

**REPORT OF THE
DEFENSE SCIENCE BOARD
TASK FORCE
ON
MILITARY OPERATIONS IN BUILT-
UP AREAS (MOBA)**

NOVEMBER 1994



**OFFICE OF THE UNDER SECRETARY OF DEFENSE
FOR ACQUISITION AND TECHNOLOGY
WASHINGTON, D.C. 20301-3140**

This report is a product of the Defense Science Board (DSB). The DSB is a Federal Advisory Committee established to provide independent advice to the Secretary of Defense. Statements, opinions, conclusions and recommendations in this report do not necessarily represent the official position of the Department of Defense.

This document is UNCLASSIFIED
Security review completed by OASD (Public Affairs),
Directorate for Freedom of Information and Security Review
on 29 November, 1994, Case Number 94-S-4860



OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3140

DEFENSE SCIENCE
BOARD

MEMORANDUM FOR UNDERSECRETARY OF DEFENSE (ACQUISITION AND
TECHNOLOGY)

Subject: Report of the Defense Science Board (DSB) Task Force
on Military Operations in Built-up Areas (MOBA)

I am pleased to forward the final report of the DSB Task Force on Military Operations in Built-up Areas (MOBA). Dr. George M. Whitesides, Task Force Chairman, and Gen (Ret) Glenn Otis, Task Force Vice-chairman, led a distinguished panel of individuals in response to the Department of Defense's increased potential for U.S. involvement in MOBA. In developing their recommendations, the Task Force reviewed shortcomings in current capability and assessed future needs that would enhance the Department's ability to perform MOBA.

The Task Force concluded that MOBA is and will continue to be, a major area of concern for U.S. forces. The Task Force also recommended that integrating existing and new technologies under operational doctrine developed explicitly for MOBA would provide a dramatic improvement in the effectiveness in the Department's ability to conduct MOBA. Technology currently exists, or could be rapidly developed, that can fill important requirements in MOBA. Finally, the Task Force determined that improving MOBA requires a systems approach that includes, but is not limited to, establishment of urban databases, analysis centers, joint training and doctrine, a test bed, and a champion.

I concur with the recommendations of the Task Force and recommend that you review the Chairman's letter and the Executive Summary, and forward the report to the Secretary of Defense.

A handwritten signature in cursive script that reads "Craig Fields".

Craig Fields
Chairman

Attachment



OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3140

DEFENSE SCIENCE
BOARD

MEMORANDUM FOR UNDERSECRETARY OF DEFENSE (ACQUISITION AND
TECHNOLOGY)

Subject: Report of the Defense Science Board (DSB) Task Force
on Military Operations in Built-up Areas (MOBA)

Attached is the Report of the DSB Task Force on Military Operations in Built-up Areas (MOBA). The purpose of the Task Force was to determine the Department of Defense's current capability to conduct military operations in built-up areas and to assess the future needs of the Department to perform this function. The Task Force focused on modernization initiatives that would have high leverage in terms of our ability to conduct military operations in built-up areas.

The Task Force concludes that:

- MOBA provides an extremely difficult environment that requires a full range of integrated systems and should be a key consideration for future material research and acquisition.
- Dramatic improvements in the effectiveness of MOBA can be achieved by integrating existing and new technologies under appropriate operational doctrine developed explicitly for MOBA.
- Technology already exists or could be developed rapidly, that can fill important requirements in MOBA.
- MOBA needs to be regarded as a single system.
- The MOBA system also involves the establishment of urban databases, analysis centers, a test bed, and a champion.

U.S. MOBA activities must be conducted in a superb manner. Anything less will fall victim to intense domestic scrutiny and international media coverage which will erode or perhaps irreparably damage U.S. influence or our desire to improve relations with indigenous populations.

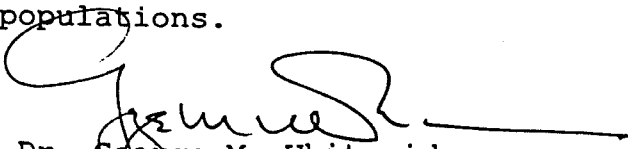

Dr. George M. Whitesides
Task Force Chairman

TABLE OF CONTENTS

Glossary of Terms	v
1. EXECUTIVE SUMMARY	1
1.1 Terms of Reference.....	1
1.2 Membership	1
1.3 Study Findings.....	2
1.4 Recommendations	3
2. BACKGROUND	5
2.1 Military Operations in Built-Up Areas.....	5
2.2 Operations Other Than War (OOTW)	6
2.3 Rationale for Study	6
2.3.1 Urban Growth.....	6
2.3.2 Future Crises	8
2.3.3 U.S. Response	9
2.3.4 Challenges	10
2.4 Required Capabilities.....	11
2.4.1 Weapons Tailored for Environment	12
2.4.2 Survivability Measures.....	12
2.4.3 Nonlethal Weapons.....	12
2.4.4 C3 and Intelligence	12
2.4.5 Sensors for RSTA	13
3. STUDY CONDUCT.....	15
3.1 Introduction.....	15
3.2 Methodology	15
3.3 Illustrative Scenarios	16

3.3.1	Convoy Scenario.....	16
3.3.2	Night Patrol Scenario.....	16
3.4	Literature Review.....	17
3.4.1	Army Science Board Study (1977).....	17
3.4.2	Hicks DSB Study (1984).....	17
3.4.3	Bobrow DSB Study (1986).....	18
3.4.4	Stiner Study (1994).....	18
3.4.5	Sullivan Study (1994).....	18
3.4.6	West Briefing (1994).....	18
3.4.7	Summary.....	18
3.5	Briefings and Papers.....	19
3.6	Lessons Learned in Recent Operations.....	19
3.6.1	Lessons Learned – Joint Task Force Perspective.....	19
3.6.2	Lessons Learned – Mogadishu, Somalia (10th Mountain Division)..	19
3.7	CINC Requirements for MOBA.....	21
3.8	Synthesis of Results.....	22
3.9	Judgments Regarding Shortcomings.....	23
3.10	Technology Needs.....	23
3.11	Findings and Conclusions.....	23
3.12	Action Plan.....	23
4.	FINDINGS.....	25
4.1	Introduction.....	25
4.2	Equipment Needs.....	25
4.2.1	Weapons and Equipment.....	25
4.2.2	Survivability.....	27
4.2.3	C3 and Intelligence.....	27
4.2.4	Sensor Systems (RSTA).....	29

4.3	Other Needs	29
4.3.1	Electronic Warfare.....	29
4.3.2	PSYOPS	29
4.3.3	Civil Affairs	29
4.3.4	Medical Support.....	29
4.3.5	Medical Care.....	30
4.3.6	Doctrine.....	30
4.3.7	Tactics.....	31
4.3.8	Leader Training	31
4.3.9	Unit Training	31
4.4	Potential Surprises.....	32
4.5	Nonlethal Weapons and Policy.....	32
4.5.1	Nonlethal Weapons.....	33
4.5.2	Nonlethal Policy Matters.....	33
4.5.3	Summary.....	36
5.	CONCLUSIONS	37
5.1	Doctrine.....	37
5.2	Training.....	38
5.3	Equipment	38
5.4	Summary.....	44
6.	RECOMMENDATIONS.....	45
6.1	Introduction.....	45
6.2	Objectives.....	46
6.3	Actions	46
6.4	MOBA as a System.....	46
6.5	MOBA Database	47
6.6	MOBA Analysis Center	48

6.7	MOBA Simulation Center.....	48
6.8	MOBA ACTD.....	48
7.	IMPLEMENTATION PLAN.....	51
7.1	Introduction.....	51
7.1.1	Responsibility for MOBA.....	51
7.1.2	Establish a MOBA Database.....	51
7.1.3	Establish a MOBA Analysis Center.....	52
7.1.4	Establish a MOBA Simulation Center.....	52
7.1.5	Initiate a MOBA ACTD.....	52
7.2	Recommended Actions.....	53
7.3	Schedule	53
8.	FUNDING OF PLAN	55
9.	SUMMARY	57

REFERENCES

BIBLIOGRAPHY

APPENDICES

- Appendix A: Terms of Reference
- Appendix B: Literature Reviews
- Appendix C: Briefings to the DSB on MOBA
- Appendix D: MOBA Requirements
- Appendix E: MOBA Implementation Plan

GLOSSARY OF TERMS

AAR	After Action Review
AC	Active Component
AC-130	Spectre (C-130 Hercules weapon platform variant)
ACOM	Atlantic Command
ACTD	Advanced Concept Technology Demonstration
AD	Air Defense
AFAS	Advanced Field Artillery System
AFB	Air Force Base
AGARD	Advisory Group for Aerospace Research and Development
AGS	Armored Gun System
AID	Agency for International Development
AP	Armor Piercing
ARDEC	Army Research, Development and Engineering Center
ARPA	Advanced Research Projects Agency
ATD	Advanced Technology Demonstration
ATGM	Antitank Guided Missile
AWSIM	Air Warfare Simulation
BDM	Bunker Defeat Munition
BDU	Battle Dress Uniform
BRAC	Base Realignment and Closure
C ²	Command and Control
C ³	Command, Control and Communication
C ³ I	Command, Control, Communications, and Intelligence
CA	Civil Affairs
CBS	Corps Battle Simulation
CEP	Circular Error Probable – a delivery accuracy measure
CEV	Combat Engineer Vehicle
CINC	Commander-in-Chief
CMTC	Combat Maneuver Training Center (Hohenfels, GE)
DOE	Department of Energy
DSB	Defense Science Board
EFOG-M	Enhanced Fiber Optic Guided Missile
EM	Electro Magnetic
EMD	Engineering, Manufacturing and Development
EMP	Electromagnetic Pulse
EOD	Explosive Ordnance Disposal
ERDEC	Edgewood Research, Development and Engineering Center
EW	Electronic Warfare
FBIS	Foreign Broadcast and Information Service

GLOSSARY OF TERMS (CONT'D.)

FEMA	Federal Emergency Management Agency
FLIR	Forward Looking Infrared
FOG-M	Fiber Optic Guided Missile (now called EFOG-M)
FOMM	Fiber Optic Mortar Munition
FOMP	Fiber Optic Mortar Projectile
FUE	First Unit Equipped
FY	Fiscal Year
GIS	Geographic Information System
GPS	Global Positioning System
HEAT	High Energy Antitank
HEP	High Explosive Plastic
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HUMINT	Human Intelligence
ICS	Intra-Squad Communication System
ID	Identification (friend or foe)
IDA	Institute for Defense Analyses
IMINT	Image Intelligence
IPB	Intelligence Preparation of the Battlefield
IR	Infrared
IRO	International Relief Organizations
Javelin	Medium Range ATGM (2-Km Dragon replacement)
JDAM	Joint Direct Attack Munition
JOSE	Joint Support Element
JROC	Joint Requirements Oversight Council
JRTC	Joint Readiness Training Center (Ft. Polk, LA)
JTC	Joint Theater Commands
JTF	Joint Task Force
JTF-SOM	Joint Task Force, Somalia
JWCA	Joint Warfighting Capability Assessment
LANL	Los Alamos National Laboratories
LAW	Light Antitank Weapon
LIC	Low Intensity Conflict
LLNL	Lawrence Livermore National Laboratory
LOC	Lines of Communication
LOS	Line-of-Sight
MANPADS	Man-Portable Air Defense System
MAWS	Medium Antitank Weapon System
MC&G	Mapping, Charting and Geodesy
MHD	Magneto Hydrodynamics
MPIM	Multipurpose Individual Munition

GLOSSARY OF TERMS (CONT'D.)

MICLIC	Mine Clearing Line Charge
MMW	Millimeter Wave
MOBA	Military Operations in Built-up Areas
MOFA	Multi Option Fuze - Artillery
MOUT	Military Operations in Urban Terrain
MTI	Moving Target Indicator (radar)
NAVAIR	Naval Air Systems Command
NEO	Non-combatant Evacuation Operations
NGO	Non-Government Organizations
NL	Nonlethal
OFDA/AID	Office of Foreign Development and Assistance/Agency for International Development
OICW	Objective Individual Combat Weapon
OOTW	Operations Other Than War
OSD	Office of the Secretary of Defense
PGM	Precision-Guided Munition
PGMM	Precision Guided Mortar Munition
POA&M	Plan of Action and Milestones
PRO	Private Relief Organization
PSRC	Presidential Selective Reserve Call-up
PSYOPS	Psychological Operations
PVO	Private Volunteer Organizations
QRF	Quick Reaction Force
RC	Reserve Component
RCA	Riot Control Agent
RF	Radio Frequency
ROE	Rules of Engagement
ROV	Robotically Operated Vehicle
RPG	Rocket Propelled Grenade
RPV	Remotely Piloted Vehicle
RSTA	Reconnaissance, Surveillance, and Target Acquisition
RTO	Radio-telephone Operator
SA	Semiactive
SAL	Semiactive Laser (homing)
SAM	Surface to Air Missile
SAR	Synthetic Aperture Radar
SEP	Soldier Evaluation Plan
SHAPE	Supreme Headquarters, Allied Powers Europe
SIGINT	Signal Intelligence
SIPS	Senior Interagency Policy Seminar

GLOSSARY OF TERMS (CONCLUDED)

SLID	Small, Low-cost Intercepting Device
SMAW	Shoulder Launched Multipurpose Anti-Armor Weapon (USMC)
SNA	Somali National Alliance (Aideed-affiliated)
SOCOM	Special Operations Command
SOF	Special Operations Forces
SOLIC	Special Operations - Low Intensity Conflict
SOP	Standard Operating Procedure
SPECS	Special Protective Eyeware Cylindrical System
SRAW	Short Range Assault Weapon (USMC program, called Predator)
STOW	Synthetic Theater of War
SWO	Special Weapons Officer
TAOR	Theater Area of Operations
TEC	Topographic Engineering Center
TOR	Terms of Reference
TRADOC	Training and Doctrine Command
TTAD	Temporary Tours of Active Duty
UAV	Unmanned Aerial Vehicle
UGS	Unattended Ground Sensors
UGV	Unmanned Ground Vehicle
USG	U.S. Government
USMC	United States Marine Corps
WAN	Wide Area Net
WMD	Weapons of Mass Destruction

1. EXECUTIVE SUMMARY

1.1 TERMS OF REFERENCE

The 1994 Defense Science Board (DSB) Summer Study on Military Operations in Built-up Areas (MOBA) was asked to assess DoD's current capabilities to conduct military operations (including peacemaking and peacekeeping) in urban terrain. The Board focused on operations other than war (OOTW) in an urban environment. OOTW can include periods of intense, localized combat. Many of the requirements and proposed solutions for OOTW are relevant to war in cities. The solutions are also relevant in low intensity conflict and in operations that provide humanitarian aid, where minimization of casualties is especially important. The guidance in the Terms of Reference (TOR, see Appendix A) requested that the Board examine:

- The potential for U.S. involvement in MOBA
- The characteristics of urban operations
- Shortcomings in current capability and operational needs (especially regarding survivability, sensors, platforms, navigation, and communication)
- Innovative solutions leading to a recommended focus for future efforts.

Addressed, were operations that might involve combat, not solely deterrence, psychological operations (PSYOPS), or other noncombat forms of conflict resolution. The study examined: improvements to sensors; weapons (lethal and nonlethal); command, control, communications, and intelligence (C³I) systems; and doctrine. It also focused on solutions to issues that could be accomplished in a relatively short time, and that do not require beginning major new programs.

1.2 MEMBERSHIP

The Summer Study group consisted of DSB members, consultants, and Government advisors (Table 1). A balance was achieved between all three types of members. Members of the research staff of the Institute for Defense Analyses (IDA) also participated in this study. Each member brought to the study his or her unique experience base relative to MOBA and OOTW.

Table 1. Defense Science Board Summer Study Group

George Whitesides – Chairman Walt Squire – Executive Secretary		Glenn Otis – Vice Chairman John Dertzbaugh – DSB Secretariat	
DSB Members	Consultants	Govt Advisors	Institute for Defense Analyses (IDA)
Joan Habermann	Robert Wilson	John Fricas	Warren Olson
David Heebner	John Fielding	Sharon Vannucci	Edward Smith
Charles Fowler	John Foss	Bob Kocher	Robert Holcomb
Max Thurman	Ev Greinke	Jay Anderson	
John Vessey	Dave Hardison	Matt Herz	
Percy Pierre	William O'Neil	Herb Wreden	
	George Sebestyen	Greg Ferdinand	
	Davis Bobrow	John Pennella	

1.3 STUDY FINDINGS

The MOBA task force assessed the probable future of U.S. military operations, examined lessons learned from recent international operations in urban environments, reviewed relevant studies, addressed ground force urban tactics and doctrine, and explored innovative technologies. The following major points summarize the findings of the 1994 DSB MOBA study (see Figure 1):

- MOBA is, and will continue to be, a major area of concern of U.S. forces.
- No single technology (including nonlethal technology) has the potential to revolutionize this type of operation.
- Dramatic improvement in the effectiveness of MOBA can be achieved by integrating existing and new technologies under appropriate operational doctrine developed explicitly for MOBA.
- Technology already exists, or could be developed rapidly, that can fill important requirements in MOBA.
- Improving MOBA requires a systems approach. Now, as before, *implementation* of improvements is the challenge.
- The MOBA system also involves the establishment of urban databases, analysis centers, a test bed, and a champion.

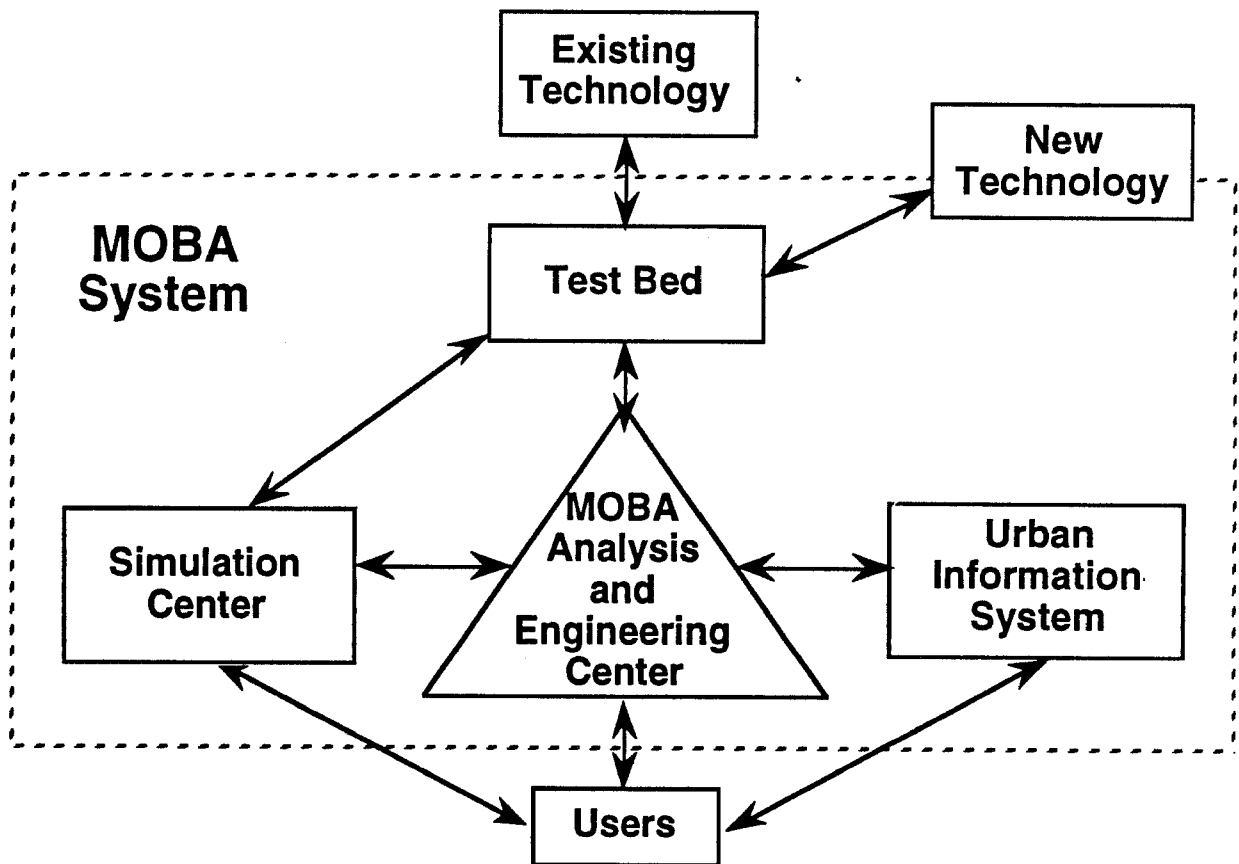


Figure 1. DSB-MOBA Study Findings

1.4 RECOMMENDATIONS

The Secretary of Defense and the Chairman, Joint Chiefs of Staff should request that the Under Secretary of Defense (Acquisition and Technology) establish an Advanced Concepts Technology Demonstration (ACTD) program for MOBA. The Commander in Chief, Atlantic Command, and Commander in Chief, Special Operations Command, are two CINCs with direct involvement in MOBA on a continuing basis; they would be logical co-sponsors of this ACTD.

MOBA-related acquisitions over the past several years have been sponsored by ARPA, the Army, and the Marine Corps, ARPA having the most direct interface with operational units in supplying equipment for recent MOBA operations. Accordingly, ARPA would be an appropriate ACTD point of contact for all involved agencies (Figure 2).

The MOBA ACTD would include utilization of the MOBA Simulation Center, the MOBA Analysis Center, and live-action MOBA exercises. The ACTD would test and evaluate weapons and supporting systems to improve U.S. forces capabilities for a variety of missions in built-up areas. These organizations and exercises would be supported by a MOBA database facility.

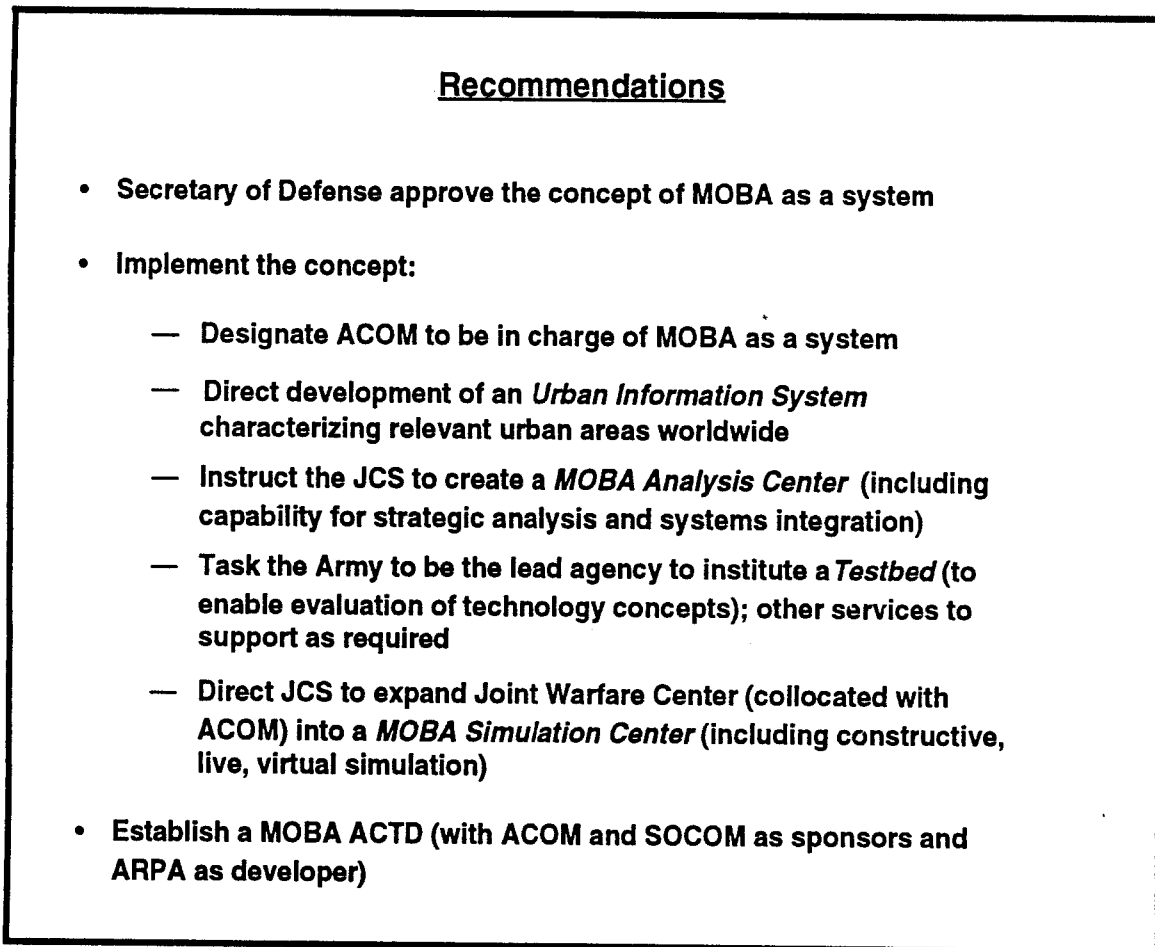


Figure 2. MOBA Study Recommendations

These actions would provide a systems approach to improving MOBA capabilities. With a champion, important progress could be made on information, doctrine, training, and materiel needed to minimize casualties and provide a favorable, early end state to future peace operations.

[This Page Intentionally Left Blank]

2. BACKGROUND

This report describes the deliberations and findings of the 1994 DSB Summer Study on MOBA. The study is a response to the belief that MOBA and OOTW are becoming increasingly important types of operations, and there is the necessity and the opportunity to improve the way in which these missions are carried out.

2.1 MILITARY OPERATIONS IN BUILT-UP AREAS

MOBA requires extensive use of Army and Marine light forces – i.e., foot soldiers. Successful operations may require other Joint components (e.g., reinforcement with heavy ground force elements and support from air and surface components of the Navy and Air Force). Complex urban operations would likely be conducted using several components of the Army (infantry, civil affairs, military police, special forces, PSYOPS, etc.) and the other Services. The Army's AirLand Battle doctrine describes tenets (initiative, agility, depth, and synchronization) that are constants, regardless of environment or location. Military operations in urban terrain (known as MOUT – synonymous with MOBA) include all military actions that are planned and conducted in regions where man-made construction affects the tactical options available to the commander.

A built-up area¹ is a concentration of structures, facilities and people that forms the economic, political, and cultural center of a region. Built-up areas include major world cities, smaller cities, towns, villages, and business strips. Tactical operations in urban zones may include:

<u>OFFENSIVE OPERATIONS</u>	<u>DEFENSIVE OPERATIONS</u>
<ul style="list-style-type: none">• Deliberate attack• Cordon and search• Building clearance• Seizure of key objective	<ul style="list-style-type: none">• Defense in sector• Evacuate noncombatants• Prepare obstacles; delay• Defeat or neutralize an attacking force

Heretofore, our military strategy and doctrine called for avoiding urban areas because of many MOBA characteristics and likely factors, including:

- Lack of detailed pre-conflict intelligence for urban centers
- Intensive manpower requirements
- Level of difficulty in conducting operations in urban terrain
- Slowed tempo of maneuvering forces - urban obstacles
- Desire to minimize noncombatant casualties and damage to population centers
- Uncertainties regarding behaviors of indigenous population elements
- Impact of conflict upon the political, ethnic, religious, and economic elements
- Ability to control urban centers without entering (surround and quarantine).

¹ "An Infantryman's Guide to Combat in Built-Up Areas," FM 90-10-1 HQ DA, 12 May 1993.

2.2 OPERATIONS OTHER THAN WAR (OOTW)

OOTW (per Army Field Manual 100-5) encompasses a wide range of operations, including: assistance, disaster and humanitarian relief, counterdrug operations, counterterrorism, counterinsurgency, contingency operations, evacuation, peacemaking, peacekeeping and enforcement, strikes and raids, and nation building. Although OOTW may be conducted in rural areas, it is increasingly likely to occur in urban regions.

Operations in built-up areas involve the terrain, the people, and the infrastructure. Nearly all modern cities now exhibit characteristics of a western city, e.g., airport, central business district, education centers, etc. Cities have large numbers of approaches, and may be difficult to defend if the commander's force is too small. However, once an attacker has gained a foothold, he may be difficult to dislodge. Cities offer an occupying force many ways to defend and infiltrate back into cleared areas after their defense has been penetrated. The greater the time spent in an urban area, the greater the amount of collateral damage likely to occur if the enemy is unconcerned with such damage.

2.3 RATIONALE FOR STUDY

U.S. MOBA activities must be conducted superbly – due, in part to intense Congressional and domestic scrutiny, international media coverage, and our desire to advance democracy with indigenous populations. Anything less will erode, and perhaps irreparably damage and compromise U.S. influence. Current U.S. military capability is a legacy of the Cold War, designed for large-scale, high-intensity operations. Our forces lack the specific doctrine, equipment, and support required to conduct urban operations with excellence.

We must provide the necessary focus and supply our forces with the right capabilities. There are existing capabilities that can readily be adapted to MOBA. But in many cases, for the reasons stated above, new and better tools, focused upon the unique elements of MOBA, are required. Drawing upon recent U.S. and allied experiences, we see that relatively small investments can provide high dividends. The critical nature of MOBA requires providing our forces with the capability to perform their missions right – the first time – within constraining Rules of Engagement (ROE).

2.3.1 Urban Growth

The rate of population growth in an urban area generally exceeds the growth rate for a nation. Populations are migrating to cities seeking employment, social support, and a better way of life. "A century ago, there were no predominantly urban countries. In 1920, the United Kingdom was the only nation with over 50 percent of its population in cities or towns of over 20,000. In 1970, 12 percent of the world's population lived in cities of 500,000 or more. Estimates are that [nearly] 45 percent of the world's population will live in urban areas by the year 2000." ²

The frequencies of occurrence of cities by size and geographic locale are shown in Figure 3. Asia leads all regions in the number over one million, with 121 cities. In some nations, notably those in Latin America, the principal city has a population larger than the remainder of the country.

Urban centers include the political institutions for nations, states or provinces, regions, and municipalities, as well as the economic base of industry, banking, and commerce. Cities are increasingly important to the control of a nation's wealth and power. Consequently, cities are becoming inviting targets for destabilizing military or paramilitary operations.

² Coates, Joseph F., The Nature of Cities--Background Notes to the Study of Low Level Combat, IDA Note No. 720, Alexandria, Va, 1970.

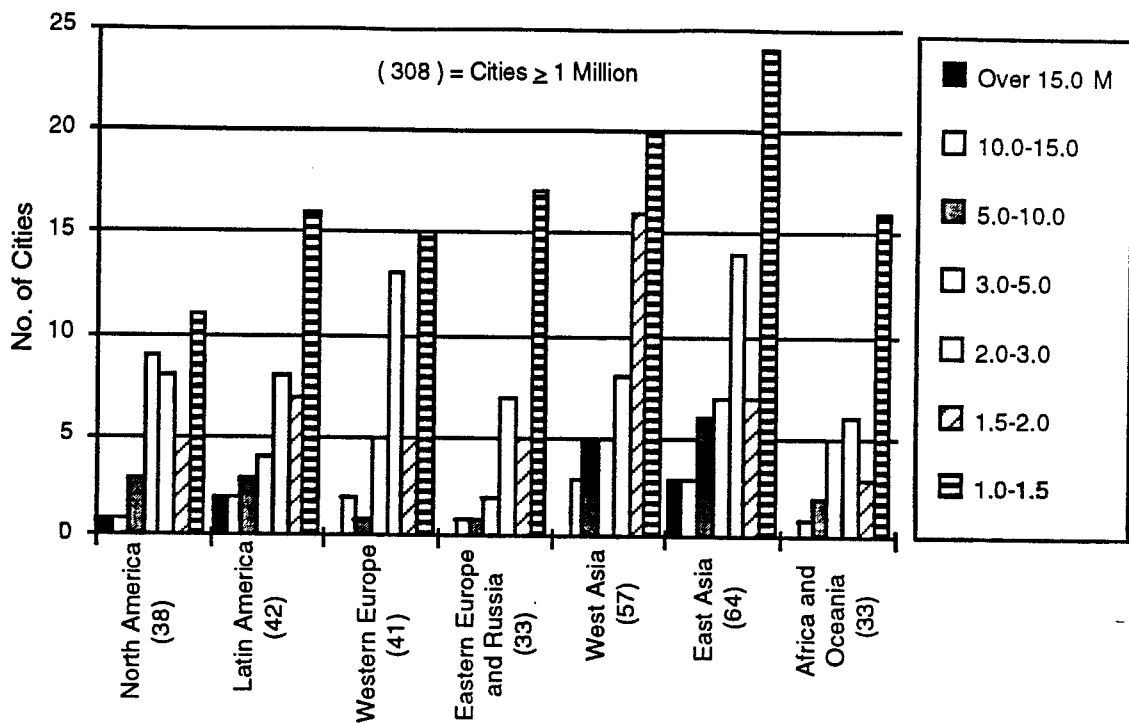


Figure 3. Distribution of Cities with Populations over One Million ³

As people seek the cities for the security they appear to offer, governments' difficulties increase. Large squatter settlements and areas of poverty exist in and around most, if not all, of the world's large cities. As people overcrowd cities and resources become overtaxed, environments grow ripe for dissent, social unrest, and humanitarian aid. For the first time, more people live in cities in the developing world than in the industrialized world. Panama City, Mogadishu, Sarajevo, Kigali, and Port au Prince illustrate that adversaries note the need to operate in and control the city – the center of political, economic, and strategic significance – the source of power.

Consequently, we are seeing greater emphasis upon military operations located in the urban areas. Insurgencies such as Sendero Luminoso (Shining Path) have forsaken rural terrain in favor of urban terrain because that is where greater unrest is found, i.e., where the people and resources are located, and it is easier to move undetected in the large urban sprawls.

It is difficult to imagine the situations our forces may be called upon to control by reflecting on life as we know it in the United States. The Washington D.C. area, for example, exhibits a relatively low population density by world standards – 7,600 people per square mile. As shown in Table 2, by the year 2000, many urban regions in foreign countries will have population densities 7-30 times that of Washington, D.C.⁴ World population is growing at the rate of one billion per decade, creating environments that often contain 50,000 to 100,000 people per square mile.

³ Rand McNally Metro Atlas, 1994 Edition, p. 22.

⁴ Olson, Warren K., and Smith, Edward, Briefing for DSB: "Studies of Urban Warfare," July 1994 (data derived from 1994 World Almanac, p. 829).

Table 2. Characteristics of Representative Cities by the Year 2000

City	Population Density (K/Mi ²)	Area (Mi ²)	Population (Year 2000)	Bldg's. (>500 Ft.)
Atlanta	3.0	131	0.4 Million	13 > 500'
Washington	7.6	357	2.7	
Houston	8.7	310	2.7	
Los Angeles	9.6	1110	10.7	20 > 500'
New York	11	1274	14.6	132 > 500'
Tokyo	28	1089	30.0	6 > 650'
Moscow	29	379	11.1	1 > 650'
Rome	45	69	3.1	
Mexico City	50	552	27.8	
Baghdad	54	97	5.2	
Istanbul	54	165	8.9	
Guadalajara	58	78	4.5	
Seoul	64	342	21.9	1 > 760'
Manila	68	188	12.8	
Teheran	128	112	14.3	
Lagos	223	56	12.5	
Hong Kong	261	23	6.0	2 > 1000'

Source: World Almanac (1994, p. 829+)

2.3.2 Future Crises

The future will most likely involve U.S. military forces operating in urban centers, particularly in operations other than war. Our opponents may range from organized military units, to terrorists and religious fanatics, to criminal cartels, to militias, to techno-bandits. There will be times when our military operations may appear non-traditional, in the sense that the missions are apt to increasingly include humanitarian and law enforcement responsibilities.

The political importance of the urban centers must be thoroughly understood. We cannot destroy or significantly damage the infrastructure of a foreign urban center in pursuit of mission attainment and expect the population to remain friendly to either U.S. forces or those we support. Nor can we indiscriminately use force in imprecise ways that cause unnecessary noncombatant casualties, without political or financial penalty.

The 1986 DSB Conflict Environment Task Force report (*Implications of Third World Involvement*) findings remain valid in the main:

"The mission might be to defeat enemy forces, deny enemy in urban terrain, bolster a friendly government, ensure the flow of supplies through urban ports to U.S. and friendly forces elsewhere, or safeguard U.S. citizens. Nevertheless, some general assumptions seem well founded:

- **Situations will not be ones of the World War II type triumphal occupation/liberation.**

- The U.S. will prefer to minimize its role in support for urban control and management.
- Any DoD role will be intended to be temporary and transitional.
- Our primary purpose will be minimum distraction from U.S. military mission and minimal disruption of "normal" civilian life.
- U.S. forces will operate under intense Congressional, media, and public scrutiny.
- There will be little chance of sustained U.S. Government or DoD priority for this type problem...."

RAND, while briefing the Board,⁵ concluded from case studies that the U.S. is moving from a strategy of containment to one of collective engagement. As a result, OOTW in urban areas may be unavoidable. Characteristics of future conflict are likely to involve:

- Political constraints (and the need for clear communication to military leaders and troops)
- Restrictive rules of engagement (ROE)
- Urban operations (cities provide a manpower-intensive operational environment)
- Use of non-government organizations (NGOs)
- A humanitarian component
- Deployment of tailored coalition forces
- A need for special operations forces (SOF)
- Increased demands on PSYOPS, Combat Support, and Combat Service Support units
- A need for specialized equipment and training
- A need to protect even benign forces.

2.3.3 U.S. Response

The U.S. has options regarding its response to urban conflict – non-involvement or involvement. Involvement may be direct or indirect, and will hinge on national interests and objectives. Operations in which we become involved must be conducted professionally and with minimum casualties. Since cities are rapidly becoming the sites of conflict resolution, U.S. doctrine, tactics, equipment, and training must support an ability to conduct MOBA without equal.

Our current capability was developed in large part for a massive, rural war in Central Europe. Since the future looks much different, new capabilities will need to be developed. To do less risks highly visible casualties, and a corresponding loss of military credibility and national prestige. Establishing both the exit criteria and the desirable end state that support our objectives is necessary prior to committing U.S. forces, to help structure the committed force, to develop a campaign plan, and to establish proper ROE.

⁵ Dr. Jennifer Taw. See also Taw's reports in the list of references.

2.3.4 Challenges

Urban Terrain. The challenges for MOBA are many. First, urban terrain presents a complex environment; soldiers must deal with the interiors and exteriors of buildings and urban infrastructure, above and below ground. Urban terrain consists of a wide range of types from large cities with high rise structures and slum areas, to small villages with dirt dwellings and unpaved roads.⁶ Urban infrastructure consists of power grids, sewage systems, transportation networks, communications media, telephone systems, etc. Target acquisition, communications, area denial, and survival of own forces become more difficult here than in open, rural terrain.

Force Management. In attempting to keep non-combatant casualties and collateral damage to a minimum, U.S. forces in MOBA may be constrained to operate under difficult rules of engagement. Some conventional weapons may not be authorized for use in urban conditions. When operating with a coalition, U.S. forces may face even greater constraints on use of standard equipment. Another challenge involves operating with other U.S. government agencies and humanitarian non-government organizations (NGO) who must be protected from enemy actions, but are not capable of self-defense.

Populations. Urban areas exist because people live and find work there. People are among the most challenging factors in MOBA because they are so fundamentally heterogeneous. Most urban populations are a mixture of social backgrounds, religions, lifestyles, and financial assets. An enemy's deliberate use of civilians to mask its own actions is perhaps the thorniest problem we currently face.

News Media. National and international media tend to focus on, and concentrate in, urban areas. Every action by military forces becomes susceptible to immediate and detailed scrutiny. "CNN Live - Worldwide" broadcasts received by friends, allies, neutrals, and enemies shape public opinion. This may inadvertently pass vital intelligence to the enemy while at the same time influencing national goals and lowering public tolerance of ill-defined, messy operations.

Funding and Organization of MOBA Improvements. It is evident, just from reviewing recent U.N. operations, that the requirement to conduct missions in a MOBA environment is rapidly increasing. OOTW may become the rule, rather than the exception. Although no single technological solution exists that solves the concerns associated with MOBA, many good technical opportunities do exist that need to be developed and tested. For several reasons, however, implementation of these solutions has been slow and fragmented:

- 1) Our acquisition was focused on those systems needed to fight the major conflict associated with the now extinct Cold War. MOBA requirements traditionally fell well down the priority list.
- 2) MOBA needs require relatively low funding levels. This, combined with the lack of emphasis, makes MOBA systems likely candidates for being the bill payer when funding reductions occur.
- 3) Training and conducting missions in MOBA receive very little emphasis at the Service schools and compete with higher priority missions in operational units.
- 4) Except for the special operations forces that focus on very specific, short duration missions, no institutional emphasis on MOBA exists.
- 5) No organizational structure exists to provide a champion for development and acquisition of MOBA systems.

⁶ Ellefsen, Richard, et al., *Urban Building Characteristics, Settings and Structure of Building Types in Selected World Cities*, Naval Surface Weapons Center, NWSC/DL TR-3714, 15 January 1977, UNCLASSIFIED.

Summary. It is important to renew our focus on MOBA, not only to improve our ability to conduct an increasingly frequent type of military operation, but also to prevent awkward, damaging national surprises. We need to be prepared for potential enemies to possess some hi-tech weapons that could counter our capabilities, and for their ingenious use of simple devices or tactics. Additional surprises could include:

- Toxic chemicals or biological weapons – would cause us problems, even if crude
- Lasers or nonlethal systems – could hamper our operations
- Weapons of mass destruction (WMD) – difficult to detect; deliverable by unconventional means.

The broader problems associated with MOBA center on defining the political objectives, dealing with multiple local political factions, and the potential for mission creep.

A less-discussed problem is the attention MOBA has previously received (Figure 4). Although addressed occasionally in the developmental and operational communities, recommendations from past studies have often gone ignored. The Board senses a continuing, disturbing problem with implementation of MOBA recommendations that needs fixing.

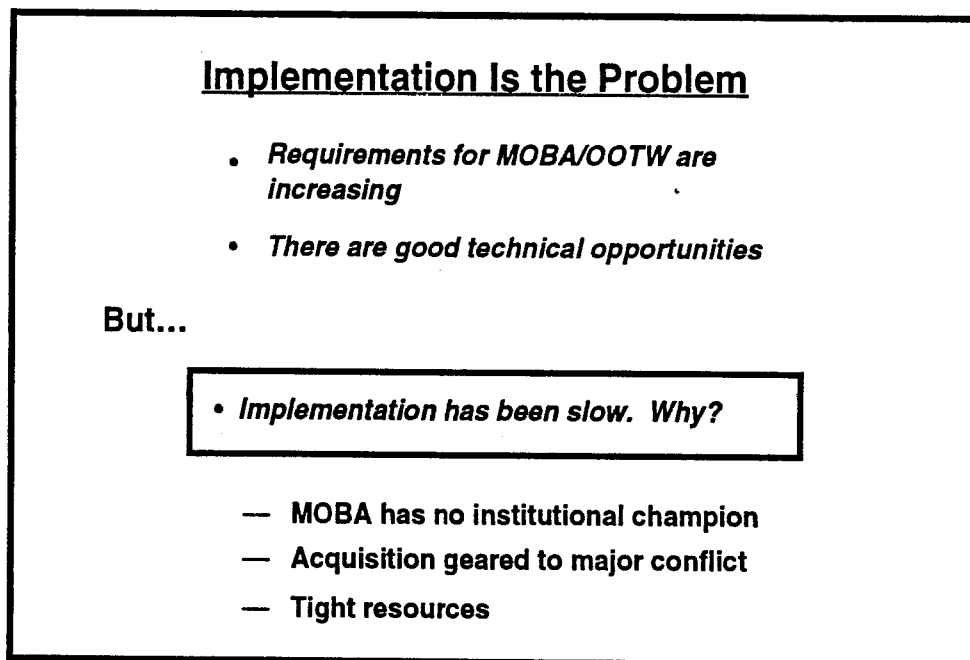


Figure 4. Implementation Challenge

2.4 REQUIRED CAPABILITIES

Urban combat operations involve closer ranges than are common outside urban terrain. Actions tend to be dismounted and at the fire team or squad level. These conditions establish the potential for high casualties. Our operational advantage – associated with the long-range, high-tech weapon platforms that use the principle of mass and mobility – tends to be greatly reduced or negated when involved in MOBA.

2.4.1 Weapons Tailored for Environment

Several of our weapon systems and developmental programs need to be reviewed for their appropriateness under MOBA conditions and objectives. Specific evaluation considerations for these weapons include:

- Three-dimensional dead spaces caused by urban structures that interact with trajectories of various weapon systems
- The proper functioning of fuzes associated with the ammunition
- Short engagement ranges ⁷ [usually under 500 meters, sometimes under 50 meters]
- Restrictive fields of fire
- Reduced target exposure times
- Possible increased exposure while engaging ⁸
- Difficulties in logistics and resupply operations
- Countering mines, snipers, and indirect weapon systems.

2.4.2 Survivability Measures

The potential for terrorist-like activities such as car bombs, land mines, booby traps, acts of violence toward individuals, crime, and the application of military weapons to cause a sense of insecurity, when coupled with direct operations against units, provide the potential for a continuous stream of casualties, as well as unpredictable triage events. Protection of the individual soldiers whether on foot or in vehicles becomes a critical concern. Development of equipment, weapons, and procedures to reduce casualties is a high priority need. Additionally, developing procedures and equipment that assist in rapidly locating and identifying casualties, and that aid their evacuation and improve their survival rate is crucial.

2.4.3 Nonlethal Weapons

Controlling crowds, reducing collateral damage, preventing injury to noncombatants or hostages, and capturing hostile individuals alive are typical requirements in MOBA. The application of some nonlethal technologies may be an excellent way to accomplish these difficult tasks. We address this subject in more detail in Chapter 4.

2.4.4 Command, Control, Communications and Intelligence

MOBA operations place unique requirements on C³I systems. Our systems were designed to function over great distances and in non-MOBA environments.

- Conducting coordinated operations in urban terrain is difficult
- Buildings break up the line-of-sight required for tactical radios resulting in generally poor communications

⁷ Reiss, David W., et al., Survey of Current Doctrine, Training, and Special Considerations for Military Operations on Urbanized Terrain, Ft. Benning: US Army Research Institute for the Behavioral and Social Sciences.

⁸ Dewar, Col. Michael, War in the Streets: The Story of Urban Combat from Calais to Khafji, David and Charles, Great Britain, 1992.

- Small unit operations with independent actions of several soldiers establish a requirement for individual communications equipment
- Collecting intelligence in cities where the population has not been displaced requires the use of local human intelligence (HUMINT) assets, as well as traditional assets to establish the who, what, and where associated with hostile and neutral factions.
- Predicting additional enemy courses of action that include the use of noncombatants or employ the various factions is difficult.
- Determining which individuals in a crowd are armed or are potential threats is problematic.

2.4.5 Sensors for Reconnaissance, Surveillance, and Target Acquisition (RSTA)

Sensors used in MOBA need additional capabilities. In particular, sensors that can assist the detection of individual snipers, mines, and indirect weapon systems before they fire (or immediately thereafter) are needed to stop such activity. The MOBA environment adds to the difficulty in locating the enemy, due to opacities and acoustic echoes, as well as the intermingling of combatants and noncombatants. Finding individuals, arms caches, and contraband is also an important MOBA activity. This implies a need to see and hear through buildings. Preventing unauthorized access to special facilities and cleared areas requires improved security devices that may in some cases couple unique sensors with nonlethal denial mechanisms.

[This page intentionally left blank]

3. STUDY CONDUCT

3.1 INTRODUCTION

The Board first envisioned the OOTW-MOBA scales of conflict as shown in Figure 5. It was soon recognized, however, that military operations can be so complex and varied that no single graphic will adequately describe what the military now faces. (For example, it is possible to enter and exit the curve at nearly any point.) OOTW seems to embrace almost all military operational activities short of (and possibly including) war. We believe that peace enforcement falls between peacekeeping (relatively benign) and peacemaking (use of measured force) – although DoD literature is sometimes inconsistent on such points.

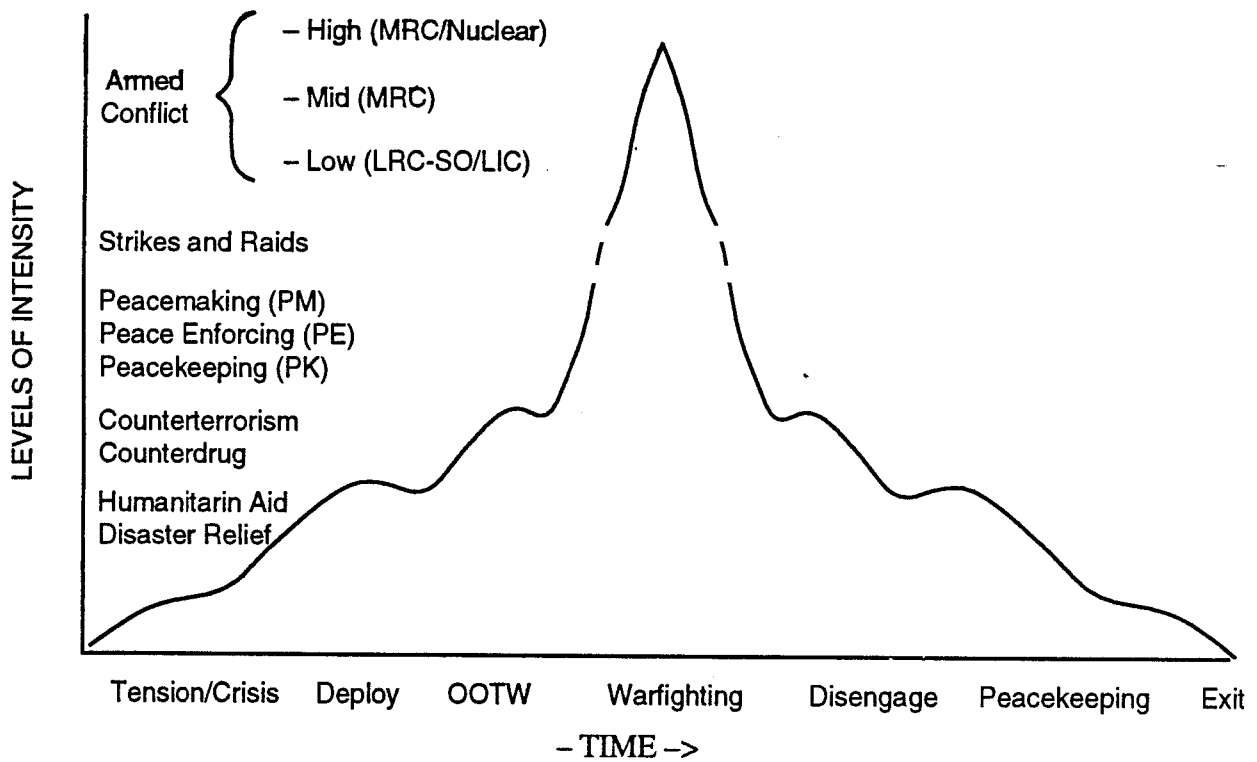


Figure 5. MOBA-OOTW Study Model

3.2 METHODOLOGY

The methodology used by the DSB in its study of MOBA involved several steps. They included: forecasting likely operations in the next 10-15 years, reviewing MOBA literature and previous studies, obtaining briefings on recent MOBA and OOTW operations, understanding current capabilities, forming illustrative scenarios, analyzing lessons learned, exploring promising technologies for MOBA, synthesizing results, and formulating recommendations. In its deliberations, the DSB-MOBA touched on many related topics, including:

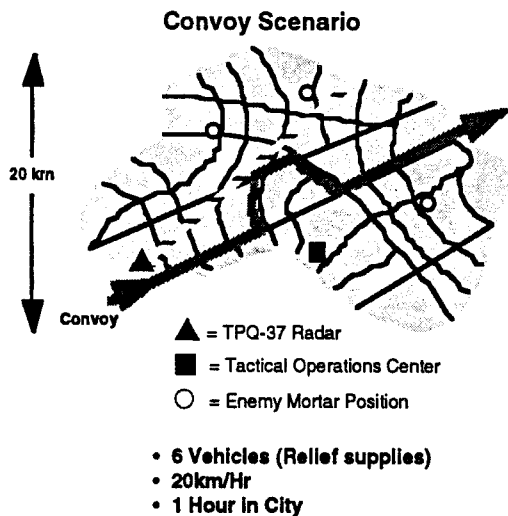
- Future Threats
- Likely Scenarios
- Urban Environments
- Intelligence Needs
- Warfighting in Urban Terrain
- Operations not Involving Force
- Civil Affairs
- Technologies and Tactics
- Force Structures
- Disengagement
- Training and Simulation
- Policy and Implementation

The following sections outline the methodology and provide information associated with each analytic step.

3.3 ILLUSTRATIVE SCENARIOS

3.3.1 Convoy Scenario

It is useful to describe typical scenarios in which U.S. and coalition forces must operate. Below (Figure 6) is a problem one often meets in MOBA-OOTW while moving a food convoy through a city. This operation might typically last up to one hour.



We can imagine the difficult threats to that convoy:

- Direct Fire - Snipers and RPGs are two hard problems
- Indirect Fire - Countering indirect fire in a city is tough
- Crowds - Semi-hostile or hungry crowds are a challenge
- Barricades - Can be formed on-call by a clever enemy
- Mines - Difficult, especially command detonated mines.

All elements, when combined, pose a serious MOBA problem.

Good surveillance and C2 are required to protect or reroute the convoy, and to counter hostile direct and indirect fires.

Figure 6. Convoy Scenario

3.3.2 Night Patrol Scenario

Another likely scenario (Figure 7) involves the use of patrols to maintain order after dark. Each scenario is rife with challenges. Listed are some of the devices that would make the urban warrior's job less dangerous, and also minimize damage to inhabitants and infrastructure.

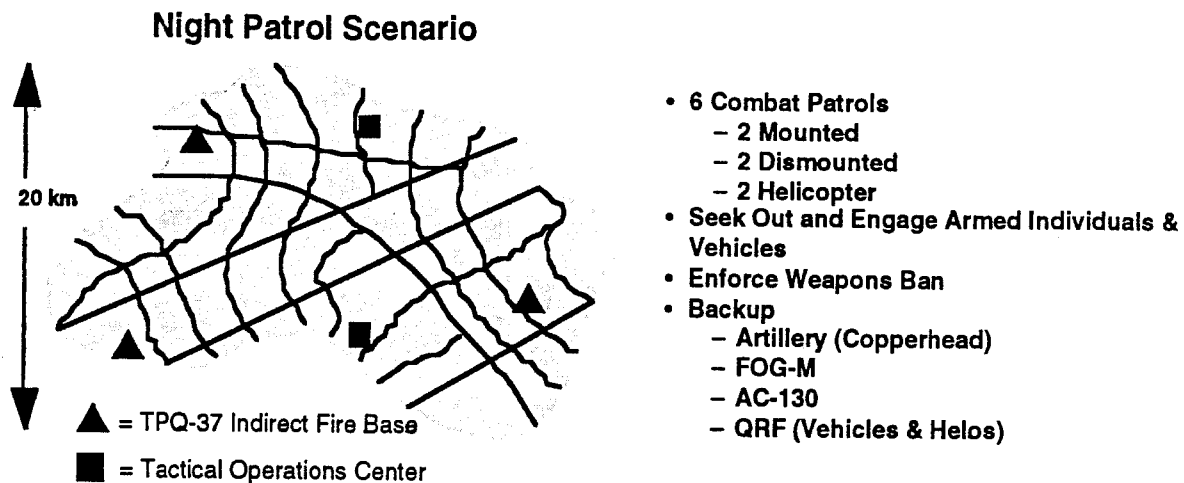


Figure 7. Night Patrol Scenario

3.4 LITERATURE REVIEW

The studies listed below were reviewed for the Board by the IDA staff. They cover a time period of 17 years. Each focused to a major extent on the subject of MOBA. Further details of these analyses may be found in Appendix B.

3.4.1 Army Science Board Study (1977-1979)⁹

This study translated the results of a combined 1977 German-U.S. study on MOBA into implementable tasks to include modeling and simulation. The assumption of the study was that combat including the use of chemical weapons between Soviet and NATO forces would occur in German cities. The primary problem areas defined in the study consisted of: locating and identifying forces, C3, defense against chemical weapons, mobility, and PSYOPs. **Findings:** that MOBA requirements were not included in existing requirements documents; that equipment is neither designed nor tested for MOBA environments; that MOBA training is cursory at best; and that MOBA-optimized munitions needed to be developed.

3.4.2 Hicks DSB Study (1984)

This DSB summer study focused on improving combat operations in urban terrain with assumptions that combat in this environment is distinctly different than in open terrain, and that opportunities exist to improve U.S. capabilities. The primary problem areas defined in the study consisted of: improper munitions fuzing and casing failures, lack of munitions to penetrate buildings to cause casualties in the targeted area, lack of countermine capability, no shallow water warfare capability, and limited urban intelligence capability. **Findings:** develop new weapons and munitions tailored for urban combat; program and budget for combined arms training; provide intelligence "desk cadre" for CINCs; improve PSYOPs and civil affairs capabilities.

⁹ See Reference list at end of report and reviews in Appendix B.

3.4.3 Bobrow DSB Study (1986)

The Bobrow summer study focused on the problems associated with controlling and managing large, Third World cities. The study listed the following assumptions: that these actions will not be a triumphal occupation; that the role of the U.S. and its forces will be minimized and temporary as the situations transition to another stage; and that there will be little chance for sustained support due to the media, the Congress, and the public sector. **Findings:** a set of 10 policy commandments with the first principle that Third World cities should be avoided; provide senior "on-call" urban management teams; request private sector trade groups to participate in a military emergency committee; assign the Army Corps of Engineers as the institutional focus for planning; request that the intelligence community establish a focal point for the topic; and develop an urban database.

3.4.4 Stiner Study (1994)

The Stiner report, performed for ARPA, focused on identifying technologies that may support OOTW. It listed a total of 27 different technologies that showed promise. The main assumption was that a critical need existed to enhance effectiveness and survivability of the forces engaged in OOTW. **Findings:** Problem areas consist of: need to detect dangerous activities; need to enhance force and police capabilities; and a need to develop supporting technologies. The technology solutions were categorized in the following areas: detection, force enhancement, force protection, C3I, and force projection.

3.4.5 Sullivan Study (1994)

Len Sullivan's report focused on global urban disorder, and emphasizes controlling crime over winning wars. His major assumption was that post-Cold War disorders more closely resemble crimes than traditional warfare. **Findings:** a sharp void exists regarding urban databases and analyses; rogue leaders and techno-bandits require non-standard responses; we must leverage existing capabilities while minimizing losses. The recommended solutions consisted of: developing procedures to use assets of military, paramilitary, and civil agencies; applying a variety of means such as political, economic, physical pressures, and sanctions; forming a center for urban analysis; and evolving a "Regional Stability Apparatus" containing high-tech special forces.

3.4.6 West Briefing (1994)

Bing West developed a briefing on the topic of Military Technological Revolution with the basic assumption that the ground forces sustain about 92 percent of casualties. He defined the following specific problems: a need to reduce the numbers of friendly and enemy casualties; a need to digitize the battlefield; and an inability to maximize the value of the upcoming Military Technological Revolution. He also stated that the infantry requirements will not be adequately funded, and feared that C2 will be over-centralized. **Findings:** Must provide sufficient funding for infantry programs – both Army and USMC; should conduct operationally-oriented field tests to develop tactics and doctrine and to evaluate organizational structures.

3.4.7 Summary

The above collection of studies represents an excellent, consistent assessment of challenges associated with MOBA. The DSB Urban Warfare Study by Hicks, et al., surfaced several needed improvements in MOUT operations that remain a challenge 10 years later. Even so, some encouraging activity has occurred in the interim. Improvements to artillery and missiles were made. Work is now underway to enhance conventional small arms with precision of fire on defiladed or hidden targets in buildings.

3.5 BRIEFINGS AND PAPERS

Approximately 50 briefings were presented to the Board from June to August 1994. Lists of meeting agenda topics may be found in Appendix C. Additional background papers were provided by some briefers. These are included in the bibliography section of the DSB report.

3.6 LESSONS LEARNED IN RECENT OPERATIONS

The Board received excellent briefs from military participants involved in several recent MOBA operations. Following are highlights of the "Lessons Learned" in Somalia.

3.6.1 Lessons Learned – Joint Task Force Perspective

MG Ernst, TRADOC, provided the Board with observations from Joint Task Force (JTF) Somalia. The JTF was formed on 7 October and was fully manned by 8 November, 1992. Its mission was: force protection, support of UN operations, and open and secure lines of communication (LOCs). Its primary ROE: 1) when engaged, use stand-off and precise, overwhelming combat power; 2) no (or minimum) casualties; 3) take the moral high ground; 4) continue training (demonstrated presence). The desired end state was to secure the peace and to get out without casualties.

MG Ernst observed that the commander does not know what he will get when forming a JTF. He stated he was lucky, and received very good people; he asked for a plans shop, and got it [not standard operating procedures (SOP)]. Ernst listed the weapons platforms brought in country. They included 30 M1A1C, 48 M2A2/M3A1, 155mm Arty w. Copperhead, 4 AC130 Spectre Gunships ("a great sensor platform"), 16 Army and USMC AH-1F helicopters, and the "star of the show – the OH-58D." Troops deployed with their basic loads. M1s and Bradleys arrived 44 hours after the call.

A JTF/SOM "response matrix" was shown (that matched enemy provocations to U.S. reactions). HUMINT was supplemented with IMINT and SIGINT national and theater assets. A Joint Support Element (JOSE) performed targeting, generally going inside the "circular errors probable" (CEPs) to check for noncombatants prior to a strike. Nightly laser exercises and other training were conducted to demonstrate readiness. Logisticians were given added TacSat radios – a common shortfall. Convoy tracking was done through "911 Somalia." Force protection included Level 3 vests, belly armor, reactive armor, and beefed-up communications equipment (MSC, MSRT, IMERSAT...).

3.6.2 Lessons Learned – Mogadishu, Somalia (10th Mountain Division)

Mogadishu is a city of 500,000 – swollen to perhaps 1.5 million by refugees. The urban environment consists largely of city blocks often not larger than a few times the size of a standard conference room. This made distances on overhead imagery difficult to gauge [field-expedient IPB terrain products, however, were rated as outstanding]. Compounds were surrounded by concrete walls of variable quality. Ceramic floors in buildings caused ricochet problems. Retaliation on a university building from which a mortar attack was launched caused the building's collapse.

Response times of 30 minutes from alert to out-the-gate indicate room for improvement. One must then add on the time to complete the mission. Digitization, real-time imagery, urban databases, and operational aids would be invaluable in shortening response times. GPS worked well in Mogadishu – buildings were rarely more than three or four stories tall. On-site processing of imagery from helicopters or other assets should include a GIS capability to tag buildings and streets with names. Names and signs are often non-existent in Third World war-torn cities.

Malaysian troops were generally treated by locals with greater respect than U.S. troops – Malaysian ROEs permitted them to fire into crowds, when necessary. The M1s and Bradleys (once in country) were a real morale booster – and affected the Somali behavior. It was stated that when the armor arrived and a “ring” operation was demonstrated around Mogadishu, *Somali firings at U.S. helicopters stopped.*

Soldier opinion is divided on whether Level 2 or Level 3 body armor is better for MOBA. Troops often fought with the front of the Kevlar vests undone for heat dissipation. DSB briefers were quite vocal regarding the importance of body armor vs. nonlethal technologies (specifically foam); they attach more importance to armor if it’s an “either/or” proposition. Less obvious to them was a need for arm and leg protection – although if weight and heat problems could be solved they would willingly slip it on, like BDUs. Other needs discussed included:

- Knee and elbow pads (like Special Forces)
- Hand-free radios (like SOF)
- M16 add-ons (TacLite, PAQ-4B)
- Radio telephone operators (RTOs) and other encumbered personnel need shotguns.

GIs want something other than the M16 – for example the new M4 short stock rifle is more useful in close quarters. The .50 Cal sniper rifle was excellent, allowing enemy snipers to be shot through trees and walls. High marks were given to the Mk 19 grenade launcher. Light antitank weapons (LAWs) were not always effective, but troops preferred three LAWs to one AT-4 (easier to crawl through small openings with LAWs). Soldiers concluded they need a better ATGM for “bunker busting.” *There is concern that the M249 may replace the M60 machine gun;* the former has problems: ammo case falls off, is inaccurate, and less reliable. GPS and quality overhead imagery were invaluable.

Regarding training – more OOTW schooling is needed for captains and lieutenants. The tooth-to-tail ratio in operations of this type has been low. Five thousand U.S. troops were in Somalia. Only 300 were infantry “ground pounders.”

No difficulty was observed with U.S. doctrine at the tactical level. At Bn-Co level, it is important to define actions in understood doctrinal terms. At the small unit level in Mogadishu, many actions – even humanitarian – translate “provide security.” Debriefings and after-action reviews (AARs) occurred after every mission. This information was used to update units prior to leaving the compound. It was stated that American forces knew with precision where key enemy bases were – they were just never given the “green light” to neutralize them. PSYOPS were used extensively. *It was difficult to pinpoint mortar and RPG fire.* Assistance here would be most valuable. *The location of weapons caches deep within the city was also a mystery. There is a strong need for all-weather, overhead monitoring capability in operations of this type.* U.S. scout helicopters (OH-58Ds) provided valuable coverage (however, their utility may have diminished, had surface-to-air missiles become a problem). Helicopters in Mogadishu had no real-time TV link to ground command posts. Verbal reports were keyed to photos with building numbers “affixed.” Additional comments from operational briefers are provided in Appendix C.

At the end of 10th Mountain Division briefing, the DSB asserted that a significant question results from this and other “operator” briefings, namely:

“Why does the U.S. permit sending its troops into foreign encounters with less than its best equipment (best helicopters, best armor, etc.)?”

3.7 CINC REQUIREMENTS FOR MOBA

The commanders of Army and USMC components of the Unified Commands were asked during the study to provide the Board with information regarding their MOBA needs. A copy of that letter is provided in Appendix D. Responses were received from seven commands, as well as from the OSD SOLIC Task Force (Revolution in Military Affairs). Their requirements were collated with those collected from units with recent MOBA experience and from other briefings. These MOBA requirements were separated into the categories shown below. The needs shown were surfaced by two or more sources.

- Weapons
 - Nonlethal crowd control
 - Custom demolitions to blow holes in walls, enter buildings
 - Improved laser designators & munitions
 - Improved 40-mm rounds (AP, CS, & bounding fragment)
- Countermeasures or devices
 - Detect and neutralize snipers, mines, booby traps, MANPADS
 - Spray devices, including cayenne pepper
 - Devices to keep locals off of military vehicles
- Equipment
 - Improved body armor (Level 4)
 - Improved situational awareness
 - Marking systems for cleared rooms, buildings, and minefields
 - Sensors to hear and see through walls
 - Vehicle mine protection kits
- Communications
 - Hands-off ICS [non-line-of-sight, embedded GPS chip and “911” capability]
 - Improved non-LOS soldier to leader radio
- Intelligence
 - Language translators
 - Rapid map generators
- Sensors
 - Improved night vision devices not degraded by illumination
 - Combat ID of individuals
 - Small thermal sights for individual weapons
 - Video camera with transmitter
 - Real-time long term, day/night reconnaissance
 - Long endurance UAVs, UGVs, and robots
 - Tagging, movement control of goods

- Training
 - More (and larger) MOUT training sites with live “shooting houses”
 - Training ammunition, including paint rounds
 - Joint training simulators

The listing is not in a priority order. However, the five needs most frequently mentioned were (1) individual soldier communications that allow for hands-off operation, (2) nonlethal means for crowd control, (3) soldier-to-leader communications, (4) improved body armor, and (5) night vision (FLIR) devices that do not degrade in urban illumination conditions. The study group also found that the requirement to detect and counter snipers, mines, MANPADS, and other weapons is a top priority for MOBA. Appendix D includes a matrix that lists each requirement by CINC.

3.8 SYNTHESIS OF RESULTS

Armed with information from briefings, reports, lessons learned, and CINC needs, the Board consolidated inputs. After some deliberation on both the scope of the study and the merits of competing technologies, a picture of useful future systems emerged.

3.8.1 Strong needs were expressed for the following devices by the soldiers themselves:

- Hands-free inter-soldier communications devices (squad and command level)
- Improved Body Armor (lightweight, cool, and effective against 7.62 mm)
- Detection and surveillance devices (snipers, mines, weapons, and AD missiles)
- Devices for “seeing through” walls (for building clearance and hostage rescue)
- Devices for nonlethal crowd control
- Laser devices (for pointing, dazzling, and weapons designation)
- Small arms (shotguns for crowd control; compact weapons for use in confined spaces)
- Night vision devices impervious to urban lighting
- Combat ID devices (anti-fratricide)
- Improved MOUT training facilities with live-fire “shooting houses”

3.8.2 There is also a need to give CINCS considerable help, including:

- Timely Intel, reconnaissance, and country profile capability (use of contractors)
- High-tech urban aids (communications, nonlethal, security...)
- Casualty reduction (especially from mines, mortars, and snipers)
- Smart weapons for precision strike
- Other deterrents (JDAM...)
- Means of dealing with neutrals
- Means of disengagement
- Virtual reality mission planner or rehearsal devices

3.8.3 Other needs surfaced regarding MOBA included: better lightweight power supplies, real-time mapping facility (to quickly reflect changes in urban landscape and assist navigation), and soldier medical survival kits.

3.9 JUDGMENTS REGARDING SHORTCOMINGS

The most important technological shortcomings entail survivability – specifically, dealing quickly with “sniper” fire (rifle, machine gun, ATGM, AD missile, mortar or artillery) and increasing protection via improved body and vehicle armors – and entering operations with good intelligence, navigation and communication abilities. Good intelligence implies a detailed, pre-existing knowledge base of the urban political and topographic environment, plus sensors tailored for exterior and interior urban operations.

Close behind, come needs associated with lethal (and some nonlethal) weapons designed for the urban environment and other means for providing crowd control and area denial.

3.10 TECHNOLOGY NEEDS

The technologies reviewed by the Board fall into multiple categories as shown in Table 3. They embrace several systems optimized for use in MOBA-OOTW, including C3 and Intelligence; RSTA sensors, weapons and ammunition; personal protection; crowd control; area denial; and force support (e.g., training devices and PSYOPS). The final column of the table refers to paragraphs in Chapter 4 that discuss the particular technology in more detail. Additional data on the state of the art in each technology area is provided in Appendix D. This information was assembled by the Board’s subgroups during their August 1994 deliberations at the Beckman Center, University of California, Irvine, CA.

3.11 FINDINGS AND CONCLUSIONS

The Board used the methodology and information highlighted above to develop findings and reach conclusions. The diverse talents of the group were used to determine whether shortfalls could best be remedied by fixes to doctrine, tactics, training, or materiel development.

3.12 ACTION PLAN

An implementation plan was developed that recognized the mottled history of attempts to improve urban capabilities, and that was mindful of current austere budgetary restrictions. It reflects an approach that the Board believes could dramatically improve U.S. urban operational capabilities. The plan entails treating MOBA as a system, and providing an umbrella program to achieve a stronger focus on useful technologies. It also provides for early testing and fielding of critical equipment. Cost estimates and a strawman schedule were developed to aid implementation.

Table 3. Technologies Reviewed, By Type

TYPE	LETHAL	NONLETHAL	OTHER	PARA.No.
WEAPONS AND EQUIPMENT				4.2.1
ATGM and EFOG-M	X	X		
Machine Gun	X			
Grenade Launcher	X	X		
Rifle	X			
Artillery	X			
Counterfire: Mort, Arty, Sniper	X			
Tank Main Gun	X	X		
Precision Rounds	X	X		
SURVIVABILITY				4.2.2
Body Armor			X	
Combat Lifesaver ("911")			X	
Urban Vehicle	X	X	X	
Robotics	X	X	X	
C3I and INTELLIGENCE				4.2.3
MOBA Radios and TV Commo			X	
Urban INTEL and Mapping			X	
Language Interpreters & Tutors		X	X	
CROWD CONTROL (Nonlethal)				4.5
Vehicle Electronic Girdle		X		
Flash-Bang		X		
Calmative Agents		X		
Obscurants		X		
Foams, Oils & Goos		X		
Nets		X		
CROWD CONTROL (Nonlethal)				4.5
Acoustic Generators		X		
Laser Dazzlers		X		
EMP & MHD		X		
SENSOR SYSTEMS (RSTA)				4.2.4
See-Through Walls Radar			X	
Urban NVEO Devices			X	
Counterfire	X		X	
OTHER NEEDS				4.3
Civil Affairs and PSYOPS			X	
Medical Support and Care			X	
DOCTRINE & TRAINING			X	4.4

4. FINDINGS

4.1 INTRODUCTION

Current technology will provide the urban warrior with the ability to better communicate, manage crowds, and stun or neutralize hostile forces. Other state-of-the-art technologies will improve U.S. capabilities to protect soldiers and crews, enter and clear buildings, detect dangerous elements, incapacitate personnel and materiel, deny regions, counter hostile fire, and provide timely intelligence and command and control. The ability of technology to fill needs is discussed below within sub-categories.

4.2 EQUIPMENT NEEDS

4.2.1 Weapons and Equipment (Figure 8).

The sub-paragraphs below describe existing and needed force capabilities. The figures provided in this section reflect the Board's judgment regarding current force capabilities and the maturity of replacement technologies. These "stoplight" charts contain circled letters: R implies serious difficulty in achieving a near-term solution, Y implies less difficulty, and G implies either an in-hand remedy that could be procured, or that a solid technical (or other) solution exists.

Conventional Weapons Adapted for MOBA. Improvements are needed to personal weapons (smaller size) and ammunition types (e.g., anti-ricochet flechettes and nonlethal disorienting devices such as flash-bang and dazzling grenades). The majority of our currently deployed ATGM and heavy weapons have arming range, back-blast, or fuzing characteristics that make them difficult to employ in MOBA. ATGMs are needed that can be fired from enclosures and used for wall breaching and bunker busting. These improvements to the soldier's armory can be made at modest cost. Some devices already exist in U.S. special forces inventories, or can be readily obtained from foreign manufacturers (e.g., Swiss flash-bang grenades).

Non Line-of-Sight Weapons. Indirect fire weapons like EFOG-M are needed that can fire over obstacles and buildings, and have high precision in the terminal area. Non-LOS technologies include munitions that are TV-guided or laser-designated, such as the 155-mm Copperhead, the Hellfire missile, and Air Force laser-guided bombs. These weapons could be further adapted for reduced collateral damage by decreasing the explosive content, *or by replacing the explosive with nonlethal mechanisms such as aerosols.*

Ultra-Precision and Low Collateral Damage Weapons. Due to the characteristically short MOBA engagement ranges (< 1000 m), precision-guided small-warhead weapons would have significant utility in cities. Further work should be encouraged on ultra-precise delivery systems to provide high lethality and low unwanted damage. Remote or weapon-mounted lasers can be used to provide precision targeting. Low collateral damage could be achieved, using small (< 5-pound) warheads. LLNL's "Peacemaker" (indirect fire) and "Deadeye" (direct fire) are examples of this type of technology. Such devices make use of bullet- or projectile-tracking IR or radar systems, and achieve precision through command-guided or semi-active seeker technologies.

Counterfire or Intercept Systems. Sniper, mortar, artillery, RPG or MANPADS intercept weapons (fixed or vehicle-mounted) are required to defend a point or area target. Many casualties have been sustained over the past few years from these "indirect fire" systems. Counterfire systems must be able to locate the firing element rapidly and precisely, and deliver accurate fire against them. There is a need for multiple systems. The kill mechanism needs to be switchable, with automatic slewing and firing as an option. Detection technologies can be thermal, radar, acoustic or, TV.

Capabilities Needed: Weapons and Equipment

- **Personal protection**
 - Lightweight, user-friendly body armor; extremity protection (Y)
 - Laser and chemical/biological (Y)
 - Vehicle protection (Y)
- **Weapons**
 - Conventional, adapted for MOBA; non-line of sight (Y)
 - Ultra-precision; non-lethal (R)
- **Integrated vision systems and obscurants** (R)
- **Counterfire or intercept systems**
 - Sniper, mortar, RPG, MANPADS, artillery (R)
- **Intelligence and electronic warfare** (Y)
- **Robotic systems**
 - Sensors and hazardous operations (R)

Figure 8. Weapons and Equipment Needs

Counter-sniper. Some near-term solutions to the counter-sniper problem include acoustic or IR detection of the bullet's path and extrapolation back to determine the sniper's location. Other systems depend on identifying the sniper muzzle flash, although these are easier to defeat using blankets or flash suppressors. Far term solutions would entail using laser weapons or conventional guns with automatic traverse and elevation mechanisms coupled to the detection device. Lasers would detect and attack optics or eyes, and conventional weapons would kill the sniper. While automatic counter fire allows extremely short response times, there are operational considerations that need further examination.

Counter-artillery. A near-term solution to the problem of counter-artillery and counter-mortar is to utilize the existing Firefinder TPQ36/TPQ37 radar to identify an enemy firing location and the Enhanced Fiber Optic Guided Missile to attack it. EFOG-M utilizes an IR sensor in the nose and is steered to the target by an operator. This permits precise target attack and lessens collateral damage. One difficulty yet to be overcome in the counter-mortar problem is response time. It is possible for individual mortar crews to emplace, fire, and depart in a matter of seconds. Indiscriminate, area fire responses are not likely to catch the firing crew, and can cause considerable collateral damage. Constant overhead UAV surveillance-differencing techniques may lessen this problem.

4.2.2 Survivability

Personal Protection. Protective equipment must be provided against an increasing number of threats. Ballistic hazards from indirect and direct fire systems must be defeated to reduce personnel casualties. Opposing forces can introduce common terrorist weapons like car bombs and fire bombs. In addition, the possibility exists that laser devices may proliferate to Third World nations. Lighter weight and less bulky individual protection can be configured for MOBA operations. Current technologies (i.e., high strength fabrics in combination with metal or composite plates) can be used for personnel armor; laser eye protection that provides ballistic protection can be achieved through narrow-notch filters. Chemical defense can be achieved through absorptive undergarments and new masks. This armor would be modular. In the near term, protection of the body and head against fragments and bullets up to 7.62 mm will be possible with a total weight of less than 30 pounds. Such integrated protection can significantly reduce casualties from grenades, handguns, rifles, and light machine guns. In addition, the current items [the special protective eye ware cylindrical system (SPECS) and sun/wind/dust (SWD) goggles] can be used to protect against laser devices - both eye dazzling and damaging.

Vehicle Protection. Current light tactical vehicles use light armor not designed to provide protection from antitank mines, machine guns, or high caliber rifle fire. Ballistic blankets have been procured in contingency quantities to provide limited mine protection for HMMWV and truck cabs. Armor upgrade kits for the HMMWV and 5-ton trucks have been developed in different configurations designed to defeat varying threats. Lightweight ceramic plates designed to stop 7.62-mm AP threats are available for procurement. Mine protection for HMMWVs and trucks can reduce casualties, but complete mine and .50 Cal protection for these vehicles is considered a substantial challenge. Recent advances in high tensile fabric systems and lightweight ceramics provide opportunities to leverage products for small arms and mine protection for tactical vehicles in the form of light weight add-on kits for existing vehicles. Ballistic fabrics are already available in fabric form to defeat small arms. To defeat mines, simple deflector plates mounted in wheel wells can deflect blast. Modeling of the ballistic events has led to improved designs for 5-ton trucks. This technology in combination with ballistic blankets can provide improved protection in the near term. Units have requested an "electronic girdle" to keep noncombatants and hostiles off U.S. vehicles. LAV-25 or Bradley vehicles could be redesigned as urban vehicles.

Robotics. Unmanned ground and airborne vehicles (UGVs and UAVs) would aid performance of hazardous tasks including: mine clearance, explosive ordnance disposal (EOD), building clearance, hostage rescue, surveillance, crowd dispersal, rescue, and communications. Robotic vehicles have been demonstrated in RSTA, barrier breaching, and mine clearing operations. Ground or airborne teleoperated vehicles would assist MOBA activities such as Intel gathering, hostage rescue, EOD, and countermine - reducing the danger to ground forces. Some may be similar to these entering use by police forces. Some remote tasks supporting MOBA are best done from the air, due to the potential for attacks on UGVs. Ground robotic systems will often require a manned presence to reduce their vulnerability to hostile forces. They can be integrated with weapon systems for self-defense or offensive purposes. Further work needs to be done to achieve integration into MOBA operations.

4.2.3 C3 and Intelligence (Figure 9)

C3I Devices. The heights of some structures in built-up areas limit our current communications performance by interfering with the propagation of EM waves. MOBA communications equipment must be designed to permit individual soldiers to communicate while clearing buildings and performing other LOS-limited, hazardous tasks. Close-quarter tactics require that radios permit hands-off communication at squad level and with higher command levels. Each soldier should be equipped with a lightweight, individual radio that can operate non-line-of-sight for short distances - using a headset that does not interfere with the soldier's ability to hear ambient sounds, and with a microphone that allows him to talk while keeping his hands free to operate his

weapon or perform other tasks. An intra-squad radio-intercom for hands-free communication among the members of a group clearing a building, conducting a foot patrol, or controlling a crowd is available as commercial off-the-shelf equipment. Militarized versions could be quickly procured. The individual soldier radio of the integrated communications system should be augmented by a GPS-aided personal status indicator that would periodically report the location and status of each soldier. A soldier-activated "911" button could access an emergency communications link.

<u>Capabilities Needed: Recon, Surveillance, and Target Acquisition</u>	
• Pre-mission intelligence	
— Military/Political (fighting capabilities, political, social, economic structure)	(Y)
— Physical (maps, infrastructure)	(R)
• Dynamic intelligence	
— Overhead imagery; situational awareness; communications	(Y)
— HUMINT; traffic monitoring	(R)
• Intelligence dissemination	
— To local JTF command structure; and real time to CINC	(G)
— To shooters (target location)	(Y)
— To individual patrols	(R)
• Special sensors	
— Counter-artillery; counter-mortar	(Y)
— Counter-sniper; counter mine; see through walls; see around corners; detect crowd formation, etc.	(R)

Figure 9. RSTA Capabilities Needed

Command radios need to be improved or replaced to overcome interference associated with buildings and reduced LOS. The communications equipment should be able to pass and receive some level of situational awareness information such as combat identification, positional data, and individual medical emergency data. Equipment needs to be interoperable between services and coalition partners.

Being able to link into local area communications systems (TV and radio) would improve our ability to communicate with NGOs, international relief organizations (IROs), private relief organizations (PROs), as well as with the indigenous friendlies, neutrals, and antagonists. The communications equipment should provide for the inclusion of language translators. In case communications equipment is captured or stolen, some simple deactivation device needs to be imbedded in the equipment to prevent its unauthorized use.

INTEL, MC&G, and Urban Navigation. Reliable, up-to-date mapping products are needed for planning operations and navigation in urban areas, particularly in Third World cities. MC&G products would include 1:5000 scale cadastral maps and near-real-time pictomaps, coupled with intelligence products that provide details of the infrastructure. When linked with GPS, an urban C2-Navigation system would result that would help prevent fratricide.

4.2.4 Sensor Systems (RSTA)

RSTA. Sensors with real-time links to the Tactical Operations Centers will provide city-wide situational awareness giving early indication of crowd formation, barrier erection, mine emplacement, and vehicle movements. UAV borne sensors provide wide area coverage. Less expensive, but more numerous unattended ground sensors (UGS) can monitor key intersections, portals, bridges, etc. UAV sensors include: imaging infrared, television, MTI radar (to detect moving vehicles), and synthetic aperture radar for all weather day/night imagery. Existing UAV sensor platforms include Pointe, Pioneer, Hunter, and Predator. Tier II+ and Tier III are more capable units expected to be available in the 2000 and beyond time frame. Currently available UGS sensors include mini-TV cameras, passage monitors, microphones, and seismic devices. These can be improved by miniaturization, improved battery life, and better communication links.

Sensors. The technology to see through walls of several types from a reasonable distance is nearly in hand. A capability to image and detect movement through an adjacent interior wall (next room) is commercially available now from Hughes. These units are small, inexpensive, and are useful in hostage situations and building clearing operations. Simple periscopes would be of use in street patrols (mounted or dismounted) to see around building corners before exposure. New periscopes would be easy to procure from Leica. None are in the current U.S. inventory.

4.3 OTHER NEEDS (Figure 10)

4.3.1 Electronic Warfare (EW). The ability to jam or preempt commercial TV and radio stations will be required. Some conventional EW techniques must be modified, taking into account the particular blocking characteristics of tall buildings and other MOBA obstructions.

4.3.2 PSYOPS. Although our PSYOPS and civil affairs forces train and function in a MOBA environment, they could be made more effective. The PSYOPS forces need the ability to control the airwaves within the area of operation with equipment that is easy to deploy and to maintain. They should be able to take advantage of the current state of the art in the different communications media and science psychology.

4.3.3 Civil Affairs. Civil Affairs units become a key asset for the commander in MOBA operation. They help create the operation's desired end state. With 90 percent of the civil affairs forces in the reserve, our ability to quickly employ these forces is limited to volunteers or a Presidential call-up. The effectiveness of these forces depends on finding sufficient individuals with knowledge of the region, its customs, language, traditions, and infrastructure. Databases are needed that contain relevant information related to potential hot spots – and that can be updated quickly. Included in this database would be a list of U.S. personnel (whether in the government, military, industry or in retirement) who are knowledgeable about regions, worldwide. Call-up of a limited number of reserve components by the Secretary of Defense needs to be allowed to enable the use of key forces such as PSYOPS and civil affairs without the use of the political statement associated with the President calling up the reserves.

4.3.4 Medical Support. With the goal of minimizing casualties, several capabilities need to be improved to support MOBA. The combat life saver training now given to some soldiers should be expanded to ensure that more soldiers can perform these skills. When a soldier becomes a casualty, means of automatically passing location and vital signs to the proper personnel in the chain of

command needs to be fielded. To complement equipment such as improved body armor and ballistic and laser face shields, antidotes to stabilize victims of chemical, biological or even radiological agents need to be developed and deployed with troops in MOBA operations. The existing, rapidly deployable hospital facilities need to be tuned for MOBA support.

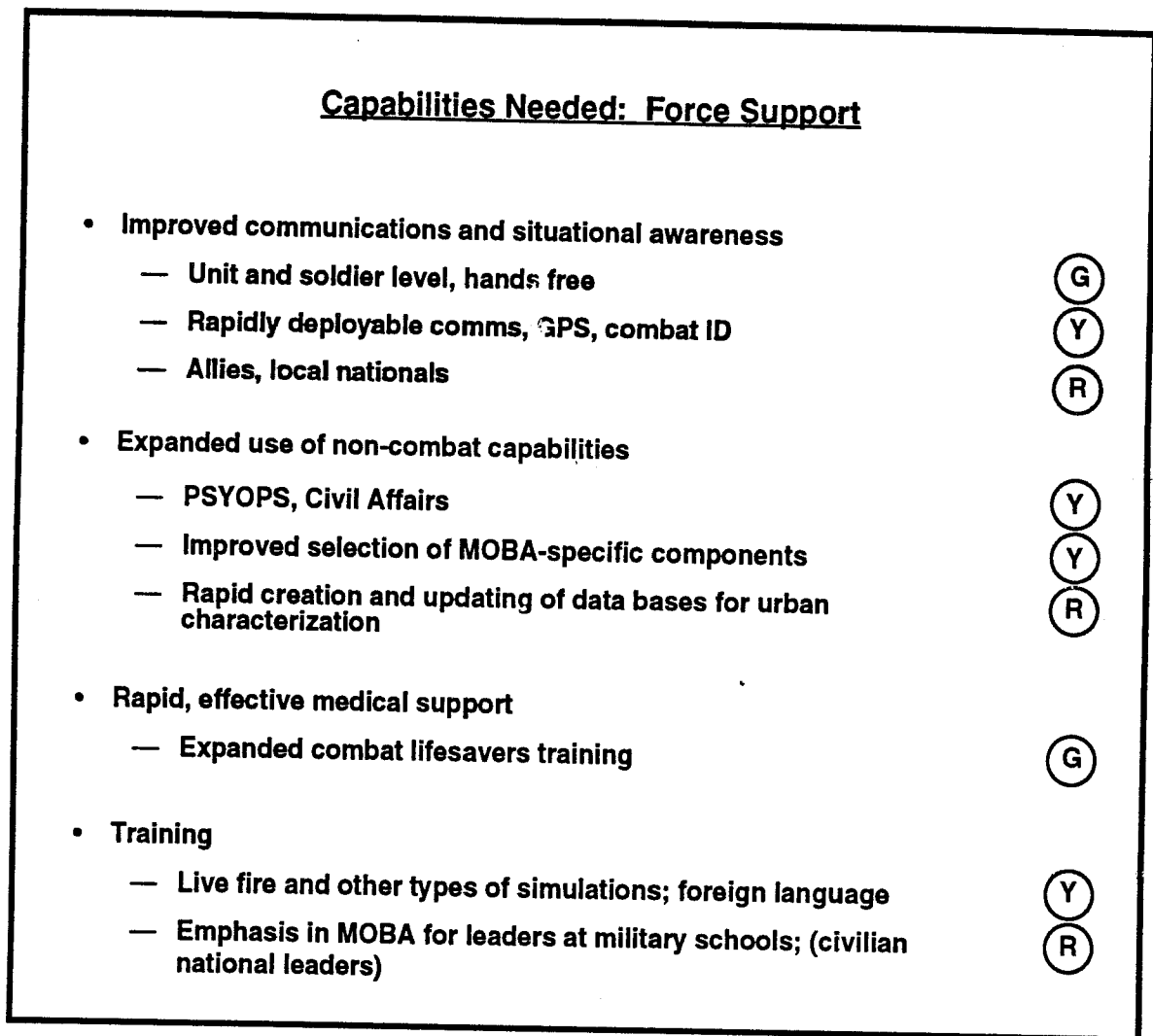


Figure 10. Force Support Needs

4.3.5 Medical Care. In MOBA, soldiers tend to operate in small units (fire teams or squads). It is not practical to assign medically trained personnel down to these levels. To improve the survivability of wounded personnel, immediate lifesaving tasks need to be performed. At least one soldier per squad is now trained in combat lifesaving skills. This program needs to be expanded to provide more trained soldiers at all unit levels. Although a rapidly deployable hospital capability exists within the 18th Airborne Corps and within special operations units, additional capability is needed for other forces that are deployed to a MOBA environment. Units that will deploy with these assets need to train using this limited capability.

4.3.6 Doctrine. RAND reviewed doctrinal publications – the draft FM 100-23 on peace operations is considered excellent. By contrast, a recent FM100-5 devotes only eight pages to

OOTW,¹⁰ and some Joint Pubs fail to mention MOBA or OOTW. The Arroyo Center has just completed a study covering means of cutting manpower requirements in urban centers. Joint requirements have not yet been addressed. Army needs cited in this RAND study include:

- Foam for filling and denying access to cleared rooms
- A light armored vehicle with ports for maintaining "presence"
- Body armor
- Better HUMINT
- Soldier training on the reading of blueprints, schematics, etc.

4.3.7 Tactics. Urban tactics with present systems have been tested recently in locations such as Mogadishu, and appear about right. New tactics will need development if advanced technologies are developed into unique urban devices.

4.3.8 Leader Training. Training for Military Operations in Built-Up Areas has been generally limited to the tactical level, i.e., to the brigades, battalion and attached units directly faced with such operations. Training facilities have been built and the Combat Training Center at JRTC and the CMTC in Germany put emphasis on such training and operations. Missing, has been training at the operational level for the senior officers of the Joint Theater Commands (JTF), and of the component services assigned to the Joint Force. Interaction with the news media should be emphasized, so that adequate coverage is provided, while simultaneously safeguarding operations and lives. Also missing is training of national-level civilian decision makers. Wargames and virtual reality mission rehearsal tools are required to help senior leaders (both civilian and military) improve their knowledge of the environment of various potential hot spots, assist planning for MOBA operations, and evaluate anticipated ROE and exit criteria.

The military generally describes the levels of war, forms of war (offense and defense), and the range of operations (war and operations other than war). Therefore MOBA is addressed only when the issue comes up at the operational level. As an example JCS Pub 3.0 doctrines for Joint operations, September 93 does not mention MOBA.

CINC's JTF commanders and service component commanders need training to address the complex nature of MOBA and the restrictions that normally attend. They need to: develop the thought processes of converting political and strategic goals into military goals and end-states; force selection and force sequencing of Joint Forces into the operational area; plan and interact with NGO; plan and interact with Allied and coalition forces; plan and interact with U.S. organizations (State, AID, FEMA, and Agencies); and develop Joint training programs and exercises.

4.3.9 Unit Training. Training of forces and education of leaders on topics associated with MOBA needs to receive more emphasis. Training facilities at several locations that replicate several different type of urban areas need to be acquired. Use of facilities closed by past or pending BRAC actions might be considered. These sites need sufficient size to allow for realistic training. Live fire and the existence of rubble and debris are critical characteristics of these facilities. Training ammunition, perhaps including paint bullets, needs to be procured. The leader training at service schools and colleges needs to be expanded, not only to include tactics associated with MOBA, but also area studies to develop awareness of what is important in planning and conducting MOBA operations, by region. Computerized language tutors would facilitate the training of GIs (who set national policy by their actions) prior to embarkation.

¹⁰ FM 100-5 (p. 2-0, June 1993) defines OOTW as activities during peacetime and conflict (as opposed to war).

4.4 POTENTIAL SURPRISES

Failure to act now, could precipitate future national surprises. Such surprises (Figure 11) could come from innovative technologies with military applications, from the political and social arena, or from the media. We must be prepared for potential enemies to possess some hi-tech weapons that could counter our capabilities, and for their ingenious use of simple devices or tactics.

The typical problems associated with MOBA center on defining the political objectives and the potential for mission creep. We must be prepared to deal with local factions in foreign cities.

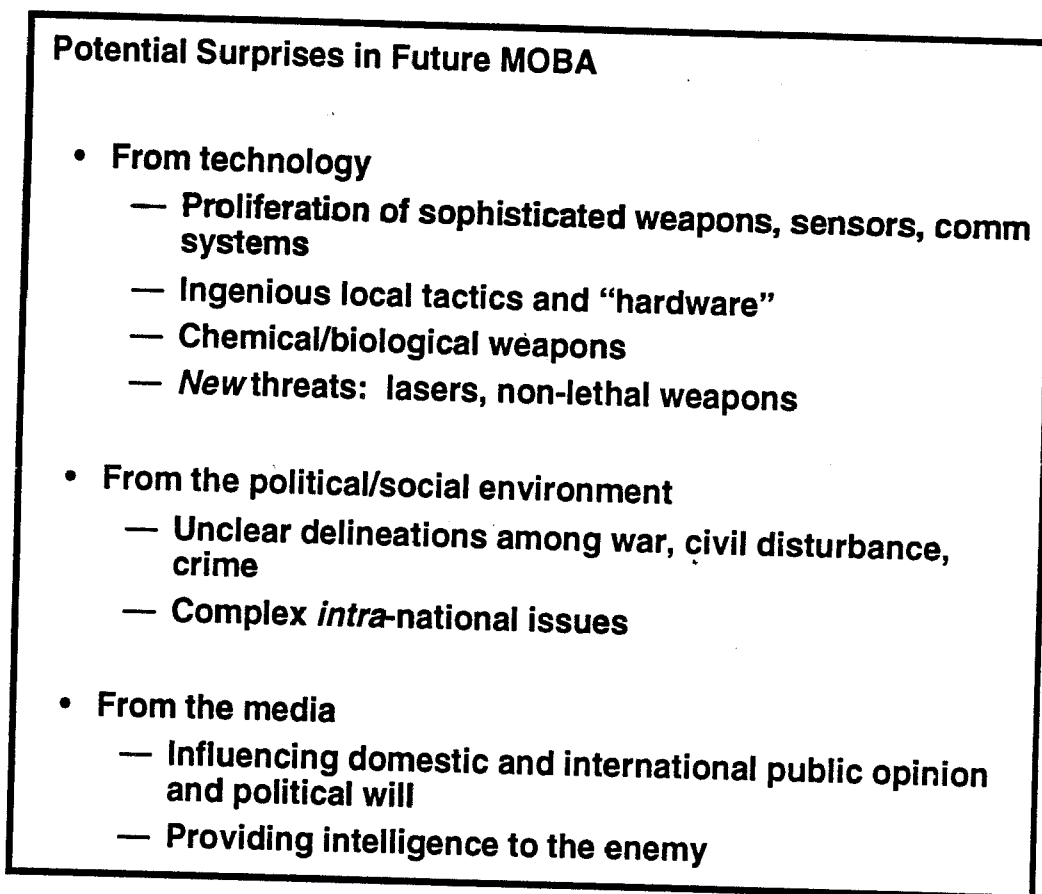


Figure 11. Potential Surprises in MOBA

4.5 NONLETHAL WEAPONS AND POLICY (Table 4)

The Board spent many hours of deliberation on this important, but thorny subject. It is accepted as a given that military forces must be equipped and trained for their primary role: to fight and win the nation’s wars whenever and wherever they are called upon to do so. The obvious inference from this is that lethal weapons are essential, and must be a first priority.

However, the recognition that OOTW are now prevalent, and are certainly the more likely future employments for U.S. forces, creates a strong motivation for evaluating the utility of nonlethal weapons and equipment. It was in this category – OOTW – that the Board’s deliberation centered on nonlethal technologies and policies.

Table 4. Nonlethal Technology Applications

Technologies and Applications	Stun, Flash/Bang	Expanding Spheres	Sticky Foams	Nets	Lasers	Acoustics	High Power Microwaves	Intimidation	Riot Control Agents	Rubber Bullets
Terrorists w/Hostages	X	X			X	X	X		X	
Crowd Control	X		X	X		X		X	X	X
Hostile/Civilian Mixed	X				X	X			X	X
Sniper					X					
Building Clearing	X				X	X			X	
Mortar/Artillery										
Checkpoint Control	X				X	X		X	X	X
Convoy Protection	X				X	X		X	X	X
Mines/Booby Traps							X			
Command & Control Nodes							X			

4.5.1 Nonlethal Weapons

The fundamental purpose of this class of weapons is to neutralize the enemy without killing. Thus, nonlethal systems can be used in situations where the enemy hides among non-hostile people, or where there is danger of unwanted collateral effects if lethal weapons are used. Unfortunately, a usually nonlethal weapon may cause unintended lethality under certain conditions: a stun gun could kill someone with a weak heart; a “rubber” bullet could hit a particularly vulnerable body part like the throat, and thus become lethal; and microwave devices could have unintended effects.

Nonlethal incapacitating chemical agents could lead to greater lethality by making enemies more vulnerable to lethal weapons. So, the results of nonlethal weapons are not clear-cut in all cases. Nevertheless, these technologies offer many advantages to joint forces engaged in urban operations where lethal weapons can have less desirable outcomes. Nonlethal technologies may also allow the operational level commanders to establish more effective and more reasonable rules of engagement.

4.5.1.1 Nonlethal Chemical Agents

So-called riot control agents and chemical calmatives offer excellent means of crowd control – which has always been a particularly difficult part of OOTW. We reviewed the many arguments, pro and con, regarding chemical use and the complex national and international legal hurdles that govern the development and employment of chemical agents – even nonlethal ones. It is clear from our study that although nonlethal chemical agents offer significant utility for U.S. forces in MOBA, the bodies that formulate world opinion and international law hold them in such repugnance that the U.S. may be prohibited from using nonlethal chemical agents in any form.

On the other hand, any nation or rogue paranational group could decide to use nonlethal agents against U.S. Forces with the certain knowledge that such use would be difficult for us to counter other than by resorting to lethal weapons. Therefore, it seems reasonable to us that the U.S. should develop promising nonlethal chemical agents that can disperse crowds, calm rioters,

or disable hostiles, and as a minimum, have select capabilities on hand even though we may be prohibited from employing them.

4.5.1.2 Other Nonlethal Technologies

Our study disclosed a wide range of so-called nonlethal technologies that have been or are currently being researched. Some are designed to attack humans, while others are meant to disable systems. Several promising technologies exist that could provide excellent capabilities to our forces engaged in relatively close quarter operations during OOTW.

The technologies cover a series of mechanisms, uses, and human responses. Flash-bang and acoustic technologies are used to temporarily stun, cause pain, or disorient personnel. Kinetic weapons are used to cause blunt trauma or to stun. Chemicals are generally used to calm, disorient, irritate tissue, or reduce visibility.

Electromagnetic devices may be used to intimidate or shock personnel (much like cattle prods) or to disable vehicles, aircraft, or facilities (using EMP or MHD technologies). Within this category, microwaves may be used to cause pain, perform area denial, or to disable and possibly explode mines and other ordnance. Entanglements and nets are used to contain or immobilize personnel or vehicles. Other anti-vehicle technologies (electrical, chemical, or mechanical) may be used to stop engines, damage tires or form barriers.

A list of most germane nonlethal technologies is provided in Table 5, along with information regarding programmatic and risk, where known. More detailed discussions on these and other needed technologies may be found in Appendix D. Due to a lack of test results, bonified cost data, or claims that may violate physical laws, it is well to treat some nonlethal technologies with healthy skepticism, until convincing details become available.

Nonlethal weapons are a claimant for funds to warfighters whose Services are already short of funds. Without an advocate for MOBA, nonlethal weapons will not survive funding priority battles.

4.5.2 Nonlethal Policy Matters

OSD SOLIC Nonlethal (NL) policy work was briefed to the Board. This office explained their oversight function and the need to provide a policy framework for research on nonlethal weapon programs. A steering committee has been formed that involves OSD Acquisition, OASD SOLIC, the Joint Staff, the Services, and Agencies. This office has defined **nonlethal weapons** as: *"Discriminate weapons explicitly designed and employed so as to incapacitate personnel or materiel, while minimizing fatalities and damage to property and the environment."*

The Board was informed that some technologies (particularly those involving chemical agents) are at risk of being completely outlawed by international tribunals in which DoD does not have a deciding role. The Geneva Conventions (chemical agents) and the Nairobi Convention (broadcast rights) are cases in point. It was stated to us that riot control agents are permissible in a crowd of non-combatants (or friends), but are prohibited from being used if combatants are present - or even combatants mixed with non-combatants. We fully understand that DoD is not the final decision maker in this policy area. Nevertheless, we were given to understand that DoD was formulating draft policy internally that would be tantamount to prohibiting nearly any development of nonlethal chemical devices.

We feel strongly that such premature policy promulgation from DoD initiatives could serve only to encourage non-DoD agencies to develop even more restrictive policies in this category. *Our judgment is that DoD should put its energies in the policy arena toward keeping open the broadest interpretation of the use of nonlethal chemicals, while supporting fully the prohibitions on the use of lethal chemical agents.*

Table 5. Nonlethal Technology Programs

TECHNOLOGY	RISK			MATURITY				ORGANIZATION
	L	M	H	POP	DEV	EMD	P	
Kinetics Soft Grenade (RAG) Rubber Bullet / Salt Shot 9mm LIC Ammo (20-75' range) Air Bag/Ball Projectile	X X	X X		X X		X X	X X	ERDC ARL,ARDEC,ERDEC/Israel ARDEC ARDEC
Directed Energy White Light (pulse-disorient) Optical Laser (grenade/other) Infrasonics Sonics Microwave Magneto Hydrodynamics		X X X X	X		X X X X	X	X	ARDEC, DOE, NWS NVEOD, ARL, DOE, ARDEC ARDEC DOE, ARDEC Brooks AFB Idaho National Lab
Chemical Calmatives Sticky Substances Engine Kills Super-Reagents De-Polymerizers	X X X X					X X X X		ERDC ERDEC, DOE, NIJ ERDEC DOE DOE
Entanglement/Envelopment Electric Stun Projectile Nets Sticky/Stinging Nets	X X	X			X	X X		ARDEC ERDEC ERDEC
Rapid Barriers Barbed Wire Ejection Air Bag Caltrops - tire defeat	X X X					X X X	X	ARDEC ARL ERDEC
Supporting Technologies Sensors (Night; Thru Walls) Periscopes Counterfire Trackers Language Translators C3I - Situational Awareness Medical Powerpacs - Lightweight Body Armor Robotics Working Dogs Holograms	X X X	X X	X	X	X		X X	Hughes, et al. Leica, etc. LLNL Commercial, MIT 21 CLW ARPA ARPA; Commercial ARPA Joint Project Offices U.S. Army MPs Brooks AFB

4.5.3 Summary

Nonlethal technologies offer great opportunities for furthering the National Military Strategy, which calls for minimizing casualties. We see that nonlethal weapons could offer a series of advantages:

- Permitting less restrictive rules of engagement
- Assisting in reducing the difficulty of dealing with a few hostiles hiding in a crowd of non-combatants
- Confusing an enemy with new effects for which he is unprepared
- Minimizing casualties to our own troops, to noncombatants, and to combatants
- Neutralizing equipment, such that repair is more difficult than it would have been under a "lethal" attack.

5. CONCLUSIONS

This section discusses several opportunities to improve our ability to conduct military operations and operations other than war in built-up areas. Actions involving doctrine, equipment, training, and tactics for employment of new equipment would improve our readiness for future events involving MOBA and OOTW (Figure 12).

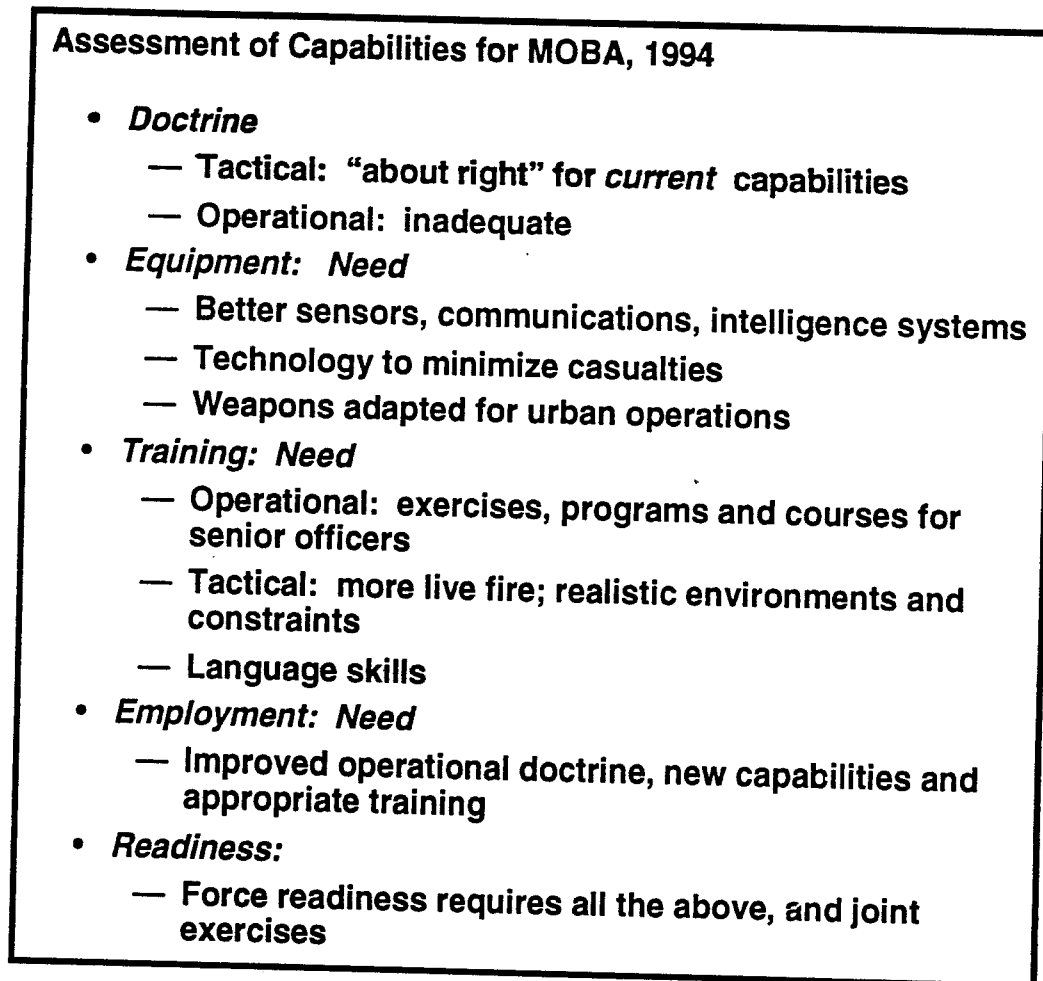


Figure 12. MOBA Study Conclusions

5.1 DOCTRINE

We considered the adequacy of our tactical procedures and operational doctrine for MOBA. We concluded that our tactics, considering the equipment available to our forces at this time, are about right. We know how to clear a building with present weapons and sensors, and we know how to search for and neutralize snipers. However, our operational doctrine on how to fight and succeed in urban warfare is not adequate. JCS Pub 3.0 does not mention MOBA. The Services, with Army lead, should be tasked to work on MOBA operational doctrine for the 21st Century.

5.2 TRAINING

We need to provide training in MOBA at the operational level. Joint exercises, command post exercises, and courses for senior officers are needed to cover the operational complexities of MOBA. Areas of concern that need to be incorporated in these training activities include: force selection; developing rules of engagement; and interaction with other government agencies, non-governmental organizations, and international relief organizations.

MOBA training facilities need to include more realism regarding their size, presence of realistic debris, and their capacity to conduct live fire exercises.

5.3 EQUIPMENT

There exists a wide array of sensor, communications, and tactical intelligence shortfalls. Fixes involve adaptation of existing weapons for urban conflict, unique technologies to detect snipers, mortars firing from the urban environment, and nonlethal methods of crowd control. There are many sensors, communications, and intelligence systems available (Figure 13) or in de-

Opportunities: Reconnaissance, Surveillance and Target Acquisition; Situation Awareness		
Solution		
Problem	Near Term	Far Term
Sensing in the urban environment	UAV-borne sensors (Ladar, MTI radar, SAR, TV, FLIR) Unmanned ground sensors (acoustic, IR, seismic, magnetic, TV)	
Look through walls; around corners	Wall-penetrating radar Periscopes	
Communications	Squad intercom systems UAV comms relay	
Individual status indication	Individual comm/Combat ID/ 911/GPS	
Talk to inhabitants	Phrase verbalizer Virtual reality language tutor	
Understand the infrastructure	Urban data bases, access to experts; expert systems	Real-time language translation

Figure 13. RSTA and Situation Awareness Opportunities

velopment that address the requirements of traditional military operations.

Many of these, however, are not optimized for, or will not meet the requirements of, MOBA. Systems that focus on urban terrain must overcome buildings of multi-story, multi-material construction. Camouflage, cover, and concealment will be provided by structures and networks not only at ground level, but also below and above the ground. Fields of view, in many cases, will be limited. Lines-of-sight for sensors and communications systems will be significantly impacted by urban structures, urban topography, and urban sprawl.

Depending on the specific nature of the military activity and the level of hostilities, operations and systems that require access to a broad frequency spectrum will also be affected. Limitations could include narrow frequency bands or having to stop certain specific local activities in order to get access to the frequency bands needed. Systems that have a built-in, wide range of selectable frequencies should be considered. Spread spectrum systems could also be useful. These latter two systems could, however, prove too expensive.

Unattended ground sensors could provide some of the answers for surveillance. Netting of these sensors could prove challenging. The data from these systems should be transmitted in a secure fashion and must be protected from tampering and jamming. HUMINT increases in importance in MOBA operations because of the need to tell the difference among friends, neutrals, and foes. Understanding the local environment and language capabilities will be critical. Effective liaison with friendly organizations and forces will prove vital to leveraging information and intelligence collected from technical sources.

There are other technologies that can help minimize casualties. Precision-guided weapons with small bursting radii will help reduce collateral damage and civilian casualties, provided that target location can be determined (Figures 14 and 15). Laser weapons, precisely directed, have almost no collateral damage. Individual self-protection such as lightweight body armor and vehicle armor kits can help protect the force.

<u>Opportunities: Reduction in Collateral Damage</u>		
Solutions		
Problem	Near Term	Far Term
Area type weapons damage more than desired target	Laser guided Small warhead PGMs	Ultra-precision weapons
Enemy among non-combatants	Incapacitating agents Flash-bang	Identify individual with weapons Non-lethal technologies

Figure 14. Opportunities to Reduce Collateral Damage

Many current weapons can be adapted for urban operations. Laser-guided weapons, fiber optic guided missiles, and concrete penetrating munitions are all examples. A High Explosive Plastic (HEP) round for the 105 mm tank gun currently exists (although a 120-mm version must be developed or adapted). The current AT-4 is cumbersome in close quarters. The weapons currently in the force have been largely developed for mobile armored warfare, with less attention paid to the urban environment.

Opportunities: Reduction of Casualties		
Solution		
Problem	Near Term	Far Term
Counter-sniper	Acoustic, IR sensors: muzzle flash, bullet tracking	Laser, automatic counter fire
Personal protection	Body armor Vehicle armor kits	25% decrease in weight at equal protection
Counter-artillery and mortar	TPQ36/37 radar and FOG-M	NLOS precision munitions Intercept device
Combat identification	IR lights, radio, situational awareness	Non-cooperative technology
Crowd control	Flash-bangs, riot agents, smokes, laser dazzler, water cannon, stun guns	Acoustics, smokes, microwaves, Voice recognition, machine translators
Medical care	Expanded training, combat life savers	Telemedicine

Figure 15. Opportunities to Reduce Casualties

We must be prepared to accept capabilities and weapons (such as water cannons or rubber bullets) used by law enforcement agencies, while remaining sensitive to the viewpoints of coalition partners to some nonlethal technologies (Figure 16).

Opportunities – Reduction of Casualties

Nonlethal Technologies

- **Technologies**
 - No standout winners
 - Wide variation in plausibility. Among the most plausible: chemicals, acoustics, lasers, microwaves.
- **Rigorous evaluation is required**
 - Offensive and defensive
- **Nonlethal technologies**
 - May be lethal
 - *May increase* the effectiveness of lethal weapons
 - Can produce especially serious injuries (blindness)
- **Technical and operational communities need information concerning limitations from treaties and international law**
- **Formulation of nonlethal policy limiting development now is premature and potentially harmful**
- **Important *chemical* systems are or may be excluded by current agreements**
 - Riot control agents, smokes, calmatives

Figure 16. Nonlethal Technologies

If the above actions are taken, the ability of U.S. forces to deal with the types of scenarios discussed earlier in this report should be dramatically increased. Our forces will be better able to neutralize harassing fires from snipers and indirect fire means. They will also be able to deal with crowds of mixed intent, while minimizing casualties to themselves and the innocent inhabitants of urban regions while conducting convoy resupply and other operations (Figure 17).

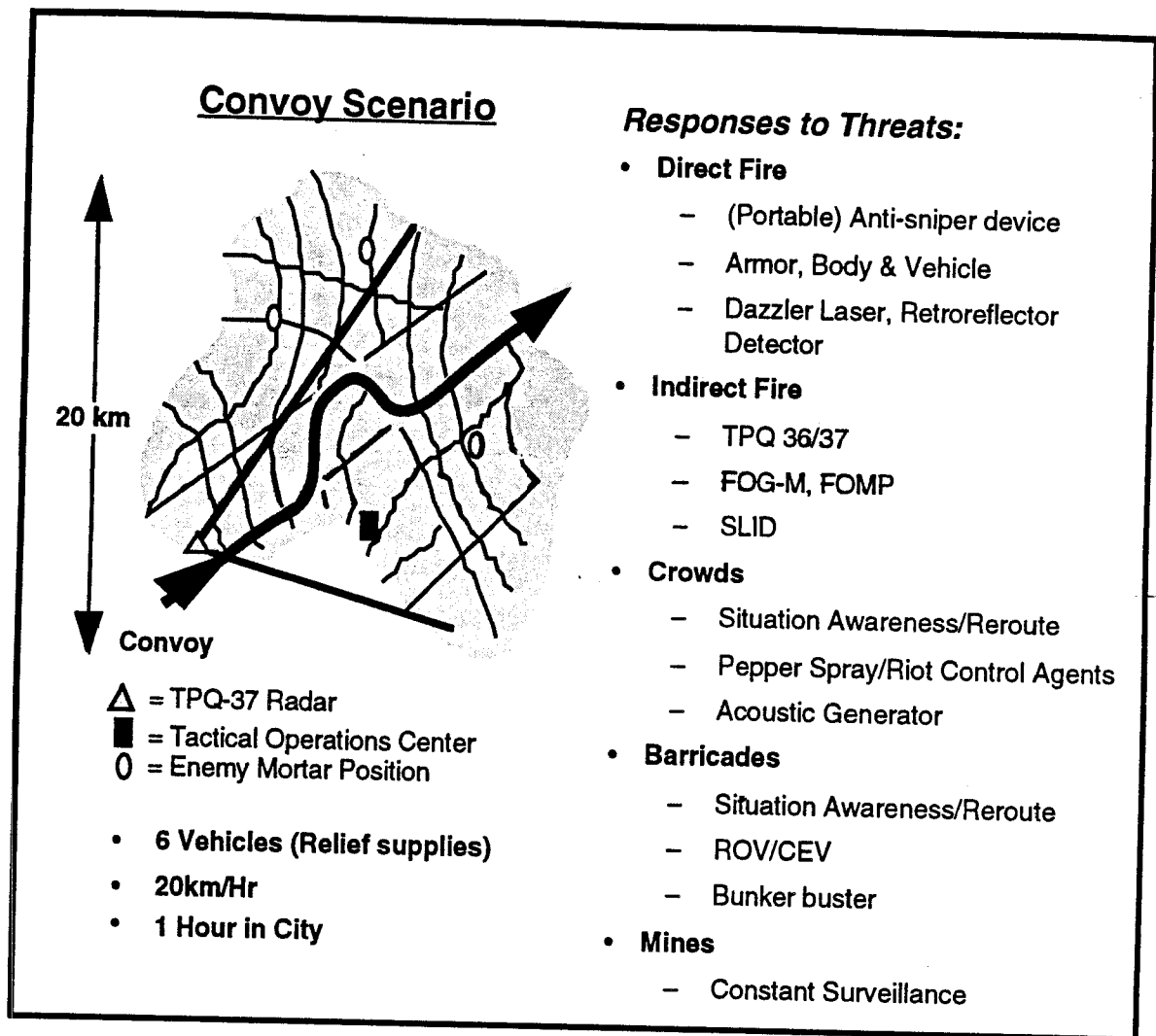


Figure 17. Improved Convoy Scenario - Ability to Respond to Threats

The night patrol example (Figure 18) will also be aided through improved sensors and other means of maintaining order after dark.

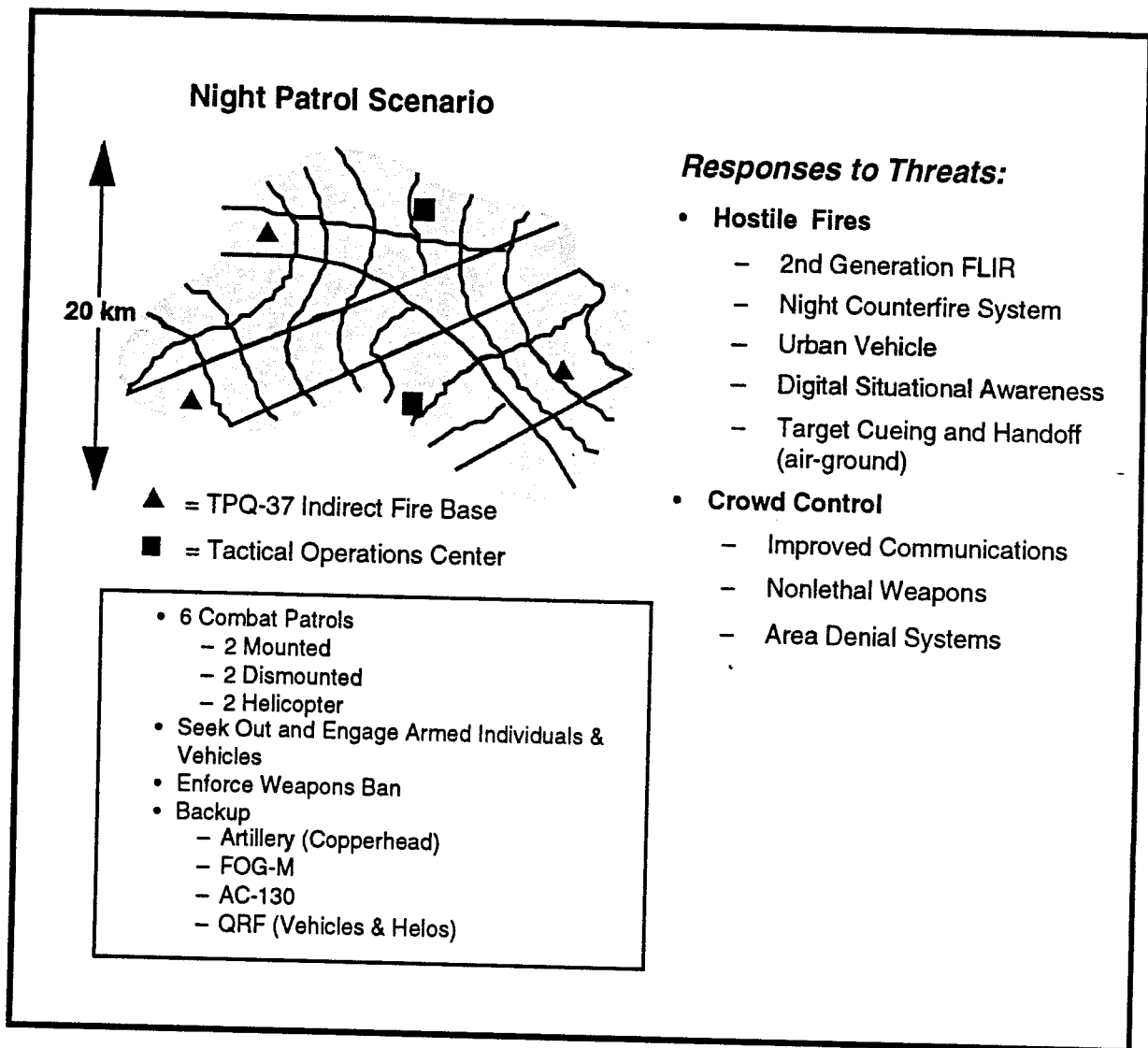


Figure 18. Night Patrol Scenario

5.4 SUMMARY

The development of appropriate operational doctrine to fit the improvements described above is a key need. More Joint exercises, testing of equipment, tactical development, operational and organizational (O&O) plans, and training must be promoted as we bring new capabilities into the force. Readiness will improve dramatically if we do the things discussed above in a systematic way (Figure 19).

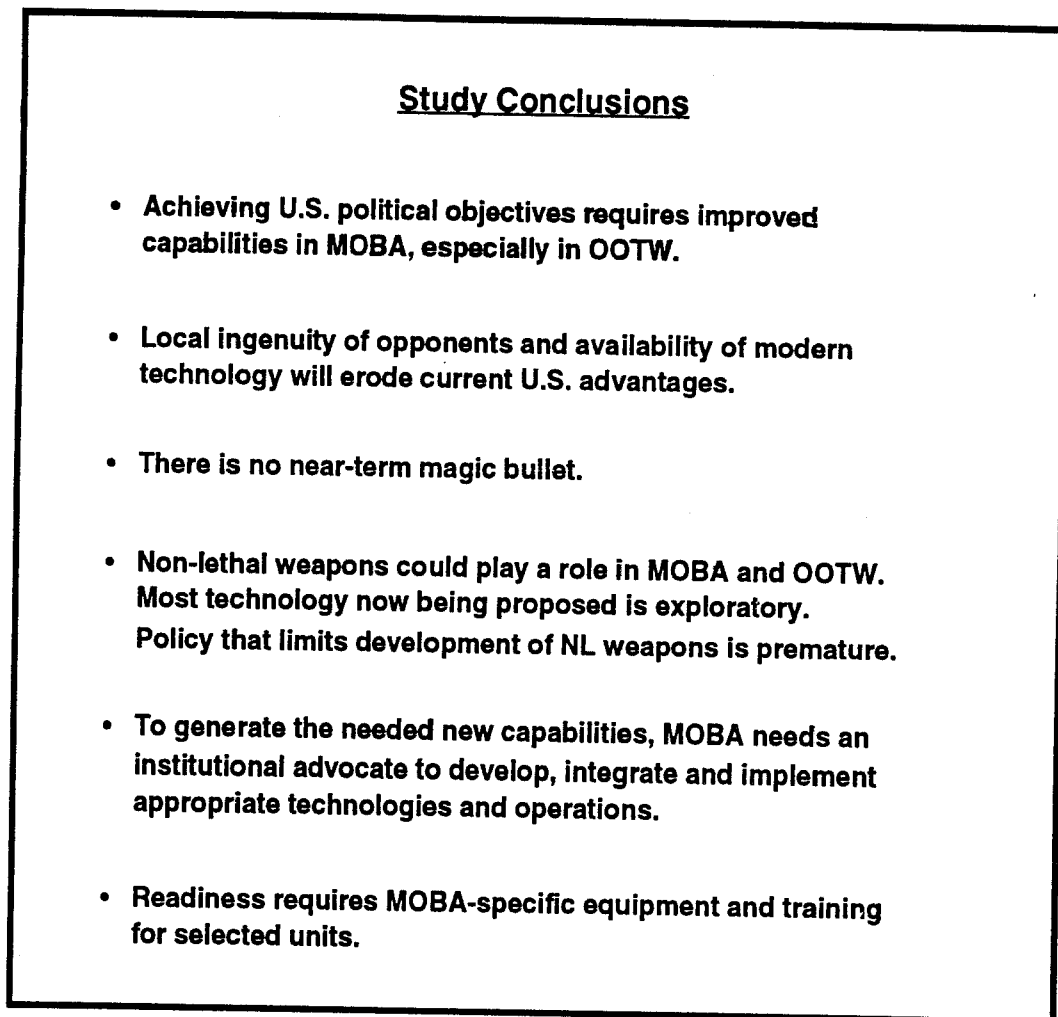


Figure 19. Study Findings

6. RECOMMENDATIONS

6.1 INTRODUCTION

The Secretary of Defense and the Chairman, Joint Chiefs of Staff should request that the Under Secretary of Defense (Acquisition and Technology) establish an Advanced Concepts Technology Demonstration (ACTD) program for MOBA (Figure 20). The Commander in Chief, Atlantic Command, and Commander in Chief, Special Operations Command, are two CINCs with direct involvement in MOBA on a continuing basis; they would be logical co-sponsors of this ACTD.

MOBA-related developments and equipment acquisitions over the past several years have been sponsored by ARPA, the Army and the Marines with ARPA having the most direct interface with operational units in supplying equipment for recent MOBA operations. Accordingly, ARPA would be an appropriate ACTD point of contact for all involved agencies.

The MOBA ACTD(s) would include utilization of the MOBA Simulation Center, the MOBA Analysis Center, and live-action MOBA exercises. The ACTD would test and evaluate weapons and supporting systems to improve U.S. forces capabilities for a variety of missions in built-up areas. These organizations and exercises would be supported by a MOBA database facility.

Recommendations

- Secretary of Defense approve the concept of MOBA as a system
- Implement the concept:
 - Designate ACOM to be in charge of MOBA as a system
 - Direct DIA to establish an *Urban Information System* characterizing relevant urban areas worldwide
 - Instruct the JCS to create a *MOBA Analysis Center* (including capability for strategic analysis and systems integration)
 - Task the Army to be the lead agency to institute a *Testbed* (to enable evaluation of technology concepts); other services to support as required
 - Direct JCS to expand Joint Warfare Center (collocated with ACOM) into a *MOBA Simulation Center* (including constructive, live, virtual simulation)
- Establish a MOBA ACTD (with ACOM and SOCOM as sponsors and ARPA as developer)

Figure 20. MOBA Study Recommendations

6.2 OBJECTIVES

The MOBA ACTD would be designed to demonstrate and evaluate a wide range of weapons, surveillance, communications, intelligence, and related equipment and systems to effectively accomplish the following missions in built-up areas worldwide:

- War
- Contingency Operations
- Peacekeeping
- Peacemaking
- Humanitarian Aid

The ACTD will also include civilian affairs activities and psychological operations involved in MOBA.

6.3 ACTIONS

ACOM -	Establish and activate MOBA Analysis Center. Designate MOBA exercise units.
Army -	Establish and activate MOBA Simulation facility within existing simulation and training centers.
Marines -	Be prepared to participate in MOBA exercises.
ARPA -	Establish point of contact to manage ACTD.

6.4 MOBA AS A SYSTEM

There are four principal actions that together lead to institutionalizing the concept of MOBA as a system (Figure 21). These are:

- (1) Assign a Joint CINC the mission for developing joint doctrine, identifying user needs (in conjunction with the services), and becoming the advocate for MOBA to receive its deserved priority.
- (2) Create MOBA databases of high-resolution for specified urban areas of the world.
- (3) Develop a MOBA analysis center where technical and operational experts can use the MOBA database, their own expertise, and fresh information to assess hot spots, develop operational options, and advise military authorities of potential crises.
- (4) Establish a Joint Forces MOBA simulation center that employs advanced technologies and urban databases to enable the interoperability of simulations of many types and in different locations.

Treat MOBA as a System

For example: Eliminate random mortar/Arty attacks

- Needs:**
- Find the fire base, day or night. Preferably before it fires, but absolutely after it fires.
 - Attack the position.
 - Minimize collateral damage.

Today's Capability: TPQ-37, counter indirect fires with mortars or artillery

Problem: Not timely, little deterrence, danger of much collateral damage

Future Capability:

- Deter indirect fires by wide scale use of night-equipped UAVs
- Detect fire bases by using remote sensors
- Find location by TPQ-37 if mortar or Arty is fired
- Eliminate fire base using EFOG-M, minimizing collateral damage
- Protect counterfire system with SLID-type device

Figure 21. MOBA as a System

Each of these four actions would have value as a stand alone entity. However, by executing all four, the Department would optimize the return on investment. It is our finding that the assignment of MOBA responsibility to ACOM would provide the essential user advocate and foster the momentum needed to spotlight the importance of MOBA. This one action is critical to the whole concept.

6.5 MOBA DATABASE

With respect to creating the MOBA database, there is already a growing demand for such a capability. There exist commercial systems today [e.g., the University of Nebraska geographic information system (GIS)] that could provide initial prototypes of needed MOBA relational databases. Moreover, the parts of the intelligence community that are involved in searching for ways to improve their support to military operations could become contributors to living databases. Other agencies – uniquely equipped to assemble unclassified urban data – should be energized. This overarching capability would support National Authorities as well as Military Commanders. As a commander and his staff perform the critical task of Intelligence Preparation of the Battlefield, the appropriate MOBA database would provide a source of seminal information.

6.6 MOBA ANALYSIS CENTER

Linked closely to the MOBA database is the notion of a MOBA analysis center. It is here that timely assessment can be made before tensions turn into full blown crises. Policy, intelligence, operations, social and political inputs, and the range of factors that go into decisions to use military forces can be considered together, using up-to-date, in-depth information and specific data about the people and their urban areas in the hot spots of interest. The thrust of this center is MOBA. However, since built-up areas are where the majority of world's population lives and works, a MOBA Analysis Center is generally applicable to nearly all potential crises. If the concept of an analysis center proves successful at the Joint CINC level, it is likely to be adopted within service commands and perhaps others. Although this idea needs the MOBA database in order to operate optimally, it would be of value to the Commanders as a central assessment capability even before the database is completed.

6.7 MOBA SIMULATION CENTER

Throughout the joint commands and across all services there are literally dozens of simulations and simulators. Field exercises such as those at Fort Irwin and at Nellis AFB are among many existing live simulations that are in operation today. Constructive battle models like the Air Force Air War Simulation (AWSIM) and the Army's Corps Battle Simulation (CBS) are prevalent throughout the DoD. Virtual simulations that establish a computer driven environment and allow the user to operate in a perceived reality are coming into greater usage across the services. However, very little virtual simulation includes MOBA, and the same can be said of constructive simulation. Some live simulations (notably in Berlin, at Fort Benning, and at Fort Bragg) address the MOBA issue, but few of these have the capability to use real ammunition.

A MOBA Simulation Center is the recommended step necessary to do two things: (1) direct some existing simulations to consider MOBA as an integral part of operations, and (2) provide the mechanism for integrating relevant simulations into a network through distributed interactive simulation. The end game would involve, for example, a real time linkage of a live exercise at Fort Benning, a constructive simulation exercise using CBS at Ft. Leavenworth, and a virtual simulation at Fort Polk. Using such a simulation laboratory, one could test new technology and evaluate new organizations to get a first cut on the value added by new initiatives. The MOBA Simulation Center could be located nearly anywhere since it would use communications and open architecture to link existing simulations and newly developed ones. Furthermore, it would be possible to get a modest operating capability in the first year of implementation by using existing models and already-demonstrated technology for distributed interactive simulations.

6.8 MOBA ACTD

An ACTD program on MOBA is needed to tie the materiel development, doctrine, testing, and training activities together. This would permit early fielding of limited quantities of MOBA equipment, *plus* an ability to test and evaluate with direct feedback into the training and doctrine community. The ACTD program would be jointly sponsored by ACOM and SOCOM, its principal Joint users. Furthermore, as an ACTD, the MOBA system would receive visibility and priority. In addition, users would get early return on investment, and only if it proved its merit to its users after several months of employment, would a system component necessarily have to be proliferated through a formal procurement action.

Clearly recommendations (1) through (4) do not depend upon the ACTD concept for their utility; however, the entire MOBA process would be enhanced and possibly accelerated by being designated an ACTD. The functional connectivity of this approach is shown in Figure 22.

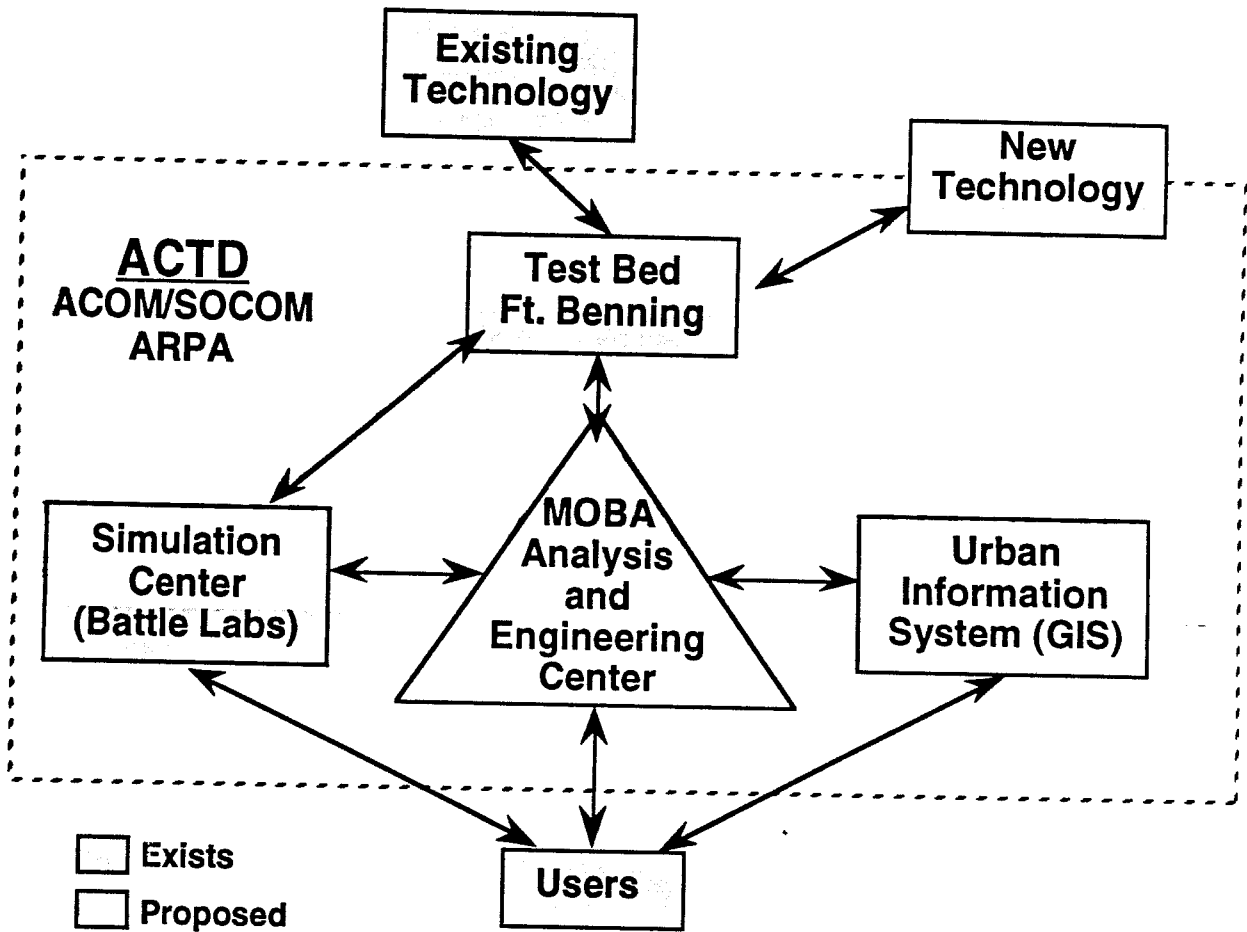


Figure 22. Functional Connectivities

[This page intentionally left blank]

7. IMPLEMENTATION PLAN

7.1 INTRODUCTION

7.1.1 *Responsibility for MOBA.*

There is currently no single advocate or champion for MOBA within DoD. Assigning a CINC responsibility for MOBA provides it both a doctrinal host and sponsor, and a proponent, without the costs associated with creating a new joint organization. Furthermore, a CINC provides the emphasis and operational orientation necessary for success.

Options. Assign MOBA to EUCOM, PACOM, SOUTHCOM, CENTCOM, ACOM, or SOCOM.

Recommendation. Assign ACOM the responsibility for the MOBA system. Situated in CONUS, in reasonable proximity to Washington and the Pentagon, ACOM's Norfolk location also places it near or adjacent to the other commands and activities located there, such as the Training and Doctrine Command. ACOM is also convenient to some of the forces most likely to be first deployed to MOBA – XVIII Airborne Corps and Marine Forces Atlantic – and supporting CONUS activities, making overall coordination of the disparate activities easier.

7.1.2 *Establish a MOBA Database*

DIA will (with assistance) establish, update, and maintain an urban area (MOBA) database library as a priority project. (All CINCs and in specific SOCOM and the Civil Affairs Brigade to provide detailed advice and recommendations on the types of information required.) The database (initially focused upon hot spots identified by the CINCs, growing to include most urban areas) will include, but is not limited to, the following information:

Biographic Intelligence: Directory, organized by functional sectors (communications, public health, transportation, utilities, government, etc.) of principals in the public and private sectors. Biographic information to include U.S. training and education, language(s), connections, political affiliation, military training, experience, etc.

Engineering Intelligence: Technical information on major elements of public infrastructure and major systems. Transportation centers and their capabilities are of interest: sea water ports, airports and airfields, fresh water ports, railroad, public transportation, roads, etc. Power grids, water projects, sewage treatment, mass transit, major industry, computational, communications (domestic and international), and medical are areas to be researched in some depth.

Institutional Services: Computerized registry of services and institutional facilities: hospitals, fire stations, police stations, churches, schools, universities, military, government, religious, cultural, historical, etc.

Demographic and Sociological: Detailed maps and profiles of socioeconomic information broken down by internal urban subdivisions. Of particular interest are descriptions of gangs, clans, family units, etc., and their relationships with other elements. Also included would be food distribution, banking, and media (newspapers, magazines, radio stations, TV stations, etc.).

Cultural and Anthropological: Profiles of DOs and DONTs for operating within the cultural milieu of the urban area.

Political and Administrative: A handbook containing information on the political and administrative structure of the urban area, to include key personnel and their offices. The municipal, regional, county, or state, governments located or headquartered in the city are of particular interest.

Cartographic: Detailed city plan including streets and main institutional facilities. Elements of information include: road network, type roads, size and construction of buildings, sewer systems, underground systems, public transportation, power grid locations, bridges, buildings over 20, 40, or 60 stories annotated, sports stadiums, police stations, jails, prisons, zoos, religious sites, military sites, armories, militia locales, and embassies or consulates. GIS relational data bases would include plans of key buildings and addresses and phone numbers of key personnel.

Attitudinal: Views of the local populace regarding U.S. and Americans. This information could be updated rapidly by the real-time monitoring of the Foreign Broadcast Information Service (FBIS) at appropriate command and analysis centers.

7.1.3 Establish a MOBA Analysis Center

To provide the capability to analyze new operational concepts and the utility of weapons and equipment for MOBA, ACOM should establish a MOBA Analysis Center. The center will be the center of excellence for developing and demonstrating the military value of new or modified MOBA tactics and doctrine and will be equipped with the requisite analytical support systems and manned by personnel from all services.

The center will work closely with similar activities sponsored by the services, CINCs, and ARPA to ensure rapid transfer of concepts and procedures and the synergistic development progress. Further, the center will establish links with NATO (SHAPE Technical Center, Military Committee, AGARD, etc.), as well as establishing bilateral coordination with United Kingdom, Germany, Israel, and other nations with MOBA experience to gain insight into their doctrine, equipment, and tactics.

7.1.4 Establish a MOBA Simulation Center

A Simulation Center is needed to evaluate changes to tactics and doctrine brought about by increasing emphasis on MOBA and OOTW. New technologies need to be evaluated before and during development, where possible. For some items, this will be accomplished best via simulation. The Simulation Center may, but need not be, co-located with the Analysis Center. As SIMNET-DIS capability is expanded to include a better MOBA capability, it is likely that components of the Simulation Center may actually be in different locations (HQ ACOM, Ft. Benning, Ft. Bragg, Quantico, etc.) and tied together as needed by a wide-area network (WAN).

7.1.5 Initiate a MOBA Advanced Concepts Technical Demonstration (ACTD)

Established by the Under Secretary of Defense for Acquisition and Technology and co-sponsored by ACOM (sponsor) and SOCOM (vice-sponsor), the ACTD would pursue the system approach to MOBA, closely incorporating the previously identified elements: the urban database library, MOBA Analysis Center, and MOBA Simulation Center. Pulling together and coordinating doctrinal, operational, and technical elements heretofore unfocused and competing as individual components. Capitalizing upon the relationship between the various elements, the ACTD will best benefit from having ARPA serve as the point of contact, based upon many of its continuing projects and association with the Army and Marine Corps on associated and similar initiatives.

Objectives. The ACTD will be designed to demonstrate and evaluate a wide range of weapons, surveillance, communications, intelligence, and related equipment, systems, and

subsystems to effectively and efficiently accomplish the following missions in built-up areas on a full variety of urban terrains:

- General war
- Contingency operations
- Peace operations (peace making, peace keeping, peace enforcement)
- Humanitarian operations
- Counterinsurgency
- Anti-terrorism

7.2 RECOMMENDED ACTIONS

- USD(A&T):** Establish MOBA ACTD and publish program plan based upon POA&M input from co-sponsors.
- ACOM:** As ACTD sponsor, in conjunction with SOCOM prepare Plan of Action and Milestones (POA&M) for MOBA System and submit through CJCS to USD(A&T). Establish and activate MOBA Analysis Center.
- SOCOM:** Serve as vice-sponsor for MOBA System ACTD and participate in preparation of POA&M.
- Army:** Establish and activate MOBA Simulation Center within existing simulation and training center.
- ARPA:** Identify Point of Contact to manage MOBA ACTD.
- Services:** Support MOBA Systems ACTD POA&M and submit MOBA requirements and recommendations to ACOM MOBA Analysis Center.
- CINCs:** Support MOBA Systems ACTD POA&M and submit MOBA requirements and recommendations to ACOM MOBA Analysis Center.

7.3 SCHEDULE

ARPA appoint POC for MOBA ACTD:	1 Nov 1994
ACOM and SOCOM submit POA&M:	1 Dec 1994
USD(A&T) issue Program Plan for MOBA ACTD:	1 Jan 1995
ACOM establish MOBA Analysis Center:	1 Jan 1995
U.S. Army establish MOBA Simulation Center:	1 Jan 1995
Conduct first exercise under MOBA ACTD:	1 Jul 1995

A detailed strawman schedule for improving MOBA abilities is provided in Figure 23.

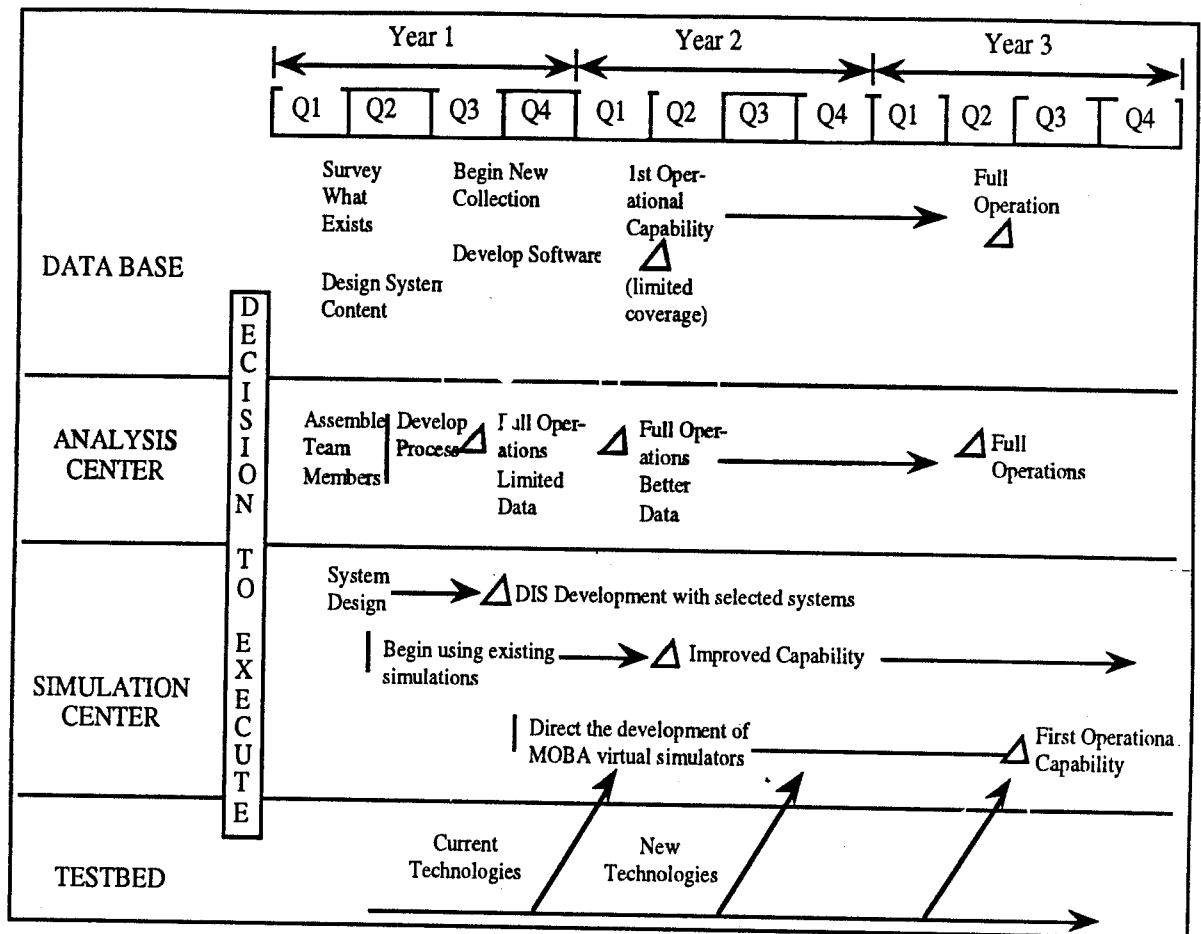


Figure 23. Schedule - MOBA Improvement Plan

8. FUNDING OF PLAN

Cost estimates associated with treating MOBA as a system were developed by examining: (1) current expenditures split across multiple programs, (2) estimating the costs associated with accelerating critical programs, and (3) providing a limited production capability to place new technologies in the hands of urban warriors for ACTD testing & evaluation.

Data, where available, were obtained from the Army's Master Plan, ARDEC databases, and existing 6.3 Advanced Technology Demonstration programs. Yearly cost estimates were also developed for a "MOBA as a System" program. The results are summarized below, and are shown in greater detail in Table 6.

<u>RECOMMENDATION COMPONENT</u>	<u>COST (\$M)</u>
Current Expenditures	\$50 / Year
Additional - to Accelerate	50
Facilities	65 / Year
ACTD / Limited Procurement	50

Table 6. Cost Estimates (MOBA as a System)

Opportunities	Currently Funded 95/96 (\$M)	Adds to Accelerate (Estimated) (\$M)	ACTD/Limited Procurement (Estimated) (\$M)												
Counter Sniper	\$ 4.0	\$ 2.0	\$ 1.0 - 5.0												
Personal Protection	3.0	1.0	2.5												
Counter Artillery/Mortar	40.0	0	10.0												
Combat ID	6.0	3.0	2.0												
Crowd Control	0	8.0	5.0												
Medical Care	0	0	0												
Sensing in the Urban Environment	0	10.0	5.0												
Look Through Walls Squad and Above	2.5	2.5	2.0												
Communications	5.0	10.0	5.0												
Individual Status	3.0	3.0	3.0												
Talk to Inhabitants	1.2	2.0	2.0												
Understand the Infrastructure	0	2.0	0												
Area Type Weapons Enemy Among Combatants	10.0	4.0	4.0												
Related Areas Mines/Robotics	0	2.0	1.5												
	25.0	4.0	6.0												
TOTALS:	\$ 99.7	\$ 53.5	\$ 50.5												
<p><u>Yearly Operational Cost (\$M):</u></p> <table> <tr> <td>Test Bed</td> <td>\$ 20 /Yr</td> </tr> <tr> <td>Analysis Center</td> <td>15 /Yr</td> </tr> <tr> <td>Simulation Center</td> <td>20 /Yr</td> </tr> <tr> <td>Urban Data Base</td> <td>10 /Yr</td> </tr> <tr> <td></td> <td><hr/></td> </tr> <tr> <td></td> <td>\$ 65 /Yr</td> </tr> </table>				Test Bed	\$ 20 /Yr	Analysis Center	15 /Yr	Simulation Center	20 /Yr	Urban Data Base	10 /Yr		<hr/>		\$ 65 /Yr
Test Bed	\$ 20 /Yr														
Analysis Center	15 /Yr														
Simulation Center	20 /Yr														
Urban Data Base	10 /Yr														
	<hr/>														
	\$ 65 /Yr														

9. SUMMARY

U.S. MOBA activities must be conducted superbly – due, in part, to intense domestic scrutiny, international media coverage, and our desire to improve relations with indigenous populations. Anything less will erode, and perhaps irreparably damage and compromise U.S. influence. Current U.S. military capability is a legacy of the Cold War, designed for large-scale, high-intensity operations. Our forces lack the specific doctrine, equipment, and support required to conduct MOBA in the professional manner they desire.

There are existing capabilities that can readily be adapted to Military Operations in Built-up Areas. But in many cases, new and better tools, focused upon the unique elements of MOBA, are required. Drawing upon recent U.S. and allied experiences, we have determined that relatively small investments can provide high dividends for our forces.

By implementing the four actions recommended in this report, MOBA would be established as the focal point for operations other than war for planning, programming, and budgeting. We see the MOBA Database, the Analysis Center, and the Simulation Center linked together in a mutually supporting sense. The DSB Task Force on MOBA believes that:

1. MOBA provides an extremely difficult environment that requires a full range of integrated systems. Because of the likely role of MOBA in the future, it should be a key consideration for future research and weapons acquisition.
2. MOBA needs a forum to act as a “forcing mechanism” with the acquisition community and the Joint Staff. The Joint Staff might consider making MOBA a JROC JWCA.
3. MOBA needs to be regarded as a single system. Major pieces involve:
 - User in charge (possibly USACOM or SOCOM)
 - Integrated information system
 - Analysis Center (potential for JS to direct USACOM to lead)
 - Testbed
 - Simulation Center (potential for JS to expand JWC)
 - Creation of a MOBA ACTD program.
4. It is possible to adapt some current weapons technology and research but MOBA needs:
 - Some new technologies (e.g., nonlethal)
 - Treatment as a system to integrate full spectrum of capabilities
 - A champion to insure implementation.

For this reason, we recommend that an ACTD be approved that consists of the three operating actions recommended in Chapter 7. Appropriate technologies, when integrated into a MOBA system with well-trained personnel, will dramatically raise U.S. capability to perform MOBA (Figure 24).

SUMMARY CONCLUSION: APPROPRIATE TECHNOLOGY, INTEGRATED INTO A SYSTEM, USED BY WELL-TRAINED PERSONNEL, CAN DRAMATICALLY RAISE CAPABILITY IN MOBA:

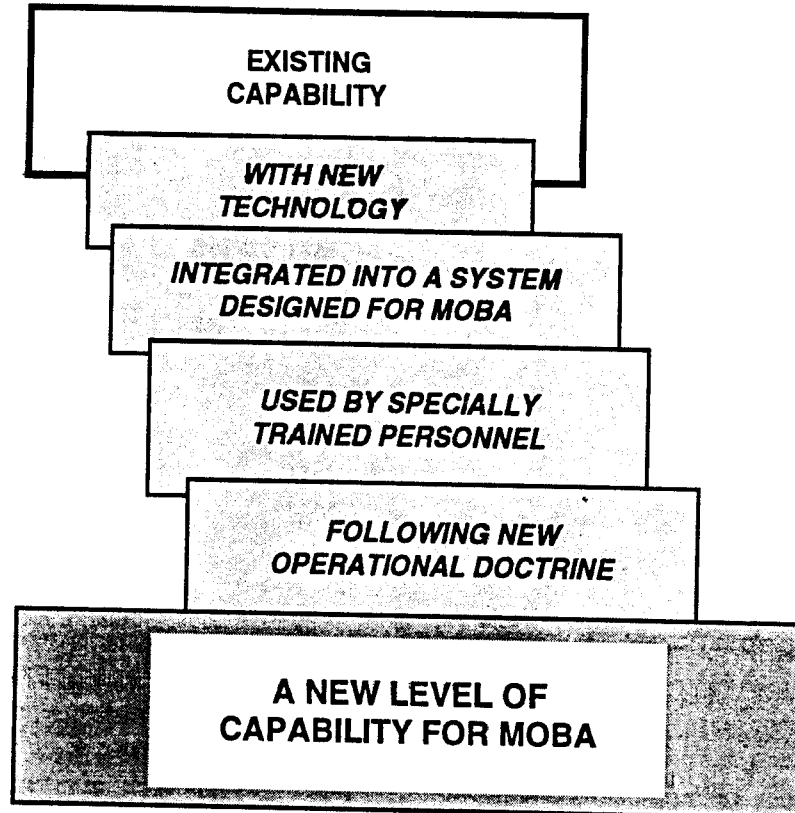


Figure 24. Summary Conclusion

REFERENCES

- 1994 Joint Military Net Assessment (U)*, OSD (SECRET-NOFORN).
- Army Modernization Plan*, Update (FY95-99), Dept. of Army, May 1994.
- Army Science and Technology Master Plan*, FY95, Draft, August 1994.
- Army Science Board Study (Military Operations in Built-up Areas)*, B034309, 1977-1979.
- Bobrow, Davis, et al., *Implications of Third World Urban Involvement*, Report of the Defense Science Board, Conflict Environment Task Force, May 1986.
- Coates, Joseph F., *The Nature of Cities--Background Notes to the Study of Low Level Combat*, Institute for Defense Analyses, Alexandria, Va, Note No. 720, 1970.
- Department of Defense Dictionary of Military and Associated Terms*, Joint Pub 1-02, Chairman, Joint Chiefs of Staff, 23 March 1994.
- Dewar, COL Michael, David and Charles, *War in the Streets: The Story of Urban Combat from Calais to Khaffi*, Great Britain, 1992.
- Doctrine for Joint Operations*, Joint Pub 3-0, Chairman, Joint Chiefs of Staff, 9 September 1993.
- Ellefsen, Richard, and Wicks, L.E., *Characteristics of Urban Terrain*, Naval Surface Weapons Center, NWSC TR 79-224, June 1979, UNCLASSIFIED.
- Ellefsen, Richard, et al., *Urban Building Characteristics, Settings and Structure of Building Types in Selected World Cities*, Naval Surface Weapons Center, NWSC/DL TR-3714, 15 January 1977, UNCLASSIFIED.
- FM 100-5, *Operations*, HQ Department of Army, June 1993.
- Folder of OOTW - SOLIC Papers, OSD SOLIC Office, July 1994.
- Hardison, David C., "Warfighting in Urban Terrain," (draft paper), July 1994.
- Hicks, Donald A., et al., *Defense Science Board Summer Study on Urban Warfare (U)*, 1984, SECRET.
- Initial Development/Application of Urban Terrain Data for Artillery Employment in MOUT*, Joint Technical Coordinating Group for Munitions Effectiveness, 61 JTCG/ME-87-1, 13 April 1987.
- Olson, Warren, and Smith, Edward, Briefing: "Studies of Urban Warfare," Institute for Defense Analyses, Alexandria, VA, 25 July 1994.
- Olson, Warren, et al., *Minutes and Briefings, Defense Science Board Summer Study on Military Operations in Built-Up Areas*, Vols. 1 through 4, June-August 1994.
- Payne, W. Scott, et al., *Promising Areas of Research and Development for Tactical Operations in an Overseas Urban Environment (U)*, 1970, IDA S-345, 1970, SECRET.
- RAND Urban Warfare Notes*.

REFERENCES (CONT'D.)

- Reiss, David W., et al., *Survey of Current Doctrine, Training, and Special Considerations for Military Operations on Urbanized Terrain*, Ft. Benning: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Stiner, General Carl, et al., *Report of the Senior Working Group on Military Operations Other Than War*, ARPA, May 1994.
- Sullivan, Leonard, Jr., *Meeting the Challenges of Regional Security*, Strategic Studies Institute, U.S. Army War College, February 1, 1994.
- Taw, Jennifer, and Hoffman, Bruce, *Operations Other Than War*, RAND, Santa Monica, CA, May 1994.
- Taw, Jennifer, and Hoffman, Bruce, *The Urbanization of Insurgency*, RAND Arroyo Center, Santa Monica, CA, 1994.
- West, F.J. Bing, *Military Technical Revolution, C2 Doctrine and Ground Combat*, Paper and Briefing for CNA Conference on MTR, GAMA Corporation, April 1994.

BIBLIOGRAPHY

- "Equipment and Environment," *Journal of Defense Research, Series B Tactical Warfare*, Fall 1969.
- "SOFPARS/Lamprey Report" (and Video), Lockheed, 1994.
- "Surveillance Through Walls and Other Opaque Materials," Briefing to the DSB-MOBA, 23 August, 1994.
- Beckwith, COL Charles, *Delta Force*, Harcourt Brace Jovanovich, 1983.
- Biddle, Stephen, et al., *New Approaches to Planning for Emerging Long Term Threats (U)*, IDA Paper P-2896, December 1993, Vol. 1 UNCLASSIFIED, Vol. 2 SECRET.
- Burrows, William E., *Deep Black: Space Espionage and National Security*, Random House, 1986.
- CENTCOM Brief, July 1994.
- Ellefsen, Richard, "Remote Sensing of Urban Terrain," *Controlling Summer Heat Islands*, Lawrence Berkeley Laboratory, U.C. Berkeley, November 1989, pp. 219-237.
- Ellefsen, Richard, "Urban Building Classification," *Proceedings of Workshop on Test Target Specifications for Wall-Breaching Trials*, Defense Research Establishment, Suffield, Ralston, Alberta, Canada, October 1986.
- Fighting in Cities Overseas*, IDA N-689 (R), May 1970.
- Hanle, Donald J., *Terrorism, The Newest Face of Warfare*, Pergamon-Brassey's, 1989.
- Nadel, Joel and Wright, J.R., *Special Men and Special Missions, Inside American Special Operations Forces, 1945 to the Present*, Stackpole Books, 1994.
- Oak Ridge Tactical Technologies Brief, July 1994.
- Paschall, Rod, *LIC 2010, Special Operations and Unconventional Warfare in the Next Century*, AUSA, Series, Pergamon-Brassey's, 1990.
- Payne, W. Scott and Taylor, Jean G., "Combat in Overseas Urban Areas," *Journal of Defense Research, Tactical Warfare*, 1973.
- Richelson, Jeffrey T., *America's Secret Eyes in Space: The U.S. Keyhole Spy Satellite Program*, Harper and Row, 1990.
- Waller, Douglas C., *The Commandos: The Inside Story of America's Secret Soldiers*, Simon and Schuster, 1994.

(This page intentionally left blank)

Appendix A

Terms of Reference



ACQUISITION AND
TECHNOLOGY

THE UNDER SECRETARY OF DEFENSE

3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010



JUN 13 1994

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Defense Science Board Summer Study on Military
Operations in Built-up Areas

You are requested to undertake a Summer Study to determine the Department of Defense's current capabilities to conduct military operations, including peacekeeping and peacemaking, in built-up/urban terrain and to assess our future needs to perform this function. The focus of your assessment should be on modernization initiatives which would have high leverage in terms of our ability to conduct military operations in built-up/urban terrain.

Military operations involving U.S. forces will increasingly involve operations such as peacemaking, peacekeeping, and humanitarian rescue in built-up areas. Recent experience in Somalia underscores this fact. Operations in such areas present a unique set of problems distinctly different from that of open terrain. The preponderance of military plans and systems are designed for employment in open terrain and many of our systems and equipments may not be as effective, if at all, in built-up/urban terrain. This includes sensors, platforms, navigation and communications systems, and weapons. While there are a number of revolutionary concepts being pursued for large-scale, mechanized warfare (Joint Precision Strike, Digitization, etc.), there has been little progress in addressing the unique problems associated with operations in built-up areas. Also, the special needs of peacekeeping will, by their nature, involve operations in built-up areas marked by a high degree of complexity and numerous constraints. Such operations today remain dominated by small-unit, infantry tactics with high attrition; collateral damage; and a slow tempo. New capabilities are needed to break out of this paradigm.

This Summer Study should examine current U.S. Military planning and capabilities for operations in built-up areas and make recommendations on how the OSD, JCS, and the Services might make them more effective. The study scope should include but not be limited to the following:

- (1) A brief review and analysis of the broad strategic situation facing the U.S., in Southwest Asia, North Korea, Africa, Central America, and in Third World




countries, focusing on the potential/likelihood of US military involvement in built-up areas and the characteristics of operations in those areas.

- (2) Identification of possible shortcomings in our ability to conduct or assist with operations in Built-up Areas, including peacekeeping and peacemaking and recommendations on how and where future efforts should be focused.
- (3) Development of innovative concepts for conducting operations in Built-up Areas. The focus should be on speed of operations; low collateral damage; and high survivability of friendly forces.
- (4) Prioritization and approximate funding levels associated with improving our capability to conduct operations in built-up areas.

The Task Force should recommend and prioritize areas that should be explored including C3I, SOF, unmanned vehicles, unattended sensors, non-lethal weapons, and equipment that would improve our capability to operate in built-up areas. The Task Force should also include an assessment of the potential impact of its recommendations on military readiness, to include training and exercises, and on operational concepts, organization, and tactics for those recommendations where such an assessment is appropriate. When appropriate, the Task Force is encouraged to share findings and recommendations with the Joint Requirements Oversight Council (JROC) to complement the ongoing joint warfighting capability assessments.

The Joint Chiefs of Staff and the Director, Tactical Warfare Programs will co-sponsor this Summer Study. Dr. George Whitesides will serve as Chairman and General Glenn Otis, USA Ret, will serve as Vice-Chairman of the Summer Study. Mr. Walt Squire, OUSD(A&T)/TWP/LW, will serve as Executive Secretary. LTC John Dertzbaugh, USA, will be the Defense Science Board Secretariat representative. The USD(A&T) will provide funding and other support as may be necessary. It is not anticipated that the work assigned to this Summer Study will cause any member to be placed in a position of acting as a procurement official.



R. Noel Longuemare

Principal Deputy

Appendix B

Literature Reviews

Review of Past Studies

- Hicks: *DSB Urban Warfare Study, 1984*
- Bobrow: *DSB Conflict Environment Study, 1986*
- Biddle: *Planning for Emerging Long-term Threats, 1993*
- West: *Military Technological Revolution, 1994*
- Sullivan: *Meeting Challenges of Regional Security, 1994*
- Stiner: *Sr. Working Group on MOOTW, 1994*

DSB Study: Urban Warfare (Hicks, 1984)

- **Objective:** Improve combat operations in urban terrain
- **Assumptions:**
 - Combat in urban area is distinctly different from that in open terrain
 - Opportunities exist to improve our capabilities
- **Problems:**
 - Munitions fuze and casing failures; need wall penetration for casualties
 - Need improved mine warfare capability
 - Have a shallow water warfare deficiency
 - CINCs need better Urban Intelligence capability
- **Solutions:**
 - Develop new weapons and munitions tailored for urban combat
 - Program and budget for combined arms training
 - Provide Intelligence “desk cadre” for CINCs
 - Improve PSYOPS and Civil Affairs capabilities

Major Points (Hicks)

- In urban combat, attacker may need to outnumber defender by 6:1-10:1
- Third-world urban fighting even more likely than in Germany
- The majority of these cities are ports
- For low-intensity operations, PSYOPS opportunities exist
- Bombs and Infantry and artillery munitions have fuze, penetration, and angle of attack problems – very little test data exists ($\leq .01\%$ of ordnance budget devoted to urban tests)
- JTCG should be funded by USDR&E to conduct full-scale test program against complete spectrum of urban targets
- Services should then fix deficiencies (JCS prioritization)
- Need new 2000-lb bomb (BLU-109) and bunker target munition
- LAW has low Ph, small entry hole, and little fragmentation
- DRAGON suffers from short range, 65m arming range, & weight

Major Points (Hicks, Cont'd.)

- Infantry needs dual-purpose (dual fuzing) ATGM warheads and ability to fire from enclosures (manned firing tests), a la AT-4
- Must expedite development of medium ATGM [Javelin] and evaluate DRAGON PIP or Milan II
- Light forces need a lightly armored direct fire cannon (hi-angle)
- US forces lack efficient countermine capability
 - Buried mine standoff detector
 - Non-metal detector
 - Surf mine detector
 - Light, fast neutralization system
 - Mines and booby traps responsible for over 50% of casualties in Vietnam
- Need smart mine systems and a priority Mine/CM program
- Need a man-portable, accurate FAE warhead + FAE family
- TRAINING for urban warfare yields the best return on investment

Urban Warfare Training (Hicks)

- **Facilities**
 - Ft. Benning
 - Ft. Lewis
 - Ft. Bragg
 - Berlin (Doughboy City)
 - Hammelburg (Bonnland)
 - Planned Facilities (Hood, Ord, Stewart, Lewis, Carson, Riley, Hawaii)
- **Training**
 - USAIS Advanced course provides 2 days of leader training
 - Berlin Brigade receives most unit training
 - Most other branches and Services do not do urban training
 - Little interest in Combat Support and Combat Service Support
- **Training Aids**
 - Limited to some surrogate travel video discs of Bonnland, and
 - BLOCKBUSTER-type simulations (Co-level manual game)
- **Need -- hard skills for individuals through Bn**

Training Recommendations (Hicks)

- Army should add programmed facilities, plus a combined arms Bn MOUT facility at NTC
- Marine Corps program is in “Overguidance” and should be reprogrammed
- JCS should develop a joint training program for use in third world forcible entry contingencies (Army, Airborne, Ranger units, Marine amphibious, and appropriate USAF units) - “Fighting For/From”
- Army and Marines should expand leader training and CS and CSS training
- Improved simulations and wargames should be developed (like TRASANA’s ACABUG) or improved training games (add villages to BLOCKBUSTER)

Remarks regarding Special Warfare are Classified -- see Hicks Brief

Findings (Hicks)

- **Shallow Water Shortfalls**
 - SEALS
 - Naval Gunfire
 - Mine Warfare
 - Inshore/Riverine Warfare
 - Explosive Ordnance Disposal (EOD)
- **Third-World INTEL is Uneven (further remarks classified)**
- **PSYOPS Payoffs (further remarks classified)**
- **Technology Assessments (see next chart)**
 - See through walls and smoke
 - Passive vehicle ID
 - Precise position location
 - Improved IR (uncooled)
 - Non-LOS communication
 - Robotic Vehicles
 - Disabling mechanisms – vehicles

Summary - Hicks Study

- Nothing was more useful to this study than hard data and simple facts... there was an appalling lack of them in the area of urban warfare.
- The fixes discussed regarding materiel and training need to be implemented.
- US needs intelligence “desk cadre” and improved PSYOPS/Civil Affairs capability
- We need to do considerably more testing of all systems (communications, weapons, vehicles, etc.) to be used in urban combat.

Bing West MTR Brief (April 1994)

Briefing Addresses Military Technological Revolution (MTR)

- **Focus:** Information War
- **Assumptions:** Ground Forces Sustain 92 % of Casualties
- **Problems:**
 - Need Ways of Reducing Friendly and Enemy Casualties
 - Digital Battlefield Offers Hope
 - Danger is That We Won't Reorganize to Maximize MTR Value
 - 2nd Danger is That Infantry MTR Won't be Adequately Funded
 - Worst Danger: The Over-Centralization of C2
- **Solutions:**
- **Fund Infantry Needs and Concepts (Army and USMC)**
- **Run Field Tests to Get Doctrine, Organization & Tactics Right**

Major Points (West)

- **Enemies Don't Doubt US Capacity; They Doubt Our Will**
- **America's Achilles Heel: Unwillingness to Take Casualties**
- **US Technical Lead Should be Good for Ten Years**
- **US Culture Emphasizes Precision Weapons – Limit Casualties**
- **Desert Storm Doctrine is In – Sherman Doctrine Out (for us)**
- **Not Self-Evident that Technical Availability Results in Optimum Weapons System Selection and Doctrine**
 - Samurai, Steam Ship, Helicopter Examples
- **Civilians are Outsiders Looking In**
- **Implicit Model for Operationalizing MTR is: Gather More Info for Centralized Decisionmaking (a Tradition of “Grafting On”)**
- **Jointness = Centralization**
- **We are in Danger of Having the Most Supervised Troops in History**

Major Points (West, Cont'd.)

- Virtual Battlefield is Visionary -- But Where is the Vision?
- Is MTR a Recycling of German Ideas Half a Century Ago?
- Vietnam Helicopter Example ("Squad Leaders in Sky" was a Missed Opportunity, Dewey Canyon Excepted)
- It is Human Nature in C2 to not be a "Potted Plant"
 - Slows down decisions
 - Great temptation to micro-manage
- Can We Task-Organize to Decentralize (NDU Wargame)?
 - Low confidence that commo architecture is linked to a preferred warfighting doctrine (76 %)
 - Need more information moving *Down*, not Up (85 %)
- When Required to Fight Close-in, Casualties are High
- But Infantry Could Fight in Decentralized Manner
 - LRPS and Marine Reconnaissance Units
 - Stingray Strike Units, Vietnam (Exchange Rate = 36:1)

Major Points (West, Concluded)

- **Army Experimenting With Decentralized Digital Transmission, While...**
- **DOD/ARPA Communications Architectures Emphasize Centralized Information Flow and C2!**
- **If you Want to Know Who's Driving the Train, Watch the Money Flow**
- **Non-Military Organizations have *Decentralized* and are Winning the Information War...**
 - **World currency traders turn within Central Banks' decision cycles**
 - **Traders gained over \$4 Billion in profits in two days (1992)**
 - **Central Bankers had more prestige, capital, staffs, credentials...**
 - **Analogies apply to Infantry, quite well**
- **CitiCorp's Wriston: "The Explosion of Information Technology is Making Obsolete the Middle Management"**

Infantry Solutions (West)

- DOD and Higher Echelons Need to Push, Not Pull Information
- Illustrative Scenarios (Implied C3I Structure vs. Desert Storm)
 - North Korean Case (DPRK): Less Centralized
 - Iran Attacks Saudi: Centralized
 - Counterattack in DPRK or Saudi Cases: More Centralized
 - Peacekeeping: Highly Variable
 - Dirt War (Going to Ground/Standoff over Seoul): Less Centralized
 - Foliage War: Less Centralized

Solutions for Enhanced Information War:

- Infantry needs more than Joint STARS
- Provide Infantry with Pattern Analysis Tools
- Fund Infantry Needs and Concepts (Army and USMC)
- Run Field Tests to Get Doctrine, Organization & Tactics Right

Summary - West Briefing

- There will not be sufficient funds for a robust C3I system
- Experience suggests that those who take the most casualties – the Infantry – will be considered last
- Missions should dictate the C3I process (centralization vs. decentralization)
- For some ground combat situations, stealth coupled with decentralization would lower friendly casualties while maintaining control and offering high exchange ratios
- If we do not create the ability to task-organize C3I, as we do in JTF adaptive force packages, we risk encountering war conditions where our preferred style is not applicable
- Adaptation has three components:
 - Capitalization
 - Conceptual Framework
 - Proof of Concept

Len Sullivan Papers

- **Focus:** Global Urban Disorder (controlling crime vs. winning wars)
- **Assumptions:**
 - Post-Cold War disorders closely resemble crimes
- **Problems:**
 - A sharp void exists regarding urban data bases and analyses
 - Rogue leaders and techno-bandits require non-standard responses (high leverage & tempo with minimum losses)
- **Solutions:**
 - Counter by a combination of military, paramilitary and civil agencies applying a variety of political, economic, and physical pressures and sanctions.
 - Form a Center for Urban Analysis; Use of CSCE
 - Evolve Regional Stability Apparatus (RSA) containing high-tech special forces (“Mission Impossible” teams)

Summary - Sullivan Papers

Sullivan proposes recasting UN/NATO forces into RSAs (Regional Security Apparati) charged with collective enforcement of international laws and standards. Also, he recommends reconfiguring US unified commands to handle urban threats and responsibilities. The goal would be to bring problems under acceptable "control," as opposed to expensive "elimination."

Neutralization and incapacitation (tricks) would usually displace death and destruction in RSA operations. RSA forces would often be extensions of domestic peacetime law enforcement agencies. This does not minimize the need for conventional military forces.

Stiner Report - MOOTW Wkg. Gp.

- **Focus:**
 - Defines military operations other than war (MOOTW, per JCS Pub 3-0)
 - Discusses 27 prioritized technologies to support MOOTW
- **Assumptions:**
 - Critical need exists to enhance effectiveness and survivability of US forces engaged in OOTW
- **Problems:**
 - Detection of dangerous activity
 - Enhancement of force and police capabilities
 - Supporting technologies (batteries...)
- **Technology Solutions:**
 - Detection (WMD, Drugs, Underground Facilities)
 - Force Enhancement (IR, Non-lethal, Neutralization of WMD & UG Facilities)
 - Force Protection (signature reduction, anti-mortar, anti-sniper, bio-med)
 - C3I (UAV, Voice Recog. & Translation, Chem/Bio expert, VR Simulation)
 - Force Projection (Penetration A/C, Tagging & Tracking, CSAR, Sea Base)

Review Summary

- **Common Themes**

- Doctrine, Organization, and Training Requirements Exist
- Data Base and Model Deficiencies are Worrisome
- An “Urban Analysis Center” Is Needed
- Technologies are Required
 - » Detection
 - » Tagging
 - » Commo
 - » Mine / Countermine
- Shortfalls in Intelligence, Language, & Definitions Exist

- **Mapping into DSB Summer Study**

- Urban Warfare
- Operations Other Than War
- Non Military Actions (Coercion...)

Current Studies

- DSB Summer Study on MOBA
- Army Science Board: Countering Evolving Threats
- SOLIC Policy: “Revolution in Military Affairs”
- Rand: “OOTW - New Demands on the Army”
- NRC: “Defensive Architecture”
- MORS: SOLIC, WG #11

Appendix C

Briefings to the DSB on MOBA

1. Agenda Lists for Five Meetings

2. Observations and Needs From Military Involved in Recent MOBA

a. MG Ernst's Observations and Lessons Learned in Somalia:

- JTF should come from Corps, not Division (CINCs and asset flexibility)
- "Ad Hoc'ing" is not a good JTF approach
- Commander should be allowed to task-organize for "worst case"
- Our tactical doctrine is about right
- C3I is "all about trust... up, down, all around"
- UN operations are complicated – UN troops do not have U.S. night vision capability
- The battlefield is 3-D; vertical battlefield poses airspace management problems
- School of Advanced Military Study provides outstanding graduates (Jedi Knights)
- SOF performance was "wonderful... and gutsy"
- OOTW requires wartime discipline (no alcohol; cannot confuse young folks)
- There was not enough Mech Infantry to protect tanks – at first
- Two to three companies were in live fire training each day
- SNA sent units out to "grade" UN force elements
- *Army needs computer graphics (quick map mission overlays for tankers and pilots); has lost this capability below Corps level. Navy has this capability.*
- IPB doctrine works – could locate SNA leaders by house they lived in
- M1s are extremely useful in eliminating roadblocks (but need urban ammo)
- Precision weapons are important (M1 and Bradley can be "precision" in MOBA)
- Should "re-seat" the Bradley with bench seats (hold 27-man rifle squad in 4 Bradleys)
- Need a "skunk works" for hardening or special kits
- Soldiers adapted weapons (MICLIC fired down street in practice)
- Live fire is essential to training in US MOUT facilities
- We need to expunge "reaction" – it is the worst form of hasty operations
- Replace "reaction" with reserve or mobile operations
- Troops equated OOTW with "gunfighting" – often combat under enforced ROE
- Combat skills deteriorate after 2-3 mo's. of OOTW without constant training for worst
- Hospital ship support is important to deal with large casualties (had Level III with CAT Scan)
- Need more surgical capability

b. *Lessons Learned in Somalia* (extracted from classified brief), Michele Flournoy, OSD

- Mogadishu ROE: No roadblocks, no "technicals," no visible weapons, no bandits
- 30 Purple Hearts in 30 days (inc. truck drivers losing eyes)
- Need to get renewed political/military support after mission shift
- Use of contractors (as interpreters, etc.)

c. *Somalia Experience*, Maj Fred Swope, USAIS

- Clan compounds - natives respected Malaysians; harassed and stole from Americans. (Malaysian ROEs allow firing into crowds)
- Somalis had U.S. ROE figured out before US troops, and used it to advantage
- Urban operations physically and mentally demanding
- LAW was more useful than AT-4 – less likely to hang up when crawling
- Somali weapon of choice was the RPG, regardless of target
- Crowds often swarmed vehicles, stealing - pepper spray was effective
- UAVs would be useful; UGVs would be stripped/stolen
- Live Fire and medical training are important as are body armor and pre-rigged demolitions
- Navigation was found to be a real challenge (no street signs or building numbers) - better maps needed (including updatable digital maps keyed to overhead images)
- Want beehive or flechette round for grenade launchers (Mk 19/M203) - ricochet problem
- Nonlethal weapons would be useful – allows graduated response using PSYOPS

d. *SOCOM Command Briefing*, BG W. Kernan

- ROE must capture national values
- UK's "Heidenweg" training center for Northern Ireland is impressive
- Army must take "appetite suppressants," yet must be in the business of saying "Yes."
- "PSYOPS is a growth industry."
- SOCOM stretched thin (Civil Affairs and SEALs are "off the scope")

e. *PSYOPS*, Jim Roberts, DoD

- Importance of continued dialogue with other side
- PSYOPS "draws the box," counters anti-U.S. propaganda, and develops feedback loops
- Need ability to do overseas satellite broadcast from Ft. Bragg
- Need Live-feed Foreign Broadcast Information Service (FBIS) – provides U.S. a quicker roll-up of foreign attitudes (now takes about a month)
- RPV technology is needed

f. *10th Mtn Div Somalia Experience*, LTC David

- Operation Restore Hope and Continue Hope – complex environment: 21 clans/subclans
- Difficulty with HUMINT, NGO interfaces
- Somali is a Level III language (no rules of grammar, straightforward for GI use)
- Contract interpreters had difficulty with physical fitness and evacuation opportunities
- Continue Hope characterized by reduced communications – may have led to casualties

- Marksmanship was key to minimizing damage in thin-walled buildings
- Most targets were engaged at ranges of 50 meters or less
- Combat Lifesaver devices worked – reduced casualties
- ROE were reasonable and were explained by JAG officers after every change
- The “enemy” were very clever and difficult to “template”

g. *Bosnia – Hands-on Experience*, LTC Kocher, US Army (ARPA)

- Sniper, mortar, mine, and situational awareness problems - “sniper alley”
- Sarajevo is/was a modern city with 5- to 25-story buildings
- Need for soldier “911” system (radio + GPS + hit button + border warning)

h. *Military Police*, COL Howard O’Brien

- MPs (3% of total force) work best for force protection, vice combat operations
- MPs train on confrontational skills, interpersonal communication, and weapons
- MPS must “see-evaluate-execute” (infantry procedures in wartime: “see-execute”)
- MP needs include:
 - Armored security vehicle
 - Nonlethal devices
 - Sniffing dogs
 - Outside vehicle radio with hands-off comms

i. *UK MOUT/FIBUA Experience*

- A briefing was provided regarding operations in, training for, and lessons learned in Northern Ireland. The briefing was labeled “For Non-attribution.”

j. *JSOC/SOCOM Briefs*, Cdr Pat Toohey, et al., SOCOM

- A briefing was provided regarding operations and need identified by SOCOM. The briefing was classified SECRET - NOFORN, and is available under separate cover.

AGENDA

DEFENSE SCIENCE BOARD SUMMER STUDY
MILITARY OPERATIONS IN BUILT-UP AREAS

JUNE 1, 1994

0900	Opening Remarks	John Ello
0915	Introduction	George Whitesides
0930	Co-Sponsor's Thoughts	MG Ralph E. Eberhart
1000	Introductory Briefing	George Whitesides
1030	General Discussion	All
1100	Review of 1984 Study	Donald Hicks
1200	Lunch	
1300	Co-Sponsor's Thoughts	Frank Kendall
1330	Somalia Experience	Michelle Flournoy
1430	ARPA Programs	Larry Stotts
1530	ARDEC Programs (Part I)	Herbert Wreden
1630	Co-Chairman's Time	Whitesides/Otis

JUNE 2, 1994

0900	ARDEC Programs (Part II)	Herbert Wreden
1100	Twenty-First Century Land Warrior	Carol Fitzgerald
1200	Lunch	
1300	MICOM Programs	John Meadows/ Bill Zecker
1430	Unmanned Ground Vehicles	Charles Shoemaker/ Michael Toscano
1600	Co-Chairman's Time	Whitesides/Otis

AGENDA

DEFENSE SCIENCE BOARD SUMMER STUDY
MILITARY OPERATIONS IN BUILT-UP AREAS

July 11, 1994

0900-0905	Administrative Remarks	W. Squire
0905-0920	General Counsel Remarks	C. Vose
0920-1000	Chairman's Time	G. Whitesides
1000-1100	IDA Brief	J. Klare
1100-1200	CIA Brief	G. Solin
1200-1300	Lunch/Discussion	
1300-1400	TRADOC Perspective	J. Gray
1400-1500	Civil Affairs	D. Mitchell
1500-1600	SOLIC Review-MORS	R. Holcumb
1600	Adjourn	

If time permits

Comparison of Previous MOBA Studies	W. Olson/E. Smith
--	-------------------

**DEFENSE SCIENCE BOARD
SUMMER STUDY
MILITARY OPERATIONS IN BUILT-UP AREAS**

JULY 25, 1994

0900 ADMINISTRATVIA	W. SQUIRE
0910 CHAIRMAN'S TIME	G. WHITESIDES
0930 ASSESSMENT OF PRIOR EFFORTS	W. OLSON/E. SMITH
1100 UNMANNED GROUND VEHICLES	C. SHOEMAKER/M. SWINSON
1200 LUNCH	
1300 LIVERMORE PRESENTATION	T. KARR
1400 HANDS-ON EXPERIENCE	R. KOCHER
1430 ACTIVE DENIAL	T. DAYTON/D. ERWIN
1530 HISTORY OF THE FUTURE	S. GARDINER
1630 DISCUSSION/WRAP-UP	ALL

JULY 26, 1994

0830 INFANTRY SCHOOL PERSPECTIVE	F. SWOPE
1000 NON-LETHAL MECHANISMS	J. KLINE
1100 HUGHES SO/LIC STUDY	K. BRETNEY
1200 LUNCH	
1230 UNMANNED AERIAL VEHICLES	D. PLACE
1330 SOCOM COMMAND BRIEFING	W. KERNAN
1500 DISCUSSION/WRAP-UP	ALL

AGENDA

DEFENSE SCIENCE BOARD SUMMER STUDY
MILITARY OPERATIONS IN BUILT-UP AREAS

AUGUST 3, 1994

0900 PYSOPS	MR. JIM ROBERTS
1000 MILITARY POLICE	COL HOWARD O'BRIEN
1100 NON LETHAL WEAPONS POLICY	MR. CHARLES SWETT
1200 LUNCH	
1300 TENTH MOUNTAIN DIVISION	LTC DAVID CPT MEYEROWICH SFC FRANKLIN MR. RICHARD HUNDLEY
1500 FUTURE TECHNOLOGY-DRIVEN REVOLUTIONS IN MILITARY OPERATIONS	
1600 SEEING THROUGH WALLS	DR. GILBERT
1630 CHAIRMAN'S TIME	DR. WHITESIDES

AUGUST 4, 1994

0800 DOCTRINE & TRAINING	DR. JENNY TAW
0900 RMA SOLIC TASK FORCE	DR. CHRIS LAMB
1000 TRADOC--SOMALIA	MG CARL ERNST
1130 UK EXPERIENCE	LTC TIM BURLS
1215 LUNCH	
1300 NON LETHAL WEAPONS & GPS	DR. JERRY FROST
1400 JSOC/SOCOM	CDR PAT TOOHEY PLUS EIGHT OTHERS
1600 NATICK BRIEF--SURVIVABILITY	MR. GARY OLEJNICZAK
1700 CHAIRMAN'S TIME	DR. WHITESIDES

**Tentative Agenda
Defense Science Board Summer Study on
Military Operations in Built-Up Areas**

**August 22 - September 1, 1994
Beckman Center, National Academies of Science and
Engineering
Irvine, CA 92715**

Monday, August 22, 1994

- 0730 - 0900 Breakfast w/DSB Chairman
(Task Force Co-chairs & Senior Review Group)
- 0900 - 1015 Kick-Off Meeting for Summer Study (All TFs)
(15 min overview by TF Chairman)
- 1030 - 1200 Task Force Executive Session
- 1215 - 1330 Lunch w/DSB Chairman
(Task Force Co-Chairman & DSB Senior Review Group)
- 1300 - 1700 Information Briefings
1300 - TENCAP (John Marrs)
1400 - Natick Brief (Gary Olejniczak)
1500 - Magneto Hydro Dynamics Brief (Cliff Stine)
1600 - Joint Mission Assessment (COL Blackburn)
1700 - Chairman's Time

Tuesday, August 23, 1994

- 0730 - 0900 Breakfast w/DSB Chairman
(MOBA Chairman, Vice Chairman, Panel Leaders & Senior Review Group)
- 0800 - 1200 Information Briefings
0830 - Demographics Brief (Mr. Dick Ellefson)
0930 - See Through Wall Radar (Mr. Mike Schwiele)
1100 - JPO Non-Lethal Weapons (Ms. Susan Hudson)
- 1215 - 1330 Lunch (Flag Officers with DSB Chairman)
- 1300 - 1430 Bang, You're Alive (Dr. Alexander)
- 1500 - 1700 First Dry Run (Warren Olson)

Wednesday, August 24, 1994

- 0800 - 1215 Individual Panel Meetings
- 1215 - 1330 Lunch
- 1330 - 1500 Individual Panel Meetings
- 1500 - 1700 Executive Session of Total Task Force

Thursday, August 25, 1994

- 0730 - 0900 Breakfast w/DSB Chairman
(Task Force Co-Chairs & DSB Senior Review Group)
- 0800 - 1200 Individual Panel Meetings
- 1130 - 1300 Lunch w/DSB Chairman (All DSB Members)
(Discussion Regarding Future Studies)
- 1300 - 1615 Executive Session of Total Task Force
- 1630 - 1800 Progress Review (MOBA Work Area)
(*Note: Beckman Center Bar-B-Que - 1800)

Friday, August 26, 1994

- 0800 - 1215 Individual Panel Meetings
- 1215 - 1330 Lunch w/DSB Chairman (Task Force Co-Chairs)
- 1300 - 1500 Individual Panel Meetings
- 1500 - 1700 Executive Session of Total Task Force

Weekend (YO-YO: Enjoy)

Monday, August 29, 1994

- 0730 - 0830 Breakfast
- 0800 - 1200 Individual Panel Meetings
- 1200 - 1300 Lunch
- 1300 - 1700 Executive Session

Tuesday, August 30, 1994

- 0800 - 1045 Task Force Work Session (Prep for Dry Run)
1100 - 1230 MOBA Dry Run (Auditorium)
1230 - 1330 Lunch
1330 - 1700 Individual Panel Meetings

Wednesday, August 31, 1994

- 0730 - 0900 Breakfast w/DSB Chairman
(Task Force Co-Chair & DSB Senior Review Group)
0900 - 1200 Executive Session of Task Force
1015 - 1200 Meeting w/JCS & JROC members
1200 - 1300 Lunch
1300 - 1700 Individual Panel Meetings
1900 Closing Banquet (Hyatt)

Thursday, September 1, 1994

- 0700 - 0830 Breakfast w/DSB Chairman & Senior DoD Reps.
(TF Co-Chairs and Senior Review Group)
0830 - 1145 Final Outbriefing
0830 - Cruise Missile Defense
0930 - Information Architecture
1045 - Military Operations in Built-Up Areas
1145 Summer Study Adjourns

Appendix D

MOBA Requirements

1. Area Weapons

Most large caliber ammunition and anti-armor munitions contain explosives designed to penetrate heavy armor. Aircraft-delivered munitions such as 500-, 1000-, and 2000-pound bombs may overmatch the MOBA environment. Precision munitions would be of significant value in urban operations that call for use of lethal force. Laser designated/guided small warhead (~ 5 pound) munitions, – gun launched, rocket propelled, tube fired, and/or air delivered – would be of considerable value in reducing casualties and collateral damage. Nonlethal payloads, such as aerosols, could also be precisely delivered with some delivery systems.

2. Weapon Needs

Needs. As military operations gravitate to the urban environment, new demands are placed on our conventional munitions. These needs were underscored by the 1984 DSB study on Urban Warfare, which identified specific improvements desired for our conventional weapons arsenal. These included:

- Development of bunker/concrete breaching munitions
- Dual-purpose ATGMs capable of launch from enclosed areas (soft-launch)
- Robust delay fuzing for artillery munitions fired into concrete/reinforced fortifications.

Background. The MOUT environment calls for a means of breaking through concrete walls (and other materials) as a normal warfighting operation. In wall breaches, a missile is expected to first penetrate a concrete or other hardened target. A secondary warhead will then detonate inside to cause casualties and create a larger hole for entrance or other purposes. Hostage rescue situations require a different break through with mechanisms that produce no/low hostage casualties.

The Light Anti-Tank Weapon (LAW) and the AT-4 produce small holes, and are single warhead missiles for light/heavier (medium) armor penetration. The requirement for MOUT is only partially met by them. The USMC SMAW (Shoulder Launched Multi-purpose Anti-Armor Weapon) is in inventory. It is not a soft launch from enclosure, and is not self-contained. The USMC SRAW (Short Range Assault Weapon), also called Predator, will be fielded by FY99.

State of the Art. Progress has been made in addressing these needs. Specifically:

- SMAW. Currently fielded as a light weight anti-armor missile, the SMAW offers limited capability against concrete/reinforced fortifications. SMAW's effectiveness is limited by its range capability (750 meters) and the inability to fire from enclosed areas. Also, SMAW targeting is accomplished by use of a spotting cartridge that has an impact of response time.
- The USMC SRAW, called "Predator," will be fielded by FY99. SRAW is a soft launch weapon that might be used by the Army with a MIPM warhead for the Bunker Defeat Munition (BDM). The Army is concentrating on fielding the Javelin anti-armor weapon. Javelin, for cost reasons, is not an optimum contender for MOUT use – quantities will be small, as against the rate of ammunition normally used in MOUT. The Army plan is to field BDM (\$2.9K unit cost) in FY95-FY96. It will be an interim measure, until fielding of the MIPM in FY2001+, which bears a unit cost estimate of \$10K.
- JAVELIN. A soft launch anti-armor missile fielded in FY94 at a unit cost of \$300K.
- BDM. A dual purpose munition, providing both breaching and light armor capability, will be produced for the Army in FY95 at a unit cost of \$2.8K.
- Indirect Fire. The recent type classification of the MK399MOD 1 MOUT fuze has increased the effectiveness of artillery munitions across the spectrum of calibers (105 mm, 155 mm,

8"). Production deliveries for both Army and Air Force gun systems will begin in FY94 at a unit cost of \$48.00.

Concern over the effectiveness of direct fire tank weapons against concrete/reinforced fortification has been reflected in the incorporation of effectiveness requirements/testing for new munitions. Breaching capability of 120 mm HEAT cartridges have been tested (and found adequate) for concrete/reinforced structures.

Greater round selection is available in 105-mm tank rounds. HEP cartridges remain in the inventory for 105-mm tank guns. These would extend MOBA capabilities of future gun systems (i.e., AGS) developed in that caliber. However, some 105-mm rounds have limited remaining shelf life.

Opportunities/Programs. Despite the advances made over the past decade, significant technical opportunities remain. To wit:

- **SRAW (Predator).** A lower cost, short range (soft launch) anti-armor weapon is currently in EMD for the USMC, with FUE scheduled for FY99 at a unit cost of \$10K.
- **MIPM.** Through the MIPM program the soft launch capability of the USMC SRAW missile will be combined with improved warhead, enhanced lethality, and increased standoff. The MIPM is scheduled for fielding in FY01 at a unit cost of \$10K.
- **SEP. (Soldier Enhancement Program).** The SEP program focuses on improved materiel for the infantryman. Included on this program are a variety of improved capabilities that include the following:
 - Assault Pack and collapsible butt stock for M249 Squad Automatic Weapon.
 - XM84 Stun Grenade
 - Small arms ammo improvements
 - 0.50 caliber multi-purpose ammo
 - 5.56-mm armor piercing ammo
 - 0.50-caliber armor piercing ammo
 - 40-mm infrared illumination cartridge
 - Optical/sighting system improvements for carbines, sniper weapons and light, medium, and heavy machine guns
- **OICW (Objective Individual Combat Weapon).** Knowledge of the urban target, its location, and weaponry is essential, and can be obtained possibly by direct observation or with use of the periscope (an Army Soldier Enhancement Program activity, for FY96). Although the 40-mm grenade family of cartridges is available, the M203 launcher is not ideal for precise shots, due to the sighting system and ballistics of the ammunition. A funded program exists for an OICW that may be capable of firing an advanced family of 25 or 30 war grenades with great precision. The OICW will also fire conventional bullet ammunition. The weapons will tie the individual soldier to the 21st Century Land Warrior fighting suit, which will link to the Digital Battlefield. An ATD exists in which the OICW will be part of 21st Century Land Warrior; FHE will occur in FY2002+. The foundation for this program is the U.S. Army Small Arms Master Plan, and the Joint Service Small Arms Master Plan. The capability of the grenade will give the soldier a force multiplier in terms of MOUT fighting.

- PGMM (Precision-Guided Maker Munition). PGMMs will provide increased lethality and precision for mortar projectiles. Under this program PGMMs will use infrared or millimeter wave guidance with an integrated semi-active laser (SAL) capability. Both autonomous and laser designated options will be available. The PGMM is contained in an ATD that will go to demonstration in FY98. Complementing this effort is the fiber optic guided mortar projectile (FOMP). This projectile is guided by a mortar crew through a fiber optic link. The crew member steers the projectile using a joystick while watching a display that gives the projectile's view of the battlefield. The FOMP will be demonstrated in FY95.

OICW and PGMM systems will increase the accuracy of fire and limit collateral damage.

3. Nonlethal (NL) Weapon Needs

3.1 Microwaves

Need. The requirement for a standoff, non-munition method of neutralizing weapons remains high. The use of this kind of capability against personnel is also desirable, but risky.

State of the Art. The capabilities of microwave technology can be summarized as follows:

- a) Anti-personnel: Used in this sense, microwaves can heat bodies to various degrees providing, under best conditions, graded levels of response.
- b) Anti-missile: If pulsed properly, microwaves can defeat wide range of guidance systems.
- c) Anti-mine, etc.: Microwaves have been demonstrated in a countermine role (burning certain system components and blasting caps). Much work is needed.

For each microwave application, there remain a number of issues. These include, but are not limited to: power source, directionality and control, and understanding/testing of the full range of capabilities and limitations.

Status. Against personnel and missiles, microwaves may be available in 5+ years. However, other factors come to bear. One must question whether such anti-personnel microwave weapons will be allowed. Although effective use can be achieved in the other roles, defenses (shielding or re-engineering of guidance systems) could often provide a countermeasure. The use of microwaves against system components by "burn-out" must be viewed as long term (> 5 years) since considerable work must be done to separate fact from fiction.

Current Programs. Most research is now Black.

3.2 Acoustics

Need. The need for standoff anti-personnel weapons that can meet the full range of graded response from nonlethal through lethal remains high.

State of the Art. Technology exists that permits acoustics to be used in fixed site point defense and, in a more limited sense, against crowds. Research must continue with regard to power source and directional control. Proximity to the source as well as the frequency used can

determine the level of effects on personnel. Protection of nearby friendly personnel may be an issue.

Status. Although well understood, the means of delivery and perhaps energy source make availability for this technology greater than 5 years away. Again, depending on the level of control attained, political suitability may depend on the level of control.

Current Programs. Research only?

3.3 Lasers

Need. There exists a specific requirement for a nonlethal means of neutralizing snipers or other isolated personnel.

State of the Art. Lasers used in a nonlethal role can be categorized as disorienting, temporarily damaging, or permanently damaging. Capabilities exist to deliver as a single burst munition (40 mm) or from a personal weapon (with an angle of dispersal of up to 15°).

Status. Available in less than 5 years, the technology exists and is capable of meeting most requirements. Of import is the time from target detection to the application of the laser.

3.4 Incapacitants

Need. A need exists for a cheap, easily distributed class of incapacitating weapons. Some currently available examples include: flash-bang grenades, riot agents, and irritating sprays.

State of the Art. These technologies are well understood and used by law enforcement agencies. Some limited research should be pursued, particularly in areas of chemicals and sprays, and expanding spheres.

Status. All of these are available off-the-shelf. The fit between technology and needs is present, but further research into the chemical area may be limited by politics and treaties.

4. Precision Weapon Needs

Need. In urban combat there is a need for the precise delivery of combat power to reduce collateral damage, to avoid damaging the urban infrastructure unnecessarily, and to keep casualties at a minimum. Urban warfare targets tend to be point targets such as snipers, RPG gunners, or small numbers of artillery or mortar tubes. The use of area effect weapons such as artillery to attack these targets will usually cause excessive damage and/or casualties (can be self-defeating and create unfavorable political consequences). In some cases, precision-delivered direct fire is most appropriate from tanks or AC-130 Gunships. Terminally guided indirect fires, delivered precisely, are also possible. By increasing the accuracy of the delivery, collateral damage can be reduced.

State of the Art. The use of PGMs is a current capability through both laser designation and on-board seekers. This technology has been developed, fielded, and used in the Gulf War. Demonstrated laser-designation systems include the Copperhead 155-mm artillery round, the Hellfire missile, and large Air Force laser-guided bombs.

Under development are mortar rounds that utilize IR or Millimeter Wave seekers with an integrated SAL to home in on a target. Also under development is a FOMP and a FOG-M. The FOG-M has a 10-15 km range and a larger footprint than the mortar round. Guidance is achieved through a daylight TV system linked by fiber optic cable to the operator.

Opportunity. The technological opportunity is to improve the autonomous seeker capability to reduce the requirement for laser-designation and the presence of an FO or UAV. This will allow

more autonomous delivery of precise fires without putting an observer at risk. This can be done in three ways: (1) by mounting the laser-designator on a UAV; (2) by adopting an IR or MMW seeker for the projectile; and (3), by utilizing a fiber optic system that can be steered to the target by a remote operator.

Status. On the Shelf - Ground or Helicopter laser designators, Copperhead, Hellfire

Under 5 years - UAV mounted laser designators

Over 5 years - IR or MMW seekers or mortars, fiber optic mortar projectiles and FOG-M.

Current Programs. Precision Guided Mortar Munitions (PGMM), a 120-mm IR/MMW seeker mortar round - ATD in FY98, scheduled fielding in FY02, currently unfunded. Fiber Optic Mortar Projectile (FOMP), a 120-mm mortar round - an ACTII demo scheduled for November 1994, unfunded program. The FOG-M (now called EFOG-M) is scheduled for an ACTD in FY95-99.

Other. Costs unknown. Medium risk technology for mortar seekers, but laser-designated systems are currently in inventory. Down-sizing of munitions lethality would require some developmental work. Joint applications in that designators are widely available.

5. Counter-Artillery/Mortar

Need. One of the concerns in a MOBA environment is neutralizing enemy indirect fire weapons. Usually employed in small numbers, they have the capability to quickly emplace, fire, and displace - and are usually not hampered by the need for great precision in their fires. To defeat this threat requires accurate target location, rapid response, and precise delivery of lethal munitions.

State of the Art. Current state of the art in counter-battery fires was designed for mobile armored warfare in Europe. Most of the components are readily usable in a MOBA environment. Target acquisition is best done through the TPQ36/37 Firefinder radar, which projects dual radar beams. An incoming projectile cuts both beams on its ascending trajectory, its flight path is calculated, then extrapolated back to determine the firing location. This is accomplished in seconds, to an accuracy of about 10 meters. This radar can be coupled electronically to artillery systems dedicated to counterbattery fire, but this would deliver an area fire response likely to cause considerable collateral damage. Precision-guided weapons such as Copperhead and Hellfire are available (or AC 130 Spectre, for a direct-fire response), and IR/MMW seeker mortar rounds are under development. FOG-M is another possible counterfire weapon.

Opportunity. The critical component of a MOBA Counterbattery system is the linkage that permits rapid response times. The TPQ36/Q37 radar is probably adequate for target detection, and the existing and developmental PGMs are probably adequate for target destruction. However, linkage between the sensor and the munitions needs to be improved. The best opportunity appears to be linking the Firefinder with the fiber-optic guided mortar projectile, or the FOG-M. The steerability of the mortar round or missile allows for precise delivery on the target by a human operator, which should alleviate collateral damage. The IR/MMW mortar rounds are of less use in MOBA due to difficulties in target recognition with those seekers in an urban environment.

Another component to the linkage is the UAV, which can be used to either laser-designate a enemy mortar tube for PGMs or to provide a video downlink of the general target area to orient the mortar operator prior to the terminal phase of the projectiles trajectory.

Status. On the shelf - The TPQ36/Q37 radar and laser-designated PGMs are available now.

Under 5 years - A C2 linkage for counterfire purposes can be implemented within 5 years using the TPQ36/Q37 and various laser-designators. The mortar round can be developed and fielded by FY99.

After 5 years - A UAV with laser designation and video-down link.

Current Programs. See paragraph 7.4 for discussion of mortar PGMs under development.

Other. No data are available on costs. The key factor here is integration of counter-fire data across service and unit lines, and simplification of data transfer. The key is rapid response time to return precise fire on enemy mortars before they can displace.

6. Survivability (Combat ID)

Need. Recent fratricide incidents in Desert Storm and in Northern Iraq have emphasized the high priority need to identify enemies from friendly and neutral forces. In MOBA, identification of enemies from noncombatants and friendly forces is even more difficult and just as high priority. Most combat identification systems have been developed for use in air defense or air-to-air combat operations, not for surface-to-surface or air-to-surface identification. Further, there has been little or no development directed toward individual soldier or small squad identification.

State of the Art. There are numerous technologies available that could be adapted to stand off identification of small squads or individual soldiers. This includes mmw interrogation and transponder systems; lasers with coded retro-reflection tape; laser interrogation with coded RF response; GPS with radio reporting, and many others. Technology possibilities are not lacking.

Status. There is no formally approved requirement for individual soldier or small squad identification. However, there are some initial concept studies being considered for initiation by the U.S. Army Combat Identification Program Office.

Current Program. The primary Army effort underway that might have some near-term spin-off application to MOBA is the Army's mmw surface-to-surface identification system development. This is an interrogation/transponder system planned for armored vehicle use. It will be demonstrated in the 1995-96 time period. An individual soldier or small squad identification could possibly be developed as a modification of this development.

A more promising near-term effort is ARPA's GPS integrated radio system. This is a limited purchase of systems for use by the European Command. It will give a unit commander the ability to know the location of those individuals or units equipped with the GPS radio system. This system could be modified to help individuals or units identify other friendlies in their area of interest.

7. Survivability (Smokes)

Need. The U.S. had a very great advantage in the Gulf war with its extensive night time operating capabilities against an enemy with very limited capabilities. Unfortunately this advantage is declining due to the worldwide availability of various night time systems. It is thus very important that the U.S. keep advancing our capabilities to keep a significant edge.

It is very important in MOBA operations (especially in buildings) to keep casualties low, achieve surprise, etc. In addition it would be most desirable to achieve a similar advantage in daylight. This could be done through creating a smoke environment in which our "night vision" devices worked and the generally available "night vision" devices did not.

State of the Art. "Smokes" have been designed that work against (1) night vision goggles and near IR, and (2) thermal IR mmw. They can be combined or used separately. A mmw "smoke" can be added to the thermal IR smoke.

Technological Opportunity. Several opportunities should be pursued:

- A. "Smokes"
 - 1. "Tailored" smoke generators

2. Tailored smoke grenades (hand and gun launched)
- B. Vision Systems
1. Thermal IR goggles
 2. Pulsed illuminators and range gated detectors to work in medium density thermal IR smoke
 3. Millimeter wave systems for imaging, ranging and designation

Status.

- A. Smoke
1. On the Shelf - non-tailored smoke grenades
 2. < 5 Years - XM56 vehicle mounted tailored smoke generator (developed). Tailored smoke grenades (hand and grenadier).
 3. > 5 Years
- B. "Vision" Equipment
1. Thermal IR goggles - with priority R&D - < 5 years
 2. Pulsed illumination < 5 years
 3. Millimeter wave systems > 5 years

Current Programs.

- A. XM 56
- B. Same work on "Thermal Goggles"

8. RSTA and Situational Awareness

Opportunities: The ability to issue instructions in a foreign language can be achieved by a small electronic unit that verbalizes pre-recorded phrases at the touch of a button. This technology is readily available. A hands-free capability that would issue pre-recorded foreign phrases in response to English language oral requests is more technologically demanding.

The ability of patrols to converse with indigenous civilians, and the ability to run HUMINT operations depends on the foreign language skills of the officers and enlisted men. The voice recognition state-of-the-art has now advanced far enough to allow the implementation of a PC-based virtual reality interactive language tutor.

A major effort is required to create an information system that will establish and maintain an urban infrastructure database for cities of potential interest. The system must provide for rapid dissemination of information to all levels.

9. Enemy Among Noncombatants

This is one of the toughest problems found in the MOBA environment. A long range method of detecting munitions (grenades, Molotov cocktails, or explosives), rifles, and handguns in crowds is needed. Incapacitating agents and flash/bang grenades have utility in the near term, in that they can be used to disable and allow search of crowds. In the future, radar or other detectors (such as metal detectors for metal weapons and "sniffers" for munitions) should be explored.

Need for the Improvement. MOBA will, as stated, most likely occur in OOTW. As such we will operate with greater scrutiny, both during planning and execution, by the interagency community. The lines delineating purely military operations from interagency operations are blurring, necessitating closer working relationships between the elements of the Federal government. In addition to interagency coordination, MOBA under OOTW will also bring US military forces into direct contact with nongovernmental organizations (NGOs), private volunteer organizations (PVOs), and international relief organizations (IROs), all of which will place continuous and nontraditional demands upon our military capabilities.

State of the Art. A relatively new initiative within the Federal government, interagency coordination is just beginning to receive the emphasis it requires. OASD(SO/LIC) will conduct an inaugural Senior Interagency Policy Seminar (SIPS) at USAWC, Carlisle Barracks, this September. There are other lower level initiatives within the government, but no functional program exists. The relationships with the NGOs/PVOs/IROs is a relatively new phenomena for the U.S. military. Heretofore the strict purview and interest of the State Department (OFDA/AID), it has recently been a matter of some study due to operations in Somalia and Rwanda. Recent training at the JRTC illustrates the need for training and exposure of our forces to these other organizations. Additionally, there is a Joint Publication (3.08 "Interagency Coordination during Joint Operations") under development.

Opportunity for Improvement. The opportunity presented is that of education and exposure. Greater emphasis during MOBA training is required, both for interagency coordination and NGO/PVO/IRO relationships. The JRTC training, OASD(SO/LIC) SIPS, and similar initiatives should be encouraged and greater emphasis during MOBA education and training are needed. Further, the MOBA ACTD should review these elements as portions of the overall training requirements.

Status: On the shelf/ < 5 years to operational readiness/ > 5 year to operational readiness. Specifically, continue JRTC and SIPS in the near term and act on recommendations coming out of the MOBA ACTD.

Current programs: JRTC training, OASD(SO/LIC) SIPS, JP 3.08 "Interagency Coordination during Joint Operations."

10. Urban Fighting Vehicle

Need for the Technology. MOBA requirements include rapid movement of forces in vehicles offering communications, fire power, and greater protection from snipers/small arms fire and mines than can be provided by HMMWVs + armor protection kits. Whereas armor (M1A2) and infantry fighting vehicles (BRADLEY) can provide these functions in certain MOBA environments, there are many in which they are ill-suited or in which a policy decision precludes armor and/or heavier vehicles. In some MOBA terrain, heavy tracked vehicles will be counterproductive as they degrade the limited infrastructure (tear up roadways); lose maneuverability due to canalization and limitation created by narrow roads; cannot carry people (tanks); and cannot operate at the rates of speed and maneuverability required during MOBA. Furthermore, this capability is required for medical evacuation under fire where the threat prevents helicopter evacuation (MEDEVAC). A wheeled, armored personnel carrier capable of providing limited fire support, protected movement of forces, protected MEDEVAC, deterrence, mobility, maneuverability, and speed is required for MOBA. However, a new weapons system program is not feasible.

State of the Art. There are two on-going programs: the LAV-25 (USMC) and Armored Security Vehicle (USA Military Police).

Technological Opportunity. Without initiating a new system, additional, limited procurement of either one or both of the on-going and available vehicles will contribute significantly to current capabilities. To enhance the survivability of these vehicles, there are required

improvements: capability to survive side/front/top RPG-type weapons, capability to better withstand AT mines, and higher angle fire support from on board weapon systems.

Status: On the shelf/ < 5 years to operational readiness/ > 5 year to operational readiness. With the proper emphasis, additional limited procurement can be accomplished within 5 years and the necessary improvements can be fielded in the > 5 year time frame.

Current programs. LAV-25 and ASV.

Other: It needs to be *strongly emphasized* that this recommendation seeks to provide a reasonable, not necessarily an ideal solution to the problem.

11. Countering MANPAD Threat

Need for the Technology. The proliferation of sophisticated MANPADS and their forecast improvements (including night capability) necessitate the ability to detect and counter IR, laser beam riding, fiber optics, and multiple sensor "shoulder fired" SAMs. The following aspects, though not an all inclusive listing, warrant further examination:

- Detect missiles prior to launch
- Detect missiles at time of launch
- Counter the various acquisition/guidance systems
- Detect the missile in flight
- Counter/destroy the missile in flight.

State of the Art. Detection and countering means are limited and are most effective against IR.

Technological Opportunity.

Status: On the shelf/ < 5 years to operational readiness/ > 5 year to operational readiness. (Information unknown in sufficient detail to adequately address.)

Current programs. All of the current programs are not known in sufficient detail to be adequately described in this paper. However, as an example, NAVAIRSYSCOM has a project called the Missile Approach Warning System (MAWS).

12. C4I Needs

Pre-Mission Intelligence. When our forces are deployed to an urban area overseas they often lack knowledge of the city, the location of electric power and communications facilities, the location of important choke points, and other attributes of the infrastructure necessary for the control of the city and for the protection of its facilities. There is a need to rapidly gain this type of intelligence before or shortly after force deployment. Current map products of potential urban hot spots are required.

Dynamic Intelligence. It is also necessary to keep up with the changing intelligence needs, changes resulting from combat, roadblocks, communications patterns, and use of facilities. In addition to imagery that could be made available from overhead assets, there is a great need for HUMINT to discover the INTENT of hostile forces.

Intelligence Dissemination. Intelligence must be distributed to the individual patrols to alert them to the immediate threat they face. For this reason, intelligence must be a two-way street (sensors providing ground truth and hostile intent to the intelligence community, and the community, in turn, forwarding relevant information with minimum lag time to the fighting force.

Special Sensors. In the area of special sensors, we need a capability to detect land mines, booby traps, car bombs and snipers; see through walls to locate personnel; and optics to see around corners to limit exposure to soldiers and lightly armored vehicles.

These reconnaissance and surveillance sensors and pre-mission intelligence capabilities are largely unique to MOBA, and are not provided for by our regular R&D program.

13. MC&G and Urban Intelligence

Need. Good maps are critical to successful operations in an urban environment. MOBA operations are complex, manpower-intensive, dangerous operations. Accomplishing OOTW and warfighting tasks with minimum risk requires full situational awareness (SA) and the ability to conduct a fast-paced operation. SA begins with an understanding of the layout of the urban zone, and the ability to overlay intelligence information on accurate map products. Updated maps must be available when (or before) troops arrive in-country. Urban cadastral maps must be updatable, because MOBA can change a city rapidly, from precision strike, from modifications by the opponents, or from operations that leave high collateral damage. Important to urban operations is the ability to provide overhead imagery at a moment's notice. Linking UAV and other imagery into mapping and Intel would aid all operations, from planning to small-unit operations. The history of paper map support in 20th century allied operations has not been good -- and left alone, will become increasingly vexing as needs shift to more detailed coverage of numerous urban areas.

State of the Art. Technologies are available to satisfy these needs. Engineer Topographic units now have field vans with map making and reproduction capability. The vans need updating, since computer technology and geographic information systems have progressed swiftly beyond the engineer acquisitions of the 1980's. The infusion of current technologies would create a powerful aid to the urban commander and soldier. Commercial companies have useful products that seem to improve monthly. Critical to providing useful urban map products is the availability of small-scale mapping products (1:5000 to 1:25000) on CDs, to include an editing and re-write capability in-theater.

Opportunities. The means to fix this problem are in-hand, and involve the intelligent application of overhead imagery, maps of multiple scale on CD-ROM, and mapping and GIS software with overlay and multimedia zoom-in capability. A path to success might involve requesting the CINCs to provide yearly estimates of the world's 6-12 most likely urban hot spots. Once approved by the JCS, national assets and unclassified means would be used to construct a workable GIS database for these areas (use of Embassy staffs, commercial contractors, etc., under the guidance of an Urban Analysis Center staff).

CD-ROM and GIS products would be developed as needed by the Defense Mapping Agency (DMA), and transferred to theater (either by airlift or by satellite downlink). In-theater, these databases would be enhanced to support the operations of the CINC, through the "enriching" talents of INTEL, Topo, Aviation, and Tactical Operations Center personnel. In this way, current, useful urban IPB products could be provided at least daily, as was done in an ad hoc manner in Operation Just Cause (Panama) and in Mogadishu (UNOSOM II).

Not all products would be used, and some needs would inevitably be overlooked. However, those not used would be available in a "warm" library, and the process would be institutionalized, such that overcoming Murphy's law would be less painful in times of crisis.

Current Programs. R&D activity continues at The Topographic Engineer Center (TEC). Increased focus on likely urban trouble spots by TEC and DMA should be encouraged. In addition, the Services should take advantage of commercial products such as:

- Global-Explorer (CD-ROM maps - 13 levels - down to street level for over 100 cities worldwide).
- Digital camera technology (used from helicopters or UAVs) to provide near-real-time imagery
- Geographic Information Systems (GIS); one provided by the University of Nebraska at low cost, that can store and recall urban data of many classes, including imagery keyed to mapping products.

14. Communication Needs

Need. In MOBA, the environment is characterized as one where propagation of communications is difficult. There are typically tall buildings, many reflective surfaces, civil communications, and unreliable local power sources. Thus there are many reflectors, high attenuation of signals, complex three-dimensional geometry, and short lines of sight. There is dense clutter and communications, including GPS, do not work in some structures. Sensors suffer from communication difficulties and from opposing force operations. Opposing forces tend to be very mobile and many use low/no technology communication methods that are more amenable to human intelligence than to remote sensors and interception. Given that MOBA operations are often conducted by small units in a decentralized way - the need for communications, location, and sensors is vital.

State of the Art. Current high frequency communication networks do not work well in built-up areas. In addition, currently sensors include a variety of passive acoustical and other listening devices that are less than effective in high traffic, noisy, built-up areas. On the other hand, lower frequency devices do work in cities. Radio broadcasts, as well various U.S. and foreign transportation operations (truck, rail, bus, taxi), and police have reporting systems and command centers that are effective in cities. There are also GPS/radio reporting systems.

Technology Opportunities. To continue to use high frequency communications, better line of sight must be available. A UAV for both communications and differential GPS is one technically feasible option. If radio batteries were lighter weight and more powerful a satellite could be used. In addition smaller, lighter power sources would enhance the variety of sensors.

Status. Commercial products - without encryption addition - could be adapted within 5 years. A UAV system is feasible in the 5-year time frame, with a more robust system in the 5+ year time frame.

Current/New Programs. Adopt commercial displays and command centers as well as available civilian differential GPS/radio reporting systems.

Cost - unknown.

Key Players - ACOM.

15. Keypad Phrase Verbalizer

Need. There is a need for mounted and dismounted patrols to communicate with individuals, small groups, and crowds. A small part of this need can be met by an electronic phrase verbalizer. This device would respond to a keypad entry by enunciating a prerecorded phrase in the appropriate foreign language. The phrase verbalizer would be about the size of a Walkman;

would be specific to a particular language; would eventually be capable of having new phrase inserted in the field; and would contain on the order of 32 phrases of 10 seconds or less.

State of the Art. This technology is commercially available. Low cost units with about six English phrases in a pocket size device are sold in joke shops.

Technological Opportunity. A military version can be developed quickly at low cost.

Status. The technology is on the shelf, but no appropriate equipment is available.

Current Programs. There is no current program known to the task force.

Other. It should be possible to specify and procure from industry about 10,000 units (1,000 in each of 10 languages) for about \$1,000 in less than 2 years.

16. Voice Phrase Verbalizer

Need. In the conduct of MOUT, better foreign language capability would help in street interactions with indigenous civilians and in the operation of human intelligence systems.

State of the Art. There are currently available machine translators for text that produce useful renditions, particularly of business or technical material. There are voice actuated systems that respond to a limited menu of spoken commands. The vocabulary of commands can be expanded if the system is trained to the individual speaker.

Technological Opportunity. The voice recognition, artificial intelligence, and computer miniaturization technologies might eventually make it possible to produce a wrist watch sized real time translator, which upon hearing a phrase spoken in a foreign tongue, would recognize the language and provide an English translation in the earphone worn by the user. Similarly, the unit would articulate phrases spoken by the user in English in the language designated.

Status. Operational readiness of this system will not occur before the year 2000.

17. Language Tutor

Need. More foreign language capability in both officers and enlisted men would help MOUT in two ways: at a low level of proficiency, patrols would be able to interact with the indigenous civilian populace to enforce curfews, seek out weapons, control crowds, and generally maintain order. At a higher skill level, it will be possible to operate HUMINT systems. The tutoring needs include both low term language training and refresher courses.

State of Art. Currently there are three basic forms of language instruction: classroom, tutoring, and self-instructional tapes. The most efficient (and expensive) instructional technique is individual tutoring; this is not generally used in the military. Total immersion classroom instruction is very time consuming; on the order of a year is required for meaningful proficiency. Self-instructional program materials are currently not interactive and require very good motivation on the part of the student.

Technological Opportunity. Advances in computer technology and in voice recognition technology make it possible to build a work station based virtual reality interactive language tutor. The tutoring would carry the student through a game structure that requires the successful negotiation of a series of verbal confrontations. The voice recognition would assess the appropriateness and the pronunciation of the student's response and would correct or reinforce as needed. The game structure would provide the motivation and the repetition. An individual student might spend 2 to 3 hours a day using the work station to try and solve the game. If the automated tutor can be made to work as well as a human tutor, there will be a two sigma improvement in instructional efficiency; also, the cost will be reduced.

Status. An automatic tutor as described should be fieldable for two field demonstration languages (say Arabic and Chinese) within 5 years.

Current Programs. There are no current programs in the military. There is some university research; also, there is one industrial program to build an English tutor for Japanese speakers.

Other. This developmental program might best be conducted in a quasi-academic environment combining voice recognition and foreign language expertise. A 5-year program at about \$5,000 per year should support the independent development of two prototypical language tutors.

18. See Through Walls Radar

Need. In built-up areas the opportunities for cover are multiple (underground, behind structures and equipment, and high in and on buildings) as are escape routes. The rules of engagement frequently put U.S. soldiers in contact with the population and limit the amount of damage to structures and the infrastructure. As U.S. soldiers carry out search, rescue, reconnaissance, and surveillance missions, they need to "see through" walls without unnecessarily destroying them. Soldiers need to be able to detect motion, life, number and placement of people, their armament, and selected substances or materials.

State of the Art. Currently available systems use radar for motion detection through windows, concrete, brick, and many interior walls. Prototype systems provide three-dimensional imaging that indicates the number of people and their positions - through many interior walls. Research is underway on discriminating non-metallic hidden material. Hughes is producing the motion detector radar and other systems mentioned. Westinghouse and other companies are addressing the problem as well.

Technology Opportunities. There are many challenges to overcome with the current state of the art. The size of equipment varies but the three-dimensional capability is too large and bulky (~150 pounds) for use on patrols. Current equipment must be relatively close to the wall to be penetrated. Tuning for signal attenuation, refraction, absorption, and reflection based on the wall material remains. In addition, compensating for false alarms can be improved. The requirements are for resolution of less than 3 inches with updates of the scene every minute.

Status. The motion detection is available now and the 3-D imaging is in a prototype status. Within 5 years there should be - with demand from commercial and defense sections - improvements, especially 2-D. The ability to detect motion, life, or substances through metallic walls or from greater distances (100+ feet) are in the > 5 year time frame and may require an entirely new technology. ARPA is testing the feasibility of using a millimeter/microwave interferometric SAR.

Current Programs. SAR is programmed ~ \$2.5M for FY94-96. Other programs are planned by ARPA at the \$5M level from FY97-99.

Key Players. ACOM, SOLIC, ARPA

19. Surveillance (Robotics)

Need. In support of MOBA, there is a need for real time, continuous, day/night, and adverse weather surveillance capabilities. A multi-sensor approach is required, which includes EO/IR, SAR, MTI radar, LADAR and laser designators. Sensor data must be immediately available to C2 elements in general and selectively down to the squad level. (Information down to the squad level would include data or things such as barriers, peripheral movements and crowd formations.)

Unmanned Aerial Vehicles (UAVs) offer a very cost effective platform for the sensor packages required. They offer a capability for survivable, low risk, continuous, multi-sensor coverage.

In the near term (off-the-shelf and less than 5 years) there are programs that can address these needs. These include the Pioneer, the short range (Hunter) UAV and the Medium Altitude (Predator) UAV.

In the far term (over 5 years) a more robust capability will be needed. Very long loiter, low observable, high altitude systems (such as the proposed Tier II+/Tier III-) should be developed. These systems should have a simultaneous multi-sensor capability, with robust beyond line of sight communications. The systems need to be highly deployable. Ground stations and C2 for the UAVs need to be small and easily integrated with other deployed C2 assets.

20. Surveillance (Unattended Ground Sensors)

Need. The current UGS program is limited and characterized by a need to hand emplace the sensors. The use of UGS is also constrained by size, weight, battery life and range.

State of the Art. UGS offer an excellent means for improving security, surveillance, and situational awareness in a MOBA environment. They offer the potential for remote monitoring of rooms, buildings, and facilities between a relatively large area of cities. These sensors can be used to monitor traffic through intersections and movement in and out of buildings. They can supplement security at key facilities and installations such as bridges, power plants, and telephone exchanges. Small remoted TV cameras can help monitor crowds, photograph participants, and identify adversaries.

Opportunity. There is a need to improve UGS. Miniaturization to reduce size and weight is important. Stealthy sensors should be built to include acoustic, EO/IR, seismic, and magnetic capabilities. These sensors should have improved "long life" power sources or the capability to be tied in with local power sources. They should be low cost and designed to efficiently transmit their data with an urban environment. Some, selectively, may need an embedded GPS capability.

21. PSYOPS and Civil Affairs

Need. As the world population continues to grow it is also becoming increasingly urban in nature. This combination of trends places great stress on existing social and political infrastructures, particularly in the less developed world where those infrastructures are often very fragile to begin with. Depending on the circumstances, the conduct of MOBA requires the commander to assess the existing infrastructures and to tailor actions to reinforce them, replace them, or create them. To complete this mission, the commander must communicate successfully and persuasively with various elements of the population within his TAOR. With increasing frequency, Civil Affairs (CA) capabilities are critical to success in MOBA. Over 96% of CA force structure and virtually all of some functional expertise (public health, public administration, civilian legal systems, etc.) reside in the Reserve Component (RC). Consequently, many crucial capabilities are not available without volunteers [Temporary Tours of Active Duty (TTAD)]; mobilization; or the politically sensitive Presidential Selective Reserve Call-up (PSRC). Heretofore, heavy reliance on volunteers has been made, but has its own price. Creating ad hoc units comprised of volunteers is disruptive, inefficient, and does not guarantee either the availability of requisite skills or their continued availability ("staying power"). Furthermore, there is no current centralized system for identifying the specific skills of Reservists acquired by their civilian occupations and/or military training.

State of the Art. Psychological operations units fall under the SOCOM. Civil Affairs units are located in the Reserves of SOCOM and USMC.

Opportunity. To improve our psychological operations and civil affairs capabilities, the following actions need to be implemented:

- Identification of existing communications nodes/systems in urban areas throughout the world.
- Access to commercial Direct Broadcast Satellites.
- Access to FAX machines/systems world wide.
- Access to computer systems such as Internet.
- Access to cellular telephone communications systems.
- Worldwide database of telephone numbers and autodialers for the command.
- Higher capacity, lighter weight, more durable, power efficient, deployable print, broadcast, and speaker systems.
- Ability to broadcast into distant, denied areas.
- Additional assets to give the commander greater capability to communicate on existing commercial radio, TV, and other mass media systems.
- Amending Title 10 to authorize the Secretary of Defense to call up a limited number of CA Reservists without a PRSC. Unit call ups are essential to this process.
- Streamlining the procedures for activating Reservists on TTAD.
- Develop and maintain an accurate personnel inventory database for CA personnel and military personnel in general who have the skills we may need to access.
- Update CA doctrine to focus upon assessing current dynamics of civil structures worldwide.
- Create and maintain an urban database library.
- Create a civil assessment information program to tap into the database for the purpose of responding to the needs of the commander in collecting, evaluating, and dissemination of critical information.
- Create and employ civil dimension templates for training in and planning for the civil dimension under a variety of tactical/mission scenarios.

Status: On the shelf/ < 5 years to operational readiness/ > 5 year to operational readiness. Most of the above are issues that will probably take at least 5 years. Detailed information is unavailable for more accurate projections.

Current Programs. Psychological operations units fall under the SOCOM. Civil Affairs units are located in the Reserves of SOCOM and USMC.

22. Training Needs

Need. Recent operations in built-up areas have demonstrated the need for "Quick Fire" short range training using live ammunition in order to build confidence, effectiveness, and develop team work. Virtual training systems offer the opportunity to integrate many aspects into MOBA.

State of the Art. Most MOBA training sites for conventional forces are built for blank fire or MILES training systems. Building and room have not been modified for the use of MILES within rooms and building. Some training sites allow live firing from building into impact areas. No virtual training systems exist at this time.

Opportunities. There are two opportunities - the development of virtual MOBA battlefields with weapons from small areas on up to all weapons and the modification of MOBA training facilities for the use of live fire by the installation of bullet absorbing materials such as the Israeli Army uses in their training facilities.

Status. Modification of MOUT training facilities is available now by using Israeli Army techniques. A program of modification could be completed within 2 years. The virtual MOUT battlefield requires the development of virtual urban digitized databases and the development of small arms weapons for use in such a facility. Both of these could be done in less than 5 years.

Current Program. None for conventional live fire (except fire houses) and urban virtual tactical trainers.

Other. Cost for modification of MOUT training facilities are not high for selected building in those facilities on a near impact areas. The cost of a MOBA virtual reality battlefield would be moderate.

23. Operational Level Senior Officer Training

Need. Training for Military Operations in Built-Up Areas has been generally limited to the tactical level to the brigades, battalions and attached units faced directly with such operations. Training facilities have been built and the Combat Training Center at JRTC and CMTC in Germany put a lot of emphasis on such training and operations. What has been missing has been training at the Operational level for the senior officers of the Joint Theater Commands (JTF) and of the component services assigned to the Joint Force. The reason for this is that specific operation such as MOBA is not the way the military treats military operation. The military generally describes the levels of war; forms of war (offense and defense); and the range of operations (war and operation other than way). Therefore MOBA is addressed only when the issue comes up at the operational level. As an example JCS Pub 3.0 doctrines for Joint operations, Sep 93 does not mention MOBA.

CINC's JTF commanders and service component commanders need training as how to best address the complex nature of MOBA and the restrictions that normally come with MOBA (e.g., collateral damage, minimizing friendly and noncombatant casualties, etc.). As such they need to develop the thought processes of converting political and strategic goals into military goals and end-states; force selection and force sequencing of Joint Forces into the operational area, planning and interaction with NGO, planning and interaction with Allied and coalition forces, planning and interaction with USG organizations (state, AID, FEMA, and agencies) and the development of Joint training programs and exercises.

State of the Art. Operational level training is conducted now by CINCs. To date, none of these periods has been known to be devoted to MOBA. War gaming capability (construction simulation) is limited for MOBA. Institutions, such as the War Colleges, have produced little on MOBA problems, operations, and solutions.

Opportunities. The forum that best fits MOBA training includes the War College-level courses, to include the Senior Joint Course at the Armed Forces Staff College to begin to establish the range of problems and possible solutions to MOBA tasks. Every CINC conducts training programs periodically for his staff and components and should be tasked to include MOBA and OOTW as topics. As DIS wargaming and facilities are developed, the opportunities to increase the frequency and depth of training will be increased. Also, the Chairman, JCS should include MOBA in an OOTW environment early on his topics of CINC wargaming and training sessions. The development of constructive simulations such as WARSIM2000 and STOW will enhance CINC training capabilities if MOBA environments are included in these projects. The development of a Joint MOBA manual will provide structure to training programs.

Status. The techniques of Virtual Reality are such that proposals in virtual and constructive simulation can be completed within 5 years - if modified to include MOBA.

Current Programs. STOW97 is now out for proposals. WARSIM2000 is now out for proposals. We also need to include more joint exercises and training as we bring new capabilities into the force.



OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3140

DEFENSE SCIENCE
BOARD

19 JUL 1994

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Defense Science Board Summer Study on Military
Operations in Built-up Areas

The Under Secretary of Defense (Acquisition & Technology) directed the Defense Science Board (DSB) to undertake a Summer Study to determine the Department of Defense's current capabilities to conduct military operations, including peacekeeping and peacemaking, in built-up/urban terrain and to assess our future needs to perform this function. The focus of the board's assessment is on modernization initiatives which would have high leverage in terms of our ability to conduct military operations in built-up/urban terrain. Much of the impetus for pursuing this study stems from our recent experience in Somalia.

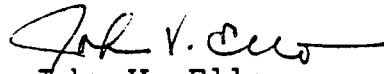
In order to assist the DSB in their deliberations, respectfully request your command respond to the following questions:

- o How does your command plan to conduct operations in built-up/urban terrain?
- o Are the current tactics and doctrine adequate to successfully execute operations in built-up/urban terrain?
- o What are the limitations on the equipment and materiel you have available to conduct operations in built-up/urban terrain?
- o What technologies should be exploited to better equip our forces for operations in built-up/urban terrain? In particular, to minimize collateral damage and to assure high survivability of friendly forces.
- o How does your command train and/or conduct joint exercises for operations in built-up/urban terrain?
- o Are your operational units robustly structured to conduct warfare in built-up/urban terrain which typically stresses small unit, low OPTEMPO operations?

- o Is there anything in terms of tactics, doctrine, training, force structure, materiel...which the Department should be undertaking to improve our ability to conduct military operations in built-up/urban terrain?

The DSB will begin the final stage of their study with two weeks of intensive deliberations beginning on August 21, 1994. In support of this effort, it would be very much appreciated if your command response could be provided to the Task Force Executive Secretary, Mr. Walt Squire, prior to the aforementioned date. His telephone number is (703) 697-7645 and data fax is (703) 693-7029. In the event you opt to provide your response via mail channels, his address is OUSD(A&T)/TWP/LW; The Pentagon, Room 3B1060; Washington, DC 20301-3100.

On behalf of the Defense Science Board Chairman, Dr. Paul Kaminski, please accept my thanks and appreciation in advance for your help and assistance in this important effort.



John V. Ello
Executive Director
Defense Science Board

DISTRIBUTION:

CAPT Schultz, USN, USACOM
Col Conklin, USAF, USCENCOM
Col Gabreski, USAF, USEUCOM
Col Critchlow, USAF, USPACOM
CAPT Woolard, USN, USSOCOM
LTC Altomare, USA, USSOUTHCOM
Col Siegert, USAF, USSPACECOM
Col Moses, USAF, USSTRATCOM
Col Barnaby, USA, USTRANSCOM

CC: J-3

MOBA REQUIREMENTS BY SOURCE

#	REQUIREMENT	SOCOM	EUROM	ACOM	SOUTHCOM	CENT COM	USMC	TRADOC	RMA LIC TF	Other Operators
1	Hands off ICS (NLOS)	X	X	X	X		X	X		X
2	Improved Soldier to Commander Comms (NLOS)		X		X		X	X		X
3	Non-Lethal Crowd Control	X	X					X	X	X
4	Improved Body Armor Capable of Stopping 7.62mm	X		X			X			X
5	Night Vision Devices Not Degraded by Illumination	X		X			X			X
6	Mout Training Facilities with Shooting Houses			X	X			X	X	X
7	Detect Sniper/Mines/Booby Traps/Wpns/MANPADS		X					X	X	X
8	Combat ID		X		X		X			X
9	Small Thermal Sights for Individual Weapons	X			X					X
10	Paint Rounds for Training & Other Training				X		X			X
11	Demo for Entering Buildings/Walls		X				X			X
12	Situational Awareness		X		X					X
13	Marking Systems for Cleared Rooms & Buildings				X		X			X
14	Acoustic Sensor Though Walls, Sewers		X				X			X
15	HE AT4 for Blasting Walls		X				X			
16	Joint Training Simulations			X	X					
17	Vehicle Anti Mine Kits	X								X
18	Language Translator						X			X
19	Video Camera With Transmitter		X				X			X
20	Real Time, Long Duration, Day Night RECON		X							X
21	UAV's with Long Loiter Time			X						X
22	40mm AP, CS, Bounding Frag Rds						X			X
23	Laser Pointer						X			X
24	GPS for Urban Navigation			X						X
25	Locate, Clear and Mark Minefields							X	X	
26	Improved Laser Designating Device & Monitors		X		X					X
27	Improved Fuze for AC130 (Concrete)	X								
28	Power Adapters for Local Electric Grid						X			
29	Refugee - Housing, H2O, Food, Medicine						X			
30	Bullet trap Rifle Grenades				X					
31	Shotguns				X					X
32	Spray Cans of Cayene Pepper & Vehicle Mounted				X					X
33	Airdrop Sleeping Agent				X					
34	Balistic Eye Protection				X					
35	Flame Thrower				X					
36	Laser Range Finder & Assimuth		X							
37	Improve Electronic CM for Aircraft		X							
38	Improve Survivability of Aircraft		X							
39	Fiber Optics			X						
40	Robotics			X						X
41	Dazzler (Laser)					X				
42	Upper Level Entry Equipment				X					
43	Obscuration Devices				X					
44	Control Movement of Goods, Tagging							X	X	
45	Seize, Destroy, Control Public Infrastructure							X		
46	Monitor, Disrupt Comms							X		
47	Locate Persons and Conduct Recovery							X		
48	Vehicle Non-Lethal Protection Devices							X		
49	Strategic Lift									X
50	Rapid Map Generation Capability				X					
51	Data Base of Population Centers				X					

Non-Lethal Technologies

Technology	Maturity	Range (meters)	Distance for Activation (meters)	Time to Effect	Duration of Effect	Comment
Optical/Flash	Now	100-2000	Instant	Instant	Instant + TBD	Battlefield Optical Munition - LANL/ARDEC; LCMS - NVL; Stingray - CECOM; Dazer - USMC
	Near	50-500	Same	Same	Same	
	Far	+2000	Same	Same	Same	
Kinetics	Now	20-100	3-10	Instant	Instant - 15 min	Sponge-ARL/ARDEC; Rubber Multi-Shot - NSWC Unk Requirement for Improvement
	Near	10-200	TBD	Same	TBD	
	Far	TBD	TBD	TBD	TBD	
Acoustics	Now	?	?	?	?	SARA demo - ARDEC; Propagational Effects - ARL
	Near	TBD	Instant	Instant	Seconds-Days	
	Far	TBD	Instant	Instant	Same	
Chemicals (Antipersonnel) Irritants/Calmatives	Now	Platform Dep.	Instant	Instant	<15 min?	Irritants, CS, CR Available; Need to Determine Delivery Methods; Calmatives - ERDEC
	Near	Platform Dep.	Instant	Instant	?	
	Far	Platform Dep.	Instant	Instant	?	
Pyrotechnic Stun	Now	Platform Dep.	Instant	Instant	5 sec - TBD	XM84 Stun Grenade - NSWC/ARDEC
	Near	Platform Dep.	Instant	Instant	TBD	
	Far	Platform Dep.	Instant	Instant	TBD	
Electric Stun	Now	0-5	>1	Instant	1 min - 1 hr	
	Near	3 - TBD	>1	Instant	1 min - TBD	
	Far	TBD	TBD	TBD	TBD	

Non-Lethal Technologies (continued)

Technology	Maturity	Range (meters)	Distance for Activation (meters)	Time to Effect	Duration of Effect	Comment
Entanglements/ Envelopments/ Air Bags	Now	0-TBD	Instant	Instant	Until removed	Net - SBI - ARDEC
	Near	TBD	Instant	Instant	TBD	
	Far	TBD	TBD	TBD	TBD	
Chemical (Others)	Now	0-100	Instant	Seconds	Minutes - Hours	Catatonics - ERDEC
	Near	0-2000	Instant	Seconds	Minutes - Hours	Combustion Inhibitors - ERDEC; Sticky Foams - DOE
	Far	Platform Dep.	Instant	Seconds	Minutes - Hours	
Radio Frequency/ EMP	Now	Platform Dep.	Classified	Classified	Classified	ARL/DOE
	Near	Platform Dep.	Classified	Classified	Classified	
	Far	Platform Dep.	?	?	?	

NOW - Immediately available for Warfighting Experimentation and Evaluation

NEAR - Available within 1-2 years for Warfighting Experimentation and Evaluation

FAR - Available 3 or more years for Warfighting Experimentation and Evaluation

NON-LETHAL WEAPONS

	Need	State of the Art	Tech. Opportunity	Status	Current Programs
Microwave					
anti-personnel	low	good	uncertain	< 5*	Some classified programs
anti-guidance	low	uncertain	uncertain	> 5	
anti-components	high	uncertain	uncertain	> 5	
counter mine	high	uncertain	uncertain	> 5	
Acoustics					
point defense	average	good	good	< 5*	
crowd control	high	good	good	< 5	
Lasers					
disorienting	high	good	high	< 5	
temporary damage	high				
permanent damage	high				
Other					
flash-bang	high	good	good	now	
rubber bullets	high	good	good	now	
riot agents	high	good	good	now	
stun guns	high	good	good	now	
irritating sprays	high	good	good	now	
expanding spheres	fair	?	fair	> 5	
nets	low	fair	low/none	> 5	
foams	low	poor	low/none	> 5	

*For the small quantities needed for a
useful capability

Appendix E

MOBA Implementation Plan

Procurement Plan

- Procure/field limited amounts of level IV body armor
- Procure/field limited amounts of extremity body armor
- Procure/field limited amounts of hands off squad radios
- Procure/field limited amounts of additional APCs
- Reduce weight of level IV body armor by 25%
- Procure/field limited amounts of vehicle armor kits
- Improve urban communications (leader-to-soldier)
- Develop/field hand-held translation devices
- Procure dazzlers for crowd control
- Procure acoustic generators for crowd control
- Develop/field high power microwave for crowd control
- Develop/field RF systems for crowd control
- Evaluate and select base nominated for closure to be national MOBA training site
- Increase MOBA training for those units most likely to deploy to MOBA
- Increase live fire MOBA training
- Improve MOBA operational doctrine
- Increase MOBA training at all levels of PME
- Institute MOBA training element in flag officer training
- Improve access to select reserve components, esp. Civil Affairs and PSYOPS
- Develop sniper detection system
- Develop anti-sniper system
- Develop mobile mortar/artillery detection system
- Develop/field means to inject PSYOPS signal into commercial media from a distance
- Develop/field urban navigation system
- Procure limited amounts of 3D imaging radar systems to see through walls
- Procure limited amounts of laser protective goggles
- Develop and field individual combat ID systems
- Develop/field limited amounts of overhead imaging system (similar to TARPS) for UAVs controlled by the JTF Commander
- Build detailed information system on specific urban features/facets

Develop nonlethal weapons technologies
Train on working with the interagency and NGOs
Develop/field thermal sights for individual weapons
Improve low, night flying capability for helicopters
Increase CQB training
Develop/field telemedicine
Develop/field system to repel personnel attempting to touch vehicles
Develop/field non-real-time mapping system for the JTF Commander
Procure/field more pepper spray
Develop/field ballistic eye protection for fragments
Procure/field small wall buster
Develop/field UAVs with better sensors
Develop/field ultra-precise munitions
Develop/field vehicle IFF system
Develop/field improved thermal/night vision systems

Why are Fixes Needed?

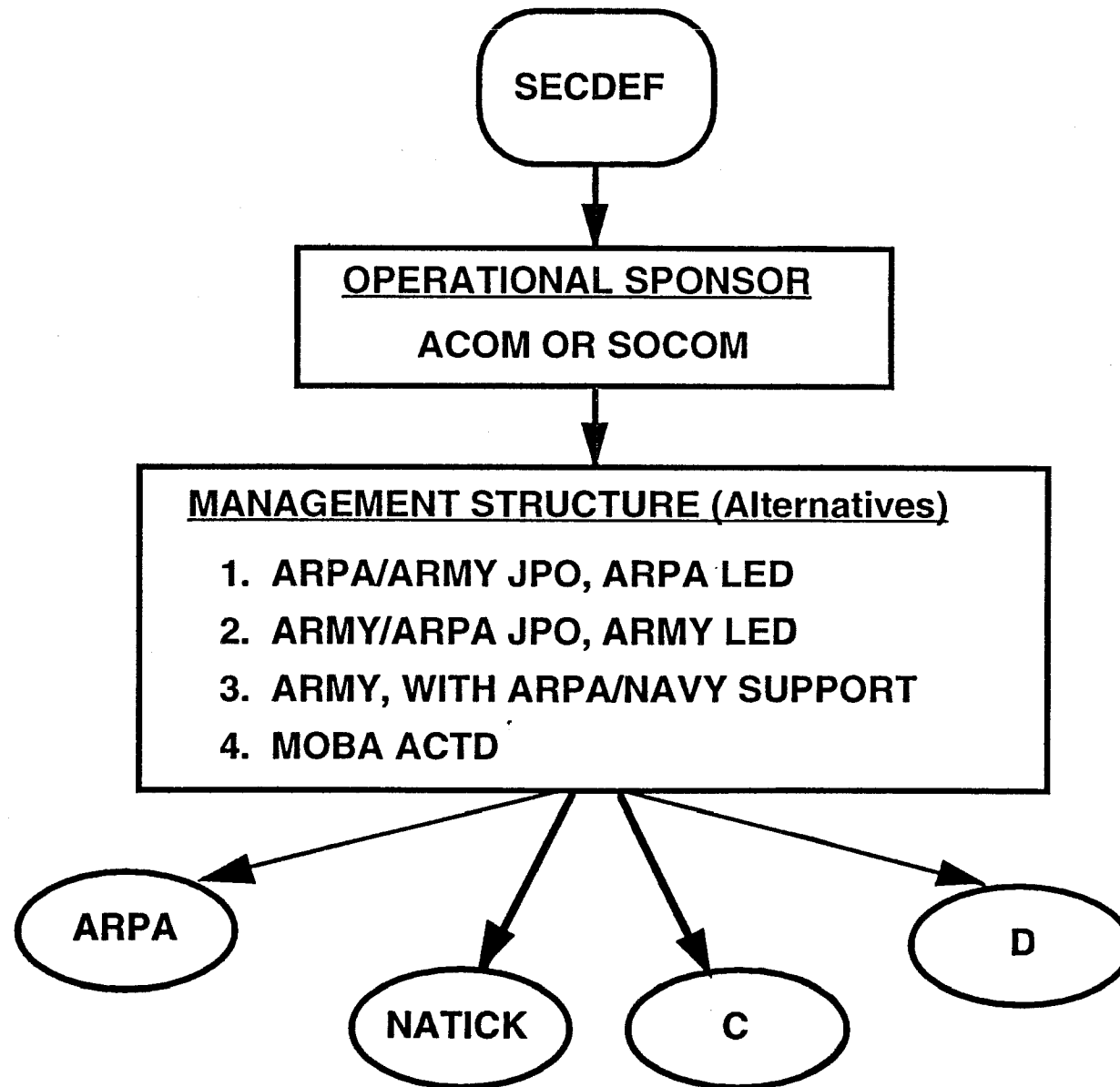
- **WHY?**

- MOBA presents problems requiring new technology and crossing service lines
- Solutions require combinations of technology and operations
- MOBA will be a problem for the foreseeable future, and requires a stable institutional home for rapid development of improved capability
-

- **GOAL**

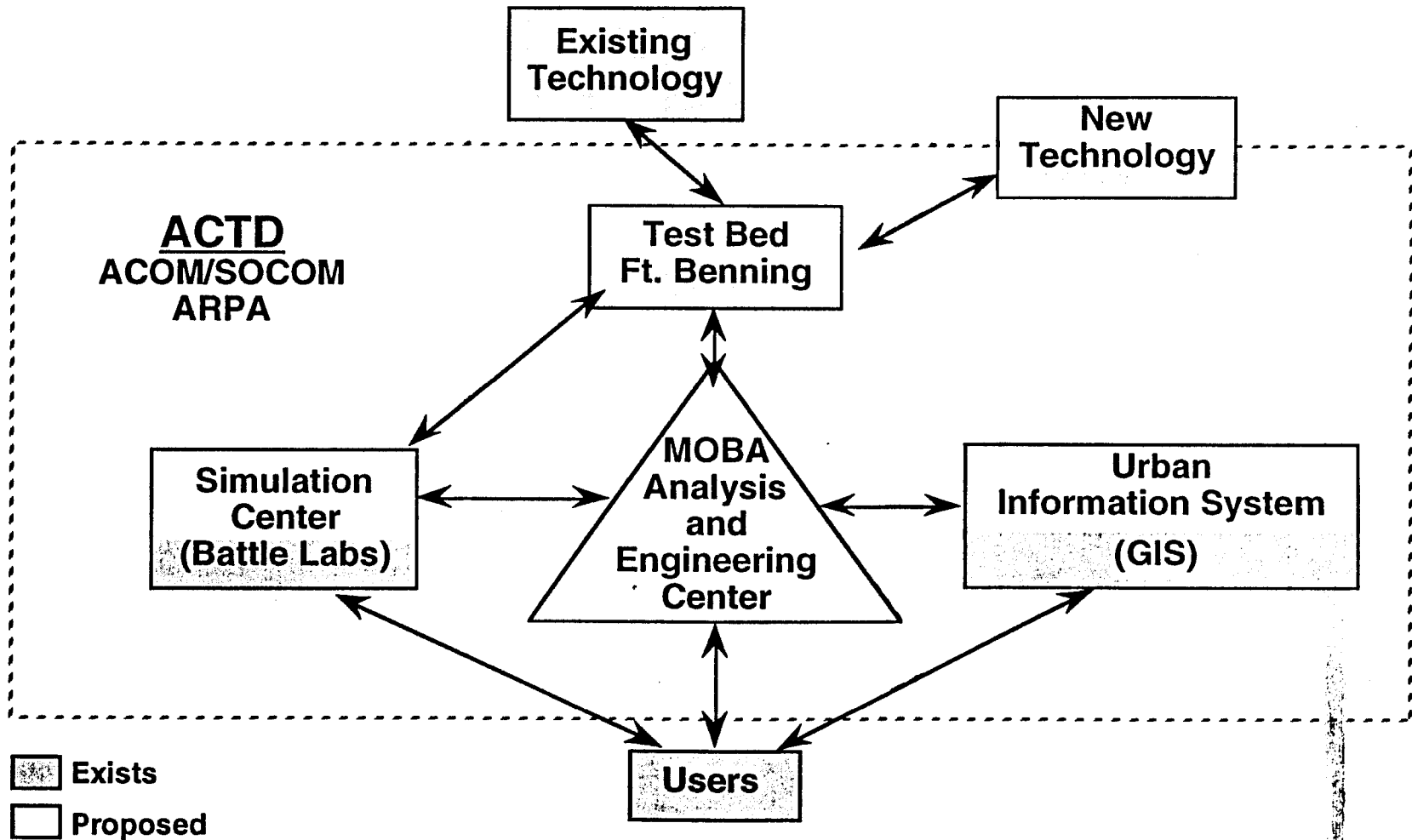
- Develop an integrated, tested set of weapons, equipment, doctrine and training techniques for use in MOBA/OOTW. This set would focus on high-priority scenarios in MOBA:
 - Countering direct and indirect fire
 - Convoy protection
 - Compound protection
 - Operations involving individual small units, including patrol and building clearing
 - Crowd control

Implementation and Rationale



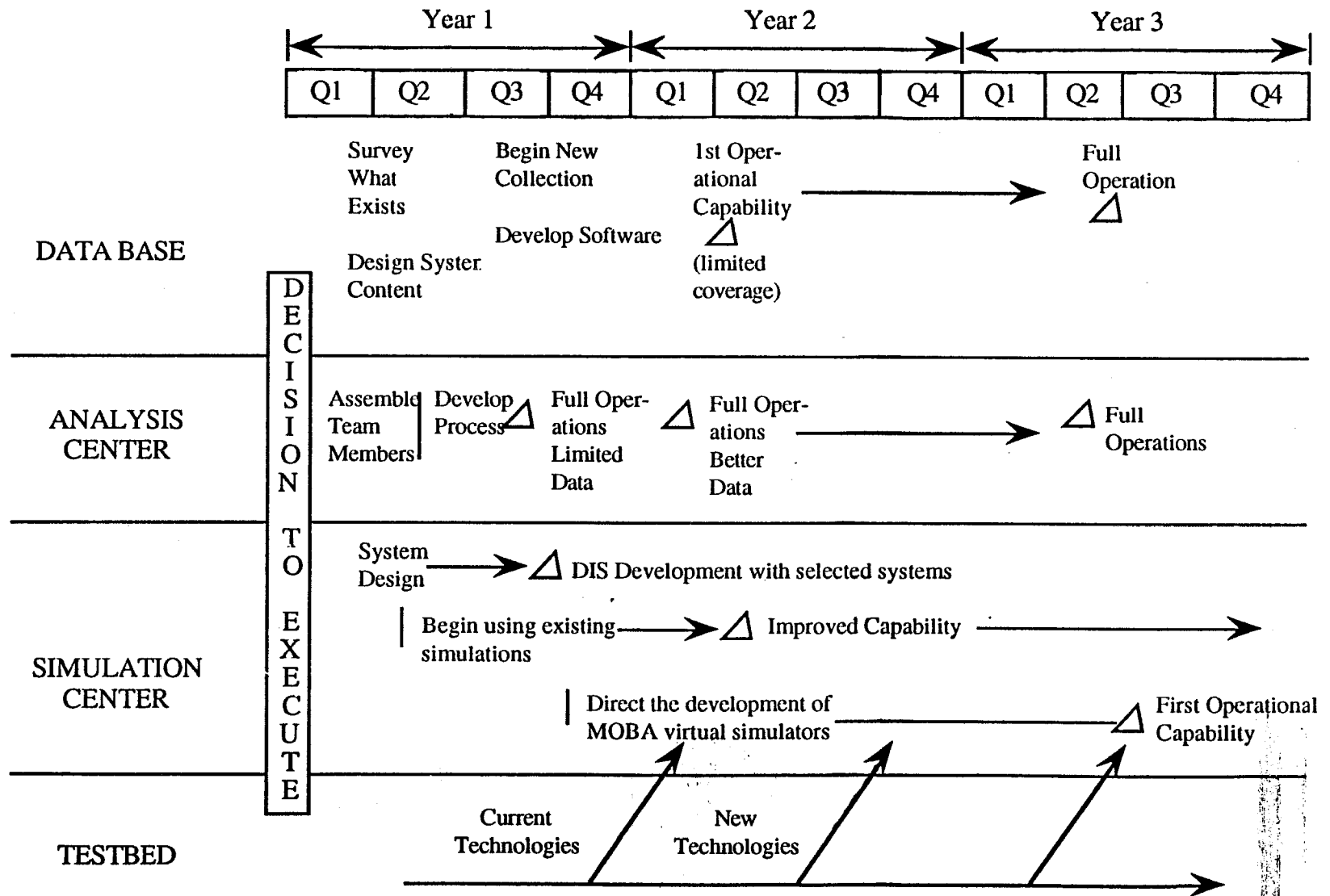
E-4

Functional Connectivities



E-5

MOBA As A System – ACTD Timeline



E-6