and Systems Engineering

Findings - There is a distinct need for a coordinated Army command and control system (manual or automated) which provides the necessary decision data to the commander (at all levels) and which can be relied on to degrade gracefully (if at all) in accordance with the command and control needs in the combat environment.

The multiplicity of independent but related command and control subsystems which are presently called upon to interoperate, and whose output data are dependent on at least partially duplicative bases, places a nearly intolerable load on the communications system without necessarily providing the data critical to the decision maker.

The above needs exist with respect to both MOBA and tactical operations. The needs of MOBA or urban related operations may well impose a requirement for some form of position and status reporting to the company commander level at an accuracy and frequency level not necessary in open country warfare due to interrupted lines of sight in built-up areas and the aforementioned tendency toward face-to-face combat within buildings. The problems introduced by MOBA must be integrated into the command and control system development if a useful C^2 system is to evolve.

Recommendation

Establish a strong C^2 Architecture and Systems Engineering group within the army, supported and supplemented by industry, as recommended by the Ad Hoc Group on C^2 in their interim report, to meet the above needs.

MOBA Command and Control Training

Finding - A derivative of the simulator used in development of prioritized C^2 functional requirements could be used to upgrade the training of commanders at all levels of MOBA and MOBA-related operations. Such a unit could be used to simulate battle conditions across multiple terrain types with a minimum financial investment and without the problems attendant to large unit exercises whose realism is at best restricted in the interests of safety. Such a simulator would have to be carefully designed to present the decision-making environment on a realistic basis without the detailed shot-by-shot simulations presently in existence for MOBA.

Recommendation

Develop a MOBA battlefield simulator for command training and expand the MOBA C^2 Training program to include simulated battle exercises.

Data Input Devices

Finding - A specific need for a highly reliable data input device which imposes minimum requirements on the individual entering the data exists in the C^2 systems area. The keystroke approach to data entry, while relatively reasonable in cost and weight, is considered to be too slow and has a high error frequency. Voice data entry has not been shown to be adequately error-free or of reasonable size and/or cost. The needs of the TOS subsystem and other C^2 subsystems would be well served by an accurate and inexpensive data input system which could be operated with minimum movement and observation on the part of the individual entering the data. Whether such a device is possible or not, its availability is highly desired.

Recommendation

Investigate the feasibility of upgraded data entry devices meeting the needs of TOS and MOBA.

COMMAND AND CONTROL SUBSYSTEMS

Army Terrain Intelligence System (ARTINS)

Findings - Prosecution of MOBA and MOBA-related operations requires the availability of detailed and current data regarding the surface, subsurface, and upper floor characteristics of built-up areas.

Recommendation

Adjust the functional capabilities of ARTINS to include: a). detailed three dimensional data and appropriate presentation thereof; and b) real time data base updating.

Position Locating and Reporting System (PLRS)

Findings - PLRS accuracy capability is stated to be approximately 100 ft. Adequate MOBA command and control will need fire team position data to an accuracy of 10-20 ft.

Recommendation

PLRS effectiveness in cities should be investigated.

SECTION 5

Communications

SECTION 5

Communications

Table of Contents

Communications in a MOBA Environment

5-1 Background and Problems

Communication is essential to command and control. The present communication capabilities under MOBA conditions are inadequate. The degree of inadequacy is relatively unknown. The problems are almost certainly greatest at the lower echelons of command from brigade down to platoon or squad. Some of the reasons for these inadequacies in present communication capababilities under MOBA conditions are:

- the useful net radio range is greatly limited, over that in open country - in some cases by a factor of 100 or more.
- high environmental noise in a VHF/UHF environment - can be orders of magnitude greater than receiver thermal noise.
- channel availability
- jamming
- interceptions of RF transmission is likely.
- incompatability with allied communication equipment
- language differences among allies and with local population

The problems of communication in a MOBA environment are not new. Serious problems were faced in WWII and as recently as the battle of Hue there were problems in communicating with the small units. Probably not too much can be gained from these past experiences in a quantitative way regarding communication performance because there seems to be little or no quantitative performance data from these past experiences. For reasons explained elsewhere in this committee report little attention has been given to communication in the MOBA environment. With a better understanding of the communication problems in MOBA, better training and planning can be carried out to improve operations. From a longer range point of view there are a number of courses open for improvement.

5-2 Sources of Information

In addition to the materials furnished to us such as the DARPA (order 2148) Study, Dr. Renier's work, the US/FRG paper, and second DARCOM-TRADOC coordination conference on MOBA, a draft copy of the operational tests - "Tactical Communications in a built up area (small town)" - was received, as well as numerous other documents as a result of visits to ECOM, Mr. Friedrich, and to TRADOC.

a. ECOM - to visit the designated MOBA point of contact for communication, Dr. F. H. Reder and Mr. John Walker. Also, discussions were held with Col. Slingerland, Commander of the Communication/Automatic Data Processing Laboratory, and a number of other CADPL personnel. Mr. John Walker had prepared a report "A Consideration of Problematic Military Communications in Built-up and Fortified Areas" (classified Confidential) which was perceptive and informative. It treats the problems of tactical communications in built-up and fortified areas according to typical street-to-street, street to building, and building to building communication paths. An extensive bibliography is given in the report on propagation and various kinds of terrain including urban and suburban areas.

A significant contact had been let with Signatron, Inc. A draft copy of the Final Report "Data Base Analysis for Military Operation in a Built-up Area (MOBA)" was furnished for information. There is a considerable body of literature (both U.S. and foreign) on VHF and UHF radio propagation in an urban environment (i.e. taxicab, police, and mobile radio communication in general) and this is documented and analyzed in the report.

As stated "The objectives of this study were to review and expand the data base and (i) assess the state-of-the-art for communications in built-up areas; (ii) determine the capabilities of the military to maintain reliable communication in built-up areas; and (iii) recommend further research efforts with the goal of improved military communications.

An interesting discussion on fiber optics was held at ECOM and a draft copy of Fibre Optics Communication for the Army by J. Robert Christian and L. U. Dworkin was furnished.

There was some discussion of Seismic Communication Experiments and copies of a number of reports of work done in the mid 1960's in the 30 Hz region were furnished by Dr. Reder.

b. Meeting with Mr. Victor L. Friedrich in the office of ASA (R&D), Col. Fox, Col. Long, and Col. Thomas in the Pentagon, to discuss various elements of the total communication system, TRI-TAC, SINCGARS, Satellite communication, security, etc. An Executive summary of the Integrated Tactical Communications System, (March 1976) was furnished.

c. Visit to Tradoc Headquarters, Ft. Monroe to meet with officers in Tradoc and from the Signal Center at Fort Gordon.

Major Robbins was the MOBA point of contact and Col. Krawciw who had been present at the last MOBA committee meeting. There was extensive discussion of the entire MOBA communication problems including the process of getting requirements established. They

informed me of a new light weight wire cable developed for sensors which would make communication by wire more practical.

A copy of the new Army Regulation No. 105-9 "Communications-Electronics Tactical Communications Support Requirements" was furnished after a discussion of the Communications Requirements data base - which does not yet contain MOBA considerations.

5-3 Findings

3.1 Only a very small number of people have been involved in considering the problems of communication in built-up areas and trying to get the necessary data and work toward solution. Dr. Reder and Mr. Walker who had been designated as special contacts for the Ad Hoc Committee's study of Communications were knowledgeable and very helpful in discussing possible ways around the problems. They had coined a term COBA (Communication Operations in Built-up Areas) to add emphasis.

It is particularly important that a much larger number of people share the concern.

3.2 Most studies and scenarios have not taken MOBA into account. Examples of this are the nap of the Earth study at Ft. Rucker, the TIDS scenarios, and the entire COMSR (Communications Support Requirements). These examples came from discussions at TRADOC Headquarters.

3.3 The type of program on Page 51 of the MOBA second DARCOM-TRADOC coordination conference is the kind of program necessary to broaden our data base - yet the task priority within the performing organization (Communications/ADP Laboratory) is ranked as low. This problem of low priority in some commands is likely due to a lack of stated requirements. The problem can be illustrated by (a) the need for information on how the Combat Arms operations will fight in MOBA; (b) then a statement from armor, artillery, infantry, etc. as to what communications they will need to fight according to the overall conceptual doctrine, (c) then the Signal Center can respond with the communication architecture to TRADOC, (d) TRADOC can then state requirements to DARCOM.

Col. Krawciw showed some spider charts used in the Base Technical Programs Related to Battlefield Systems document. A special spider chart for MOBA hopefully will help to speed the process of getting the needs recognition into the hands of the people who have to make decisions on MOBA programs.

3.4 All new proposed programs are required to pay particular attention to the COMSR data base in accordance with Reg. #105-9. Therefore, COMSR should be brought up to date to include MOBA.

3.5 MOBA has not been taken into account in any communications equipment specifications to date.

3.5.1 We need to know the limitations of existing equipment in the field. This will aid in training and operational planning. The initial testing of the PRC-77 at Havre de Grace was useful, but, of course, only a beginning. These tests showed limited capability of the PRC-77 at 30.4 MHz and they are useful in understanding some of the limitations. Further testing should be more quantitative and carried out over the entire frequency range.

Also, it would appear to be useful to study the PRC-77 in a repeater mode. Another test would be to confirm the efficacy of having the PRC-77 unattended at the top of a building and coupling it to a field phone in a basement command post by way of wire. This results in bandwidth loss until fiber optics communciation cables are available in the future, but this has been suggested as an alternative to the use of radio communications from the top of the building to the basement if propagation losses are too great.

3.5.2 All new equipment such as SINCGARS should be tested early in all of its modes so as to check the effects of propagation losses, multipath, etc. in the new equipment's various modes of operation. This new net radio to repace the PRC-77 and VRC-12 series has many important features important to MOBA. Greatly expanded number of channels, encryption for secure communications, and ECCM capability (through two techniques).

3.5.3 Planning for new systems such as the new multiple subscriber systems should take MOBA into account early in the development cycle and this appears possible.

3.6 Local public communications particularly in the FRG should be useful. As as example it was found that the German military were still using their public telephone system when Berlin was captured in World War II (according to discussion at TRADOC headquarters). Such a system is likely to be far more useful to the defender than the attacker. The U.S. should have a good set of plans of the total communication public system including cable routings, etc. It is likely that if the enemy captures a town and U.S. forces subsequently drive him out he will destroy exchanges, etc. However, if the U.S. has a good set of plans it may be possible to patch into the telephone cables and effect a reasonably good internal communication system. Discussion at TRADOC indicated that the public telephone system is not likely to be useful below battalion level.

3.7 Survey should be made in built-up areas where combat is likely to occur and "good" locations should be placed on maps, on the basis of the best information that can be obtained in the near term. From a longer range point of view it is hoped that models can be established and proven which will permit prediction of "good" sites, losses to be expected, etc.

3.8 There is a lack of communication compatability with our allies. This includes modulation techniques (we use CVSDM - continuous variable slope delta modulation - the French, for instance, use digital PCM) the U.K. has a good digital interface with us, according to people at ECOM.

While there is incompatability with allies some analog interface equipment is being built and an attempt is being made to have inter-operability with our allies.

Because of both language difficulties and equipment problems it will probably be necessary to have exchange of liason personnel. At the TRADOC meeting personnel there believed that problems could be worked around in this way.

From a longer range point of view the TRI-TAC program will certainly provide interservice compatability. Equipment from that program will probably be used for battalion and above. From discussion no consideration had been given to MOBA environment.

3.9 MOBA operation may require more communication equipment, such as more net radios, and more wire for field phone operations, for interconnecting with antennas on top of buildings down to command posts, etc. This can result in changed T.O.E.'s so that operations can be improved in the MOBA environment. Studies that establish how much increased cost effectiveness can be achieved by such increases, i.e., what kind of multiplier effect in combat effectiveness could be achieved by such increases would be useful, but should be done after there is better definition of just how MOBA will be operationally performed.

3.10 The special forces have had the problem of moving into areas, camouflaging operations, establishing field expedient antennas, and communicating over fairly long distances. Some useful data may be obtained by investigating their experience.

3.11 It is important that there be early quantititive testing of the gains which may be achieved by both space and polarization diversity techniques. Studies made by Signatron indicate COBA performance improvement could be achieved from these techniques.

3.12 From a longer range point of view there is a need for a systematic quantitative data base over a wide range of frequencies under MOBA environmental conditions. Frequencies from seismic (30 Hz), ultrasonic, H.F., VHF, UHF, S.H.F. through millimeter to U.V. have been suggested. Since the greatest amount of radio net equipment in the field and now planned is in the VHF area this should receive highest priority. There are indications that UHF may have some advantages in the MOBA environment and should also receive high priority in testing. Although there are some arguments against HF, the Army has some equipment that could be tested and useful data obtained.

Although it can be argued that much data exists from taxi cab, police, and other mobile communications, they all involve elevated station antennas. Little quantitative data exists on urban or suburban propagation with low elevation antennas. Also, there is little quantitative data concerning inter-building, intra-building, short distance street-to-street and street-to-building propagation.

It is important that tests be carried out for various modes of the communication equipment, voice, digital (where applicable) and with security equipment or modules.

There is some new millimeter equipment which could be tested for short range line of sight.

Also there are now some models of manpack equipment AN/PSC-1 which operates in the U.H.F. with a satellite. Tests of this in a MOBA environment should be made.

3.13 From a longer range point of view it is desirable to develop a communication propagation and range model for built-up environments. Development of such mathematical models requires assembly of a systematic data base.

3.14 It is important that optical communications systems using fiber optics be pushed aggressively. Major advances have been made in recent years. Work is being sponsored by NSF, by the Army and the other services and by industry. I believe there is good coordination of effort in government.

Certainly as more sensor information has to be communicated the large bandwidth of fiber optics will be useful.

There is a strong feeling that wire will be required more in MOBA than in open operations. In some studies fiber optics is shown to have significant weight advantages and tests have indicated it is very rugged.

In the report mentioned earlier an air lavable (by helicopter or possibly RPV) cable system is in exploratory development.

3.15 There is a need to keep alert to new ideas and developments that may improve COBA. Consideration should be given to the possible development of disposable repeaters. These may be of use in other than MOBA because as one of the men in the TRADOC meeting said "our communications in the open are barely good enough today".

At the Communications Automatic Data Processing Laboratory a small ILIR program was described by Dr. Maass. This is a unique approach called (Multiple Electronically Synapsing Hierarchy). It consisted of initial study and conceptual design of a system in which there would be random distribution of system elements (relays) over an area to bridge the distance between two or more terminal stations.

The Packet system work being done in conjunction with DARPA should be examined for applications - particularly for digital communication. Quoting from the ECOM Laboratories Posture Report FY 76 "The combined net result led to the acceptance of the Packet Radio concept as an alternate candidate for tactical information distribution via time division multiple access integrated communication, navigation and identification systems". Results from a test bed model system in the Bay area should be examined for possible application of this system concept to MOBA.

3.16 There is a need to continue R & D in antennas. For instance as a part of an experimental program to measure polarization diversity advantages some antenna development is necessary. The problem of degraded coupling caused by proximity of the users body and of the building with the PRC-68 has not been solved according to discussion at ECOM.

5-4 Recommendations:

4.1 The Army should make certain that requirements for systematic quantitative data collection for COBA are clearly recognized and stated, and are given sufficient priority in the commands responsible for doing the work. Such data provides information to help in the training for better communications in built-up areas, for fixes that may be made in present equipment and for taking MOBA properly into account in future communication systems and equipment development.

4.2 As data becomes available from systematic testing and data collection it should be made available for introduction into training programs. The results of the Signatron contract have already analyzed the existing data base and suggestions of points to be emphasized in training can come from this report.

4.3 The program that has been recommended by Signatron, i.e., a polarization diversity and space diversity measurement program that will provide a diversity data base for MOBA radio communication should be carried out. It may well be that MOBA radio communications can best be improved by use of diversity. Space and polarization diversity

require neither transmitter modification nor extra frequency allocation. If tests indicate that significant improvements in communication capability can be achieved by either or both of these techniques then product improvement programs should be initiated and the fixes implemented.

4.4 Consideration should be given to establishing a forum composed of the various school commanders to get together to discuss the MOBA problems and possible solutions. This was suggested at the TRADOC meeting as a means of getting greater emphasis on MOBA..

4.5 As new communication equipment becomes available it should be tested in a MOBA like environment in all of its various modes. The new SINCGAR family of radios is a good example. It offers several features which should be helpful in a MOBA environment, not the least of which is security.

4.6 Studies and scenarios should involve a MOBA environment. To date we were told that they do not.

4.7 New communication equipment specifications should consider the MOBA environment. An example of where this might be first applied is the proposed mobile subscriber system.

4.8 Investigate the use of present public telephone systems as a means of military communications - particularly in the FRG. A part of this investigation should include how the information on exchanges, substations, cable routings, etc. should be furnished - i.e. drawings, maps, or other format. Also, the investigation should include how far down in the level of command such communication can be used.

4.9 Investigate the possibility and desirability of locating "good" communication points in built-up areas in the FRG. The experience of the Berlin Brigade will be useful here. If this is done then the proper format for providing the information (maps, or written instructions) should be established and used.

4.10 Investigate the role of field wire in COBA. There are strong proponents of using wire. Equipment exists for laying wire links over short distances to avoid exposing personnel for the deployment.

New lighter weight wire cables have been developed for Navy use and we were told that we could expect lighter weight wire for field operations. Consideration of this should be a part of the investigation.

4.11 Electro-optical communication particularly by way of fiber optics should be well supported. The advances that have been made in the recent past have been outstanding and it offers opportunities for communication over large bandwidths and with good security and freedom from jamming.

4.12 Provide further emphasis on having interoperability with Allies' radios. Effort is certainly going on in this area, but it needs further emphasis.

4.13 Throughout consideration of COBA an open mind and search for new ideas should be maintained. This includes:

a. An assessment of foreign equipment for application to COBA.

b. Investigation of the development of a disposable repeater.

c. An assessment of Packet as applied to COBA.

d. Basic and applied work in antenna design.

e. Basic research such as investigation of ultraviolet communication techniques.

SECTION 6

Non-Chemical Weapons & Ammunition

SECTION 6

Non-Chemical Weapons & Ammunition

Table of Contents

INTRODUCTION

Material contained in this section comprises general sections on findings and recommendations and detailed sections dealing with nine specific classes of non-chemical weapons and their application to military operations in built-up areas. Each detailed section presents a set of conclusions and recommendations related to the weapon category with which it deals. In all, 31 recommendations are made. Rather than bring that mass of detail into a summary, the reader is referred to the sections dealing with topics of particular interest to him. However, there are some general observations warranting emphasis at this point.

Military operations in built-up areas, MOBA, introduces many unique problems when non-chemical or conventional weapons and ammunition are utilized in either offensive or defensive roles in urban areas. These urban areas are complex and heterogeneous and vary depending upon the age of the city, the amount of planning that was part of the city's basic development, and the construction techniques prevalent at the time of structural development. The very nature of the city is such that it favors the defender. The city offers many opportunities to hide and conceal personnel, weapons and ammunition. Likewise, the city has the additional vertical dimension providing many alternate opportunities for defense over a typical open-area battlefield. This vertical dimension extends not only above ground, but also includes underground utility tunnels, subways and sewers. Upper floors, basements, sub-basements, tunnels and sewers become part of the battle scene and provide not only concealment but protected passageways for the rapid movement of troops of both sides through multiple paths.

It is considered that outdoor engagements would be fought by combined infantry and armor task forces at short ranges. Close range fighting with conventional weapons and ammunition (non-chemical) would be face to face and would seldom exceed 50 meters. The vulnerability of personnel and combat vehicles would be increased because of the likelihood of unexpected or sudden attacks from above, or from cover afforded by buildings, rubble or tunnels. Likewise, the movement of vehicles would be difficult in cities where cratered or rubbled streets have resulted from artillery attacks or bombings and bridges and overpasses are most likely impassable.

In the course of the study of this task, it has been found that there are no stated requirements for the operation of weapons or ammunition for military operations in built-up areas. ROC's of the future should state definite MOBA requirements and desired operational characteristics.

When considering the subject of non-chemical weapons, ammunition and vulnerability, there are definite deficiencies in the current data base regarding weapons effects, material degradation in MOBA and the capability to conduct military operations in built-up areas. Such deficiencies exist because of the past emphasis on the development of weapons and ammunition for open area combat. When considering the use of these weapons and ammunition in MOBA, general problems such as the following appear:

1) Arming distances for direct fire weapons are too great for MOBA such that most direct fire HE projectiles and anti-tank missiles will not be armed before target contact.

2) Most large caliber manpack weapons can be fired from confined spaces inside buildings, but the adverse effects of overpressure and backblast on the weapon crew must be considered.

3) Scatterable mines developed for dispersion from artillery or aircraft would have a large number of mines landing ineffectively on roof tops, courtyards, and other inappropriate areas.

4) Precision guided missiles may not have guidance and control established at the short ranges of MOBA and some guided weapons cannot be fired at depressed angles.

5) Weapon or terminal effects are not completely known or optimized for MOBA. Included are current warhead and indirect artillery effects against typical structural materials of the city, spalling effects and breaching effects.

6) Personnel and vehicle vulnerability from non-chemical weapons and ammunition are not completely known under MOBA conditions. Included is the vulnerability of personnel to urban debris such as masonry spall, shattered glass, etc., and vulnerability of vehicles to attack from above.

SOURCES OF DATA

1.	Briefing at Pentagon for MOBA Panel	18-19 January 1977
2.	Briefing at Pentagon for MOBA Panel	15 January 1977
3.	Briefing at Pentagon for MOBA Panel	14 July 1977
4.	Special Weapons Meeting at Aberdeen	26 October 1977
5.	Special Weapons Meeting at Pentagon	15 November 1977
6.	Proceedings of DARCOM/TRADOC Conference on MOBA	19-20 July 1977
7.	Reports and Summaries Furnished to us by Participants in the Meetings Above	

6-1.0 GENERAL FINDINGS

After three sessions of generalized briefings and discussions of MOBA operations, and two days of detailed review of current programs aimed at the development of new weapons, modifications to existing weapons, and of the technical data needed to develop adequate doctrine for the employment of our weapons assets, this sub-group of the Panel reached one strong overall finding.

The Army has the resources within its own establishment to develop the field weaponry and equipment far better suited to the MOBA environment that the current inventory weapons. However, those resources were not being effectively employed as of November 1977, the date of our last meeting.

We found a curious lack of enthusiasm for MOBA-oriented equipment development—evidenced most significantly by the off again-on again funding history of DARCOM laboratory programs aimed at what seemed to us to be appropriate MOBA goals.

The DARCOM laboratories and their contractors seemed to us to be standing ready, willing, and eager to help, but hesitant to devote a substantial effort from their own resources to programs of real promise for fear that money to pay for the work would not be forthcoming.

It seemed to us that this lack of enthusiasm was symptomatic of another perhaps deeper and potentially more serious problem. While the panel, and most of the higher-level Army people with whom we talked in the course of the program review, are convinced that city fighting will be inevitable in any likely contingency—and most importantly in a conventional confrontation in Europe—the Army as a whole seems not to regard it as a really serious problem. In particular, the idea seemed very prevalent that if we had to fight in cities, we would have to do it with the weapons (and other equipment) already developed for the kind of combat for which the Army is now so well trained and equipped—characterized by rapid movement over relatively open terrain.

Such combat is a war of tanks and helicopters and artillery—a war of rapid deployment and redeployment heavily dependent on the power of machinery, tanks, guided missiles, precision guided munitions, rapid, reliable communications, and an effective overwatch of the battlefield through helicopters, radars, and crucially dependent on air supremacy for tactical air support and interdiction.

This attitude—make do with what we have and learn to use it in cities when and if it really becomes necessary—may well be dangerously shortsighted. It should not really be very difficult to fix the arming circuitry of a weapon so that it becomes effective at ranges of 10 or so meters for shell or TOW class weapons. If the arming distances of the weapons we have are substantially longer, the weapons may prove nearly useless in the cramped environment of urban combat.

Despite the very real concern of the higher level people, as exemplified by the DARCOM/TRADOC conference in July, a development program needed to assure our weaponry being well-suited to the MOBA environment has not been developed. A sense of urgent dedication is necessary if a substantial improvement is to be achieved in the next few years.

We did not find a strong program aimed at defining the technical opportunities for improving our weaponry MOBA capabilities. We did not find large scale exercises (or even modest ones for that matter) in realistic MOBA environments—using the weapons and equipments we have as a starting point—with weapons systems designers assigned to the exercises to learn directly the limitations imposed by the MOBA environment, and to suggest changes in design or method of employment to overcome those deficiencies.

We did not find a clear-cut definition of the most likely MOBA scenarios. Recognizing that the Army has had little recent MOBA experience, and that the Viet Nam experience has little that is relevant to European combat, it is not surprising that the weapons system development community is uncertain as to what is more important. It makes a big difference if the objective is simply to kill the inhabitants of a building by reducing it to rubble rather than dislodging enemy in that building with minimum damage to the building and minimum casualties to the civilian population of the town.

On the positive side, we did find that a substantial beginning had been made in the gathering of information crucial to the engineering design of weaponry for MOBA. Good experimental work on wall-breaching by a wide range of devices ranging from small arms through tank guns and large shaped charge munitions was reported to us, as well as experiments to define the limitations imposed on shoulder-launched and crew-served missiles by employment in confined spaces. Data on the effectiveness of weapons employed against people in buildings has been gathered, with spall and fragment patterns behind typical walls—data crucial to the rational design of new weaponry and to the sensible employment of existing weapons in battle. Promising beginnings have been made on the development of small, man portable devices exemplified by the MISER low signature recoilless weapon for anti-tank and anti-personnel in built-up areas. The RAW grenade device, the SHAWL follow-through warhead, and programs to develop warheads for the 2.75 inch helicopter-launched rocket well tailored to the MOBA environment seemed to us particularly promising.

In summary, we found a lot of capability, and a substantial amount of good work. We did not find a program to define the problems and opportunities posed by MOBA in terms that would inform the engineers and inspire the developers in the conventional weapons community. We perceived a lack of urgency with respect to pursuit of the MOBA problem. Our conviction is that our inability to carry out conventional combat in the MOBA environment is a deficiency of the first order and one that demands a deliberate program response.

6-2.0 RECOMMENDATIONS

Recommendation One - Define the Opportunities

From our findings that the developers were uncertain as to what was most important for MOBA weaponry development, and from the finding that some of the Army felt that making do with essentially what we have now was the best course of action, we feel that steps must be taken to define the technical opportunities for a real improvement in our MOBA weaponry posture, not just to a few high level people in TRADOC and on the Army Staff, but also to the Army laboratories and development agencies and their contractors—the people who will do the actual development if it is to be done.

To this end, we think there can be no substitute for experience with the existing inventory weapons—experience with those weapons employed in realistic environmental situations on a scale large enough to illuminate the interactions between the weapons, the vehicles, the communications systems, the city, and the men.

We are not proposing that we put a red team in a suburb of Munich and attack it with artillery, tanks, helicopters and infiltrating infantry, blowing holes in the buildings where necessary, and bulldozing away the rubble to clear a path for the tanks.

On the other hand, we do see a real need for both communities, the TRADOC planners and the DARCOM developers, to gain an informed understanding of the MOBA environment to inform the developers and inspire the planners. Since the laboratory of real combat is not available, we must create a simulation realistic enough to serve the ends of both kinds of developers—tacticians and materiel designers.

We believe it is essential to conduct battalion scale exercises in representative built-up areas to test our doctrines, communications, and weapons systems working together as a system. Such exercises, adequately supported and studied by participating weapons designers, could do more to define the opportunities for innovation and to uncover the current operational deficiencies in our Army in MOBA than any single other step. The scale is important—lest the interactions be overlooked. The presence of engineers from the laboratories is important. They are the people who can do something about making the present systems work better, or make the new systems we may well really need. It is important that the exercise not be a one shot deal—so that lessons thought to be learned can be verified and changes in either equipment or tactics can be evaluated.

Interpretation and refereeing an exercise of the sort and scale envisioned will be very difficult. Absent the rubble, the smoke, and the enemy fires and much of the real difficulty of MOBA operations will be missing.

In preparation for the exercises, it should be possible to develop a team of referee/interpreters who have been exposed to experiments on real structures attacked by real warheads in experiments such as those being conducted by the Corps of Engineers in the course of their work on building vulnerability and protection, and by DARCOM in warhead development. Knowledge of such matters as persistence of dust obscuration inside buildings is as essential for simulation of combat effects as is knowledge of the kill probability of a LAW against a Russian tank.

We recommend that the Army develop plans for a series of large scale MOBA exercises aimed at simulation of the most likely European scenarios to develop tactical doctrine and assess the appropriateness of equipment for MOBA. It should be clearly understood that active participation in the management, assessment, and refereeing of the exercises by technical people is essential to the success of the program.

To this end, we recommend that TRADOC and DARCOM prepare plans for participation in large scale MOBA exercises. Such preparation would involve assembling a team of system designers and tacticians, training them through exposure to small-scale MOBA combat environmental experiments, and assigning them appropriate responsibility and authority so that they could effectively extract the lessons from the experience. This same group should be instrumental in planning and carrying out any weapons system developments whose need arises from the exercises.

Recommendation Two - Cut the Talent Loose

In the course of our review, we found some examples of really promising ideas which, as of November 1977, were unfunded. In addition, we found some reluctance on the part of Laboratory Directors to "bet on the come" for MOBA-related ideas. This situation is apparently attributable to some off again-on again funding experiences in the past. One example of an unfunded but promising program was a multi-purpose submunition for the 2.75 inch helicopter rocket. While there may be some question as to the role of the helicopter in MOBA, it is unlikely that its utility will be enhanced by not developing warheads for its armament that could be expected to be very useful in MOBA operations.

In view of the success in the past of the Laboratory Directors' fund concept in starting innovative programs, and in view of the perceived hesitancy on the part of Laboratory Directors and Program Managers to undertake MOBA-related developments without assurance of full funding, we recommend that a MOBA directors fund be established. A moderate level of funding assigned to the Laboratory Directors and Program Managers concerned with MOBA weaponry would permit early start feasibility investigations and demonstrations of systems which the designers believe in, and should go far toward making the developers believe that the Army is serious in its desire to improve its capability in MOBA. In addition, a program to encourage joint Army/DARPA advanced development projects for MOBA may be a useful stimulant to bring forth new ideas.

The panel would recommend a fund of approximately $1M for distribution to Program Managers for initiation of MOBA improvements of their projects; a fund of approximately $600K for Weapons Laboratory Directors to stimulate innovative thinking internally; and a fund of $500M each in the Army (managed by DCSRADA) and DARPA (managed by DARPA) to stimulate initiation of the joint projects referred to above.

6-3.0 CURRENT STATUS OF CONVENTIONAL WEAPONS FOR MOBA

6-3.1 SMALL CALIBER WEAPONS

GENERAL

For military operations in built-up areas, small caliber weapons carried by individuals or mounted upon vehicles are important weapons for both defense and offense. For purposes of this discussion, "small caliber" is defined as all weapons up to and including 40mm. "Small arms" are the individually carried weapons and "support weapons" are machine guns and vehicle mounted guns. The small arms individual weapons available from various sources are both extensive and unique; pistols range from simple automatics to convertibles which become submachine guns; rifles range from long range accurate sniper rifles to rifles which can shoot around corners, and grenade launchers range from single round launchers to multi-shot launchers that can be mounted on rifles. This analysis will deal primarily with those items which are considered normal field issue to minimize the real life logistics of supplying unique high usage ammunition for MOBA operations.

A. Small Arms Individual Weapons

Current small arms individual weapons in normal inventory are the M1911 A1 .45 caliber pistol, M14 7.62mm rifle, M21 sniper rifle, M16A1 5.56mm rifle, M79 and M203 grenade launchers. Night vision sights are the AN/PVS-2, AN/PVS-4 and the M9821.

For offensive use, the individual small arms weapons could be employed for the systematic clearance of defending personnel from the built-up area. Initial assaults will probably be conducted under extensive use of smoke, at night or under other conditions of limited visibility. Intense close combat will require suppressive fire at close range. Under these conditions, automatic firing weapons with extensive ammunition supplies will be required. The current individual weapons, other than grenade launchers, are geared to such high volume fire.

The present arming distance for rifle launched grenades is 14 to 30 meters. This arming distance should not be changed since it is based upon safety to the user. In MOBA, where engagement is typically less than 50 meters, it doesn't appear practical to provide range finders to assure arming is achieved at target impact. A more reasonable solution is to train troops in the use of these weapons under the short range conditions allowing them to achieve the ability to easily estimate target ranges commensurate with arming of the grenade.

Studies conducted by the Army in the early 50's indicated that most casualties from small arms fire were not the result of aimed fire. This cast doubts on the need for high precision rifles except for snipers.

To neutralize human error in aiming, project SALVO attempted to provide controlled dispersion to 300 to 400 meters. Ammunition was developed, using several bullets in tandem. The SPIW program followed, using both single flechettes and bullets to be fired in series and auxiliary mounted systems using multiple flechettes. Cost and technical problems have basically eliminated these programs from the development area. Automatic high rate of fire small arms weapons presently appear to have characteristics which appropriately meet the dispersion needs and minimize the need for special ammunition rounds. It would not appear practical or necessary to pursue the multi-projectile programs for MOBA.

A small arms improvement to increase effectiveness and simplify aiming would be in the possible use of a laser pointer. Such a device could provide the infantryman with the capability of quickly projecting a "spot" on intended targets and thus eliminate the need for conventional aiming. Laser pointers are well within the state of the art of current technology and have been used by various law-enforcement agencies. A study to determine the applicability of a laser pointer for MOBA appears in order.

B. Small Caliber Support Weapons

Small caliber support weapons are the M60 7.62mm general purpose machine gun, the M2HB .50 caliber machine gun, and the 20mm to 40mm vehicle mounted guns such as the M163 20mm Vulcan Air Defense gun and the M139 20mm cannon carried by the M114A1E1.

These latter vehicle mounted weapon systems are self-supporting and normally have armor piercing rounds for defense against mechanized armor and HE (high explosive) fragmenting rounds for anti-personnel use. The armor piercing rounds appear to have application for MOBA in penetrating walls and other barricades and the fragmenting rounds have use for anti-personnel suppressive fire. Typically, 10m to 100m arming ranges are utilized in the HE fragmenting rounds and the armor piercing rounds do not require arming delays. Accordingly, these rounds appear to have application for use in the close range MOBA situation.

In the support weapons area, current weapons and those under development can provide firepower which will be utilized for MOBA. The effectiveness of these weapons and the human factors involved in the use of these weapons for MOBA must be determined.

C. Development Activities

Current individual weapons under development are the XM235 5.56mm squad automatic weapon (SAW) and the 30mm grenade system (using a multi-shot launcher adapted to the M16 rifle). Current support weapons under development are the DIVADS air defense system (using a 35mm or 40mm gun system), the Infantry Fighting Vehicle System XM2/XM3 and the interim improved XM113A1, both using the 25mm gun system.

As in the case of available weapons, the effectiveness of weapons under development and the human factors involved when used for MOBA must be evaluated. Accordingly, primary emphasis must be placed upon evaluating these factors prior to recommending new developments or modifications to present weapons.

Development tasks identified in the Fiscal Year 1978 TRADOC R&D and Analysis Tasks seem appropriate for MOBA needs. These tasks are:

(a) Multi-round wall penetration from small arms weapons with consideration for user safety. Weapons included in this testing are the M16 rifle, M60 machine gun, .50 caliber machine gun, .45 caliber machine gun, SAW's, M203 and M79 grenade systems.

(b) Testing to establish noise level from small arms and automatic weapons fired from confined areas together with evaluating target acquisition from these quarters.

(c) Penetration studies using 20 to 40mm guns against nonmetallic materials.

(d) A study of hand held high rate of fire automatic weapons. The two identified candidates to replace the obsolete World War II "grease gun" are the American 180 (with laser) used by law enforcement agencies and the List and Williams prototypes. These and other candidates recently available should be examined.

In addition, DARCOM has underway demonstration tests of the developmental 30mm grenade system (which includes an automatic launcher and laser range finder). Included is an evaluation of multi-shot effects of the HEDP round on typical wall structures.

D. Conclusions

Present FY 1978 proposed TRADOC R&D Analysis Tasks and the 30mm DARCOM tests would provide a basis for identifying real development needs to better adapt the small caliber weapons to the MOBA environments. It further appears that the obsoleting of weapons and recent weapons developments in the small caliber area may be reducing the small arms that are available in the field which best fit MOBA. Examples of this are:

(a) Replacing .50 caliber (12.7mm) machine guns with the M60 machine gun. This change, reducing projectile size from 12.7mm to 7.62mm, may reduce the ability to penetrate MOBA defenses and to provide effective richochet fire power.

(b) Obsoleting the World War II "grease gun" without a replacement readily-available weapon leaves the Army without a lightweight high rate of fire close-range weapon.

The Army trend to reduced manpower levels, with the emphasis on high mobility, may critically affect the ability to operate in the MOBA environment. A planned study on ammunition supply, scheduled in 1978, is important because of the high usage of ammunition for MOBA. Also, the use of vehicle mounted 20mm to 40mm guns and the required effective range should be studied for MOBA.

In the small arms area, it appears that present technology can supply the needs of MOBA. The real problem becomes identifying the optimal weapons that provide for both open field use and for MOBA. It appears that high rate of fire automatic weapons which can supply suppressive fire power and are mobile and effective at short ranges are ideal. Night vision sights and possible laser spotting devices will be important to carry out the expected mission needs. The 40mm and the new 30mm grenade systems appear to be ideal weapons for the close quarter conflict anticipated. The flexibility and reaction time of a multi-shot rifle-mounted grenade system would appear to be a significant improvement over present single shot systems. In the larger vehicle-mounted gun system, the effectiveness of an HEI projectile will be dependent upon target range and thus may require more rapid arming to be effective in a MOBA environment.

E. Recommendations

1. It is recommended that the Fiscal Year 1978 TRADOC R&D and Analysis Tasks (as listed under Development activities), be approved and funded. These tasks would define the applicability of small caliber weapons for MOBA and better identify development needs.

2. It is recommended that the use or development of special small caliber weapons strictly for MOBA be discouraged. Emphasis should be placed upon assuring that small caliber weapons being improved or developed consider the needs of MOBA such that weapons can be used in both open field and MOBA.

3. It is recommended that care should be exercised in the obsoleting of small caliber weapons, such as .50 caliber machine guns or WW II "grease guns," to assure that MOBA needs are not seriously affected.

4. It is recommended that extensive troop training for MOBA be carried out to assure that safe and effective use is made of small caliber weapons available and that tactics of operations are both practical and understood.

6-3.2 ARTILLERY AND MORTARS

GENERAL

The artillery/mortar weapons include the towed and self-propelled howitzers (or guns), the recoilless rifles and the mortars. The towed weapons are of minimal use for in-city fighting, whereas the self-propelled would have some utility. The recoilless rifles are generally being replaced by TOW and Dragon. However, past usage of the RRs in MOBA operations have shown them to be very useful—particularly the 106mm. The mortars are designed for indirect fire use. This results in difficulty in attacking targets behind buildings, barricades, etc. The remainder of this section will discuss the characteristics of current weapons, their effectiveness for MOBA, conclusions and recommended future activities.

A. Effectiveness of Artillery/Mortar Weapons

There are several general problems encountered in the use of artillery for MOBA. These problems can be grouped into the categories of systems, weapon, projectile, and fuzing. The problems encountered are briefly as follows:

- Systems - It is difficult to direct artillery fire in the MOBA environment. Observers cannot detect the hit points and target destruction. As the artillery moves into the urban area, the mode of fire shifts from indirect to direct. It is anticipated that over 50 percent of the MOBA artillery fire is direct fire. Direct fire is possible with most artillery weapons, but mortars are designed solely for indirect fire.

- Weapons - The various artillery weapons are either towed or self-propelled. The towed and most of the types of self-propelled provide no crew protection, thus the operating area is highly vulnerable to the small arms fire, fragments, etc. from enemy weapons fired from building concealment. The recoilless rifles, although shown to have been effective direct fire weapons that could be used in MOBA are now being removed from the inventory. The mortars that exist range from the light-weight company mortar to the very heavy immobile 4.2 inch mortar. In all cases, the mortars have no capability for use in the direct fire mode.

- Projectiles - Existing projectiles are very poor penetrators. They are designed to fly well in air, but have very erratic trajectories in soil, barricades, rubble, etc. In fact, they often richochet or broach, sometimes resulting in a significant hazard to the firing personnel. In addition, the projectiles often break-up or the fuze is driven back into the projectile in hard structure impacts, sometimes resulting in fuze failures

- Fuzes - Current fuzes all have too great an arming time to allow their use in short range encounters. Currently the only delay fuzing feature available is a set pyrotechnic delay. Such an approach to delay fuzing results in a very unpredictable behind-target burst point for the projectile. It can be anticipated that with this type of delay fuzing, a projectile will often travel clear through a small building and function somewhere beyond its back side, thus providing no effectiveness inside the building.

B. Development Activities

The development activities in progress or planned that can provide improved effectiveness for MOBA are as follows:

Weapons - The primary activity that is being initiated is the study and potential development of a new self-propelled Howitzer. This system will probably have better crew protection (including CBR), more on-board ammunition, and the appropriate resupply vehicles. No new mortar or recoilless rifle developments are known.

Projectiles - Most of the new projectiles under development are to provide increased range or better terminal accuracy. Examples are the RAP rounds and Copperhead.

A potential new development that could be designed for improved ICM effectiveness in MOBA could be the SADARM type, which is being investigated, but is not yet scheduled for development. Studies are planned to evaluate the penetration requirements for nonmetallic material and masonry/earth-timber structures such as bunkers. Data generated in these studies will be useful guides to better projectile designs for MOBA.

Fuzing - There are numerous fuzing development activities in progress, but only two are known which should provide improved performance for MOBA. These developments are the structure/bunker penetration fuze and the dual mode delay which is the element in the artillery fuze which provides the delay function. The bunker penetration fuze is to be a single piece item that will provide better penetration characteristics and will be ballistically matched to current PD fuzes. The dual mode delay is based on the principle of void sensing, which allows it to detonate the projectile shortly after the projectile has penetrated a wall or barricade, thus assuming function within the enclosure. The arming time for nearly all current artillery/mortars/RR fuzes is such that minimum arming distance is at least 200 feet, and in some fuzes much longer. For effective use in MOBA, these arming distances must be significantly less.

C. Conclusions

Generally it is concluded that current artillery/mortar development activities do not address the MOBA problem. They are primarily directed at increasing range, ballistic matching of projectiles and improved techniques for defeating armor, which are all extremely important, but of little benefit to MOBA.

D. Recommendations

The various current weaknesses for MOBA of artillery/mortar can be strengthened by pursuing the following activities which are additional to those activities already in progress.

1) For projectiles, designs that would provide good penetration characteristics should be pursued. A probable configuration would be a blunt nosed design with a base mounted void sensing fuze. The projectile's in-flight ballistics could be maintained by using a light windscreen ogive.

   Another projectile activity would be the development of a cargo round of target-activated (such as SADARM) or terminally-guided submunitions. These could be deployed over the urban areas in appropriate places and attack from the vertical rather than primarily from the horizontal as Copperhead and the unitary rounds do.

2) For fuzing, the development of a base-mounted void sensing fuze would be a significant improvement. The current artillery delay element is a pyrotechnic time, which does not insure projectile function within target enclosures. The new dual mode delay will achieve such function but is in a nose-mounted fuze, which may fail structurally during penetration, possible resulting in failure of the delay device. A similar void sensing delay fuze should be considered for mortar projectiles.

3) An evaluation should be made of the minimum allowable arming distance for artillery/mortar/RR fuzes. Such a study would have to include what protective measures could be provided for the operating troops—such as body armor, so that they could safely use their weapons at reduced arming distances.

6-3.3 LARGE CALIBER MANPACK WEAPONS

GENERAL

The large caliber manpack weapons include TOW, Dragon, LAW, recoilless rifles, rocket launchers and similar systems which provide heavy fire power in a manpacked configuration. A feature of these weapons is the backblast at firing. This backblast is required for zero recoil effects, but it introduces hazards. The backblast results in a detectable launch signature and, in confined areas within buildings, the backblast and subsequent overpressure are a hazard to nearby personnel.

For MOBA, use of buildings as firing positions for the large caliber manpack weapons is desirable. For effective employment, the backblast and overpressure effects of these weapons need to be reduced significantly. In addition, combat in MOBA requires maximum effectiveness of the warheads against both enemy armor and personnel, as well as for breaching interior and exterior walls of buildings.

A. Use of Current Large Caliber Manpack Weapons In MOBA

The large caliber manpack weapons incorporate adequate anti-armor warheads. Some potential improvements are possible in this area. A primary requirement for MOBA is also to achieve high lethality against enemy personnel. This dual lethality is necessary to defeat the enemy infantry/armor teams and to provide effective fire against infantry-only targets in the city environment.

In addition, in a city environment, combat involves a major amount of fighting against defensive troops within buildings. Such enemy troops are expected to have effective fire coverage of existing doorways and windows.

Thus the success of the combat is at least partially dependent upon the ability of the friendly forces in the assault to breach new openings into building interiors.

In Viet Nam (specifically in the retaking of Hue after the Tet Offensive) wall breaching was a critical tactic. In the sector of the city where construction was similar to that in Europe, the LAW was ineffective in breaching walls. Both the 3.5 inch rocket launcher and the 106mm recoilless rifle were used instead with success; however, these two weapons are now obsolete.

The available large caliber manpack weapons all have the backblast characteristic which limits their utility in confined spaces associated with MOBA. In open area combat, the signature provided by the backblast is an accepted risk in achieving the necessary engagement ranges. In MOBA, however, engagement ranges are much shorter and the "hard" launch is probably not a firm requirement.

B. Effectiveness of Current Weapons in MOBA

The current man-portable weapons are not well suited to MOBA. Although they provide adequate anti-armor capability, improvements in anti-personnel capability appear desirable. In addition, as evidenced in Viet Nam, the smaller weapons such as LAW do not provide the necessary wall breaching capability while the weapons which were effective in this role are no longer considered current. The Dragon or TOW may provide the desired wall breaching capability and tests to determine their effectiveness are in order. However, neither appears suitable for use in small confined areas. In addition, the need to use a relatively expensive guided weapon to accomplish wall breaching at short ranges raises the question of cost-effectiveness.

C. Development Activities

The principal problems associated with the large caliber manpack weapons have been recognized and activities have been included in proposed FY 79 DARCOM-TRADOC MOBA tasks to investigate solutions.

Activities to provide soft launch, as well as minimum signature weapons are included. Several specific examples that have been noted are:

- Shoulder-Launched Multi-Purpose Assault Weapon (SMAW) — This is a man-portable, tube launched, in tube burning, rocket powered, infantry assault weapon. It has a dual mode warhead and it is being designed for firing from enclosures.

- Riflemans Assault Weapon (RAW) — This design incorporates a fuzed warhead which is launched by an attachment to an M16 rifle. It can be fired from small enclosures, in fact, any that an M16 can be fired from.

- Minimum Signature Envelope Recoilless (MISER) — MISER is designed to be a low signature weapon capable of breaching building walls. This design contains the blast, flash, and smoke within the projectile, thereby allowing firing from within enclosures.

- ARMBRUST System — This concept is similar to MISER and is being developed in the FRG. It is also a signatureless device, but is currently heavier and longer than MISER, making it more difficult to handle.

- Ring Airfoil Multi-Purpose Munition (RAMP) — This is a "semi"-recoilless rifle that launches a large diameter (5-6 inch) ring airfoil grenade. It is being designed to be compatible for firing from enclosures and will have a short arming distance as required for the MOBA application.

Other weapon development activities are being initiated (on a technology basis) that address the problem of firing from enclosures. The basic approach currently suggested for these studies is an "Eject then Ignite" principle. Various concepts exist for accomplishing this type of weapon launch, but they must be evaluated in respect to their applicability to MOBA type weapons.

Warhead deficiencies have also been recognized and tests of various warheads including the current LAW, Dragon and TOW as well as HEP and other warheads are recommended. No mention of improving anti-personnel capability is noted, however, in the DARCOM-TRADOC tasks. Some specific warhead development activities that have been noted are:

- Dual Mode Warhead — This warhead is intended for use on SMAW and is being investigated by the Naval Surface Weapons Center at Dahlgren. In tests to date, it has penetrated nine inches of reinforced concrete or 40 inches of sand and timber.

- RAMP Warhead — The warhead for the RAMP munition is a modified Miznay-Schardin design for wall penetration which is combined with a fragmenting case for anti-personnel effects. It has been indicated that the warhead has substantial penetration capability but no specific data are available.

A general study of MOBA assault warheads has been suggested, with initiation recommended for Fiscal Year 79 at the DARCOM-TRADOC July 1977 Conference.

Arming delay studies are also suggested since, in general, the arming distance of the current large caliber man-portable weapons appears excessive for the short weapon to target ranges considered applicable to city operations. These studies are considering safety versus utility of the weapons.

D. Conclusion

- The available large caliber manpack weapons have been primarily designed for the anti-tank mission in open terrain. As such, they are not well suited to MOBA. They have excessive signatures; cannot, in general, be fired from small confined areas; and do not incorporate warheads which appear to provide adequate effectiveness in the wall breaching role. Simple modifications may substantially improve their utility.

- The deficiencies have been recognized and activities have been suggested through DARCOM/TRADOC tasks to provide solutions to some of these problems.

- Weapons in the conceptual phase of development, appear to continue to emphasize long-range, open-terrain engagement of armor with little apparent emphasis on MOBA. (See Precision Guided Missile discussion.)

E. Recommendations

Activities to solve deficiencies in current weaponry as applied to MOBA should be accelerated to provide a better data base for weapons development agencies and contractors.

Trade studies of implications of MOBA requirements should be an integral part of new weapons development. Such trade studies should identify the added cost and/or reduced effectiveness which might occur when trying to provide both MOBA and open-terrain capability in a single weapon. The results of such studies, together with results of conceptual studies of MOBA-only weapons, could then be used in simulations to derive a better understanding of the desired weapon mix and better identify desired operational characteristics of next generation weapons.

Weapons such as the ARMBRUST-300 appear to be compatible with MOBA requirements. There may be several other similar systems in existence or under development probably compatible with MOBA requirements. In the European group of nations, it would appear that weapons for urban use would have received considerable emphasis during the past several years because this type of warfare has been experienced in the European areas.

6-3.4 PRECISION GUIDED MISSILES

GENERAL

The principal usage of Precision Guided Missiles is for the destruction of relatively small, fixed or mobile, hard targets such as armor, bunkers, fortified positions, buildings, etc. These targets are applicable for MOBA operations as well as open terrain operations.

Precision guided missiles include: (1) man-portable systems in which the launch operator has direct line-of-sight to the target (e.g., the TOW or Dragon type weapons) or (2) systems which are launched at long standoff, are fired in ballistic trajectory and subsequently acquire and home on energy emanated or reflected from the target (e.g., the cannon launched guided projectile type weapons).

For weapons of the first type, MOBA usage implies the following requirements:

a) The weapon should be small and relatively lightweight to enhance its portability within a building or from building to building. Set-up-time should be minimal and the weapon should be capable of firing from the shoulder or simple bipod mount.

b) The weapon should present minimum signature to prevent location of the firing position.

c) The weapon should be capable of arming in a short distance (perhaps 10 to 30m) since engagement ranges of 50m or under are expected in most engagements in urban areas.

d) "Soft launch" capability should be available to permit weapon firing from within small enclosed areas to minimize overpressure and backblast.

e) Simplicity of operation should be emphasized to minimize training requirements. This permits use of the weapon by any member of a combat team as opposed to relying on specialists, the loss of whom may make the weapon worthless.

For weapons of the second type, MOBA operations imply the following requirements:

a) Positive means of target identification must be employed since "friendly" and "hostile" units will be in close proximity, if not intermixed.

b) Command and control requirements should be minimized to minimize reaction time as well as to compensate for C^3 problems attendant to MOBA operations.

A. Precision Guided Missiles Considerations for MOBA

1) Current Army Capabilities

Currently deployed Army PGM's include the Dragon and TOW. Systems under development are the "Hellfire" and the "Copperhead" cannon launched (155mm) guided projectile. In addition, a number of guided missiles are currently in the concept definition phase, including the IR Fire and Forget missile, the Standoff Target Activated Fire and Forget (STAFF) weapon, the Advanced Heavy Antitank Missile (AHAM), the Terminally Guided Submunition (TGSM), the Terminally Guided Missile Warhead (TGMW) for the General Support Rocket System (GSRS), a Millimeter Wave Beam Rider Missile and an Active/Semi-Active Millimeter Wave Seeker equipped missile for helicopter or ground vehicle launch. The majority of these conceptual weapons are being developed for anti-tank combat in open terrain and emphasis is being placed on achieving armor penetration and defeat at relatively long (1 Km or greater) engagement ranges.

Other Precision Guided Missiles currently available, or being developed by other services, include laser guided bombs; electro-optical contrast seeker equipped bombs and missiles; and millimeter wave seeker equipped missiles. These weapons generally fall into the categories of (1) large unitary weapons for destruction of large fixed or mobile targets such as bridges or ships or (2) long standoff (greater than 5 Km) weapons for defeat of armor targets.

2) Use of Current Weapons in MOBA

The current U.S. Army PGM's, although usable in MOBA, are not well suited to these operations. The man-portable systems, Dragon and TOW, do not have a "soft" launch capability (to minimize overpressure and backblast) and have arming delays in excess of that considered desirable for MOBA operations. In addition, both require a reasonably proficient operator with significant training.

The TOW could be utilized in protecting long avenues of approach and could possibly be used as a "wall-breacher." Its usefulness in this latter role is questionable since its warhead has been optimized for armor penetration and not for providing defeat of fortified positions or breaching of walls. In addition, the TOW is a fairly large crew-served weapon and not well-suited for rapid redeployment in areas filled with obstacles such as rubble, or rapid movement from room to room in a building.

The Dragon, because of its smaller size and increased portability, is somewhat better suited for MOBA operations. However, its warhead is optimized for armor defeat and, as it now exists, is not well-suited for other MOBA missions.

The current 155mm CLGP weapon, which uses a semi-active laser homing seeker, could be utilized for destruction of buildings or fortifications as well as for an attack on armor. Significant problems, however, exist. Smoke, dust and haze may obscure the target from the seeker. In addition, the presence of intervening structures (e.g., buildings), compounds the problem of providing a clear line-of-sight from the target to the seeker. The problems of fire control, i.e., providing the Fire Direction Center with accurate target location data, will also be severe because of the close proximity of friendly and hostile forces. Target location data will have to be sufficiently accurate to ensure the capture of the reflected laser spot by the seeker to avoid collateral damage to friendly troops. In spite of these shortcomings, the use of a CLGP type weapon for MOBA would appear to be superior to use of conventional artillery techniques.

The same comments apply to the other laser guided weapons and in part to the E-O seeker guided weapons. That is, their use will be hampered by presence of obscuring material in the atmosphere and fire control will be a major problem. However, they still appear to represent a better fire support solution than use of unguided weapons against appropriate MOBA targets.

A number of the weapons in the concept definition phase are intended to alleviate, in part, the problems associated with laser guided weapons. Specifically, millimeter wave seekers are being considered to reduce the obscuration effects of rain, fog, smoke and haze. However, the majority of these weapons are being designed for long stand off anti-armor applications and thus may provide limited utility in the MOBA environment.

3) Effectiveness of Current Weapons in MOBA

In summary, the current Army PGM's have serious restrictions and their effectiveness in MOBA operations appears limited. For man-portable weapons, operational ranges are based on open terrain conditions, firing from enclosures has not been emphasized, terminal effects have been concentrated on the defeat of armor targets only, and significant training is required to achieve proficiency.

For the laser guided weapons, obscuration effects will be severe and fire control is a significant problem.

4) Development Activities

PGM's in development and the conceptual phase are continuing to reflect emphasis on the long range defeat of armor. Some effort is being expended to provide soft launch for unguided anti-tank weapons. The techniques being considered are probably applicable to man-portable guided weapons. In addition, some effort is being expended to provide weapons with simpler firing sequences than the current man-portable weapons. An example is the IR fire-and-forget weapon in which operator control is not required after launch.

For the semi-active mode weapons, efforts are being conducted to reduce the obscuration effects of smoke, haze, fog, and rain. Such efforts may solve obscuration problems; however, fire control will remain a significant problem area.

In future development activities, a number of possibilities appear to offer advances in MOBA capability. For a near-term man-portable weapon both TOW and Dragon appear candidates for modification.

B. Conclusions

- The PGM's developed to date, as well as those in engineering development, have been slanted toward anti-armor engagements in open terrain and relatively little emphasis has been placed on MOBA usage of the weapons. Because of this emphasis, these weapons will be of limited utility in MOBA without modification.

- Improvements in next generation weapons, (i.e., those in the conceptual stage) appear to be slanted toward long-range anti-armor engagements in open terrain. Some of the improvements will, however, aid in MOBA use. Specifically, use of seekers which can penetrate fog, rain, smoke and haze will alleviate some of the obscuration problems associated with MOBA.

- For long range delivery systems such as the 155mm CLGP and GSRS the provision of accurate target location information to the delivery vehicle is a significant problem. Failure of the weapon seeker to capture the designated target may result in a greater hazard then benefit to the friendly forces.

C. Recommendations

- Requirements for man-portable PGM's in MOBA should be evaluated in simulation and field exercises. Because of the relatively short range of engagement, unguided (or simple trajectory control) weapons may provide adequate accuracy at significantly lower cost. In addition, because of the relative simplicity of operation, these latter weapons may offer advantages for usability by all available friendly troops.

- The incorporation of "soft-launch" techniques, the reduction of arming ranges and alternate control techniques to provide shorter minimum range should be considered. Additionally, the use of improved anti-personnel capability warheads should be investigated.

- The feasibility of modifying TOW and Dragon to provide desirable MOBA characteristics should be investigated and compared with the development cost and feasibility of a replacement weapon for the best cost effectiveness.

- Investigations of alternate warheads for the man-portable PGM's should be investigated. Candidates include HEP and shaped charge with explosive follow-through charges.

- Investigations of millimeter wave seekers should be continued. Their ability to penetrate smoke and other obscuration may make them a viable alternative to lasers in the semi-active mode of operations. Initial efforts should concentrate on signature measurements in an urban environment.

6-3.5 WALL BREACHERS

GENERAL

Wall Breachers are required for the penetration of structures and bunkers. The penetration of structures in MOBA is not unlike the penetration problems encountered in typical military operations such as defeating tanks, armored vehicles and bunkered emplacements. Perhaps the most unusual features for MOBA are: (1) the close range of the encounter, generally a few meters and seldom beyond tens of meters, (2) the number and variety of the structures to be breached and (3) the desire, in most cases, not to obliterate the structure. For this reason, much of the typical armament has some usefulness but we shall see some deficiencies and unique needs for MOBA.

Urban structures can be grouped into categories. Light structures include residential and small buildings generally constructed of light wooden framework, sheet metal, stucco, etc., and can be penetrated oftentimes by even small caliber fire. Medium structures include public buildings, etc., constructed of brick reinforced masonry and thicker materials and can be penetrated oftentimes with heavier artillery and explosive charges. Heavy structures include basements, foundations of large buildings, dams, bridge abutments, retaining walls, etc., constructed of the heaviest reinforced masonry, earthen backfill and sand bagging and can be penetrated oftentimes with multi-shot heavy artillery and explosive charges.

Structural targets in MOBA are generally poorly defined as opposed to targets of a more conventional military nature. Such targets as gun emplacements, tanks and armored vehicles can be pinpointed whereas in built-up areas one does not know which structures must be penetrated nor does one know how many and what type of opponent may be hidden.

In MOBA, the engagement is at very close range. High accuracy is not as critical except in pinpoint sniper type encounters. Generally, the structures have easily breached doors and windows. Doors and windows can be booby traps, however, and the usefulness of surprise entry through holes in walls is obvious.

A few comments on anti-personnel kill mechanisms should be made. Direct fire through walls has limited usefulness since one needs to know the location of personnel behind the wall to be effective whereas automatic weapon fire through large breached holes has high effectiveness. Fragmentation devices that penetrate the structure and then explode inside are generally more effective—the grenade through a window or door or breached opening, for example. Spall can also be considered for producing lethal fragmentation beyond a wall without actual perforation. This involves producing a sufficiently strong short duration shock transmitted through the wall to throw off lethal fragments from the wall itself.

With these few general comments we now turn to the types of penetrators, what's available, what are the current deficiencies and then draw some conclusions and make some recommendations.

Types of Penetrators

The first type of structure penetrator might be termed Kinetic Energy Penetrators. In these we can include the typical jacketed small caliber rounds as well as the much heavier longer rods. These can be subcaliber rods fired from heavy artillery with sabots. Their performance depends on high density metals traveling at high velocity boring their way through because of their length and high kinetic energy. The problems are launching the rods to high velocity, assuring their end-on impact and preventing their break-up on impact.

Another type of structure penetrator is the shaped charge—much used during and after World War II. These devices have phenomonal penetration power for their size. Achieving penetration five times their diameter into armor and even more into concrete is not unusual. Their limitations are that they must be fired at a rather well-defined standoff from the target, and their kill beyond the wall is mainly along the sight path of the small diameter hole they produce.

Shaped charge-like cutting rings can be used to cut holes through walls. Examples are the Ring Airfoil Grenade (RAG) and Jet-Axe. Jet-Axe is used by fire departments to gain entry to warehouses and large buildings for fire hoses and firefighters. Currently these shaped charge devices are capable of perforating eight inches of wood planking, eight inches of reinforced concrete, eight inches of filled concrete block, or three layers of brick. Such shaped charges could be effectively used for MOBA but require hand emplacement.

For thicker walls, multiple stage blasting can be used. Warheads are now being studied that use a shaped charge to drill a deep hole on the first functioning and then are followed immediately by a trailing explosive charge. This second charge buries itself into the hole produced by the shaped charge and is then detonated. This buried charge is very effective in causing break-up and perforation of quite thick walls.

A final technique is simply the detonation of large explosive charges placed against the wall—a technique used in demolition.

What's Available

Current Army inventory includes a number of the above type penetrators in sizes suitable for light, medium and heavy structures. These range from penetrators fired from the M16A1 rifle (for the lightest structures) through the M2HB .50 caliber and similar Heavy Machine Guns. The 105mm Howitzer and large caliber guns have projectiles capable of perforating medium and somewhat heavier structures with delay blast to produce fragmentation beyond the barrier. There are several lighter weight recoilless rifles that can deliver shaped charge type warheads capable of perforating all but the heaviest of armors now in use and consequently could be effectively utilized for many wall breaching needs. Finally, military vehicles themselves can be used as battering rams to breach light structures.

Problems of Current Wall Breachers

Perhaps the biggest concern is the safe arming distance used in most fuzing on the heavier weapons. Generally the designs call for no fire out to some minimal range—oftentimes beyond the distances that might be most often encountered in MOBA. There also seems to be some lack of testing and cataloging of performance of current inventory items against structures most likely to be found in built-up areas.

Conclusions

Much of the current weapon inventory is well designed to perforate structures and barriers and would be equally effective against structures to be found in built-up areas. Generally the heavier the weapon and the heavier the structure it is capable of defeating, the longer is the range for which it is designed. Thus, Howitzers, self propelled guns, tank guns, guided projectiles, etc., all accomplish longer ranges. The fuzing, however, is often designed for no fire at short range and makes these inventory items less effective at the close range usually found in MOBA. Some of the recoilless devices are a hazard for the firer if fired from enclosed spaces and the flash and smoke reveal the firing position.

The close ranges for MOBA will require special studies, redesign or modification of some inventory items and could require some development of special new devices best suited to these operations—for example, a Jet-Axe type wall breacher.

Recommendations

1) It is recommended that the weapons having structure and bunker penetration capabilities, be investigated with respect to redesigns or modifications required for short or point blank range. In particular, projectile or fuze modifications that are well within the capability of current technology would seem to offer fast and cost effective improvement in structure defeat for MOBA per recommendations of DARCOM/TRADOC Conference of July 1977.

2) It is recommended that study, testing and cataloging of the performance of current inventory items against nonmetallic materials in layers and thickness most likely to be encountered in MOBA be made.

3) It is recommended that the possible use of inventory items from all services should be examined. For example, the "Exrod" Navy ordnance destruction device is a mass focus type warhead capable of projecting a mass for many tens of feet and knocking the fuze off a dud bomb. This item could possibly be used to perforate a wall as well and could be set-up at the ranges in MOBA, thus not unduly exposing friendly troops.

   A second example is the possible use of land mines for wall breaching. Land mines are designed usually to perforate armor. Such mines should be studied to determine if minimal modification, using current technology, could adapt them for wall breaching use.

4) It is recommended that Jet-Axe, used by fire departments to gain entry to buildings, be investigated for MOBA. While this system introduces additional logistics considerations, it does offer the capability for breaching large holes without the need for repeated firings.

6-3.6 MINES - OVERPASS AND OFF-ROUTE VEHICLE: ANTI-PERSONNEL

GENERAL

Mines can be used for military operations in built-up areas as a defensive weapon. Direct engagement mines located along the potential routes of enemy armor and infantry are very effective. When supported by off-route mines, a synergistic increase in effectiveness is achieved.

Both anti-armor and anti-personnel mines have applications for MOBA, particularly in combination, to engage enemy armor/infantry teams. The Claymore mine, or modern derivations, provides excellent anti-personnel effectiveness, and can be easily camouflaged where debris is prevalent.

For future anti-armor mines, several concepts from the ERAM (Extended Range Anti-Armor Mine) and STORM (Sensor Tank Off-Route Mine) programs offer significant potential in MOBA applications. They all employ the self-forging long standoff warhead design being developed for SADARM, with a current diameter and length of approximately six inches. Other diameters could be selected as needed. Considering the lethal potential of heavy metal designs, using depleted uranium or tantalum, three to four inch diameters could provide tank kill capabilities.

Mine warheads could be fixed to walls, with fabric camouflage or mounted in concealed firing positions in doorways, between buildings or along side streets. Single and multi-directional, i.e., multiple self-forging plates, are feasible to meet firing angle requirements. Fuzing probably would be achieved via IR detectors, although pressure tapes or offset magnetic sensors could also be used. Command initiation is also feasible.

Typically, the supporting Claymore type mines could cover the area ahead and behind the anti-armor line of fire and could be triggered by the anti-armor mine fuzing to provide a combined attack on the enemy infantry/armor team.

The advantage of the off-route mine concept lies in its ability to provide a form of fire cover to scatterable mines to impede clearing operations. At the same time, scatterable mines prevent the enemy infantry from searching out the off-route mine locations.

Mine emplacement has historically been by hand in surveyed locations. Presently, the armed forces have a capability for scattering mines in remote areas. These are by artillery fire, ADAM and RAAM; ground vehicles, GEMSS; helicopter, GATOR and M56; and high performance aircraft, GATOR. These systems have the requirement for scattering mines over the countryside, along roads and adjacent to protected areas. Use of any or all of these systems appears to be inappropriate for MOBA because of the high percentage of mines that will land in ineffective areas such as roofs, gutters, gardens, drainage systems, etc. Of the small percentage that do land or rebound to roads and streets, most will come to rest at a position unlikely to have beneficial weapons effect. Hand emplaced mines and hand scattered mines appear to be required for MOBA operations. Several mine types should be considered: Overpass type Vehicle Mines, Off-Route Vehicle Mines and Anti-Personnel Mines.

A. Overpass Type Vehicle Mines

The present military inventory includes M-15, M-19 and M-21 mines. These are large, heavy, must be hand emplaced, and are easy to deactivate when their position is known. Thus, they must be camouflaged or buried and be placed in a position of likely vehicle overpass. Cobblestone, brick, concrete, or asphalt streets do not readily lend themselves to either burying or camouflage. These mines are normally pressure fuzed so they will operate only if wheels or track passes over them. A pressure hose, tape switch, or tilt rod could be used but these would add to the recognition features and make the mine easy to find and remove.

An overpass mine, to be useful in MOBA applications, should be small, (about 5 to 8 pounds), influence fuzed, easy to manually arm and easy to bury, conceal or camouflage. A likely candidate is the XM-75 GEMSS if a manual arming system is developed for it. Perhaps the MOPMS (Modular Pack Mine System) would be a better candidate to consider.

B. Off-Route Anti-Vehicle Mines

The only current off-route anti-vehicle mine is the M-24 Mine System. This uses a tripod-mounted recoilless anti-tank rocket and a tape switch or interrupted IR beam to trigger the rocket at point blank range. The equipment is large, heavy and appropriate only where there is enough room to mount it. Further, it requires concealment of the tape switch or IR illuminator.

Off-route shaped charge or mass focus warheads could be used and could be fastened to building walls or otherwise concealed. One device that may have some merit (with the addition of a sensor or command link) is the "Exrod" used by the Navy for destruction of ordnance items. ERAM, mentioned earlier, is being developed by the Air Force for a scatterable off-route mine. This may be usable in MOBA with the development of a hand emplaced version.

Of specific interest is STORMS which is being developed by ARRADCOM as an anti-vehicle (tank, APC, self-propelled gun, wheeled vehicles, etc.) mine system that has application to urban warfare. The mine is envisioned to be a one man-portable, self-contained unit capable of being emplaced and activated by one man in less than a minute. Emplacement would be overlooking expected avenues of incoming vehicles including rooftops, upper story windows, and other elevated positions as well as along roads at ground level. This system must distinguish vehicles from people and from other non-targets. Its self-forging fragment warhead would be capable of projecting a lethal slug from a standoff position of over 100 feet.

C. Anti-Personnel Mines

Present anti-personnel mines are either hand emplaced (booby trap type) mines or artillery delivered scatterable mines (ADAM). In development is GEMSS, a ground emplaced mine and GATOR, a helicopter and high performance aircraft delivered mine system that includes anti-personnel mines. Another air delivered anti-personnel mine is WAAPM, now out of inventory.

The emplacement requirements for anti-personnel mines are not as severe as for an anti-vehicle mine which requires a vehicle overpass. Artillery and aircraft methods of deploying scatterable anti-personnel mines are not, however, considered appropriate for MOBA. A hand-armed, hand scatterable and easy to conceal mine is required. Some effort has been given to adapting the ADAM to hand arming.

D. Development Activities

Except for the Claymore mine, there is nothing in the current inventory suitable for MOBA mine warfare. The Claymore with a command link or a sensor system could be effective for the anti-personnel requirements of MOBA.

Certain programs requiring continued development activity hold the promise of providing mines to meet both anti-vehicle and anti-personnel requirements for MOBA. STORMS is directed toward meeting the off-route anti-vehicle requirements. MOPMS (Modular Pack Mine System, or more probably, MEMS, Manually Emplaced Mine System) should meet the dual need for an overpass anti-vehicle mine, as well as an anti-personnel mine.

In all cases these mines must be capable of being hand armed, hand emplaced, used on the surface or buried and provided camouflage as necessary. The off-route mines must be one-man portable and simple to set up and use.

A further desirable feature yet to be developed is a capability for mine field command and control. Current technology for RF and hardwire control is certainly applicable. With the fluid conditions expected in MOBA, it may be desirable to command arm/disarm, command detonate and command self-destruct. The present MOPMS development includes these features. In order that the enemy can't countermeasure the system, some security or code must be used for mine control. The variety of the mine addresses used, the degree of security required, and the complexity of the commands transmitted add to the electronic complexity and cost of the systems. The effective development of an adequate command and control system awaits a realistic weighing of the requirements for such systems. The optimum requirements for MOBA will probably be quite different from the requirements for open area applications.

The development of effective MOBA mine systems requires that adequate funding be provided. The development to date has been done with limited discretionary funds of each agency based on their interpretation of the Science and Technology Objectives Guide (STOG) and recommendations of the DARCOM-TRADOC conferences on MOBA.

The first DARCOM-TRADOC conference on MOBA in September 1976 outlined a number of tasks for FY 78, two of which are of concern to scatterable mines:

Task #	Short Title
13	Armor Vehicles in MOBA
15	Obstacles & Booby Traps

Neither task was funded in FY 78 and neither was included in the FY 79 proposed program list prepared by the second DARCOM-TRADOC conference on MOBA in July 1977.

E. Conclusions

There is nothing in the present inventory or in final stages of development for a mine system that could be effectively used in MOBA applications, except the Claymore mine adapted for target activation or command detonation.

Today's technology can be applied to programs such as the STORMS off-route mine to meet the needs associated with the warhead, alerting sensor and boresight sensor. The self-forging long standoff warhead design is currently under development and can be applied to STORMS. For the alerting sensor, the application of acoustic or vibration sensors with suitable signal processing is available through current technology. For the boresight sensor, the application of IR, Optical, Laser, RF or microwave technologies with appropriate signal processing is also available through the utilization of current technology.

While technology is available for the development of such a mine, a viable funded program is needed to proceed with such development.

F. Recommendations

Pursue MOPMS or MEMS and STORMS with requirements that are also applicable for MOBA. Develop the requirements for command and control for MOBA applications of mine fields. Determine the use and techniques of camouflage and the use of dummy mines to enhance the mine field. Develop a scenario and tactics so that development requirements can be generated for the above MOBA uses.

6-3.7 ARMOR VEHICLES AND THEIR WEAPONS

GENERAL

The tank will be a major weapon on both offense and defense in the MOBA situation--much as it is in open area warfare. Its mobility, firepower, and armor protection against small arms, shrapnel, etc. remains an important feature in the MOBA environment. The MOBA environment, however, will have the impact of reducing some of the positive attributes of the tank and accentuating some of its weaknesses.

The high speed mobility of the tank for survivability will not be able to be used in most MOBA situations. The tank will become more susceptible to fire from above, and the weaker top armor will make it more vulnerable in that situation. Because of the three dimensional aspects of MOBA combat, the limited visibility of the "buttoned-up" vehicle will be a negative factor. The inability of the main gun to be elevated above 20° will limit the tank's capability in short range, three dimensional MOBA combat. The main gun, designed for long range killing, will not be as effective in the very short range MOBA situations. The narrow streets and close proximity of buildings in Central Europe will limit movement of the vehicle and also may limit traversing of the turret and main guns in some cases. The tank is also particularly vulnerable to mines in MOBA due to this restricted maneuverability. At the same time, the cover and concealment afforded the enemy by buildings will provide the opportunity for surprise—and the requirement for very fast reaction. Higher traversing accelerations and rates than are now available may be highly desirable.

The fast reactions required, along with limited visibility in the MOBA environment, will also demand very fast reaction I.F.F. capabilities. These same aspects will also require a means for navigating in the cities, and communications to facilitiate command and control.

The MOBA situation will certainly demand the use of combined arms/infantry support in the employment of tanks. It is highly likely that the tanks will operate singly, supporting a squad of infantry. Without infantry coverage, the tank will have little chance of survival in a MOBA environment. The limited maneuver area, inability to use high speed, limited visibility of the crew, and the cover and concealment offered the enemy makes the tank extremely vulnerable to hand held weapons. The infantry must provide support and protection against such weapons. With that support, the tank and its weapons can be a strong force in MOBA combat.

Obviously, some things could be modified on the tank or added to the tank to increase its effectiveness in a MOBA environment. It is highly desirable that any changes be minor and that they not impact the normal mission of the tank. While the panel did not review the properties of the MICV in detail for MOBA applicability, it appears that many of the limitations that apply to tanks need not apply to the IFV/CFV.

A. Conclusion

The conclusions drawn with respect to the utilization of armored vehicles are listed as follows:

The armored vehicle in a MOBA environment:

- A major weapon
  - Protects against small arms and shrapnel
  - High firepower
  - Mobility
- Cannot operate alone!
  - Must operate in combined arms team
  - Must have infantry support
- Limitations
  - Limited vision
  - Vulnerable to attack from above
  - Cannot use high speed mobility for protection
  - The tank does not have effective short range weapon (vulnerable when using commander and loader M.G.) (7.62mm coax. limited in motions). (No short range fuzed HE main gun round.) (IFV will not have all of these limitations.)
  - Poor fordability of rivers in cities
  - Distinctive signature (visual/audio)
  - Too large to operate in many European streets
  - Main gun limited in elevation
  - Relatively long time to traverse turret in fast reaction MOBA situations
  - Poor IFF in limited visibility MOBA situation.
- Needs
  - Improved visibility
  - Greater top surface armor protection
  - Effective short range weapon
  - Capability to provide effective fire at higher elevation angles
  - Very fast reaction I.F.F.
  - Higher rate gun drives
  - Means for navigation in the cities
  - Mine detection/neutralization capability.
  - Improved short range communications capability

B. Recommendations

In order to effectively conduct military operations in built-up areas, combined infantry and armor task forces should be utilized. The very nature of short range combat in urban areas requires that attention be given to correcting the limitations of armored vehicles and their weapons in a MOBA environment. It is recommended that programs be established to meet some of these needs as follows:

- A program to define concepts to provide the armored vehicle commander with greater visibility and protection against small arms fire and shrapnel. Visibility should be 360° and must not be limited upward. Top protection must be adequate. It would also be desirable to provide protection for the commander while he is operating the .50 cal. machine gun.

- An investigation of the effectiveness of armor blankets used on armored vehicles when moving into a MOBA situation. Greater top surface armor protection is definitely needed in the MOBA environment. It is possible that this could be accomplished by the addition of armor blankets.

- An investigation of lower velocity rounds with short time S&A and wall breaching capability (although undesirable from a logistics standpoint). While the main gun firepower of the tank is an effective weapon in MOBA, there is a need for an effective short range weapon to be used for wall breaching and attack of personnel in buildings.

- An investigation of the potential of a FAE capability for armored vehicles along with the capability to project FAE into upper floors of buildings and possibly into basements, sewers, utility tunnels, etc.

- An investigation of ways to provide crews and systems with very rapid reaction. The close quarters, short ranges, and three dimensional aspects of MOBA require such rapid reactions. This is especially true of gun positioning (gun drives), IFF, and the ability to navigate in the city. Along with these is the need to communicate for command and control, which entails a real need to improve short range communications in built-up areas.

- An investigation of means for detection and neutralization of mines to allow effective use of armored vehicles for MOBA.

6-3.3 REMOTELY CONTROLLED VEHICLES AS WEAPONS

GENERAL

In the past 20 years, the armor people have looked at the possible applications of remotely-controlled vehicles and have concluded that they do not have sufficient applications to the conventional armor role to warrant continued development. The role of remotely-controlled vehicles in the MOBA environment, however, has not, but possibly should be, considered. It is doubtful that a remotely-controlled tank, or similar large tracked vehicle, would prove cost effective in a MOBA situation. Consideration, however, might be given to a small, mobile, remotely-controlled infantry support vehicle.

The remote control concept, with its limitations, should only be considered in a situation where the tactical employment of the vehicle makes it expendable—or where the control system has a chance for survival and a human operator does not. Otherwise, it is more cost effective to put the operator in the vehicle.

The remotely-controlled vehicle must be controlled directly by an operator—or go through a series of preprogrammed maneuvers set in by an operator. Direct control by an operator presupposes: that the operator can "see" where the vehicle is and where it will be going, that the operator knows where he wants it to go, and that he has some control link to the vehicle. Thus, the operator must have visual contact with the vehicle and its "target"/or destination—or have a T.V. view of the path of the vehicle and know the route to its destination. The MOBA environment is not very conducive to either of these conditions for other than very short travel distances. The control communications link will likewise be a problem in MOBA except for short distances.

Thus, a remotely-controlled vehicle, used in the MOBA environment as a weapon for infantry support, should be a low cost, expendable, agile, short-range vehicle. The ways in which a remotely-controlled vehicle could be tactically employed as a weapon in urban warfare are as follows:

- It could be used as a low speed "guided missile". A carrier of munitions (of many types) that could be directed to a desired point and detonated.
- It could be used as a weapon carrier in any extremely hazardous environment. For example, transporting and ejecting spray FAE against an enemy position in a well protected building.
- It could be used as a transport for resupply across a hazardous area.
- It could be used to provide fire cover for advancing infantry—possibly by direct wire control and with suitable weapons.

- It could be used as a decoy to draw enemy fire and reveal their positions.

The desired characteristics of such a vehicle are:

- It should be small.
- It should have the capability for high bursts of speed, but need not have sustained high speed capability (possibly use of a hydraulic accumulator power source).
- It should have high maneuverability and small turning radius.
- It must be armored to survive small arms fire and shrapnel.
- It must be low cost.
- It must have a secure control communications link.
- It must be simple to operate, service, and maintain.
- It must be easily transportable to the point of deployment.

A. Conclusions

To our knowledge, such a vehicle does not exist today. There is considerable question whether the tactical employment and effectiveness of such a vehicle would warrant development, and whether it could be made at a low enough cost to be cost effective.

B. Recommendations

A concept analysis is probably warranted in order to answer the questions raised under the preceding paragraph and determine if there is a need for remotely-controlled vehicles for MOBA.

It is an ideal candidate for a DCSRADA/DARPA program. It should be analyzed in the context of the recommended large scale exercises.

6-3.9 FAE WEAPONS

GENERAL

Fuel Air Explosive (FAE) is a means of providing an extremely powerful blast for concussion effect over a given area by dispersing an explosive fuel into a vapor cloud over a target and then detonating the fuel. Fuel can be any of a number of volatile liquids which do not need oxygen from the air to be exploded. Some of the fuels that have been used in the past are: ethylene oxide, propylene oxide, and methylacetylene/propadiene/propane (MAAP); this is a liquid petroleum with traces of butane. The explosive result is accomplished by dispersing the fuel into an aerosol and then detonating it. A center burster tube, running through the center of the canister, explodes when the canister probe hits the ground. This explosion ruptures the canister into predetermined metal strips about two inches wide which radiate from the blast. The cloud detonator, about 180 milliseconds later, then explodes the fuel air cloud. The cloud that is generated is approximately four feet thick with a radius of about 25 feet. The detonation yields a tremendous blast that creates an overpressure on the ground of about 400 pounds per square inch. This is enough force to explode mines and booby traps, defoliate trees and kill persons within the 25 foot radius but not to cause craters, stray fragments or harm persons outside the area (a person standing 50 feet from the impact point would probably escape injury).

Presently, the U.S. Army does not have any Fuel Air Explosive Weapons in its inventory. However, the SLUFAE system is currently in engineering development and full scale production is planned for the 1980s.

The SLUFAE mine neutralization system is under development by the U.S. Army Mobility Equipment Research and Development Command (MERDCOM), Ft. Belvoir, Virginia. Tests indicate it will provide Army ground combat forces with a vehicle mounted, rapidly deployable system to breach minefields and neutralize explosive booby traps in daylight or darkness or under adverse weather conditions.

The SLUFAE system consists of a 30 tube armored launcher mounted on the M548 full track cargo carrier, a rocket propelled fuel air explosive round, and a firing control system. The round contains approximately 85 pounds of propylene oxide fuel, a central explosive burster, two cloud detonators, an electronic fuze, a rocket propulsion motor, a ring fin stabilizer, and a cross parachute for range control.

Basically the SLUFAE system functions as follows: The round is launched 350-1000 meters from the target. Upon impact it deploys two cloud detonators which are ejected approximately 10 milliseconds before the highly volatile liquid chemical is explosively dispersed into an aerosol cloud. Approximately 135 millisecond delay is achieved with the cloud detonator before the cloud is detonated. Repeatable impact velocities are required to allow time for the FAE cloud formation and to ensure proper detonator position. Blast effects are sufficient to detonate or neutralize anti-tank and anti-personnel mines or explosive booby traps.

A. FAE Use for MOBA

Several problems become apparent when one considers the possible application of the SLUFAE weapon in a MOBA environment. Since the weapon was designed with the intent of maximizing the overpressure created, the effect on buildings would be to rather easily reduce them to rubble. This is contrary to one of the objectives of the current planning for a MOBA situation. Secondly, the minimum range and fuzing capability of the present system is limited to at least 350 meters to ensure adequate user safety. This would offer a problem in accurately emplacing the rounds inside of the building or alongside the building that was the intended target. Furthermore, the accuracy of the weapon as it presently exists is relatively poor for this application. Nevertheless, it could be utilized rather effectively for clearing mines or booby traps from large open areas and/or from streets or freeways.

B. Development Activities

The current SLUFAE weapons detonate approximately 85 pounds of fuel, as previously stated. If the weapon were to be made man-portable, obviously the weight of the total round, which is currently about 200 pounds, would have to be reduced significantly. Further study would need to be accomplished to determine the minimum size warhead that could be made to reliably detonate an aerosol cloud in all weather conditions. Some work in this area has been done by the Naval Weapon Center, China Lake, California, and to date the smallest warhead size that has been initiated under laboratory conditions has contained approximately 8 pounds of fuel.

Additionally, BRL has proposed investigation of the effectiveness of a FAE cloud placed on the exterior of buildings and also on the interior of buildings using the SPRAYFAE technique. The SPRAYFAE concept is one in which a fuel air cloud is disseminated using high pressure containers and a special nozzle.

C. Conclusions

The present SLUFAE system would fulfill some of the mission requirements for MOBA. It would be useful for clearing and destroying booby traps and mines that might be placed in roads and larger open areas within the city. The Fuel Air Explosive concept also appears to offer promise for MOBA with additional development. The current FAE system would have some effects which are highly undesirable for combat in confined areas such as major European cities. The major disadvantage is that the overpressure created with the present weapon is very substantial and would likely reduce most buildings to rubble, contrary to the desired intent.

Ideally, one would like to fill a complete building with an aerosol cloud which could then be either ignited (to burn the cloud) or detonated with a low enough overpressure for incapacitating or killing the occupants, but not severely damaging the building. Additionally, it

would be desireable to launch or deploy the fuel aerosol cloud with a man-portable weapon. This, as noted, would create other problems in being able to reliably and successfully detonate a substantially smaller charge than has been tested to date in and under all types of weather conditions. Finally, since the fighting ranges would be approximately 50 meters or less, adequate safe separation between the soldier that launches the weapon and the target must be provided.

D. Recommendations

It is recommended that the specific application of FAE for MOBA be investigated further. The tasks for such an investigation are as follows:

1) Determine the overpressure that is required in order to incapacitate or kill human occupants and yet minimize the damage to buildings.

2) Determine the means for reduction of the overpressure to the level required by task 1. This task should include investigations of the type of fuel utilized, the shape of the cloud, the ignition delay and, for exterior use, the investigation of the effect of wind and general weather conditions.

3) Conduct an investigation of the safe-separation distance required for arming and define the hardware requirements for an appropriate fuzing system for MOBA FAE weapons concepts generated.

SECTION 7

Chemical Weapons & Defense; Radiological Defense

SECTION 7

Chemical Weapons & Defense; Radiological Defense

1. General - Background for this task was obtained by reading available Army doctrinal publications (FM's) and documents in the DDC collection; by visiting appropriate Army laboratories for briefings and discussions; and from a briefing by personnel of the Foreign Science and Technology Center. The Science and Technology Objectives Guide - FY78 and the Proceedings of the Second DARCOM/TRADOC Coordination Conference on MOBA provided information on current and planned Army R&D efforts in the area of MOBA. The conclusion reached from this collection effort is that very little consideration has been given by the Army to the special problems, if any, presented by the possibility of chemical warfare in MOBA. Doctrine for chemical warfare is clearly established by publications such as FM100-5, FM101-40, FM21-40 and FM3-1, but none of these discusses chemical operations in MOBA. Similarly, doctrine for MOBA in FM100-5 does not address chemical aspects of fighting in cities. Draft FM90-10, Military Operations in Built-up Areas states that in the attack on urban areas by "threat forces", "incapacitating or lethal chemical fires are (frequently) employed during bombardment to inflict casualties and preclude destruction of key facilities". Despite this, there is no further development of offensive or defensive doctrine in MOBA in that document. Outside of official publications there is abundant literature dealing with some aspects of MOBA and with chemical warfare, but very little that relates the two. A GTE-Sylvania study for DARPA, completed in 1973, refers to the use of smoke and the riot control agent CS, but not to other incapacitating or lethal chemicals.

   There is an increasing recognition that chemical operations will probably be a part of MOBA if war in Europe should occur. Available literature on Soviet tactics shows that the U.S.S.R. Army expects both MOBA and chemical operations to occur and they train accordingly. The possibility of reducing collateral damage makes the use of chemicals a likely alternative to high explosive weapons. Additionally, if non-combatants are present, as is likely, incapacitating chemicals can be used to clear buildings and other enemy strong points (of enemy) without killing civilians. U.S. Army MOBA experts are beginning to consider chemical operations to be a part of MOBA and we can expect greater emphasis on the use of chemicals in the future.

   Nonetheless, today there is little that is definitive relating chemical operations and MOBA; thus, this portion of the Study Group report is based on speculation and judgement.

2. Offensive Chemical Operations

   a. Current Army capabilities for delivery of lethal chemicals are limited to the 155 mm and 8" howitzers. A 155 mm GB projectile has been type classified but is not in production; an 8" VX projectile is currently in engineering development. These new chemical munitions

are "binary"; that is, the lethal chemicals are assembled at the firing point and the projectile is non-lethal until fired. "Big Eye", a joint development with the Navy and Air Force, is a chemical bomb in which the toxic agents are dispersed pyrotechnically. There is no weapon and ammunition combination currently in the inventory which would permit the individual soldier to deliver lethal chemicals. Smoke and riot control agents, however, can be delivered by a variety of weapons, including the M79 40mm grenade launcher.

b. The very limited variety of lethal chemical delivery means is very likely to inhibit the offensive use of toxic chemicals by the U.S. Army in MOBA. The GTE Sylvania report mentioned above notes that delivery means for smoke are inadequate because desired quantities could not be delivered. Current techniques for screening large open areas employ indirect fire or air-drop. During street fighting at close quarters, current delivery systems are limited and new delivery means are definitely needed. The problems of delivery of chemicals and smoke are similar and it follows that new delivery means are required for chemicals also.

c. There is little data available on the effectiveness and persistency of toxic chemicals in urban areas. Although it is known how chemicals will disperse when released in the open, it is not known how they would disperse in the city or in what concentration. There have been no studies of the best way to obtain required concentrations in buildings, or in streets, tunnels and other places peculiar to the urban environment, nor of persistency indoors compared to outdoors. A sysems analysis has been proposed as part of the FY79 DARCOM Program to determine "the effectiveness of various chemical agents based upon the man/agent/environment relationship which exists in built-up areas."

d. Development Activities - There is some limited reference to the need for improved offensive chemical agents in STOG-78, but not specifically in relation to MOBA. STOG 78-3.15 states a need for improved MOBA capability without reference to chemical operations. There are no ongoing R&D programs with the objective of developing material for chemical operations in MOBA.

e. Conclusions -

(1) Current chemical operations doctrine does not specifically address MOBA.

(2) There is no officially recognized need for development of new weapons or chemicals for use specifically or predominantly in MOBA.

(3) The data base lacks information on dissemination, persistency and effectiveness of chemicals, either lethal or non-lethal, in built-up area.

(4) Weapons currently in the inventory are inadequate for operations in built-up areas. A capability is needed for individuals to deliver chemicals into buildings through windows, open doors or other breaches in the walls. A direct fire delivery capability is needed from tanks, SP and towed howitzers and engineer assault guns. A new delivery means is needed to lay screening smoke, riot control or toxic chemicals to assist offensive operations.

f. Recommendations

(1) The systems analysis of the use of chemical agents in MOBA proposed by the 2nd DARCOM-TRADOC Coordination Conference on MOBA should be executed. Output of the study should include: Data base information on dissemination, dispersal, persistency and effectiveness of toxic and non-toxic chemicals in built-up areas; weapon concepts for individual, crew-served, artillery, rocket, tank and air delivery of toxic and non-toxic chemicals in MOBA: recommendations for development of new chemical agents if required for MOBA.

(2) A toxic chemical grenade for the M79 grenade launcher should be developed.

(3) A chemical submunition warhead for air and rocket delivery should be developed for use in screening large areas in built-up areas.

(4) Feasibility of a warhead capable of penetrating concrete and masonry walls and delivering chemicals inside buildings should be investigated. If feasible, such ammunition should be developed for the 105 mm tank gun for use in MOBA.

3. Protection Against Chemical Weapons

a. The Army considers five functions associated with defense against chemical operations: warning; protection, decontamination; prophylaxis and therapy; and monitoring to determine safety after attack. Equipment exists for performing all of these functions to one degree or another in the open or in MOBA. Most of the current equipments have limitations which inhibit usefulness in any sort of operations, MOBA or otherwise. Materiel improvements are needed in all of the functional areas to bring the Army to an acceptable level of operational capability in any toxic chemical environment. Most of the material deficiencies which adversely affect the Army's capabilities in the field will also affect its capabilities in MOBA. These

are generally well-known within the Army and developments are underway to alleviate some. As in the case of offensive chemical operations, the special problems of operating in urban areas in a chemical environment have not been addressed, and it is necessary to speculate as to what some of these special problems may be.

b. Warning. The M8 alarm is being procured and deployed in Europe. It is limited to the detection of nerve agents and does not warn of the presence of other chemicals such as mustard, lewisite, phosgene or adamsite. However, the nerve agents are the most likely to be employed so the M8 will warn of the expected threat. The usefulness of this device in cities has not been specifically determined, but its performance should be no better nor worse than in the open. No remote detector exists, so it is not possible now to test for the presence of toxic chemicals before entering an area. This could present a special problem in MOBA since toxic chemicals could be confined to one or more buildings or even one or more rooms of buildings in a city. The tactical solution is to remain masked and protected in any case that the presence of toxic vapors is suspected.

c. Protection. A protective mask is in the hands of troops and protective clothing is being issued in Europe. Collective protection equipment is available in limited quantities for limited purposes (e.g., the M51 shelter). Armored vehicles of the U.S. Army do not have CBR protection, although the Army has been directed by the Congress to prepare a plan to provide such protection. Soviet armored vehicles have a positive pressure and filtration system which permits the crew to operate the vehicles without wearing individual protective gear. The need to wear individual protective equipment for extended periods of time in a chemical environment severely limits the activities and operations of any Army. This is true whether in MOBA or not. Training can alleviate the problem, but cannot eliminate it.

d. Decontamination. Kits for decontamination of people and equipment are available and are moderately successful. In MOBA, however, the decontamination problem is immense if a city has been subjected to a massive chemical attack by high altitude missile airburst ("toxic rain"). Again, the only currently available way to operate in a contaminated city is in individual protective equipment.

e. Prophylaxis. There is no practical prophylaxis for new agents available now. There are antidotes (principally atropine) available which are carried by the individual and self-injected if exposed to nerve agents. An improved antidote, TAB, was exploited from the 1973 mid-East war and is now issued to forces to Eurpoe. There is no different problem associated with operations in cities than in the open.

f. Detection. Chemical agent detector kits are used by CBR trained personnel to detect dangerous vapor concentration by color changes in detector tubes or enzyme tickets. These are useable equally well in cities or in the field. Again, if the presence of an agent is suspected, the user must wear individual protective gear.

g. Development Activities. Improved individual and protective equipment is under development. A new mask, the XM29, capable of being donned in 4 seconds, is in development now. It also embodies other improvements including better communication capability. Improved chemical alarms including a remote chemical agent detector are also in development. The STOG, section 78-5.3.1 through 78-5.3.4, details needs for defensive chemical equipment such as alarms and individual and collective protective equipment. STOG 78-7.2.1 b established the need for "A prophylactic/antidote protective system to provide long term protection against chemical agents in order to eliminate the reduction in individual efficiency, motivation and effectiveness caused by protective equipment". This is really the only way to provide an order of magnitude improvement in the Army's capability to operate in a chemical environment.

h. Conclusions

(1) The Army's posture to operate in a chemical environment, MOBA or otherwise, is minimal but improving as the realization grows that use of chemicals is likely if there is a war in Europe.

(2) Special problems of warning, detection, decontamination and collective protection exist in a MOBA environment, none of which has received significant attention by the Army.

(3) The information deficiency in the data base cited in paragraph 2 (c) applies equally to the area of protection against chemical operations.

(4) Materiel developments in the defensive chemical area should include considerations of MOBA so equipment will be useful in any environment or combat condition.

i. Recommendations

(1) The MOBA systems analysis (paragraph 2 f (1)) should include consideration of protection against chemical agents and recommend materiel developments that are needed.

(2) If there is the least hope of developing the prophylaxis/antidote protective system of STOG 78-7.2.1 b, the Army should launch a major effort to bring this system to fruition. Research has been

conducted on the mechanism by which nerve agents attack the nervous system and development of a prophylaxis system may be possible as a result of continued investigation.

(3) Increased R&D on the development of catalytic agents which hydrolize toxic chemicals is recommended. STOG 78-5.3.2 specifies a dry decontaminant if possible to reduce logistics and handling problems.

(4) Remote detection of chemical agents and an alarm system to alert small units should be developed. An infrared spectral analysis detector currently is being developed.

4. Protection Against Nuclear Radiation

a. Lt. Raymond R. Lutz of the Foreign Science and Technology Center has prepared a report, Urban Warfare: Characteristics of the Battlefield, dated September 1977. In an unclassified abstract of this report, Lt. Lutz says that research and analysis of open source literature shows that "The Soviets anticipate use of nuclear weapons by both sides should a war in Europe occur." It follows that the U.S. Army should consider it probable that nuclear weapons will be used also in MOBA in the event of a war in Europe. Defense against nuclear attack currently consists main of passive measures, namely, taking cover where protection is available against flash, thermal, blast and radiation effects. The protection provided in a city against flash, thermal and initial radiation energy probably exceeds that in the open. Blast may produce additional secondary casualties from flying and falling debris and glass which would not occur in the open. On the whole, protection in the city is more readily available than in the field where foxholes or bunkers must be prepared to produce some degree of protection. Armored vehicles provide some protection against blast, thermal and flash, but little or no protection against initial neutron radiation.

b. Residual radiation and fallout present significant operational problems, whether in a city or in the field. This radiation, in the form of beta and gamma rays, prevents operational use of the contaminated area for varying periods of time after the blast or after arrival of fallout. The Army has no protective clothing which will permit personnel to operate in areas contaminated by nuclear radiation, except for very short periods of time. Again, this problem exists whether the contaminated area is in a city or in the open. A city area contaminated by residual radiation, however, would be more difficult to cross because of rubble caused by blast effects of the weapon. An area of residual nuclear contamination is usually safe for occupancy after 2-5 days. This must be determined by nuclear survey teams. Fighting in a city where there is nuclear contamination is not

possible until the radiation is reduced to a level of acceptable risk. Radiation exposure levels and time of exposure must be closely monitored to prevent accumulation of an unacceptable dose.

c. STOG-78 contains several paragraphs stating objectives for improving the Army's capability to operate in a nuclear environment. These include hardening objectives, nuclear burst detection, nuclear survey, eye protection equipment, improved dosimetry and others. The development of these equipments would benefit operations in MOBA as well as in rural or open areas. As in the case of chemical protection there is a STO (78-7.2.1 c) for "A means for the prevention and/or treatment of nuclear radiation sickness or for mitigating the effects of ionizing radiation". The accomplishment of this objective would achieve an order of magnitude improvement of our capability to operate in a nuclear environment, in the city or in the open.

d. Conclusions

(1) The effects of nuclear explosions and nuclear radiation in cities have been studied, tested and documented.

(2) Military operations in a city contaminated by residual nuclear radiation are possible only under the same conditions as in the field.

(3) Clothing or equipment to provide physical protection against the effects of ionizing radiation, particularly neutrons and gamma rays, is impractical for the individual soldier under today's state-of-the-art. Some protection is provided by armor in combat vehicles, by sand bags and by earth in foxholes and bunkers.

e. Recommendations

(1) Development efforts underway and proposed to develop improved burst detection; monitoring and survey, dosimetry, eye protection equipment, and hardening technology should be continued. These developments will improve the Army's posture for both operations in the open and MOBA.

(2) The development of a preventive/cure for radiation sickness (STOG 78-7.2.1 c) should be vigorously prosecuted.

SECTION 8

Mobility

SECTION 8

Mobility

Mobility was one of the separate sections of the Military Operations in Built-up Areas study assignment. Topics nominated for consideration were:

(a) Rubble in streets effectively blocks wheeled traffic until removed.

(b) Direct routes from point to point are not always available.

(c) Over limited range, buildings provide the enemy with excellent observation of movement and a vantage point for attack. All vehicles are vulnerable.

(d) Helicopter movement in city "canyons" is severely restricted.

(e) Visibility restrictions caused by night, haze, smoke and other obscuration compounds movement problem.

and

(f) Current casualty evacuation is largely based on helicopter movement. Ground or underground evacuation will usually be necessary during MOBA. Movement of wounded by wheeled vehicle is generally unacceptable in MOBA because of severe jolting of the wounded caused by rough roads, rubble, etc.

Technological improvements of existing capabilities or creation of new capabilities without significant degradation of non-MOBA capabilities are sought in response to the effects above on the mobility function.

I have read quite a bulk of material on the topic and reviewed the mobility related R&D aspects of the Army program as well as the Scientific/Technology Objectives Guide and have reached a satisfaction to the end that, THERE IS NO NEED FOR DEVELOPING A NEW ITEM OF AUTOMOTIVE EQUIPMENT FOR MOBA.

The several papers on MOBA display an increasing awareness on the part of the Army Training and Doctrine staff that MOBA has been a neglected area in the past and indicate to this writer that an appropriate level of attention is in the process of being achieved. Where the topic could not be spoken of openly in the past because of sensitivity of the international public, it now appears that a realistic public understanding that war must involve built-up areas is being achieved. The combination of public understanding and army training and doctrine development appears to this writer to be the most significant developments in the MOBA field during the last four or five years.

There is sufficient experience in the U.S. Military and Intelligence community with MOBA operations to establish the basic elements of mobility impediments. (Some elements of contact with the experience were passed to Col. Jaschen recently.)

Medical demands on mobility in MOBA appear to be minimal. There seems to this writer to be an attitude in Army Medical R&D which is both realistic and non-optimistic with regard to the role of technological based mobility changes of Army equipment. To the extent that anything will work (in the medically related mobility arena) the current equipment will work. The operation of the medical service delivery and casualty treatment/evacuation system is different only in detail in MOBA compared to non-MOBA. No new (mobility) equipment of an automotive type appears required.

Of all the concerns relative to mobility in MOBA, the existence of street barriers to wheeled traffic is the most significant. Indigenous armed forces have developed a history of barricading streets with local mat rials (predominately overturned vehicles) as effective barriers to the para-military or military operations directed against them. We should presume that this type of barrier can be made more effective as the result of deliberate military planning and well thought out fields of covering fire. The wheeled vehicle cannot mount and pass such barriers nor will it be enabled to do so by design change. The tracked vehicle may only marginally mount and pass such barriers. There have traditionally been nonpassable barriers to vehicular traffic—street barriers are merely one of these. Overcoming the barrier to mobility presented by hastily erected street barricades may be found in equipping some classes of vehicles with deliberately designed winching/towing devices to allow the barricade to be "picked apart" through removing its keystone elements.

The development suggested is for a practical means of attaching the basic winching devices of current vehicles to barricade elements without dismounted personnel, i.e., to provide a means for armoured vehicles to dismantle street barricades without undue exposure to covering fire or land mines incorporated in the barricades.

The helicopter mobility restriction appears to be more related to its vulnerability to automatically controlled gun and missile fire than to the basic characteristics of built-up areas versus non-built up areas. Built-up areas offer a plethora of cover and landing sites and the hazards of operation from man-made physical obstacles (wires and cables) are not unique to built-up areas. The operation of helicopters with ground cooperation of the units being serviced seems entirely feasible from an equipment point of view. Changes in armour philosophy are in order—as it is in the case of wheeled vehicles—due to the possibility of light arms being brought to bear from super-elevation angles, but that is not a technologic/mobility consideration of any new form.

I have avoided repeating the categories and structures of the several scenarios of MOBA that the analysis of the question require. I have read and studied several and feel that there is no significant aspect of mobility in MOBA that I have failed to think and read about over these last several months. I feel quite secure that the mobility of our current forces is as adequately developed for MOBA as is reasonable and that no new vehicle classes or severe modifications of current classes is called for. My sole recommendation is that of the enhancement of anti-barricade capability previously mentioned.

SECTION 9

Psychological Factors

SECTION 9

Psychological Factors

OVERVIEW

An assessment of Army requirements, activities and capabilities was conducted regarding psychological factors in MOBA (Military Operations in Built-up Areas). The objective was to identify critical technical problems and to recommend high payoff technical solutions.

The principal finding was that the U.S. Army needs increased capability for dealing with psychological components of MOBA. This is especially apparent in relation to efforts by several allied nations and by Soviet forces.

The most critical need is for the development and application of training and simulation techniques to prepare regular combat units of the U.S. Army for MOBA.

INTRODUCTION

Military operations in built-up areas (MOBA) are manpower-intensive and characteristically involve high levels of personal stress. Therefore, psychological factors carry potentially greater impact than in other typical combat situations. Military history also verifies that psychological factors significantly influence the combat effectiveness of forces engaged in MOBA.

This report provides an assessment of key psychological components in MOBA and recommends research and development activities and application of advanced technology to improve the U.S. Army's effectiveness in MOBA. Only those "psychological factors" which can be shown to influence individual or group performance in behavioral terms were considered in developing recommendations.

One premise underlying this report is that MOBA is basically an extension of combat conducted in open areas. While the stress level of combat in MOBA is greatly increased, essentially the same forces and equipment must be used in both combat environments. It does not appear practical for the Army to set up special organizations, to select special personnel or to provide much specialized equipment or supporting services for MOBA. It has been assumed that operations in MOBA will be conducted by regular forces using organic or locally available equipment and materials. Consequently, the psychological preparation for MOBA in the Army becomes very important.

Three major groups of people become involved in MOBA - own (including allied) combat forces, enemy combat forces, and local civilian populations.

In this paper, primary emphasis is on U.S. Army personnel. Enemy forces include all regular combat personnel of the opposing side and hostile partisans. Local population include civilians, local and national police and local government personnel, and indigenous civilians, who may be induced voluntarily to assist our forces. The presence of civilians complicates the conduct of military operations and can create additional sources of stress for Army combat personnel. The psychological factors in MOBA relevant to the three basic groups are different but inter-related.

Military psychology is concerned with a number of topic areas. A listing of these will serve to indicate the areas considered in arriving at the recommendations given in this report. The topic areas include:

- selection
- training
- evaluation of performance
- motivation and morale
- human engineering of equipment
- perception
- leadership and decision making
- interpersonal communications
- propaganda
- deception
- group dynamics and team work
- stress and fatigue effects

The reader should note that psychological components of MOBA cannot be considered in isolation from many other factors. Weapons, communciations and supply, for example, have significant relationship to psychological considerations in MOBA. As a result, recommendations made herein should be considered jointly with those made in related areas.

THE PSYCHOLOGICAL NATURE OF MOBA

Warfare in built-up areas typically involves quantitative and qualitative differences from combat in open country. Some of these differences have direct, psychological consequences. Others have indirect, but not insignificant consequences. Allowance must be made for these consequences if combat effectiveness is to be maximized.

The following list describes some of the circumstances of MOBA which have psychological implications:

- Combat will typically occur at close range
- Danger may exist in all directions, including above and below
- Fire from snipers is a severe threat
- Direct observation may be severely limited
- Normal communication channels are likely to be unreliable
- Fighting is likely to be intense and to occur with little warning
- Maps may be inadequate and orientation difficult
- Most action will take place at a small unit or combat team level
- Tactics and use of weapons must be suited to local conditions

- While battle planning may be centralized, execution is decentralized
- Use of combined arms support will be reduced
- Periods of combat may be extensive, covering weeks or months
- Fighting may continue during the night
- Resupply of munitions, food and water will be more difficult
- Presence of civilian personnel can be expected
- Medical support may be greatly reduced. Casualties and dead may remain with operating forces.

These conditions place a high premium on the skills, initiative, motivation and ability of combat personnel to handle the physiological and psychological stresses of MOBA. Reports of previous experience in MOBA show that attention to these factors can be a potent multiplier of force effectiveness. Conversely, lack of readiness will produce unnecessary losses of personnel and failure to achieve combat objectives, whether offensive or defensive.

Consequences of inadequate preparations include:

- Physical and mental exhaustion
- Reduced individual and group morale and effectiveness
- Disorganized, inflexible responses to rapidly changing situations
- Reduced alertness and concentration
- Impaired decision-making processes
- Lack of effective leadership, especially at small unit levels
- Impaired physical functioning
- Regression to old, inappropriate behavior patterns
- Problems in maintaining civilian control and avoiding mob behavior
- High rate of casualties

FINDINGS

Examination of the conditions and requirements for MOBA, as presently understood, produced the following conclusions: Urban growth in potential battle areas increases the future likelihood of MOBA. At the same time, awareness that the subject of MOBA requires more attention is increasing within the army. Some MOBA-oriented research and development activities have been initiated. For example, the Army Human Engineering Laboratory is testing the use of weapons in a MOBA environment. There is a MOBA newsletter and Field Manuals on MOBA are being prepared.

However, at present there appears to be no systematic effort by the Army to define the effects of psychological factors in MOBA or to prepare soldiers to cope with them. For example, no specific research and development activities on MOBA are active or planned by the Army Research Institute for the Behavioral and Social Sciences. A proposed list of MOBA program tasks for DARCOM and TRADOC in 1978 includes no activity on psychological aspects of MOBA except for the small task on Human Factors by the Human Engineering Laboratory. (Reference: Second DARCOM-TRADOC Coordination Conference on MOBA, 19-20 July 1977, Letter Report Number 232, U.S. Army Human Engineering Laboratory.) In contrast, the FBI Academy at Quantico, Virgina, has an active program dealing with definition of psychological components of such related topics as terrorism, hostage cases and civil distrubances. A California police academy conducts courses to prepare law enforcement personnel to understand and handle combat-type stresses in oneself and in others.

There is an existing base of knowledge and experience relevant to MOBA available to the U.S. Army, principally among veterans of fighting in European towns and villages during World War II, among veterans of fighting in Seoul during the Korean War, and among veterans of battle of Hue during the war in Vietnam. However, this knowledge is not being fully used.

The existing, organized data base on MOBA is inadequate. Little quantitative data exists. Furthermore, standard MOBA scenarios are lacking and existing models of MOBA limited. The Human Engineering Laboratory has an effort in progress to develop an historical data base for MOBA. This project, however, is still at an early stage. Several computer models exist but are inadequate for handling many problems related to MOBA. Standard scenarios would be useful for various elements of the Army to develop and evaluate approaches to fulfilling their particular functions in MOBA.

The U.S. Army's training capabilities for MOBA are inadequate or nonexistent. The U.S. Army's existing training areas in the U.S. are in open country. Two notable exceptions are in training provided by the Berlin Brigade and the training provided for Special Forces personnel. In general, our troops are not being prepared psychologically for conditions of MOBA. Lack of relevant knowledge and skill and lack of experience in handling high levels of stress will produce fear and lack of confidence in actual combat, thus crippling combat effectiveness. Morale will deteriorate rapidly if personnel perceive themselves to be in a "no-win" situation or in one for which their leaders are not prepared. In contrast, current Soviet training places a high degree of emphasis on "moral" (psychological) readiness for combat. This involves experience in handling conditions such as extreme fatigue, weather and exposure to live firing in training. The Soviets specifically prepare troops for the rigors of MOBA. Also, both the Federal Republic of Germany and the United Kingdom have developed specialized, realistic training villages for MOBA. These facilities simulate many of the environmental, physical and decision-making demands of MOBA.

The importance of training for both troops and junior leaders in combat is evident in data reported by S.L.A Marshall in his paper, "Aspects of Leadership in Viet Nam". He reports that "35 to 40 percent of our casualties in Viet Nam come from our own blunders rather than from the guile and strategems of the enemy. Our troops fall into the same traps over and over again". Also, he reported that somewhere between 75 to 90 percent of our casualties occurred in the first 5 to 10 minutes of engagement.

The importance of training for psychological readiness is well expressed in the following statement: "A skill must be developed ahead of time under a situation of maximal complexity. A soldier should learn to perform any action under conditions of inner stress and excitement, as well as positive and negative emotions. For this reason, in psychological training, it is essential to create a situation which is psychologically close to combat (that is, causing great stress on the mind, will, and feelings), and train for protracted work which involves maximum tension, abrupt and sudden complications, use of protective chemical warfare equipment, use of heavy interference; also training in the dark or while blindfolded, simulation of injury, and so forth. It has been shown in experiments that the preliminary training of personnel under conditions which simulate expected difficulties helps a person to adapt to them and to maintain optimum functional activeness and effectiveness of activity". (From Military Psychology by V. V. Shelvag, A. D. Glotochkin and K. K. Platonov, Moscow. 1972.)

Physical training for MOBA is needed. Recent experiences show U.S. troops have sometimes been unable to handle physical requirements of combat. In MOBA, upper body strength becomes relatively more important. Here again, training provided Ranger personnel is closer to what is needed. However, specific requirements for MOBA have not been defined.

Current organization, doctrine and training for medical support is not consistent with conditions anticipated for MOBA. The current approach is based on evacuation of casualties. This may not be possible in a MOBA environment. The consequence will be higher loss of wounded and an adverse psychological impact on remaining troops. Also, different patterns of wounds occur in MOBA.

Knowledge of weapons, tactics and doctrine of potential enemy forces in MOBA is available. Little activity was found, however, directed at the use of psychological factors to reduce the potential effectiveness of enemy forces. Dealing with snipers is a particular problem. Some attention is being given to the use of smoke and foam as a means for concealing our forces and increasing uncertainty in enemy decision processes.

The overall conclusion is that the U.S. Army is not adequately preparing itself for the psychological factors in MOBA. There are a number of specific areas needing research and development in order to improve the Army's capabilities.

The highest priority need is to develop and implement a realistic, demanding program of training for MOBA. Special training and simulation methods and materials will have to be developed for such a program.

RECOMMENDATIONS

The following specific efforts are recommended to develop a data base and advanced technology for dealing with psychological components of MOBA.

1. Expand the current effort which is developing an historical data base on MOBA to collect, document and analyze personal experience data from veterans of MOBA combat.

2. Develop specific performance requirements and criteria for individual and unit performance in MOBA.

3. Define the variables which control or limit individual and unit performance and obtain empirical data on their functional relationships, including physical and psychological factors.

4. Develop a standard set of MOBA offensive and defensive scenarios.

5. Refine and extend computer simulation models of MOBA to be suitable for training use as well as for tactics and weapon development.

6. Conduct research to define specific MOBA training requirements, scenarios and performance measurement methods.

7. Conduct Cost Training Effectiveness Analyses (CTEA) and define and develop special training facilities needed for training in MOBA operations. This includes required simulation devices. An initial installation should be obtained as a research and development facility as well as for training.

8. Develop acceptable techniques for using or simulating the use of live-firing in MOBA training.

GLOSSARY OF ACRONYMS

AAH	-	Advanced Attack Helicopter
ADAM	-	Artillery Delivered Antipersonnel Mine
AHAM	-	Advanced Heavy Antitank Missile
ARRADCOM	-	U. S. Army Armament Research & Development Command
ARTINS	-	Army Terrain Information System
ARTEP	-	Army Training Evaluation Program
AVRADCOM	-	U. S. Army Aviation Research & Development Command
CACDA	-	U. S. Army Combined Arms Combat Development Agency
CADPL	-	U. S. Army Communications/Automatic Data Processing Laboratory
CBR	-	Chemical, Biological, Radiological
C^2	-	Command and Control
CCD	-	Charge-Coupled Device
CDEC	-	U. S. Army Combat Developments Experimentation Center
CERCOM	-	U. S. Army Communication & Electronics Materiel Readiness Command
CIC	-	Combat in Cities
CLGP	-	Cannon Launched Guided Projectile (Copperhead)
COBA	-	Communications Operations in Built-Up Areas
COMSR	-	Communications Support Requirements
CORADCOM	-	U. S. Army Communication Research & Development Command
CS&TA	-	Combat Surveillance & Target Acquisition
CTEA	-	Cost Training Effectiveness Analysis
CVSDM	-	Continuous Variable Slope Delta Modulation
DARCOM	-	U. S. Army Material Development & Readiness Command

GLOSSARY OF ACRONYMS (Continued)

DCSRADA	-	U. S. Army Deputy Chief of Staff for Research, Development & Acquisition
DIVADS	-	Division Air Defense System
DMA	-	Defense Mapping Agency
DYNTACS	-	Dynamic Tactical System
ECCM	-	Electronic Counter - Countermeasures
ECOM	-	U. S. Army Electronics Command (no longer in existence; elements of ECOM now comprise ERADCOM, CERCOM & CORADCOM)
EMID	-	Electromagnetic Intrusion Detector
ERAM	-	Extended Range Anti-Armor Mine
ERADCOM	-	U. S. Army Electronics Research & Development Command
ETL	-	U. S. Army Engineer Topographic Laboratory
FAE	-	Fuel Air Explosive
FET	-	Field Effect Transistor
FLIR	-	Forward Looking Infrared
FRG	-	Federal Republic of Germany
GEMSS	-	Ground Emplaced Mine Scattering System
GSRS	-	General Support Rocket System
HEP	-	High Explosive Plastic
HOWLS	-	Hostile Weapon Locating System
IFF	-	Identification Friend or Foe
LAW	-	Light Antitank - assault weapon
LOA	-	Letter of Agreement
LOPAIR	-	Long Path Infrared

GLOSSARY OF ACRONYMS (Continued)

MERADCOM	-	U. S. Army Mobility Equipment Research & Development Command
MEMS	-	Manually Emplaced Mine System
MENS	-	Mission Element Need Statement
METRRA	-	Metal Re-radiation
MISER	-	Minimum Signature Envelope Recoilless
MOBA	-	Military Operations in Built-up Areas
MOBACS	-	Military Operations in Built-up Areas Combat Simulation
MOPMS	-	Modular Pack Mine System
MOUT	-	Military Operations on Urbanized Terrain
MTI	-	Moving Target Indicator
NSF	-	National Science Foundation
PEWS	-	Platoon Early Warning System
PGM	-	Precision Guided Munition
PLRS	-	Position Locating and Reporting System
RAAM	-	Remote Artillery Antiarmor Mine
RAG	-	Ring Airfoil Grenade
RAMP	-	Ring Airfoil Multi-Purpose Munition
RAW	-	Riflemans Assault Weapon
REMBASS	-	Remotely Monitored Battlefield Sensor System
ROC	-	Required Operational Capability
RPV	-	Remotely Piloted Vehicle
RR	-	Recoilless Rifle
SADARM	-	Search & Destroy Armor
SBA	-	Short Base Acoustic Array

GLOSSARY OF ACRONYMS (Continued)

SCORES	-	Scenario Oriented Recurring Evaluation System
SHAWL	-	Special Hard-Target Assault Weapon-Law
SINCGARS	-	Single Channel Ground & Airborne Radio System
SLAR	-	Side Looking Airborne Radar
SLUFAE	-	Surface Launched Unit - Fuel Air Explosive
SMAW	-	Shoulder-Launched Mutli-Purpose Assault Weapon
SOTAS	-	Standoff Target Acquisition System
STAFF	-	Standoff Target Activated Fire and Forget
STOG	-	U. S. Army Science & Technology Objectives Guide
STORM	-	Sensor Tank Off-Route Mine
TAC	-	Terrain Analysis Center of U. S. Army Engineer Topographic Laboratory
TADS	-	Target Acquisition & Designation System
TATAWS	-	Tank Anti-Tank Assault Weapon System
TGSM	-	Terminally Guided Submunition
TGMW	-	Terminally Guided Missile Warhead
TOE	-	Table of Organization & Equipment
TOW	-	Tube-Launched Optically-tracked Wire-guided Missile System
TRADOC	-	U. S. Army Training & Doctrine Command
UGS	-	Unattended Ground Sensors
VTOL	-	Vertical Takeoff & Landing

Arthur D. Little Inc.

ACORN PARK
CAMBRIDGE, MASSACHUSETTS 02140
(617) 864-5770

JAMES M. GAVIN
DIRECTOR AND ECONOMIST

April 4, 1978

Dr. Joseph H. Yang, Executive Director
Army Science Board
The Pentagon, Room 3E 390
Washington, D.C. 20310

Dear Dr. Yang:

I have read the draft final report of the ASB Ad Hoc Group on Military Operations in Built-up Areas (MOBA) and concur in their findings. They have reached some general conclusions about the Army's posture for MOBA as follows:

- In a European war, MOBA are inevitable because of the ever-increasing urban nature of the terrain. Cities and towns will become part of the battle and need to be recognized by commanders as possible strong points or objectives.

- Segments of the Army have recognized that a renewed awareness of MOBA is needed and are trying to prepare the Army for that contingency. DARCOM and TRADOC have a program underway to investigate material effectiveness in MOBA, but it is low-level ($2,175M proposed in FY73; $6.5M proposed for FY79). However, there is no money in FY78 for this purpose.

- In each of the areas studied, there are deficiencies in current and developmental equipment when it is used in MOBA. These deficiencies are qualitatively known, but hard quantitative data on the materiel degradation in MOBA is not yet available. A prime example is RF communications. We know that radios don't perform well in MOBA, but we don't know how much their performance is degraded in various urban environments.

- Material requirements documents do not now specify operability criteria in MOBA. The Group feels that all material developed by DARCOM should be usable in cities as well as in the open -- this should be a specified requirement even as temperature extremes are specified.

The Group also believes that, philosophically, specialized materiel developed solely for use in MOBA should be avoided. Because the Army will be changing from open-field to city operations and back, specialized material for one environment or the other would be a handicap.

- In most cases, using today's technology, the materiel deficiencies noted can be corrected or improved. In some cases new materiel may need to be developed to provide the needed capability for MOBA, but can be made dual purpose for operation in the open also.

- There are some foreign equipments available now which could be adapted to fill capability gaps. There equipments should be evaluated by DARCOM to determine suitability.

- Psychological factors in MOBA need to be studied in greater depth. There are some aspects of MOBA which make urban combat psychologically more debilitating than combat in the open. The major recommendation for overcoming these factors is training, so we feel that increased training in MOBA is essential. Technology can provide realistic facilities and simulations to help achieve the necessary training.

The body of the report consists of a short introduction, an executive summary and nine separate sections, each dealing with a different functional area of MOBA. The nine separate sections contain detailed discussion of the functional areas, from which a set of conclusions or findings is drawn, and conclude with recommendations based on the conclusions. The Study Group has selected from the many different recommendations a set of technical solutions to MOBA-related materiel problems which they believe have the highest payoff possibilities. These are included in the Executive Summary. I concur with the Study Group that these do offer high payoff possibilities and I strongly urge the Army to increase current efforts to bring about overall improvement in its readiness posture for MOBA.

Sincerely,

James M. Gavin
LTG, USA (Ret)

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

APR 24 1978

Dr. James J. Renier
Executive Vice President
Honeywell, Inc.
Honeywell Plaza
Minneapolis, Minnesota 55408

Dear Jim:

I read the draft report on MOBA in the following order: INTRODUCTION; SECTIONS 1 through 9, and then the EXECUTIVE SUMMARY. I was most impressed with the quality of the INTRODUCTION and the EXECUTIVE SUMMARY. Studying the content of the report against the Terms of Reference under which panel members must toil, and do so in a very short time, I should like to commend you and members of your ad hoc group for a difficult job well done.

The study clearly surfaced the need within the Army to understand and to document the following:

1. The basic and general characteristics of built-up areas in Western Europe in a NATO/PACT conflict. (It seems to me that the 567 towns and villages in the FRG provide a good sample size of possible built-up areas.)

2. The types of military operations that are most likely to occur in built-up areas (war of attrition, search and destroy, encirclement, etc.) in case a NATO/PACT war should unfold now, in five years, in ten years, etc.

3. With a clear understanding and articulation of what military operations in built-up areas are likely to be, one can then, based on specific threat assessment and force structure at hand of the moment, analyze and specify the weapons, ammunitions and C^3 required to accomplish the operational objectives.

4. The role of science and technology is to bridge the gap between operationally required capabilities and the existing capabilities of

various systems in the field. The best contribution the ad hoc group can make is to help identify the science and technology areas that can help or expedite the filling of the gap.

Without focused information on MOBA (a definition of MOBA does not exist in the JCS PUB 1 or AR 310-25), members of the study group must be left to rely on an approximate notion of what MOBA might be, and draw conclusions and recommendations of traditional concerns to the Army, as any realistic, intelligent people would do. Of the conclusions and recommendations, I would like to endorse the following:

1. The terrain analysis effort at the US Army Engineer Topographic Laboratory should include future potential built-up areas. This analysis effort should include the details which depict building heights, widths of city streets, bridge clearances, subway routes, pipelines, etc. The data bank should also include locations of underground installations such as power and communications centers, etc.

2. The soldiers operating in the BA should be equipped and trained to use the following weapons and equipment:

a. Shoulder-launched, crew-served weapons with fast firing rate.

b. Night vision and smoke/debris penetrating sensors.

c. Personal protection equipment (including NBC protection).

d. Remotely-launched precision weapons.

e. Wall/building breaching ammunitions.

f. Portable mobile communications sets.

g. Off-route anti-vehicle, anti-personnel mines and remotely-controlled mines.

h. Casualty treatment/evacuation and decontamination equipment.

3. Though not covered in the TOR, I think the section on psychological factors was very penetrating and well presented.

Dr. James J. Renier

Without a clear understanding of what MOBA is (as is the case), I find it difficult to take seriously the recommendations regarding modeling of MOBA and the requirements for a "strong C^2 architecture and systems engineering group."

Finally I would like to thank you and members of your study group for taking time and energy to respond to a tasking which was not clearly defined, and for doing a professional job for the Army.

Sincerely,

Joseph H. Yang

Joseph H. Yang
Executive Director
Army Science Board

Copies furnished:
GEN Donn A. Starry
GEN John R. Guthrie
Dr. Percy A. Pierre
Dr. J. Ernest Wilkins
Dr. Phil DePoy
LTG Edward C. Meyer
LTG Donald R. Keith
Dr. Marvin E. Lasser
LTG James M. Gavin (USA, Ret.)

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
WASHINGTON, D.C. 20310

REPLY TO ATTENTION OF:
DAMO-TRS

3 OCT 1978

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (RESEARCH, DEVELOPMENT, AND ACQUISITION)

SUBJECT: Final Report - Army Science Board Ad Hoc Group on Military Operations in Built-up Areas (MOBA) (Redesignated MOUT)

1. The Army General Staff and Major Commands have reviewed the subject report (Tab B). The comments have been consolidated and are forwarded in accordance with your request of 6 July 1978.

2. In general, the report is timely, to the point, and comprehensive. The findings and recommendations of the Ad Hoc Group appear valid.

3. The report addresses a deficiency in combat training and capability for ground forces that is of vital concern to the Army. The report reinforces the need for a MOBA training complex at every division and brigade size installation. New MOBA training facilities at Fort Bragg, North Carolina and Hohenfels, West Germany are included in the FY 80 budget and should be strongly supported.

4. There is a great need for one agency to oversee MOBA, or Military Operations in Urbanized Terrain (MOUT) to provide a cohesive plan of development and direction to the entire MOBA effort.

5. Specific comments are contained at Tab A.

6. The Berlin Brigade has recently developed a MOBA training package oriented at individual and company-sized unit training objectives (Tab C). This effort represents a significant breakthrough in MOBA training techniques. The Seventh Army Training Center and Berlin Brigade are developing a MOBA ARTEP. These actions could provide a standard for Army MOBA training.

FOR THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS:

Renick

R. D. RENICK, JR.
Brigadier General, GS
Acting Director of Operations and Readiness

3 Incl
as

CF:
OCSA

C-1

SPECIFIC COMMENTS
on
FINAL REPORT - Army Science Board Ad Hoc Group on Military Operations in Built-Up Areas (MOBA)

1. Chapter 14, FM 100-5, should be used to provide tactical doctrine for MOBA. Additionally, land forces tactical doctrine, Chapter 14, ATP-35 (STANAG 2868), once validated, will provide the same from a NATO point of view.

2. The Army Science Board Ad Hoc Group on Military Operations in Built-up Areas (MOBA) final report is correct in so far as it describes the threat to the Army missions from urban combat. Future studies may well reflect the DA policy emphasis on the opposing force (OPFOR) program, AR 350-2, 15 August 1978. The considerable volume of unclassified Soviet military writing on MOBA is not acknowledged in the report. Recommend:

a. That the report in the executive summary incorporate by reference the Defense Intelligence Agency unclassified publication Soviet Military Operations in Built-up Areas, DDI-1100--155-77, July 1977.

b. That the assessed Soviet MOBA weaknesses (insufficient training time, control difficulties, communications, and fire coordination) be noted as more redressed by training than by newly developed equipment.

c. Further information on the subject is available in the Stanford Research Institute unclassified technical note Soviet Tactical Doctrine for Urban Warfare, SSC-TN-2625-16, December 1975, prepared for Defense Advanced Research Projects Agency.

3. The study appears deficient in its failure to treat intelligence as a major factor of combat operations. While it is functionally alluded to in Sections 2, 3 and 4, it is either summarily treated as data inputs or referenced as a first order function for targeting. To be complete the study should address the major role of intelligence in the Command and Control decision process as it impacts on the commitment of resources in general and the execution of plans in particular. Particular attention should be given to the potential multiple source availability and the significant interrelationships of strategic/macro indicators and the more ephemeral local data.

4. While there is an obvious need for special purpose MOBA training facilities, consideration should be given to weapons and equipment requirements for MOBA. The report notes many new weapons and equipment for use in MOBA under development but not much emphasis on determining present weapons systems capabilities. While studying weapons/equipment for MOBA, a key first question to be answered concerns the proliferation of these devices as it impacts on the already overburdened infantryman.

5. Combat support and combat service support must also be studied in a MOBA context. What is the role and mission of Army Aviation in MOBA, of the Military Police Corps, etc?

6. The development of simulations and models for use in MOBA has been too slow. The simulations/models in the report have not been developed for Army use. One not mentioned was Blockbuster, a manual company level CIC simulation being developed by CAC but still a long way from the hands of the users.

a. Reference DYNTACS, page 15. The DYNTACS model is not readily adaptable for use in a MOBA study. The "closed game" structure of DYNTACS requires that all tactics be preprogramed into the model. It would be exceedingly difficult to quantify the fluid urban tactics in order to formulate an appropriate decision table. In addition, DYNTACS does not play dismounted infantry.

b. Reference recommendation 7, page 19. While DYNTACS is technically operational at Fort Leavenworth, heavy resource requirements have precluded its use in all but extremely high priority studies. The model is not available for R&D work of the type envisioned for a MOBA application.

7. The unique aspects of logistical support in MOBA must be addressed on a basis equal to the other major areas covered by the report.

8. As data permits, individual soldier MOBA skills should be included in appropriate soldier's manuals and ARTEPs.

9. Aerial photography prior to an operation should be added to the techniques discussed in urban mapping. Additionally, emphasis in mapping requirements should weigh offensive equal to defensive considerations.

10. In addition to the evolutionary concept of training facility construction discussed in the report, the use of actual buildings, as opposed to typical MOBA fabrications, is highly desirable. This increases training and research value tremendously. During a recent allied FTX, the Berlin Brigade was able to secure a portion of Berlin that was destined for destruction and used it as an objective for a company sized force. Further efforts in this area are ongoing in Berlin.

11. Reference page 6. The third and fourth paragraphs recommend a strong C^2 architecture and systems engineering group for MOBA purposes. It is noted that the ongoing AC^2MP (Army Command and Control Master Plan) Study considers the questions of overall C^2 architecture and systems engineering management in detail, but is not specifically directed at MOBA. MOBA considerations might well be treated more explicitly in this study.

12. Reference paragraph 3b, page 8. In the last paragraph, dealing with mobility, no mention is made of recent technological advances in the area of Individual Life Devices. Such items (e.g., Aerospace General Corporations

Individual Tactical Air Vehicle scheduled for CEP testing in April 1979) provide a superior agile and responsive means of mobility over and within built-up areas. Such an item would allow commanders to better see, feel and control the MOBA battle.

12. Reference page 43-46. The REMBASS program was terminated as a result of the RDAC FY 80 funding level.

13. Reference page 50. RPV technology should be modified for accuracy as follows:

a. Change paragraph 1, line 2, to read: "...reconnaissance, target acquisition, and laser target designation."

b. Change paragraph 3, first sentence, to read: "The first generation RPV will operate 20 km from the GCS. A growth potential is desired which will extend this radius to permit flight operations to 50 km. This RPV will utilize a data link which requires that the RPV remain within radar line of sight from the GCS."

14. Reference paragraph 3.6, page 66. The last sentence of the paragraph is inaccurate. It is anticipated that local telephone communication will be extremely valuable in MOBA operations; especially defensive type.

15. Reference 3.14, page 68. In order to accomplish the envisioned tasks, a much more rugged system of fiber optics then presently exists would be required.

16. Reference paragraph 6-3.1A, page 83. While a laser pointer may have a practical application in a MOBA environment, it appears unlikely that its utility would compensate for its cost and the overburdening of the infantryman with another piece of equipment to carry, maintain, etc.

17. Reference paragraph 6-3.1 D(a), page 84. Statement is misleading. The only system that is scheduled to replace the .50 cal MG with the M60 is the M48 A5 tank.

18. Reference paragraph 6-3.7B, page 108.

a. Future armored vehicles will be hardened on the top; however, to protect against anti-tank munitions is prohibitively expensive and would cause an unacceptable increase in vehicle weight.

b. Safe/arm distances are being decreased in the new family of tank ammunition.

19. Reference paragraph 2a, page 117. Mention is made of the 66MMXM96 CS rocket which is being developed primarily for MOBA. The rocket fired from the M202A1 launcher, provides good range and very accurate delivery of its CS payload.

20. Reference paragraph 3b, page 119. Statement is incorrect. The M8 alarm series of chemical agents alarms will detect vapors/aerosols of nerve agents, phosgene, hydrogen cyarride and cyanogen chloride.

21. Reference paragraph 3c, page 119. The deployed M60 Series Tank and M551 Sheridan are equipped with the ventilated facepiece type of collection protection. Additionally, the Army has recently completed a study establishing requirements for NBC collective protection for Army Combat vehicles

22. Reference paragrapn 3d, page 119. The M12A1 Power-Driven Decontamination apparatus while not sufficient to clean a city can be useful in decontaminating key areas.

23. Reference paragraph 3g, page 120. A system under development, which could have a significant effect in MOBA is a field collective protection kit which utilizes rooms in existing structures to rapidly create gas-proof shelters. The kit contains a filter, power supply and a special entrance way which fits over the doorway of the selected room.

Honeywell

DR. JAMES J. RENIER
Executive Vice President

November 17, 1978

LTC Robert F. Sweeney
Army Science Board
Office of the Assistant Secretary of the Army (RD&A)
Washington, D.C. 20310

Dear Colonel Sweeney:

Thank you for your letter of 11 October 1978 asking for my review of the Army Staff Comments (attached) on the final report of the Ad Hoc Group on MOBA. I am indeed gratified by the observations contained in General Renick's cover letter as to the timeliness and comprehensiveness of our report.

The specific comments of the Army Staff and Major Commands seem to break down into three categories:

- Errors or additions in fact (para. 1, 6, 12 (pg. 2), 12 (pg. 3), 13, 17, 19, 20, 21, 22, 23).
- Basic omissions or deficiencies in the study (para. 2, 3, 5, 7, 9).
- Comments on the Ad Hoc Study Group recommendations (para. 4, 6 a and b, 8, 10, 11, 14, 15, 16, 18 a and b).

My comments will briefly address each of these categories.

The comments which point out errors in fact or which present new factual data not included in the study add to the accuracy and completeness of the report, but I don't believe that they change the basic recommendations which we made.

I'll discuss the comments referring to basic omissions or deficiencies separately:

Para. 2. The DIA report referred to was not available for our review, although we did use the SRI report as background on MOBA. Since our study was oriented toward U.S. materiel deficiencies, we examined materiel requirements as affected by operational needs. We did not study in any detail Soviet MOBA weaknesses, nor how they have been redressed. In section 1 we emphasized the value of and need for special training for combat in urban terrain.

(more)

Honeywell Inc.
Honeywell Plaza, Minneapolis, Minnesota 55408, Telephone 612/870-2208

Para. 3, 5, 7. Again, since the study was oriented on materiel technology, we did not include separate discussions of intelligence, combat support, combat service support and logistics, although equipment needed to perform these functions in every case was studied. As pointed out in the Army comments, sections 2, 3 and 4 of the study examine intelligence gathering and correlating equipment; section 5 made recommendations concerning communications equipment (part of C^3I), and section 8 looked at mobility needs, part of the logistics problem. Artillery, armed helicopters and communications equipment are all part of the combat support system and are included in the study. We did not examine in any detail engineer equipment needs nor maintenance equipment needs as we felt these were more or less independent of the MOBA environment. And by no means did we make any attempt to look at roles and missions in MOBA as we felt that aspect to be outside the limits of our Terms of Reference.

Para. 9. Aerial photography certainly will provide essential input data to map preparation, whether or not the map is to be used in MOBA. Our study looked at the mapping needs unique to MOBA and the special problems generated by the urban environment.

I think I should also respond individually to the Army comments which affect the Study's recommendations.

Para. 4. We absolutely agree with everything said in this paragraph. We tried to emphasize the same points, but evidently did not do so sufficiently. See particularly our General Findings on page 3, four of which deal with these subjects. In almost every area we found lack of data concerning current equipment capabilities for MOBA and recommend further testing to see if MOBA needs could be satisfied by using, adapting or modifying equipment already in the inventory.

Para. 6. Concur. I understand that DYNTACS would be very difficult to use for any type of MOBA situation. Perhaps some CARMONETTE routines could be used for CIC simulation. CARMONETTE, in differing versions, is in use at CAC, TRASANA and CAA.

Para. 8. Concur. See Page 17

Para. 10. Concur. A good idea where practicable.

Para. 11. Concur that MOBA considerations should be treated explicitly in the AC^2MP Study.

Para. 14. Concur. Para. 4.8 Page 70 recommends tests to determine how far down in the level of command existing telephone communication can be used.

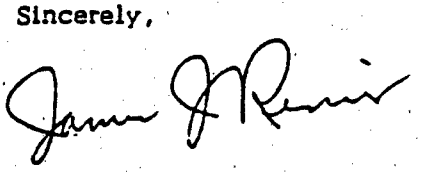
Para. 15. Concur. Para. 4.11 Page 70 recommends further development of fiber optics for communication, recognizing that current technology must be improved.

Para. 16. We would recommend only that the laser weapon be considered and perhaps tested for its utility in MOBA. We feel that in the sudden encounter and short ranges typical of MOBA, quick, accurate small arms fire is essential.

Para. 18. In those cases where the Army has made a decision that one of our recommendations is prohibitively expensive or otherwise unacceptable, we certainly defer to that decision. In most cases, our recommendations were intended as possible solutions which should be tested for cost/effectiveness. We concur, of course, with the decreased safe arm distances in the new family of tank ammunition to accommodate the needs of MOBA.

All in all, I'm pleased by the results of the Army review of our Study, I see no basic or substantive disagreement between our recommendations and the Army's position. I hope that the Army can now move forward in a serious effort to improve its capability to operate in urbanized terrain. I sincerely hope that our Study has been, and will continue to be, useful in motivating and implementing improvements.

Sincerely,



JJRenier/kw

cc: Dr. Joseph H. Yang

DISTRIBUTION:

OSA	1
OUSA	1
CS, Army	1
VCS, Army	1
DUSA(OR)	1
HQDA (DAMI-ZA)	1
HQDA (DAMO-ZA)	2
HQDA (DALO-ZA)	2
HQDA (DAMA-ZA)	2
Defense Documentation Center ATTN: DDC-TSR Cameron Station Alexandria, Virginia 22314	1
Defense Science Board OUSDR&E Pentagon, 3D1040	1
Commander US Army Material Development & Readiness Command 5001 Eisenhower Avenue Alexandria, VA 22333	2
Commander US Army Training & Doctrine Command Fort Monroe, VA 23651	2
Commander US Army Forces Command Fort McPherson, GA 30330	2
Commander-in-chief US Army Europe/Seventh Army APO, NY 09403	2

Commander
USA Intelligence & Security Command
Arlington Hall Station
4000 Arlington Blvd.
Arlington, VA 22212 — 1

Commandant
US Army War College
Carliste Barracks
Carliste, PA 17013 — 1

Chief of Engineers
US Army
Washington, D. C. 20314 — 1

Dr. James J. Renier
President, Control Systems
Honeywell, Inc.
Honeywell Plaza
Minneapolis, Minnesota 55408 — 1

LTG James M. Gavin (USA-Ret)
Chairman of the Board
Arthur D. Little, Inc.
Acorn Park
Cambridge, Massachusetts 02140 — 1

Dr. Paul W. Kruse, Jr.
Principal Staff Scientist
Honeywell Corporate Technology Ctr
Bloomington, Minnesota 55420 — 1

Dr. Russell D. O'Neal
3889 Waldenwood
Ann Arbor, Michigan — 1

Dr. Ralph E. Fadum
School of Engineering
N. C. State University at Raleigh
Raleigh, North Carolina 27607 — 1

Dr. John D. Weisz
Director
USA Human Engineering Laboratory
Aberdeen Proving Ground, MD 21005 1

Dr. J. Ernest Wilkins, Jr.
EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, Idaho 83401 1

Army Science Board
Office Assistant Secretary of the Army (RDA)
Washington, D.C. 20310 2