



**U.S. Army Research Institute
for the Behavioral and Social Sciences**

Research Report 1770

**Measures of Platoon Leader Situation Awareness
in Virtual Decision-Making Exercises**

Laura D. Strater and Mica R. Endsley
SA Technologies

Robert J. Pleban
U.S. Army Research Institute

Michael D. Matthews
U.S. Military Academy

20010524 051

April 2001

Approved for public release; distribution is unlimited.

**U.S. Army Research Institute
for the Behavioral and Social Sciences**

A Directorate of the U.S. Total Army Personnel Command

**EDGAR M. JOHNSON
Director**

Research accomplished under contract
for the Department of the Army

TRW Inc.

Technical review by

Bruce W. Knerr
Richard E. Christ

NOTICES

DISTRIBUTION: Primary distribution of this Research Report has been made by ARI. Please address correspondence concerning distribution of reports to: U.S. Army Research Institute for the Behavioral and Social Sciences, Attn: TAPC-ARI-PO, 5001 Eisenhower Ave., Alexandria, VA 22333-5600.

FINAL DISPOSITION: This Research Report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this Research Report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Research Report 1770

Measures of Platoon Leader Situation Awareness in Virtual Decision-Making Exercises

Laura D. Strater and Mica R. Endsley
SA Technologies

Robert J. Pleban
U.S. Army Research Institute

Michael D. Matthews
U.S. Military Academy

Infantry Forces Research Unit
Scott E. Graham, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

April 2001

Army Project Number
20262785A790

Personnel Performance and
Training Technology

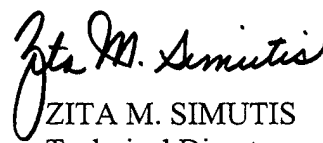
Approved for public release; distribution is unlimited.

FOREWORD

The Infantry Forces Research Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences conducts research to investigate the challenges presented by the 21st Century battlefield. Force modernization efforts must be guided by research to identify those systems and procedures that can produce the greatest benefits for U.S. forces now and in the future.

This study investigated the situation awareness (SA) of platoon leaders in simulated MOU (Military Operations on Urbanized Terrain) missions. Since information availability and usage are integral to the development of situational dominance for any military force, identification of the multidimensional elements that comprise a soldier's SA is a critical first step in developing technologies and training methods to improve SA. A preliminary analysis of platoon leaders' SA requirements formed the basis for developing measures to quantify SA in Infantry exercises. Three instruments were developed, providing both objective and subjective SA measures which were then implemented during simulated MOU missions.

The investigation established that SA could be quantified and measured in a light Infantry MOU environment, despite the complexities of the information demands. The results demonstrated the utility of virtual exercises in the Squad Synthetic Environment to support both research and training. Not only were SA differences identified between experience levels, but also between scenarios and the point in the simulation at which they were queried, providing an initial demonstration of the sensitivity of the measures. Qualitative and quantitative SA differences between more experienced and less experienced officers suggest it may be possible to train less experienced officers to attend to the available information differently, thus enhancing both SA and decision-making while improving the cost-effectiveness of leader training. Critical aspects of the research were briefed to the Chief of the Dismounted Battlespace Battle Lab (DBBL) Simulation Center on 14 November 2000 and to the Deputy Director of the DBBL on 17 April 2001.


ZITA M. SIMUTIS
Technical Director

ACKNOWLEDGEMENT

We would like to thank Mr. Rich Wampler of TRW for his support in the planning of the project and assistance in the development of the SA Requirements Analysis and Dr. Bruce Leibrecht of TRW for his invaluable assistance in the organization and refinement of the final report. We'd also like to thank Mr. Jim Centric, Mr. Mike Dlubac, and Mr. Norm Blankenbeckler of TRW, Mr. Billy Potter of Lockheed-Martin, and Mr. Bob Jordan, MAJ John Hyatt, MAJ Humphreys, CPT Joe Neuwirth, and CPT Chris Pflanz of Fort Benning.

MEASURES OF PLATOON LEADER SITUATION AWARENESS IN VIRTUAL DECISION-MAKING EXERCISES

EXECUTIVE SUMMARY

Research Requirements:

As the Army moves to exploit information age technology, Infantry forces will be called upon to gather information and achieve situational dominance in an increasingly complex environment. Superior situation awareness (SA), in terms of the warfighter's ability to access and use available information to improve lethality, survivability, and communication, will be a pivotal factor in the ability of the Infantry force to meet this challenge. The challenges of Military Operations on Urbanized Terrain (MOUT) contribute to the complexity of the task of Infantry forces, through the effects of a three dimensional, non-linear battlefield, a poorly defined enemy, an unpredictable and volatile civilian presence, and restrictive Rules of Engagement (ROE). In this complex environment, the systematic measurement of SA will promote better understanding of the specific information requirements of warfighters, and yield vital insights regarding the techniques used by Infantry leaders to enhance SA, and ultimately decision-making and action.

Infantry platoon leaders operate in a complex environment requiring that they attend to multiple information sources, prioritize among competing and sometimes conflicting goals, and make rapid decisions, all under highly stressful conditions where the loss of life, either their own or others', is a constant threat. To complicate the matter, platoon leaders are often relatively inexperienced officers, with minimal service time, training and experience to draw on. In this environment, superior SA provides tremendous advantages to those with the ability to acquire it and the experience to use it.

Procedure:

The current project focused on three distinct functional goals. The first phase involved an SA requirements analysis identifying elemental factors essential for the development of superior SA by platoon leaders in a MOUT mission. Infantry subject matter experts assisted in a goal-directed task analysis to identify the SA requirements. The second phase involved development of objective and subjective SA measures to support research of Infantry leaders' SA during MOUT exercises in the Squad Synthetic Environment, a virtual simulation. The third and final phase entailed implementation of these measures in four separate simulated MOUT missions to determine whether the measures could reveal SA differences, both between scenarios and within a scenario at different times. Perhaps most important, the virtual investigation explored differences between the level and type of SA in experienced and inexperienced platoon leaders.

By identifying characteristic differences in the processing of SA information with experience, it may be possible to identify training methods that can increase the efficiency and

effectiveness of training less experienced platoon leaders to see the patterns and threats that are more apparent to officers with higher levels of experience. This would provide the double benefit of maximizing training value while decreasing the training time required to produce officers who are better prepared for the battlefield.

Findings:

Despite a small sample size, data analysis revealed several findings of interest. First, experienced officers were better at locating both friendly and enemy elements on a map. Second, more experienced officers focused their attention on the enemy to a greater degree than less experienced officers, so that they had a better understanding of the enemy strengths and the threat posed, while less experienced officers better understood friendly strengths. While further research is needed, this finding could have significance for developing training methods. Third, the objective SA measures demonstrated sensitivity to experience level, type of scenario, and point in the simulation at which the measures were taken, providing preliminary indications of their utility for the study of SA under the unique conditions encountered in Infantry operations.

The investigation established that SA could be quantified and measured in a light Infantry MOU environment, despite the complexities of the information demands. The results demonstrated the utility of virtual exercises in the Squad Synthetic Environment for both research and training. The accuracy differences identified between experience levels, scenarios and measurement halts provide an initial demonstration of the sensitivity of the SA measures.

Utilization of findings:

The SA measures developed here can be used in follow-on research to delve more deeply into the construct of SA in the light Infantry environment. Additional research can test these measures both in simulations and in live training environments. The finding that more experienced officers have a better understanding of the locations of both enemy elements and their own platoon members, and the implication of this information, can be used to train less experienced officers to focus on key information. Further, the finding that more experienced officers are better at identifying both the highest enemy threat and the strongest enemy location shows an increase in situation comprehension in these areas. By focusing on the ways in which SA changes with experience, it may be possible to train less experienced officers to attend to the available information differently. Trainers could develop instructional techniques to improve SA accordingly, focusing on the development of a mindset that constantly considers what the enemy will do next. Such advances would enhance both SA and decision-making while improving the cost-effectiveness of leader training.

MEASURES OF PLATOON LEADER SITUATION AWARENESS IN VIRTUAL DECISION-MAKING EXERCISES

CONTENTS

	Page
Introduction.....	1
The Challenge of Situation Awareness in Infantry Platoon Operations.....	1
Situation Awareness in Infantry Operations.....	1
Differences in Abilities Required to Develop Situation Awareness Among Individuals.....	3
Evaluating Situation Awareness in Infantry Operations.....	4
Study Objectives.....	6
Phase 1: Situation Awareness Requirements Analysis.....	6
Overview.....	6
Method.....	7
Results.....	7
Phase 2: Situation Awareness Measures Development.....	12
Situation Awareness Global Assessment Technique (SAGAT).....	12
Situation Awareness Behaviorally Anchored Rating Scale (SABARS).....	14
Post-Trial Participant Subjective Situation Awareness Questionnaire (PSAQ).....	15
Phase 3: Soldier-in-the-Loop Investigation.....	15
Method.....	15
Results.....	19
Discussion.....	27
Conclusions.....	29
References.....	31
Appendix A: Detailed Results of the SA Requirements Analysis.....	A-1
B: SAGAT Instructions to Platoon Leaders.....	B-1
C: SABARS Instrument.....	C-1
D: PSAQ Instrument.....	D-1

CONTENTS (continued)

	Page
E: Biographical Information Questionnaire	E-1
F: Assault Scenario Flow Chart.....	F-1
G: Defend Scenario Flow Chart	G-1
H: Data Analysis Results.....	H-1
I: Acronyms.....	I-1

LIST OF TABLES

Table 1. SAGAT Queries	13
2. SABARS Factors.....	24
3. Summary of SAGAT Regression Analysis with SABARS and PSAQ Ratings	27

LIST OF FIGURES

Figure 1. Model of situation awareness levels and decision-action process.....	2
2. SA requirements analysis: primary goal structure.....	9
3. Example from SA requirements analysis: Secondary goal 1.1-Avoid enemy detection	10
4. SA requirements for Infantry platoon leaders in a MOUT mission	11
5. SAGAT query 1	14
6. SAGAT query 1 showing elements located on the map by a participant	19
7. SAGAT mean scores by experience level.....	20
8. SAGAT mean scores by scenario	21
9. SAGAT mean scores by halt number	22

10. SAGAT mean scores-scenario by halt interactions	23
11. Knowledge of communications with friendly elements by experience level and scenario	23
12. SABARS scores for gathering information/following procedures by experience level.....	25
13. SABARS scores for focusing on the big picture by experience level	25

MEASURES OF PLATOON LEADER SITUATION AWARENESS IN VIRTUAL DECISION- MAKING EXERCISES

Introduction

Situation awareness (SA), knowing what is going on in the situation around you, is a fundamental requirement for combat success. It forms the foundation for military decision-making and task execution. In the demanding Infantry combat environment, superior SA brings tremendous advantages by promoting information dominance, improving security and survivability, and optimizing lethality. The future battlefield calls for advanced technologies, leader development, and training concepts targeted at enhancing SA at all echelons. These goals can only be achieved through systematic effort and knowledge regarding SA. As Infantry forces apply technological advances to expand battlefield information flow, it becomes increasingly important to understand the factors shaping SA in Infantry operations, to include the interrelationships among those factors. Experience has proven that more information does not necessarily produce better SA or improve situational dominance. The development of training programs and technologies that enable employment of forces with high levels of SA depends upon a solid foundation of knowledge regarding SA in the Infantry arena.

The Challenge of Situation Awareness in Infantry Platoon Operations

Endsley, Holder, Leibrecht, Garland, Wampler and Matthews (2000) provide an analysis of the role of SA in Infantry operations. Infantry platoon leaders decide how they will deploy, orient, and direct their squads based on their mission, situation and SA. Achieving high levels of SA in the highly complex and dynamic environment is not easy. Many stressors act to degrade the platoon leader's SA, or to prevent him from gaining a high level of SA to begin with. Time pressure and the rapid tempo of operations can significantly challenge platoon leaders who often must struggle to maintain an up-to-date awareness of a rapidly changing reality. The conditions for gathering and assimilating information may rapidly deteriorate during combat operations.

Fatigue brought on by heavy physical exertion, lack of sleep and nighttime operations also degrade the platoon leader's ability to detect and process information vital to good SA. Poor environmental conditions, including noise, fog, weather, and smoke can directly obscure critical information. Stress and anxiety associated with warfare and the inherent uncertainty and confusion can all act to reduce SA (Endsley et al., 2000). Periods of significant task underload or task overload can also lead to SA problems.

The factors that shape SA also can be greatly influenced by the enemy, who can alter the tempo of the battle and dramatically affect the conditions under which a battle is fought. Thus, Infantry operations frequently must be conducted under the challenges of a number of factors, some naturally occurring, some task or enemy induced, that can all act to seriously degrade SA.

Situation Awareness in Infantry Operations

Endsley (1988) formally defined SA as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the

projection of their status in the near future” (p. 97). This mental representation of the state of the world involves perceiving critical factors in the environment (Level 1 SA), comprehending what those factors mean (Level 2 SA), particularly when integrated in relation to the soldier's goals, and at the highest level, projecting what will happen in the near future (Level 3 SA). The higher levels of SA allow soldiers to function in a timely and effective manner. These three levels are depicted in Figure 1, and will be described further.

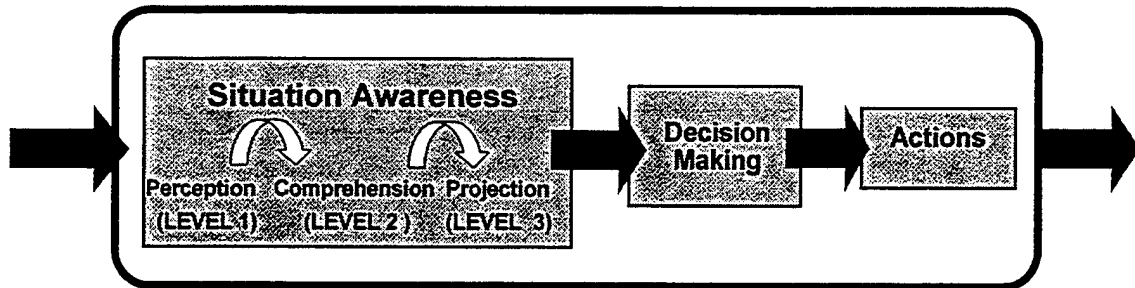


Figure 1. Model of situation awareness levels and decision-action process (from Endsley et al., 2000).

Level 1 Situation Awareness—Perception of the Elements in the Environment

Achieving SA begins with perceiving the status, attributes, and dynamics of relevant elements in the environment. Important elements include the position and actions of friendly forces, enemy forces, and civilians; terrain features; obstacles; and weather. In Infantry operations factors such as noise, smoke, confusion and the dynamics of a rapidly changing situation may often obscure critical elements of the situation. Numerous sources of information compete for the platoon leader's limited attention and mental processing resources. The platoon leader can obtain information from direct observation of the environment, from verbal and non-verbal communication with others, or from electronic systems and sensors. Each source of information may carry its own level of reliability. Confidence in information (based on past experience with the system, organization, or individual providing it) forms a critical part of Level 1 SA for the Infantry platoon leader.

Level 2 Situation Awareness—Comprehension of the Current Situation

The platoon leader's comprehension of the situation stems from a synthesis of disjointed Level 1 elements. Level 2 SA extends to an understanding of the significance of the information that is present, in the context of the platoon leader's goals. The platoon leader integrates Level 1 data to form a holistic picture of his environment, including a comprehension of the significance of objects and events. For example, upon seeing the impression of a certain type of vehicle track in soft ground, an experienced leader may realize that enemy units have passed through the area and consequently adopt a stealthier posture. A less experienced leader may see the same cues (Level 1 SA), but not be able to understand their meaning as well. The platoon leader typically interprets Level 1 SA (perceived data) with reference to his goals or plans in order to build Level 2 SA.

Level 3 Situation Awareness—Projection of Future Status

At the highest level of SA, the platoon leader is able to predict or project the future actions of the elements in the environment, at least for the very near term. He accomplishes this by combining knowledge of the status and dynamics of the elements with comprehension of the situation (Level 1 and Level 2 SA). Platoon leaders with a high level of SA are able to anticipate where and when the enemy will strike. They can estimate how much time they have until reinforcements arrive or until supporting fires can be delivered on a target. This look-ahead capability gives them the knowledge and time necessary to decide on the most favorable course of action to meet their objectives and goals.

Differences in Abilities Required to Develop Situation Awareness Among Individuals

In addition to the problems that the battlefield environment poses on the development of SA, significant individual differences exist in the degree to which people are able to detect and assimilate information to form a coherent and complete picture of the situation. While this issue has not been studied in detail in Infantry operations, as much as a tenfold difference in SA abilities has been reported among trained individuals in other domains. Anecdotal information would suggest that individual differences likely exist in those involved in Infantry operations as well. These SA abilities have been found to be highly stable within individuals (Endsley & Bolstad, 1994).

A number of factors most likely contribute to individual differences in SA ability (Endsley et al., 2000). Some may involve basic capabilities, such as pattern matching skills, perceptual speed, spatial ability, and attention sharing. At the same time, significant advantages in SA can be gained through training and experience in the warfighting environment. Training and experience allow leaders to develop mental models and relevant memory stores that provide rapid real-time pattern matching of perceived information to form the highest levels of SA. These memory structures make it possible for an individual to understand what information is important, how to direct one's attention to maximum advantage, and how to correctly interpret and integrate the information that is perceived. Under the strain of battlefield conditions, these capabilities are decisive in allowing Infantry soldiers and leaders to gain and maintain SA.

Improving the SA skills of Infantry leaders offers potential payoff in combat effectiveness. Little detailed information is currently available about how SA differs among Infantry leaders as they gain experience and knowledge, however. Because SA itself has not been studied in detail in the Infantry environment, little is known about what factors allow highly successful leaders to quickly gain and maintain high levels of SA, or how well this issue differentiates those leaders from others. By better understanding the processes, skills and knowledge associated with high (and low) levels of SA in Infantry operations, training programs that are more carefully focused on enhancing SA skills can be created to help inexperienced officers more quickly achieve higher levels of both SA and performance. Examining the ways in which SA differs between experienced and inexperienced Infantry officers forms one goal of the present research.

Evaluating Situation Awareness in Infantry Operations

Future research on the nature of SA in Infantry operations and the development and validation of training programs or new technologies depends upon the development and validation of measures of SA for Infantry operations. "When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind" (Lord Kelvin, quoted in Bartlett & Kaplan, 1992, p. 504).

By carefully examining the SA developing behaviors of experienced and inexperienced Infantry officers and measuring the level of SA, we may be able to gain insight into the ways in which warfighters can form SA under challenging conditions.

Situation Awareness Measurement Techniques

Measures of SA can be classified into four broad types (Endsley et al., 2000):

- Process indices—which examine how individuals acquire and process cues available in their environment. These process indices may be obtained using devices such as eye trackers or by studying communication patterns,
- Direct measures of SA—including purely subjective measures such as self-ratings or observer ratings, and more objective measures of SA which compare an individual's reported perceptions of the environment to some "ground truth" reality,
- Behavioral measures of SA—which try to infer SA from the actions that individuals choose to take, based on the assumption that good actions will follow from good SA and vice-versa; and
- Performance measures of SA—which try to infer SA from the end result, based on the assumption that if more kills are scored, for instance, SA must have been higher.

The pros and cons of these general measurement approaches and their applicability to Infantry operations are outlined in Endsley et al. (2000). For the purposes of the present research, we concentrated on developing and validating more direct measures of SA. Aside from the fact that other more inferred measures of SA are fairly circular in logic and therefore of little direct use in developing an understanding of SA in Infantry operations, more direct measures of SA can provide far more detail about the SA construct itself. That detail is needed to develop new training methods. Direct measures of SA include both subjective and objective measurement techniques.

Objective Measures of Situation Awareness

The most widely used approach to objectively measuring SA is the Situation Awareness Global Assessment Technique (SAGAT) (Endsley, 1988, 1995). Using SAGAT, a simulated exercise is halted at randomly selected times, information sources (e.g., communication channels, virtual displays, or new information technologies) are blanked and the exercise is suspended while participants quickly answer questions about their current perceptions and understanding of the situation. Participant perceptions can then be compared to the real situation

(as determined by simulation computer data or experienced observers who have knowledge about the actual state of events) to provide an objective measure of SA. By collecting SA data in this manner, SAGAT provides an objective, unbiased assessment of SA. This method provides a tool capable of measuring SA across all three levels, based on a comprehensive analysis of domain-specific SA requirements (Endsley et al., 2000).

In other domains such as piloting high performance aircraft, SAGAT has regularly yielded a high degree of validity (Endsley et al., 2000). It has good predictive validity, with SAGAT scores indicative of pilot performance in a combat simulation (Endsley, 1990a). Content validity was also established, showing the SAGAT queries to be relevant to SA in a fighter aircraft domain (Endsley, 1990b). A number of studies have demonstrated no noticeable impact on performance associated with inserting the freezes to collect SA data via SAGAT (Endsley, 1995, 2000). New queries (detailing each of the critical aspects of the situation that the Infantry leader or soldier can be asked to report upon during a "halt") need to be established for the Infantry domain, however, to make this approach viable for studying SA in Infantrymen.

Subjective Measures of Situation Awareness

An easy to administer method for measuring SA is to ask exercise participants to provide a rating of their own SA. Alternatively, skilled observers may be asked to provide a rating of the SA possessed by the exercise participants. While subjective ratings are simple and direct, they also have several limitations. Individuals making subjective assessments of their own SA have no objective basis for their judgments. They may not know what they do not know (e.g., there may be an enemy just over the next hill waiting to ambush them). Such subjective measures also tend to be global in nature, and as such do not provide the detailed diagnostic resolution that is available with objective measures.

Subjective self-assessments of SA have been found to be poorly related to objective measures of SA (Endsley & Selcon, 1997). Nonetheless, a person's subjective level of SA may be important for determining how he will act. Those with the belief that they have good SA may be more likely to act upon that knowledge (to either good or ill effect, depending on the accuracy of that belief), and those who believe their SA to be poor may be less likely to act (either wisely or unwisely) (Christ, McKeever, & Huff, 1994). The Situation Awareness Rating Technique (SART), the most commonly used subjective measure of SA, also incorporates workload assessments that are inappropriate for the Infantry domain. Therefore, we sought to develop a simple subjective self-rating measure of SA for this effort.

Observer ratings may be slightly better than self-ratings because more information about the true state of the environment is usually available to the observer than to the mission participants. However, observers tend to have less insight into the mental state of the person being evaluated and are forced to rely more on observable actions and verbalizations of the participants to infer the person's level of SA. One means for minimizing this difficulty is to ask observers to evaluate the degree to which individuals are carrying out actions and exhibiting behaviors that should promote the achievement of high levels of SA. This approach removes some of the subjectivity associated with making judgments about someone's internal state of

knowledge and allows them to make judgments about things that are more readily observable. In the current effort we sought to develop a behaviorally anchored rating scale for this purpose.

Study Objectives

The present research is an exploratory effort conducted within a virtual battlefield simulation—the Squad Synthetic Environment (SSE)—at the platoon level. The research had several main objectives:

1. To develop an understanding of the specific factors that are important for SA at the level of the platoon leader,
2. To develop objective and subjective measures for studying SA in platoon leaders and to conduct a preliminary evaluation of their utility and validity, and
3. To explore the quantitative and qualitative ways in which SA differs between experienced and inexperienced platoon leaders using these measures.

These objectives were accomplished in three phases:

- Phase 1: Situation Awareness Requirements Analysis
- Phase 2: Situation Awareness Measures Development
- Phase 3: Soldier-in-the-Loop Investigation.

Phase 1: Situation Awareness Requirements Analysis

Overview

The SA requirements analysis was performed as a goal-directed task analysis following the methodology of Endsley (1993) and Endsley and Rodgers (1994). The SA requirements were defined as those dynamic information needs associated with the major goals or sub-goals of the platoon leader in performing his job in a MOU (Military Operations on Urbanized Terrain) mission. To accomplish the analysis, the major primary and secondary goals of the mission were identified, along with the major subgoals necessary for meeting each goal. Associated with each subgoal, the major decisions facing the platoon leader were identified. The SA requirements for making these decisions and carrying out each subgoal were then identified. These requirements focused not only on what information the platoon leader needs, but also on how that information is integrated or combined to support each decision.

Several considerations need to be mentioned in relation to the SA requirements analysis:

1. At any given time more than one goal or subgoal may be operational, although they may not have the same priority. The analysis does not assume any prioritization among the goals, or that each subgoal within a goal will always be active.
2. The analysis was based on goals or objectives, not tasks. The analysts strove to be as technology-free as possible. How the information is acquired was not addressed. It could be through direct observation, verbal communication, new technology, or cognitive processing by the platoon leader of new or previously acquired information.

Many of the higher-level SA requirements fall into the latter category. The way in which information is acquired can vary widely between individuals, over time, and between situations.

3. The analysis sought to determine what platoon leaders would ideally like to know to meet each goal. It was recognized that they often must operate on the basis of incomplete information and that some desired information may not be available at all.
4. Static knowledge, such as doctrine, procedures or rules of engagement (ROE), was outside the bounds of this analysis. The method focused only on dynamic situational information affecting what the platoon leader does.

Method

Source of Input

Six male Infantry subject matter experts (SMEs), three active duty and three retired commissioned officers, assisted in initial knowledge elicitation sessions using the goal-directed task analysis methodology (Endsley, 1993; Endsley & Rodgers, 1994). The SMEs participated in one intensive individual interview session each, lasting approximately two hours. One of the six, an active duty field grade officer, collaborated in a final review of the goal hierarchy developed from earlier sessions.

Procedure

Each SME responded to a series of open-ended questions by the authors designed to elicit detailed responses concerning doctrinally-based goals and the decisions associated with the accomplishment of those goals. The SME then addressed the information needed to formulate these decisions. Interviewers held their questions until the SME reached a natural stop in his narrative response, so as not to interrupt the flow of ideas. At this time, particular care was taken to ascertain exactly how each piece of information was used. Higher-level assessments related to comprehension and projection were determined in this manner.

The six initial interviews were scheduled two per day, with at least a one week interval between interview dates to allow interviewers to review the data, break it down and reorganize it, identifying knowledge gaps to be filled in during the next scheduled sessions. After the first two complete interview sessions, SMEs viewed a graphical representation of a preliminary goal hierarchy developed from data collected in the early sessions, coupled with a review of the available literature in the field of Infantry SA. SMEs examined the outline with a view to developing consensus and identifying gaps in the analysis. This process continued through three iterations, including review of the first draft of the completed document, until SMEs were in general agreement with the analysis. A field grade SME with research experience performed a final review and refinement of the completed goal hierarchy.

Results

The detailed results of the complete goal-directed task analysis can be found in Appendix A. Figure 2 shows the overall goal hierarchy structure of the analysis, with Attack, Secure and

Hold Terrain shown as the overarching objective. While this is not the precise overarching objective of every MOUT mission, an overwhelming majority of mission goals would fit beneath that umbrella. One of the main thrusts of this research was to develop SA requirements and measures applicable across a broad range of operational parameters.

The overarching objective (Attack, Secure and Hold Terrain) was partitioned into seven primary goals, where the priority of individual goals varies across missions and even across the course of a mission. The seven primary goals are:

- Avoid Casualties
- Negate Enemy Threat
- Movement: Reach Point X by Time Y
- Assault Through Objective
- Hold Objective
- Provide Stability and Support Operations (SASO)
- Function in a Team Environment

Listed under each of these seven primary goals are the secondary goals, which are often employed to meet the mission objectives. Each secondary goal shown in Figure 2 is listed on a separate page in the detailed results of the requirements analysis (Appendix A), broken down into subgoals. For each subgoal, some of the questions that the platoon leader is considering are listed, followed by the SA elements necessary to answer these questions.

To facilitate a discussion of the requirements analysis format, Figure 3 illustrates the SA requirements for secondary goal 1.1—Avoid enemy detection. This secondary goal is partitioned into three subgoals: 1.1.1—Project enemy behavior, 1.1.2—Avoid danger areas, and 1.1.3—Utilize available cover and concealment. All three of these subgoals might come into play during the operation of other goals, and they might occur at times when the secondary goal here, Avoid enemy detection, is either impossible or undesirable. For instance, if the enemy already knows the platoon's location, the platoon leader will still want to project what the enemy's behavior might be, avoid danger areas, and utilize any available cover and concealment. Thus, when these subgoals are listed in later parts of the analysis, they are listed under the secondary goal of interest, assigned a new number connecting the subgoal to the secondary goal, but the questions and SA requirements are not repeated. The original identification number for the subgoal is used to refer the reader to these listings of questions and SA requirements. For example, under secondary goal 5.1—Prepare for enemy counterattack, is a listing for subgoal 5.1.5—Project enemy behavior (1.1.1), showing the reference back to the secondary goal where this subgoal is delineated.

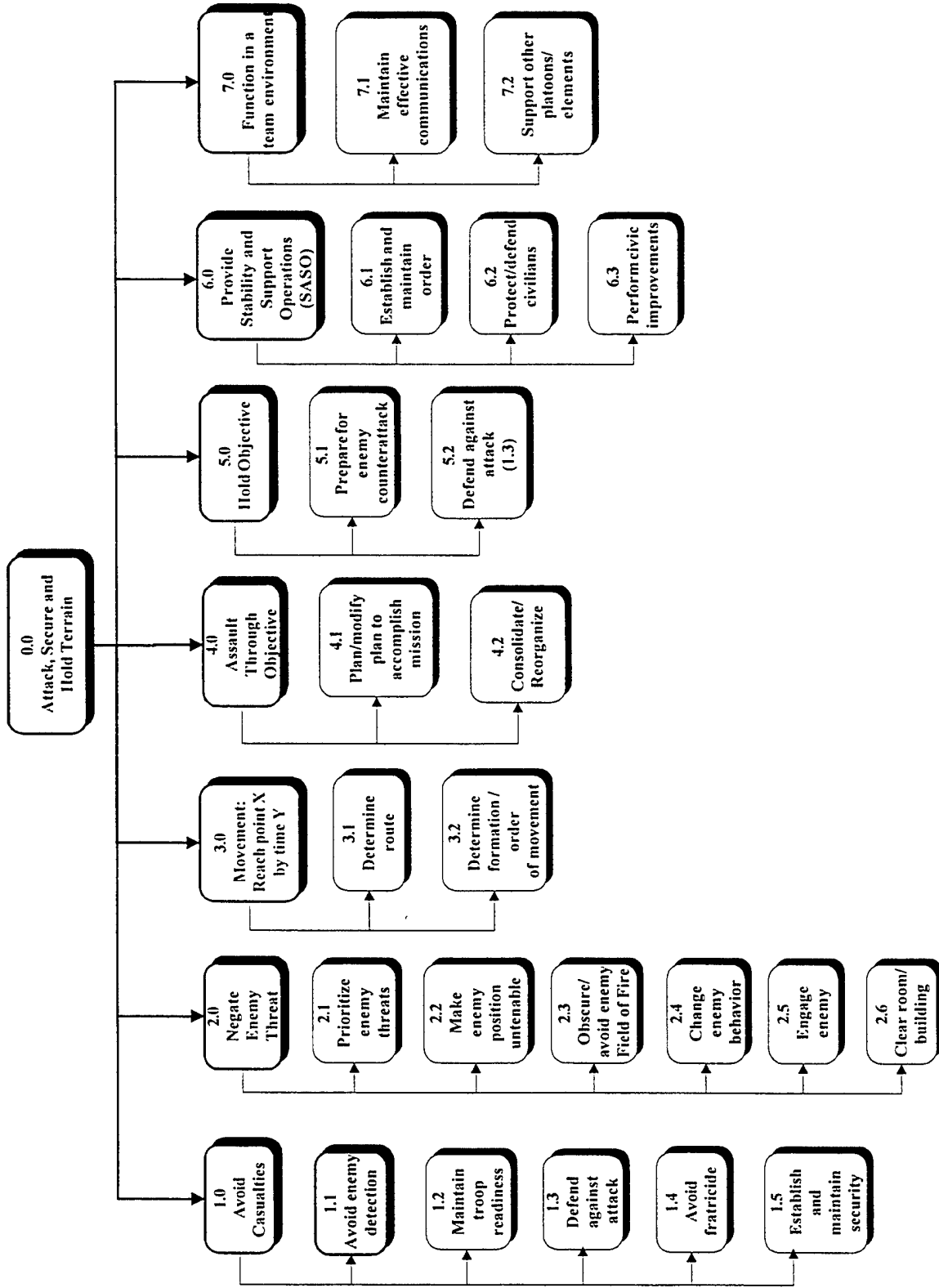


Figure 2. SA requirements analysis: primary goal structure.

As shown in Figure 3, the bottom box in each column lists the areas of SA needed to answer the questions and meet the goal in the boxes above it. If a complete set of SA requirements from another goal is needed to meet the current goal, the original goal is listed in the SA requirements in bold font, which refers the reader to a complete listing of SA requirements.

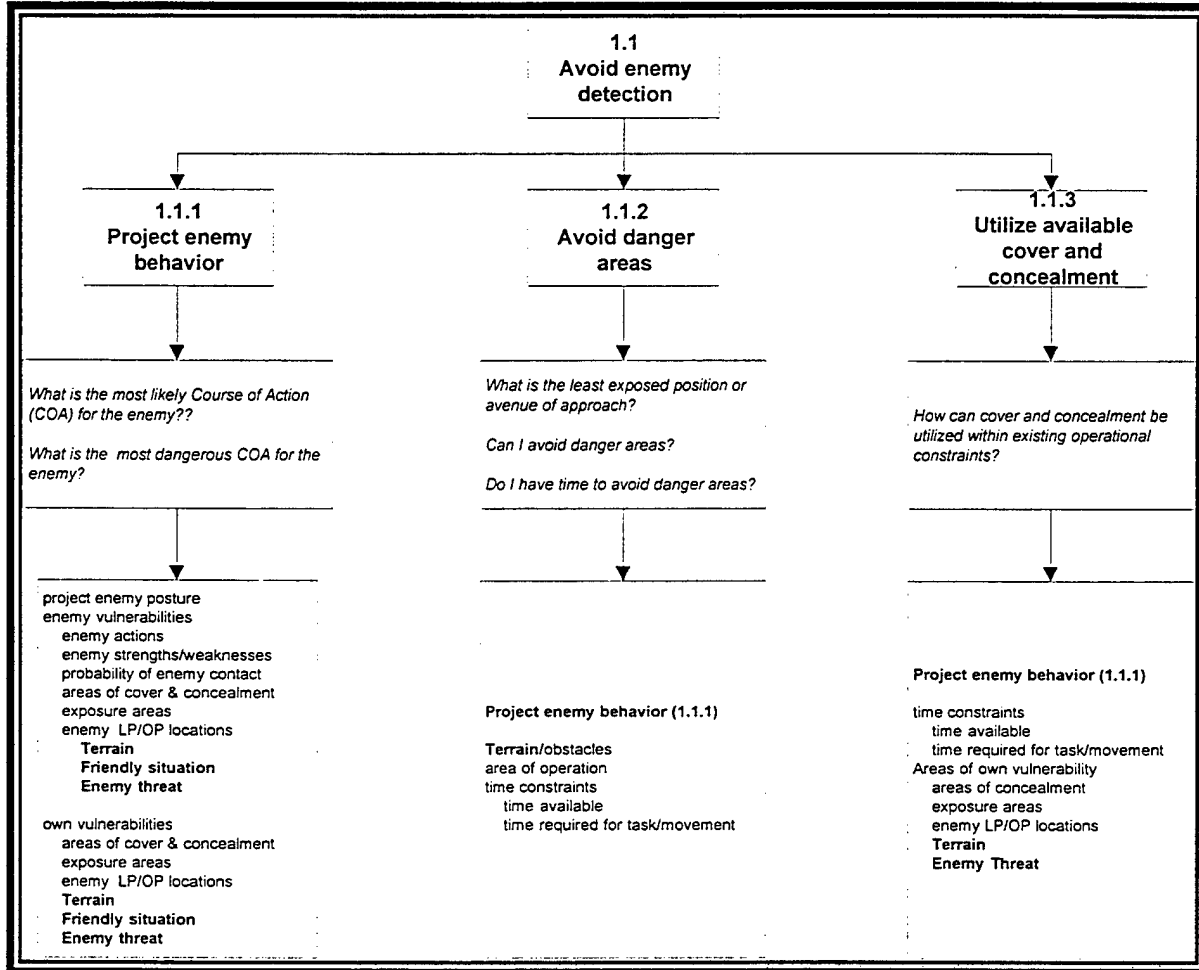


Figure 3. Example from SA requirements analysis: Secondary goal 1.1—Avoid enemy detection.

Many SA elements come into play in very diverse settings and goals, and to list them individually under each subgoal would be redundant. Instead, these often required information requirements are listed separately in categories on the final page of the analysis. Where these items are called upon in other pages of the analysis, they are also shown in bold letters. For example, certain elements of the Friendly Situation play into virtually every decision made by the platoon leader, such as the Commander's Intent and the unit mission.

Figure 4 summarizes the secondary SA elements identified for the platoon leader in the analysis across all of the major goals and subgoals in the MOUT mission. Level 3 (projection) SA items are shown flush with the left edge of the cell, while Level 2 (comprehension) elements are indented once, and Level 1 (perception) items are indented twice.

ENEMY THREAT

Anticipated enemy actions
 project enemy posture
 enemy vulnerabilities
 resistance expected
 projected impact on mission
 projected dispersion around weapons
 projected impact of LP/OP location
 enemy expectations of my behavior
 projected enemy casualties
 likelihood of attack
 enemy level of resistance
 enemy combat power
 projected enemy breach points
 likely enemy avenues of approach
 enemy maneuverability
 enemy strengths
 enemy weaknesses
 enemy disposition
 enemy intent
 enemy objective
 enemy composition
 enemy actions
 enemy strengths/weaknesses
 probability of enemy contact
 areas of cover & concealment
 exposure areas
 enemy LP/OP locations
 enemy psychology
 enemy patterns of movement
 enemy field of observation
 enemy field of fire
 location
 dispersion
 numbers
 weapons
 ammo/supplies
 objective
 unit type
 equipment
 experience level
 morale/commitment
 vehicle
 capabilities/skills/training
 recent actions
 enemy doctrine
 past behavior/actions
 religious/political beliefs
 locations of ammo/supplies
 movement of weapons
 security/patrol formations & schedule
 enemy center of gravity
 building vantage points

CIVILIAN SITUATION

projected civilian behavior
 projected civilian casualties
 projected civilian response
 level of threat
 potential for goodwill
 potential for escalation
 level of organization
 mood of crowd
 religious/political beliefs
 morale/commitment
 intent
 proximity to sensitive sites (church, school, political center, etc)
 location
 number
 agitators present
 threatening actions
 weapons
 training/skills

Rules of Engagement

FRIENDLY SITUATION

Anticipated friendly actions
 Troop psychology
 Projected troop fatigue
 Soldier mental fatigue
 Projected performance on task
 Potential for fratricide
 Anticipated relative locations of other units
 Own vulnerabilities
 projected casualties
 strategic significance of weapons
 projected impact of action on mission
 projected effect of action
 projected benefit/cost of action
 projected ability to avoid fires
 likelihood of deception success
 projected effects of moving casualties
 ability to detect enemy presence
 ability to avoid enemy detection
 likelihood of enemy contact
 dispersion required
 forces required
 resources required
 force ratio
 Commander's Intent
 unit objective
 planned friendly actions
 combat power
 availability of fires
 priority of fires
 combat multipliers available
 timing of support
 protection provided
 friendly composition
 unit type
 experience level
 morale/commitment
 character of soldiers
 individual soldier discipline
 capabilities/skills/training
 fatigue/soldier load
 troop disposition
 distance traveled
 time in lead/on task
 resistance encountered
 troop doctrine
 past behavior/actions
 religious/political beliefs
 friendly field of observation
 friendly field of fire
 enemy LP/OP locations
 supply level
 re-supply access
 weapons characteristics
 Specifics of pre-planned fires
 Confidence in intelligence information
 communication plan
 reliability of comm channel
 information to communicate
 areas of poor communication
 handling of casualties
 medical facilities/personnel
 evacuation plan
 number of casualties
 severity of casualties
 commo call signs and frequencies
 equipment
 technologies available (NVG, laser, etc)
 vehicles
 skills
 training
 experience
 reliability
 fatigue
 location
 dispersion
 numbers
 weapons
 ammo/supplies
 Range to other troops
 direction to other troop
 timing of fires
 fires calling procedure
 location of fires
 troop movement

TERRAIN

Projected impact of terrain
 Effects of terrain on communications
 Estimated time required for movement
 Projected safety of routes
 Projected physical requirements of route
 Projected mental requirements of route
 cover & concealment
 area of operations
 type of terrain
 routes of ingress & egress
 fortifications
 day/night
 features
 high ground
 construction type
 conditions
 building accessibility
 building usage
 mechanical entry points
 explosive entry points
 rubble
 mud
 booby traps
 areas of damage
 severity of damage
 light level available
 building vantage points
 windows
 doorways
 rooftops
 vegetation
 obstacles
 buildings
 size/type of room
 activities in adjacent rooms
 usage
 mass construction
 framed construction
 entry points
 vantage points

WEATHER CONDITIONS

projected effects of weather
 temperature
 precipitation
 wind
 direction
 speed
 light levels
 visibility
 ambient noise

TIME CONSIDERATIONS

Projected time to objective
 Projected difficulty of task
 Projected time to cover & concealment
 Time constraints
 time available
 time required for task/movement

DANGER AREAS

Projected areas of enemy attack
 Projected areas of enemy detection
 roads
 streams
 open areas
 railroad tracks
 corridors
 stairwells
 windows
 doorways
 funnel areas

Figure 4. SA requirements for Infantry platoon leaders in a MOU mission.

Phase 2: Situation Awareness Measures Development

This project endeavored to develop both objective and subjective measures of SA to investigate SA for the Infantry platoon leader. Based on the results of the SA requirements analysis, three instruments were developed to measure SA during Infantry platoon leader operations: SAGAT, the Situation Awareness Behaviorally Anchored Rating Scale (SABARS), and the Post-Trial Participant Subjective SA Questionnaire (PSAQ).

Situation Awareness Global Assessment Technique (SAGAT)

The Infantry platoon leader version of SAGAT utilizes a customizable PC-based computer program which presents officers with the same 21 standard queries which are designed to assess all three levels of SA (perception, comprehension, and projection). The queries are presented at discrete points in time during simulated missions. Queries address major SA elements such as location of strongest and weakest enemies and friendlies, number of casualties suffered by the officer's platoon, and expected enemy and civilian actions over the next five minutes.

SAGAT questions were developed by examination of the SA requirements list. Queries were selected based on several criteria:

1. The query must be answerable at any time during the mission,
2. It must have a right or wrong answer,
3. Participants must be able to easily respond to the question (Yes-No, Multiple Choice type queries),
4. Queries must address SA elements, not strategies and decisions which build from SA,
5. Questions must cover all three levels of SA, perception, comprehension and projection.

The SAGAT queries were selected to cover the broadest range of SA requirements possible, across the multiple goal areas that were assessable in the simulation environment. An objective was to create the minimum number of queries that would cover the full range of information requirements. The queries were developed to assess SA at a reportable level that could be scored as correct or incorrect based on simulator or SME input. The queries were reviewed by the SMEs for understandability and appropriateness, and revisions were made accordingly.

This process resulted in 21 questions. Table 1 contains a complete listing of SAGAT queries, along with the available responses. (Eight of the items were not administered in the investigative portion of the study—Phase 3—due to limitations of the simulation or missions. Those items are marked with an asterisk in Table 1.) The SAGAT method permits flexible administration by allowing the test administrator to determine which questions to block, which questions to always show (in random order), and which questions to show in random order *after* those questions that are always presented. Each query was presented graphically on the monitor of a computer. The actual screen image for each query is shown in Appendix B, along with the written instructions.

Table 1

SAGAT Queries

	Query	Response Options
1	Indicate the location(s) of each element on the map.	Enemies, Enemy Heavy Weapons, Myself, Squad 1, Squad 2, Squad 3, Weapons Squad, Detached Troops, Other Friendlies, Civilians, Commander
2	Which enemy element is your highest level threat?	E1-20 (enemies), W1-20 (enemy heavy weapons)
3*	Can all the assigned squad tasks be accomplished within the time requirements?	Yes, No
4	Which enemy locations are the weakest?	E1-20 (enemies), W1-20 (enemy heavy weapons)
5	Which enemy locations are the strongest?	E1-20 (enemies), W1-20 (enemy heavy weapons)
6	Which friendly locations are the weakest?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
7	Which friendly locations are the strongest?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
8*	Will weather be an impact on operations?	Yes, No
9	Which friendly forces are currently exposed to enemy fire/attack?	M, Squad 1, Squad 2, Squad 3, W, D1-10, F1-10
10*	Is fatigue impacting on friendly troops?	Yes, No
11*	Which of the following supplies are insufficient for mission completion?	Water, Ammo, Food, Equipment, Troops, None
12	Does the enemy know the location of your platoon?	Yes, No
13*	Which of the following assets are available to support you?	Supporting fire, Smoke, NVG, Reinforcements, Emergency medical care, None
14*	Which troops are in locations that do NOT offer concealment?	Squad 1, Squad 2, Squad 3, Weapons Squad, Detached Troops, None
15*	Which troops are in locations that do NOT offer cover?	Squad 1, Squad 2, Squad 3, Weapons Squad, Detached Troops, None
16	How many casualties have you suffered?	0, 1, 2, 3, 4, 5, 6, 7, ..., 29, 30, >30
17	What do you expect the enemy to do in the next five minutes?	Attack, Nothing, Move positions, Defend, Retreat, Other
18	What do you expect civilians to do in the next five minutes?	Become hostile, Riot/attack, Form a crowd, Disperse, Nothing, Move positions, Get in the way, Other
19	Who has the advantage in the current situation?	Friendly troops, Enemy troops, Friendly and Enemy troops equal
20*	For which friendly element are plans not being executed as per orders?	Squad 1, Squad 2, Squad 3, Weapons Squad, Other Platoons, Supporting units, None
21	Which friendly elements are NOT in communication with you?	Squad 1, Squad 2, Squad 3, Weapons Squad, Other Platoons, Supporting units, None

* Not used in the soldier-in-the-loop investigation, Phase 3 of this study.

Figure 5 shows the first query always presented to the participant and the foundation for all subsequent queries that showed cartographic data. For this first item, participants identified the locations of friendly, enemy and civilian elements on a map of the virtual environment. Small color-coded icons appeared in a panel on the right side of the screen and participants used a standard drag-and-drop technique to place items on the map or to move them from one location to another once they have been “dropped” onto the map. Some elements permitted the creation of multiple reports, such as Enemies, Enemy Heavy Weapons, Adjacent/Other Friendly Troops, Detached Troops and Civilians. Icons for other elements were removed once they were placed

onto the map. The participant was only allowed to locate one Myself, Squad 1, Squad 2, Squad 3, Weapons Squad, and Commander. When the participant was satisfied that he had placed all elements onto the map in their correct location, he selected "Done" in the bottom right hand corner, and the next query was presented. All subsequent queries were presented in random order, to prevent participants from anticipating the queries and thus "preparing" for the SA assessment by paying special attention to those elements covered in the SAGAT queries. (Note: If this type of selective attention process had occurred, officers would be expected to perform better on later halts than on earlier halts. The data analysis showed no such trend.)

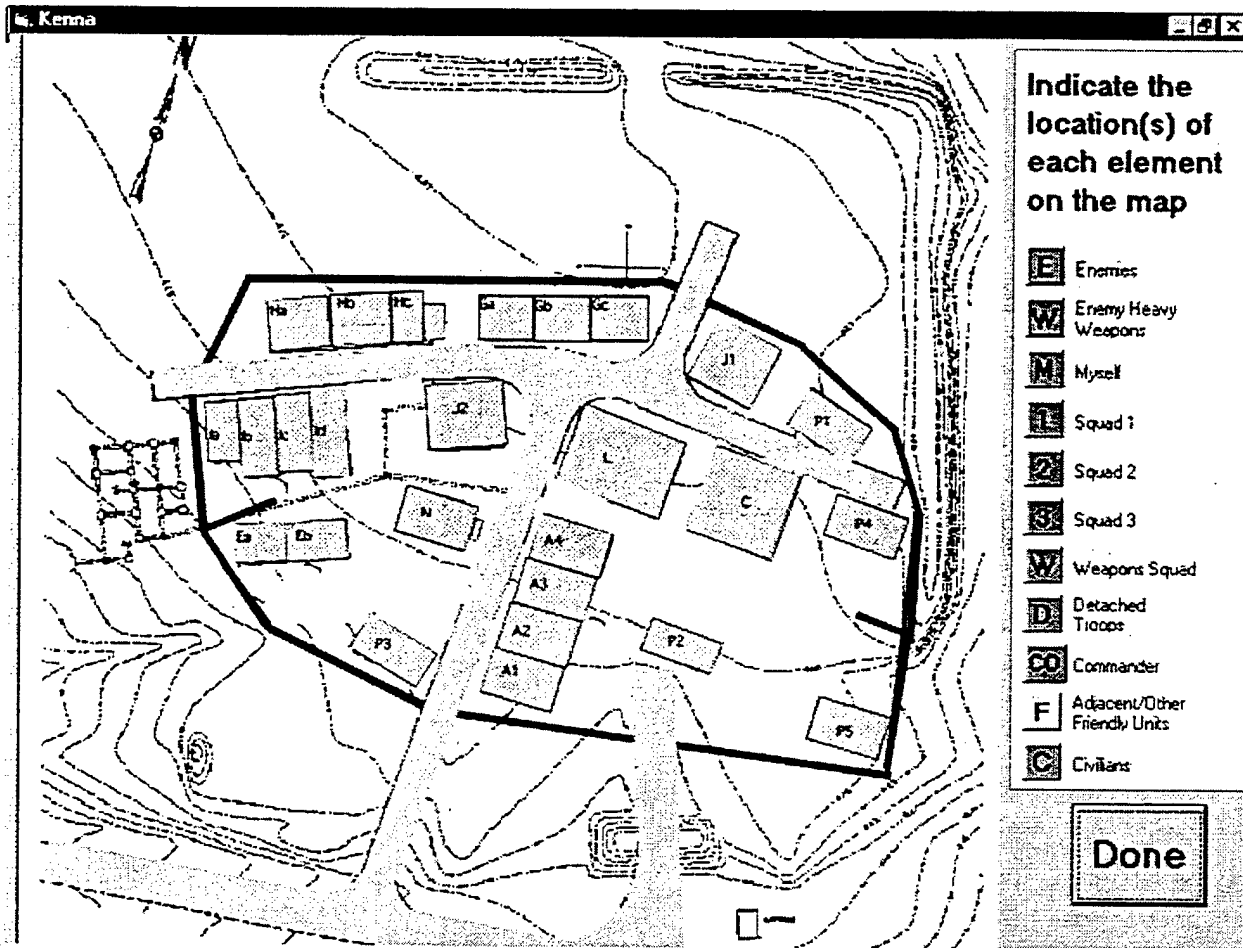


Figure 5. SAGAT query 1.

Situation Awareness Behaviorally Anchored Rating Scale (SABARS)

The SABARS measures consisted of 28 questions selected from the question pool developed during Phase 1 and judged by an SME familiar with all aspects of the project to have relevance for the SSE simulation. The final questionnaire was reviewed by all six SMEs for understandability and revised as needed. The SABARS items elicited ratings from an independent Observer/Controller (O/C) on how well the platoon leader exhibited behaviors consistent with acquiring and disseminating SA information during the exercise. Since SA

actually refers to an individual's internal representations of elements in the environment (perceptions, comprehension, and projections), it is important to note that the SABARs measure does not rate actual SA, but rather outward actions that indicate a greater likelihood of good internal representations. While behaviors can be an important indicator of mental processes, they can also be misleading.

The O/C's subjective rating of the participant's SA-related behaviors was assessed using items such as "*Solicits information from squad leaders,*" "*Communicates key information to commander,*" "*Asks for pertinent intelligence information,*" "*Identifies critical mission tasks to squad leaders,*" and "*Assesses key finds and unusual events.*" The quality of the behaviors were rated on a five-point scale ranging from 1 = "Very Poor" to 5 = "Very Good," with intermediate ratings of "Poor," "Borderline," and "Good." An additional response of "Not Applicable" was added to the scale for behaviors that were either not demonstrated or could not be assessed from the scenario. The SABARS instrument is shown in Appendix C.

Post-Trial Participant Subjective Situation Awareness Questionnaire (PSAQ)

The PSAQ instrument (presented in Appendix D) consisted of three items designed to elicit the participant's subjective ratings for:

- workload—how hard the officer worked during the scenario,
- performance—how well the officer performed during the scenario, and
- self-perceived SA—how aware the officer was of the evolving situation.

These items were rated on a five-point scale. For workload, a rating of 1 meant that the officer was not working hard, while 5 meant he was working extremely hard. For performance, a low rating reflected poor performance, while a high rating reflected extremely good performance. A rating of 1 on SA indicated that the officer was not aware of the evolving situation, while a rating of 5 indicated the officer was completely aware of the evolving situation.

Phase 3: Soldier-in-the-Loop Investigation

Conducted in an immersive virtual simulation environment, the purpose of the third phase of the study was four-fold: (a) examine the suitability of the SA instruments developed during Phase 2; (b) explore how experienced officers might differ from inexperienced officers in terms of SA; (c) explore the effects of different scenarios and measurement halts on SA; and (d) examine the interrelationships among the various SA measures used.

Method

Participants

Fourteen officers (13 Infantry and one Armor) participated in the investigation. The average age of the seven lieutenants was 23.7 years. For the captains, the average age was 27.9 years. Time in service ranged from 11 to 83 months for lieutenants and 49 to 133 months for captains. All captains had served as platoon leaders while none of the lieutenants had served in that position. All officers were Airborne qualified and four from each group had completed

Ranger school. Six lieutenants and three captains had engaged in training exercises at the McKenna MOUT site at Fort Benning, but only one officer had ever been in an SSE simulator like that used in this experiment (Pleban, Eakin, Salter, & Matthews, 2001).

Materials

Biographical Information Questionnaire. The Biographical Information Questionnaire (presented in Appendix E) was a paper-and-pencil instrument designed to elicit general biographical information from the participant such as age, prior military experience and training.

SAGAT. A laptop computer was used to administer SAGAT during three halts in each of two scenarios: Assault and Defend. Queries were presented either until the participant completed the full battery, or until 4 minutes had elapsed, whichever came first, at which time the platoon leader returned to the combat simulation. Of the 21 queries in the SAGAT battery, 13 were deemed appropriate for the scenarios used and the capabilities of the SSE (see Table 1, where the omitted items are denoted by asterisks).

SABARS. Immediately following completion of each of the four scenarios, the O/C, a retired Infantry officer, completed a SABARS rating form based on the participant's behaviors. It should be noted here that eight items were removed from the analysis due to a large number of "Not Applicable" ratings. These eight items are marked with an asterisk in the SABARS rating form found in Appendix C.

PSAQ. The PSAQ was administered at the conclusion of each of the four scenarios, and participants rated each item along a five-point scale. Response categories varied for each question (see Appendix D). Officer comments were solicited at the end of each item.

Small Unit Leader Decision-Making Scenarios

Scenarios were set in a small European-style town, a virtual representation of the McKenna MOUT training site at Fort Benning, Georgia. Infantry SMEs developed six possible scenarios; four were selected for the variety and training value provided. The four scenarios were Assault, Defend, SASO and Secure Village/Downed Helicopter. In each scenario, between four and seven decision points occurred, where specific decision-making actions were expected, e.g., notify commander of movement, determine status of injured soldiers, warn troops against firing on civilians. Each platoon leader participant completed all four scenarios, but only the Defend and Assault scenarios were used for SAGAT measurements. See Appendices F and G for flow charts delineating the action sequence and decision points for each SAGAT scenario.

Simulated scenarios focused on the interactions between the participant, who filled the role of platoon leader, and his Commanding Officer (CO), three squad leaders, and platoon sergeant. Scenario developers presented cognitively challenging simulations through the use of severe time constraints, realistic and complex situations, incomplete or uncertain information, and multiple decisions. A wide variety of events were utilized, e.g., sniper fire, injured soldiers/civilians, NBC (Nuclear, Biological, and Chemical) threat, death of CO. Scenario

instructions required minimal movement from the participants to maintain the focus on the decision-making aspects of the scenarios.

Simulation Environment

Three full-immersion SSE simulators from the Dismounted Battlespace Battle Lab's Land Warrior Test Bed at Fort Benning, Georgia, were employed; one for the platoon leader and two for role-playing squad leaders. The CO used a joystick-controlled desktop version of the SSE immersible system. Each SSE simulator consisted of an enclosure with black, sound-dampening fabric on three sides and a 9-ft by 8-ft projection screen as the fourth wall. The enclosures reduced extraneous light and minimized distractions from outside sources. One side of the rear panel fabric in the participant's enclosure was tied back to permit observation by those recording the results of the research. Using a communication system similar to those used in the field, participants were able to communicate with squad leaders, the CO, and the platoon sergeant. For a more complete description of the SSE simulation, see Pleban et al. (2001).

Procedure

Each individual platoon leader participated in the simulation on one day. The order of participants (experienced vs inexperienced platoon leaders) was alternated across days, to guard against any confounding effects of improvements in training processes or trainers over successive days. (For a more complete description of the procedures used, see Pleban et al. (2001).)

Participant training. A different participant served as platoon leader each day. The participant arrived early in the morning for an initial briefing on the research objectives. After completion of the Biographical Information Questionnaire, the SAGAT test administrator presented the participant with written instructions on the SAGAT procedures (Appendix B), then led the participant through a trial SAGAT run on the laptop computer.

Following SAGAT training, the participant entered the simulator for a brief training session, with instruction on some of the key features. In addition, he was shown how various entities were depicted in the virtual environment, i.e., enemies, civilians, and vehicles.

Experimental procedure. At the completion of training, the participant received written personal profiles of the CO, the three squad leaders, and the platoon sergeant. These profiles provided cues to guide the platoon leader in determining which squads to deploy to meet various mission objectives. The role-player CO then met with the platoon leader for a mission briefing, followed by the opportunity for questions and 10-15 minutes to develop a plan before briefing the squad leaders and platoon sergeant on the plan. At this time, the platoon leader and role-players proceeded to their assigned positions, performed system checks, and began the exercise.

Participants encountered either the SASO or Downed Helicopter/Secure Village scenario first, as the pre-test condition, followed by Assault, then Defend, then and the remaining scenario. During each scenario, a researcher recorded data regarding the decisions made by the platoon leader while the O/C supplied limited direction to the participant as needed. If the

participant failed to perform key actions, he was prompted accordingly. At the conclusion of each scenario, the O/C provided feedback to the participant on actions not performed or incorrect information relayed. Next, the participant completed the PSAQ while the O/C completed the SABARS instrument. Each scenario ended with an After Action Review (AAR) guided by the CO.

SAGAT. Administration of SAGAT occurred during the Assault (2nd) and Defend (3rd) scenarios. When the action was halted at three predetermined halt points in each scenario, the SAGAT administrator wheeled a cart holding a laptop computer over to the participant. Each SAGAT session lasted a maximum of 4 minutes, less if the participant completed the questions before the allotted time expired. The timer began as soon as the participant clicked the "Start" button (see Appendix B). For identification purposes, the participant's name along with the scenario and halt number were displayed at the top of the start screen. Query 1, asking the participant to locate all elements on a map, was always presented first. After the participant completed locating elements on the map, subsequent queries were presented in random order. While the participant completed the SAGAT queries, the role-player CO completed a paper and pencil version of the SAGAT queries which was then used to score the participant's responses. At the conclusion of each SAGAT halt, the laptop was removed and the simulation resumed exactly where it had been halted.

Responses for each question were captured in a data file by the SAGAT program. Separate files were created for each participant and each SAGAT Scenario. A technical problem resulted in loss of data for the first participant in the Assault Scenario. Each line of data in the file contained the participant number, scenario, trial number, halt number, query number, and the participant's response.

The SAGAT program stored X and Y coordinates for each element in Query 1 along with a unique label identifying the item. For example, the fifth enemy location identified would be labeled E5. Another program read these coordinates from the data file and positioned the elements on a map. This map was used to score both location data and subsequent questions about the relative strength and weakness of friendly and enemy troops. For an example of a completed map, see Figure 6.

To score location data, the participant-generated map was compared with (a) a screen shot from the simulation's Plan View Display showing the actual locations of the computer-generated squads engaged in the exercise, (b) the key provided by the CO, and (c) the briefing materials given to participant before each scenario. Analysis was limited by the fact that enemies and adjacent friendly platoons were not actually depicted by the computer simulation, so they had no physical location in the virtual world even though the results of their actions were seen and heard by the participant. As a result, some latitude was allowed in the identification of correct locations for these elements of the simulation, giving the benefit of the doubt to the participant. Missing data were omitted from the analyses.

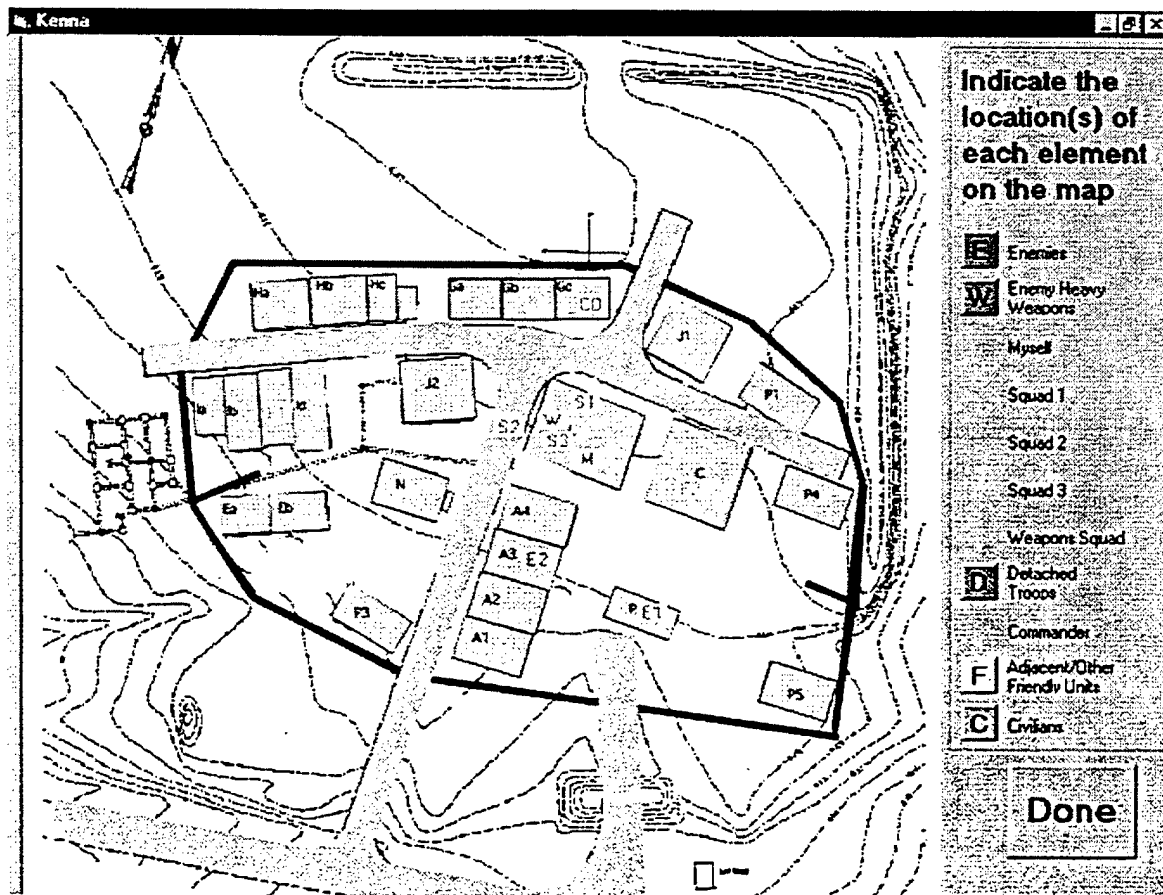


Figure 6. SAGAT query 1 showing elements located on the map by a participant.

Results

The various SA measures were examined to determine the impact of Experience Level and Scenario Type on platoon leader SA during the exercises. The results for each SA measure are presented separately. Subsequently, the relationship among the SA measures is discussed.

Objective Ratings of Situation Awareness

The platoon leader's responses to each SAGAT query were compared to the actual state of the environment at the time of the halt as recorded by the simulation computer and the trained SME/observer. This process provided an accuracy score for each query. The first query provided during each halt asked participants to report on the location of their own platoon elements, adjacent friendly elements, and enemy elements. Due to the highly scripted nature of the scenarios and the timing of the halts, adjacent friendly units and enemy elements occupied consistent locations for a given scenario and halt for all study participants. Thus, if a sniper fired shots from building P-2 during the Assault scenario for the first participant, he did the same for every other participant. This facilitated identification of the number of items that participants should have located on the map for a given halt. The percentages of elements that participants correctly located in each of these three categories (own, adjacent, and enemy elements), along

with the total percentage of correctly identified elements, were calculated. Accuracy for the remaining queries was calculated, based on the data collected from the simulator computer and the SME/observer.

The accuracy scores for each SAGAT query type were analyzed via Analysis of Variance (ANOVA) to determine whether they displayed sensitivity to differences in Experience, Scenario, and Halt Number, and the interactions among these variables. (An arc tan transformation was applied to the SAGAT scores prior to analysis in order to meet the assumptions of homogeneity of variance.) An overall SAGAT score was computed, however, past studies have shown that SA accuracy on individual queries is highly independent, leading a combined SAGAT measure to be insensitive (i.e., it tends to mask trade-offs in SA between different aspects of the situation). The results of this study were no different. As expected, the overall SAGAT score showed no significant relationship with Experience, Scenario or Halt Number. Therefore, each query was analyzed individually to determine sensitivity to experience, scenario and halt effects, and the interactions among them. Results of the ANOVAs for each SAGAT query type are shown in Appendix H (Tables H-1 through H-42), along with the means for each condition combination. Only the results of statistically significant differences ($\alpha = .05$) will be discussed.

Experience. Two of the four location items showed significant differences between experience levels. The more experienced participants were significantly better at locating both enemy troops ($p = .03$) and elements of their own platoon ($p = .03$) on the map. Three additional SAGAT queries exhibited significant differences for experience level, with more experienced officers better at identifying both the location of the strongest enemy ($p < .01$) and the location of the element posing the highest threat to their platoon ($p = .01$) than less experienced officers. Conversely, less experienced participants were better at identifying locations of the strongest friendly elements than more experienced officers ($p = .01$). Figure 7 shows these significant experience level differences. No other SAGAT queries produced significant differences between experience levels.

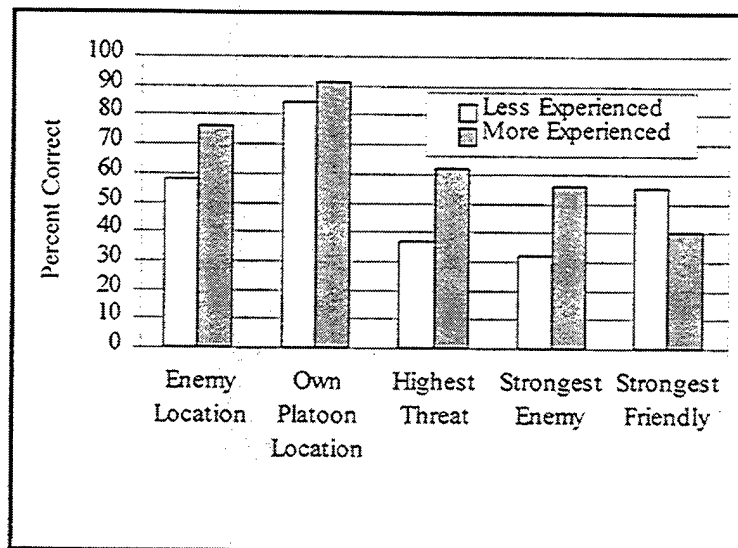


Figure 7. SAGAT mean scores by experience level.

Scenario. Several queries showed a significant effect for Scenario with participants scoring higher in the Assault scenario in identifying the strongest friendly element ($p < .001$), determining whether enemies knew the participant's location ($p = .02$), and the degree to which they predicted future enemy actions ($p < .001$). In addition, participants had higher SA in the Assault scenario regarding the locations of adjacent friendly units ($p < .01$) and total elements correctly located overall ($p < .001$). Higher SA scores were found in the Defend scenario for identifying the locations of the weakest enemy elements ($p < .001$) and exposed friendly elements ($p < .001$), and knowing the number of casualties suffered ($p < .001$). In the Defend scenario, however, no casualties were suffered at least until the third SAGAT halt, while in the Assault scenario, the officer's platoon suffered casualties even before the first SAGAT halt occurred. Similarly, there was no close or clearly defined threat until the third halt of the Defend scenario, and therefore no opportunity for friendly troops to be exposed to enemy fire. Thus, the number of casualties was zero and enemies did nothing for most of the Defend scenario, making those much easier questions to answer in this case. The observed differences may also reflect the fact that the Assault scenario always preceded the Defend scenario. Figure 8 depicts the significant differences between scenarios.

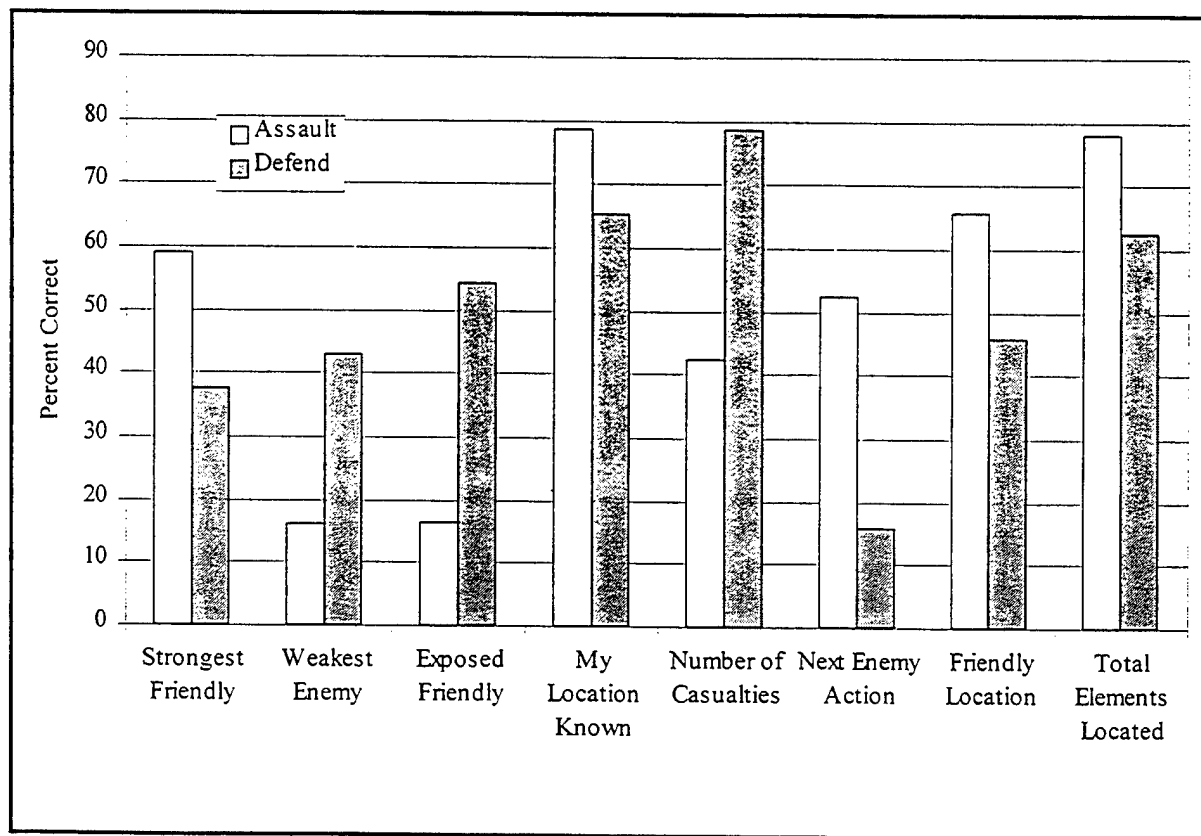


Figure 8. SAGAT mean scores by scenario.

Halt number. Three SAGAT queries showed a significant effect for SAGAT Halt Number: expected enemy actions ($p < .001$), expected civilian actions ($p < .01$), and own location known by enemy (see Figure 9). For these three queries, performance declined after the

first halt, possibly indicating that SA on these factors declined as the scenario progressed and pre-mission briefing information became more dated. It may also reflect the complexity and uncertainty that are characteristic of these missions. These results do discount the possibility that participants may have been preparing for the SAGAT queries, as they did not improve with practice, in agreement with previous research on this technique.

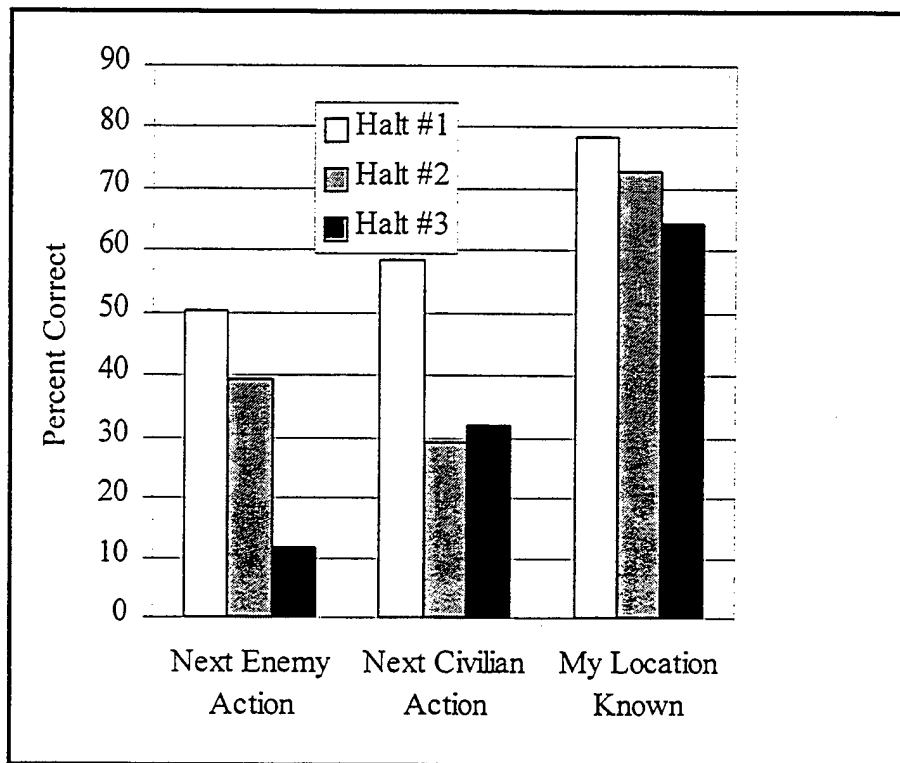


Figure 9. SAGAT mean scores by halt number.

Interaction Effects. Finally, four significant interactions were identified: a scenario by halt interaction for identification of strongest enemy ($p = .01$), own location known by enemy ($p = .04$), expected enemy actions ($p < .001$), and expected civilian actions ($p = .03$) (see Figure 10). Knowledge of the strongest enemy location improved over time in the Defend Scenario, while it declined over time in the Assault Scenario. For expected enemy actions, SA started out much higher in the Assault scenario than in the Defend scenario, possibly due to elapsed time from the pre-mission briefing. Knowledge of civilian actions started out higher in the Defend Scenario, but decreased more than in the Assault Scenario. Knowledge of whether the enemy was aware of the platoon location decreased at the end of the Defend Scenario, but not the Assault Scenario. These findings could also be an artifact of scenario structure, and must be viewed with caution.

There was one significant Experience Level by Scenario Interaction regarding knowledge of communications with friendly elements ($p = .02$) with experienced platoon leaders being more aware of this in the defend scenario than the assault scenario and novice platoon leaders showing the opposite pattern (see Figure 11).

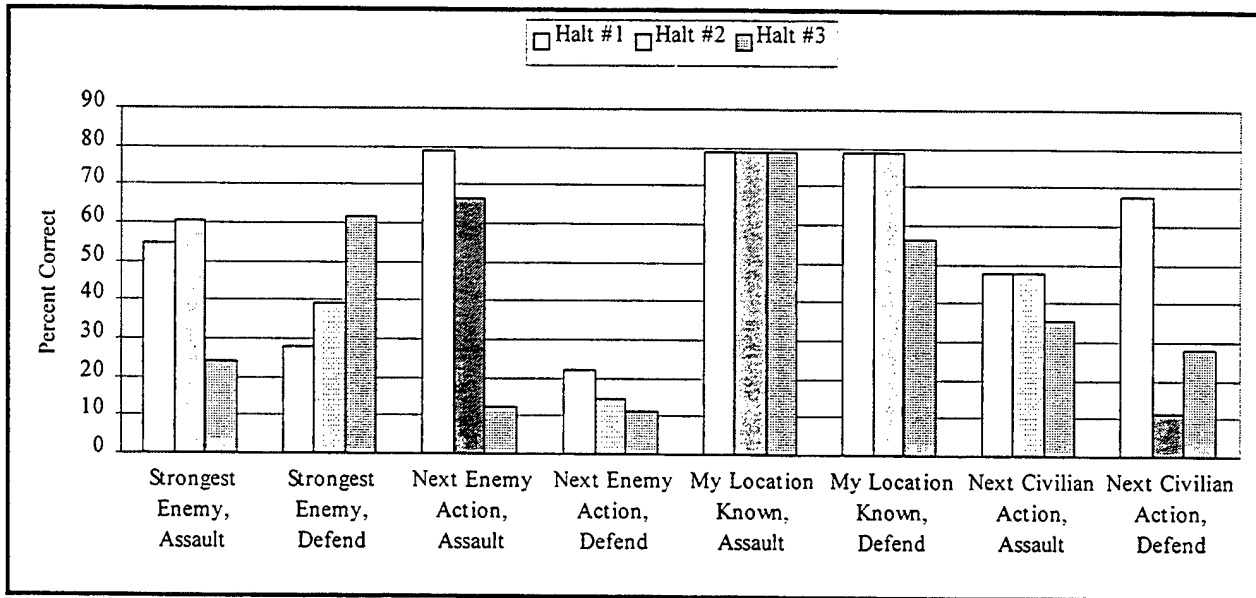


Figure 10. SAGAT mean scores—scenario by halt interactions.

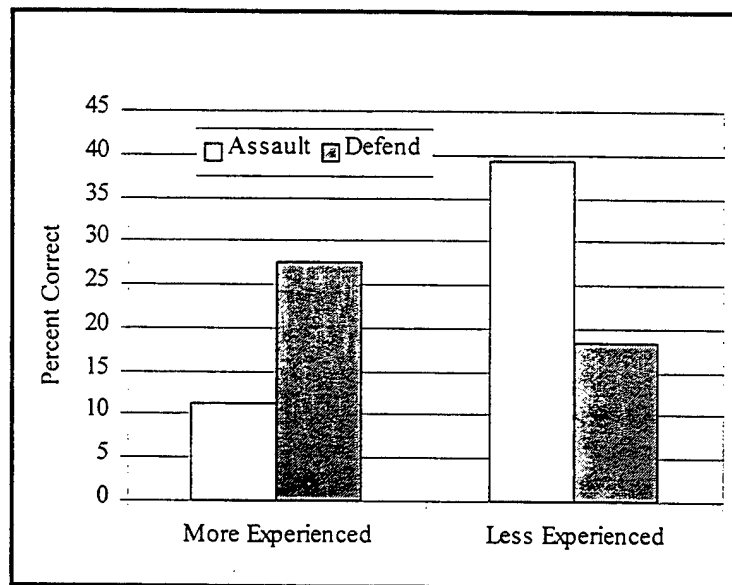


Figure 11. Knowledge of communications with friendly elements by experience level and scenario.

Subjective Observer Ratings of Situation Awareness on SABARS

Twenty SABARS items were completed by the O/C for each scenario. Scores for these items were subjected to a factor analysis. The analysis resulted in combining the 20 SABARS items into four factors (see Table H-33), which account for approximately 67% of the variance in

the items (see Table H-34). The factors are shown in Table 2. Two additional factors did not load heavily on any SABARS items and were of questionable value (contributing only an additional 12%). In view of the small sample size, those two factors were dropped from the analysis. It should be noted that many of the items were highly intercorrelated (Table H-35).

Table 2

SABARS Factors

Factor 1: Gathering Information and Following Procedures	Factor 2: Focusing Externally versus Internally	Factor 3: Proactively Seeking Key Information	Factor 4: Focusing on the Big Picture
<i>Uses assets to effectively assess environment</i>	<i>Identifies critical mission tasks to squad leaders (-)</i>	<i>Employs squads tactically to gather needed information</i>	<i>Communicates key information to squad leaders</i>
<i>Utilizes a standard reporting procedure</i>	<i>Solicits information from squad leaders(-)</i>	<i>Discerns key information from reports received</i>	<i>Communicates to squads overall situation and Commander's intent</i>
<i>Identifies OCOKA elements</i>	<i>Communicates key information to commander</i>	<i>Ensures avenues of approach are covered</i>	<i>Solicits information from commanders</i>
<i>Sets appropriate levels of alert</i>	<i>Gathers follow up information when needed</i>	<i>Locates self at vantage point to observe main effort</i>	<i>Monitors company net</i>
<i>Assesses information received</i>	<i>Asks for pertinent intelligence information</i>	<i>Assesses key finds and unusual events</i>	<i>Asks for pertinent intelligence information</i>
<i>Gathers follow up information when needed</i>	<i>Assesses key finds and unusual events</i>	<i>Overall situation awareness rating</i>	<i>Communicates key information to commander</i>
<i>Monitors company net</i>	<i>Discerns key information from reports received</i>	<i>Solicits information from commanders</i>	
<i>Overall situation awareness rating</i>		<i>Assesses information received</i>	
<i>Assesses key finds and unusual events</i>		<i>Identifies OCOKA elements</i>	

Note: Loadings are positive unless otherwise indicated by a negative sign.

Factor 1, with all positive factor loadings as seen in Table 2, is labeled Gathering Information/Following Procedures. The highest loadings for Factor 2 were in a negative direction for Identifies critical mission tasks to squad leaders, and Solicits information from squad leaders, leading experimenters to refer to this factor as Focusing Externally versus Internally, where Internally refers to the leader's platoon, and Externally refers to resources outside the platoon. Factor 3 is called Proactively Seeking Key Information because the information is actively sought and the focus is on key information. Factor 4, centered on communicating key information, is called Focusing on the Big Picture. Factor scores were computed based on the weighted combination of all items with a factor loading of higher than 0.30 on each factor.

These four SABARS factors were analyzed by ANOVA (Appendix H, Tables H-36 through 39) for all four scenarios to determine whether the behaviors differed significantly across Experience Level or Scenario, or if there was an Experience Level by Scenario

Interaction. The ANOVAs for the SABARS factor scores showed two significant effects. Factor 1—Gathering Information/Following Procedures—showed significant effect ($p = .05$) for Experience Level, with more experienced officers receiving higher scores, as shown in Figure 12.

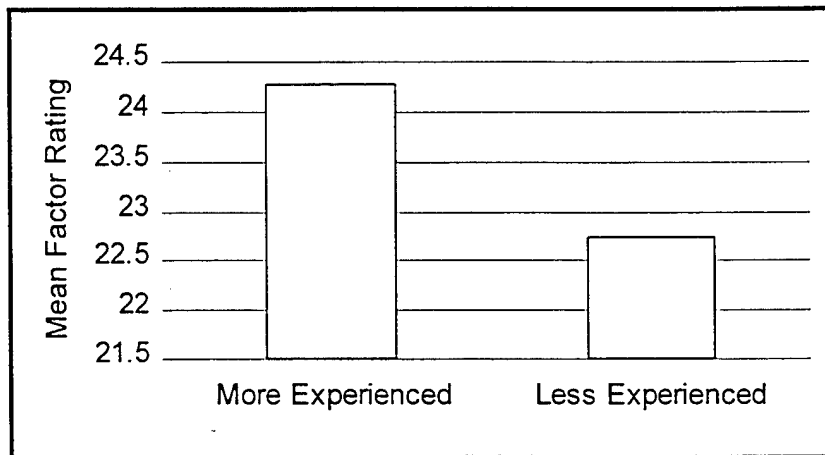


Figure 12. SABARS scores for gathering information/following procedures by experience level.

Factor 4—Focusing on the big picture also showed a significant effect ($p = .01$) for Experience Level, with more experienced officers receiving higher scores, as shown in Figure 13.

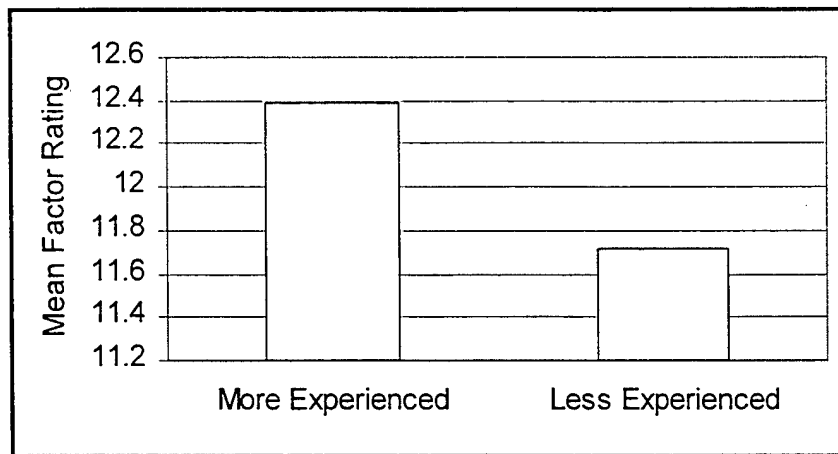


Table 13. SABARS scores for focusing on the big picture by experience level.

Subjective Self-Ratings of Situation Awareness

Participants' PSAQ ratings of Workload, Performance and SA were analyzed via ANOVA (Appendix H, Tables H-40 through 42) for all four scenarios, but no significant effects were found for Experience Level, Scenario or an Experience Level by Scenario Interaction.

Comparison of Situation Awareness Measures

Although SAGAT has been well validated in many studies in a variety of environments, the SABARS measure is a relatively new measure of SA. To determine whether the behaviors as rated on the SABARS questionnaire or the PSAQ self-ratings are predictive of the level of SA measured via SAGAT, step-wise regression analyses were conducted. With each of the SAGAT queries as dependent variables, regressions examined whether any of the SABARS or PSAQ measures predicted SAGAT performance (on the same scenarios for the same participant).

Generally none or only one item showed up in most of the regression models as being predictive of SA as measured by SAGAT. This may reflect low predictiveness of some of the SABARS measures, or that SABARS and SAGAT are tapping into unrelated aspects of SA. It may also reflect the small sample size of the investigation.

As shown in Table 3, SABARS factors and PSAQ measures accounted for a significant portion of the variance in five SAGAT queries. Factor 4, Focusing on the Big Picture, explains 31.1% of the variance in percentage of enemy locations correctly identified, while PSAQ Workload explains 15.1% of the variance in identifying the locations of adjacent friendly units. Factor 3, Seeking Key Information, accounts for 21.6% of the variance in identifying the location of the strongest friendly force. Two items, SABARS Factor 3, Seeking Key Information, and the PSAQ measure of SA explain 41.3% of the variance in the participants' ability to correctly identify the number of casualties suffered. Finally, PSAQ Workload comprises 22.9% of the variance in the degree to which participants were aware of which force had the advantage. Table 3 shows these significant relationships, with their associated F-values, probability values and the squared correlation (R^2) values, corresponding to the portion of variance in the dependent variable (SAGAT query) accounted for by the model (SABARS and PSAQ measures).

One caveat must be added here: some of these SA measures are highly inter-correlated. (See Table H-35, showing the correlation matrix for all SAGAT measures with significant correlations highlighted.) Inter-correlation of variables can have significant implications for the validity of the regression model (for example, only one of two highly correlated variables might be included). Further research is needed to confirm these results.

Table 3

Summary of SAGAT Regression Analysis with SABARS and PSAQ Ratings

SAGAT Query	Model	F-Value	P-Value	R ²
Enemy Locations	4-Big Picture Focus	11.293	0.003	0.311
Adjacent Friendly Locations	Self-Rated Workload	4.442	0.045	0.151
Strongest Friendly	3-Seeks Key Info	6.871	0.015	0.216
# Casualties	3-Seeks Key Info, Self-Rated SA	8.434	0.002	0.413
Advantage	Self-Rated Workload	7.429	0.012	0.229

Discussion

These findings from the soldier-in-the-loop investigation show an interesting effect of experience on platoon leader SA. While more experienced officers demonstrated superior Level 1 SA in identifying the locations of both their own troops and enemy troops—as would be expected, the more important story involves the subsequent cognitive processes—the transformation of the information into higher-level SA. More experienced officers identified the strongest enemy and the highest enemy threat with greater accuracy than officers with less experience, while less experienced officers demonstrated superior performance at identifying the strongest friendly elements. Thus, not only did experienced leaders demonstrate higher levels of SA on certain factors, as might be expected, but SA also proved qualitatively different with level of experience. That is, with increasing levels of experience, platoon leaders shift their focus from concentrating on friendly disposition to focusing more on enemy disposition. In support of this finding, Shattuck, Graham, Merlo and Hah (2000) conducted a card sort procedure in which they found that novices initially requested more information on friendlies than enemies, but experienced officers tended to prefer enemy information to friendly information. This shift in information attended to with the gaining of experience merits careful investigation. Training programs that teach new officers which information is most important, and how to assess and assimilate enemy information into their mental picture, may be warranted as the Army increasingly strives to develop more cost-effective methods for training new officers.

In addition to examining the SA of platoon leaders, this research represents an initial effort to systematically develop a SAGAT battery for Infantry operations. While the present research was not designed to validate the measures, per se, it provides a good indication of their sensitivity and utility for assessing SA in Infantry operations. The SAGAT measures showed good sensitivity to differences in platoon leader experience level and scenario and demonstrated how SA changed significantly over the course of the simulation exercises. Given that SA is a multi-dimensional construct, it is also important that SAGAT showed good diagnosticity in revealing the ways in which SA changed across experience levels and scenarios. Overall, the investigation indicates that further use and development of the SAGAT measure in Infantry exercises would be warranted.

The SABARS instrument represents an initial attempt to develop a subjective scale of situation assessment behaviors that might be useful for evaluating SA in Infantry operations. Ratings indicated that more experienced officers exhibited more behaviors related to Gathering Information and Following Procedures (Factor 1) than less experienced officers, as might be expected. Because the rater completing the SABARS questions knew which officers were experienced and which were not, however, it is possible that this merely reflected a halo effect.

Two SABARS factors, Proactively Seeking Key Information and Focusing on the Big Picture, were significantly predictive of the level of SA exhibited by the officers on several SAGAT queries. Behaviors associated with Focusing on the Big Picture accounted for almost one-third of the variance in the platoon leader's knowledge of enemy locations. Results indicating that more experienced officers focus greater attention on enemy disposition suggest that training new officers in the behaviors associated with Focusing on the Big Picture may be effective in increasing SA among less experienced officers. Proactively Seeking Key Information demonstrated significant predictive value for the officers' knowledge of the strongest friendly location and the number of own casualties.

It should be noted that this was an initial attempt to look at the utility of a measure such as SABARS. Since it was collected with only one rater, no analysis can be made of its reliability. In addition, only a small sample size was available in this research. Its results must therefore be caveated accordingly. More research is needed to assess both the reliability and validity of this measure.

Since this research was based on a small sample, it is difficult to say whether these findings will hold up to further investigation or whether additional relationships between the SABARS factors and the level of SA possessed by platoon leaders might exist. Therefore, no serious changes to SABARS are recommended at this time. Rather, these findings can only be taken to indicate a tentative level of utility for such a measure. Further research is needed to examine the SABARS scales with a larger test population and a wider range of scenarios and testing conditions. Also, it should be noted that the relationships found are modest, though significant. Research is needed to further determine significant sources of SA differences in addition to the behaviors incorporated on this scale. The PSAQ scales were not sensitive to the experience levels or scenarios used in this research.

While evidence for the sensitivity of global measures of self-rated SA and workload such as those used here has been mixed, PSAQ ratings did show some sensitivity in the present research. Self-rated SA was significantly related to the officers' knowledge of the number of casualties. Self-rated workload was significantly related to the officer's knowledge of the location of adjacent friendlies and which side had the advantage. Workload has been found to be significantly related to low SA in other domains, and under certain conditions can certainly be seen to be a problem for SA in Infantry operations.

Finally, as a part of this research, a significant effort was made to delineate the SA requirements of platoon leaders. This analysis should be seen as preliminary and should be further developed and validated with Infantry officers who are experienced in MOUT operations. In addition, similar analyses are needed for other Infantry missions and echelons. In addition to

providing the basis for the development of the SA measures used in this research, these analyses of goals, decisions and SA requirements are highly valuable in developing new technologies and training methods for improving SA in Infantry operations.

Pleban et al. (2001) present additional results of the soldier-in-the-loop investigation, to include decision-making performance and relationships between SA and decision-making.

Conclusions

In conclusion, an exploratory research effort to examine the degree to which SA could be measured in simulated MOUT missions was conducted. A battery of objective and subjective measures suitable for Infantry operations was developed, based on a detailed analysis of the platoon leader's situation awareness requirements, and tested. The results of this analysis demonstrate that these measures, particularly SAGAT, show good promise for measuring SA in future studies of Infantry operations. Other measures merit more testing and evolution.

It is important to remember that these data were obtained from scenarios run in a virtual environment designed for individual combatants. The results of this research effort provide support for the utility of such scenarios in both research and training exercises. Future research would benefit, however, from studies conducted in diverse locations, including actual field studies during training exercises at a training facility such as the McKenna MOUT site at Fort Benning. Although the difficulties of conducting research in such an environment are great, they are not insurmountable, and would provide important information regarding elements of the SA construct that are impossible to investigate at this time in the virtual environment.

Future studies also should continue to validate these measures of SA, specifically by looking for links between measures of performance or decision-making and measures of SA. Because SA is a multidimensional construct, it is reasonable to assume that multidimensional performance and decision-making measures will provide the most utility for comparison with measures of SA. Just as an overall SAGAT accuracy score fails to show effects for experience, comparison of specific SA measures to overall performance measures are likely to obscure relationships that may exist between SA and specific decisions or outcomes. Further work is needed to develop SA requirements for other Infantry positions, following the methods used here, and to develop SA measures to allow for research on SA at different echelons. Further research to refine and validate these SA measures is also needed.

References

- Bartlett, J., & Kaplan, J. (Eds.) (1992). Bartlett's familiar quotations, 16th edition. Boston: Little, Brown and Company.
- Christ, R. E., McKeever, K. J., & Huff, J. W. (1994). Collective training of multiple team organizational units: Influence of intra- and inter-team processes. In G. E. Bradley and H. W. Hendrick (Eds.), Human factors in organizational design and management-IV (pp. 323-326). Amsterdam: Elsevier.
- Endsley, M. R. (1988). Design and evaluation for situation awareness enhancement. In Proceedings of the Human Factors Society 32nd Annual Meeting (pp. 97-101). Santa Monica, CA: Human Factors Society.
- Endsley, M. R. (1990a). Predictive utility of an objective measure of situation awareness. In Proceedings of the Human Factors Society 34th Annual Meeting (pp. 41-45). Santa Monica, CA: Human Factors Society.
- Endsley, M. R. (1990b). Situation awareness in dynamic human decision making: Theory and measurement. Unpublished doctoral dissertation, University of Southern California, Los Angeles, CA.
- Endsley, M. R. (1993). A survey of situation awareness requirements in air-to-air combat fighters. International Journal of Aviation Psychology, 3(2), 157-168.
- Endsley, M. R. (1995). Measurement of situation awareness in dynamic systems. Human Factors, 37(1), 65-84.
- Endsley, M. R. (2000). Direct measurement of situation awareness: Validity and use of SAGAT. In M. R. Endsley and D. J. Garland (Eds.), Situation awareness analysis and measurement. Mahwah, NJ: LEA.
- Endsley, M. R., & Bolstad, C. A. (1994). Individual differences in pilot situation awareness. International Journal of Aviation Psychology, 4(3), 241-264.
- Endsley, M. R., Holder, L. D., Leibrecht, B. C., Garland, D. J., Wampler, R. L., & Matthews, M. D. (2000). Modeling and measuring situation awareness in the Infantry operational environment (ARI Research Report 1753). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Endsley, M. R., & Rodgers, M. D. (1994). Situation awareness information requirements for en route air traffic control (DOT/FAA/AM-94/27). Washington, DC: Federal Aviation Administration, Office of Aviation Medicine.

Endsley, M. R., & Selcon, S. J. (1997). Designing to aid decisions through situation awareness enhancement. In Proceedings of the 2nd Symposium on Situation Awareness in Tactical Aircraft (pp. 107-112). Patuxent River, MD: Naval Air Warfare Center.

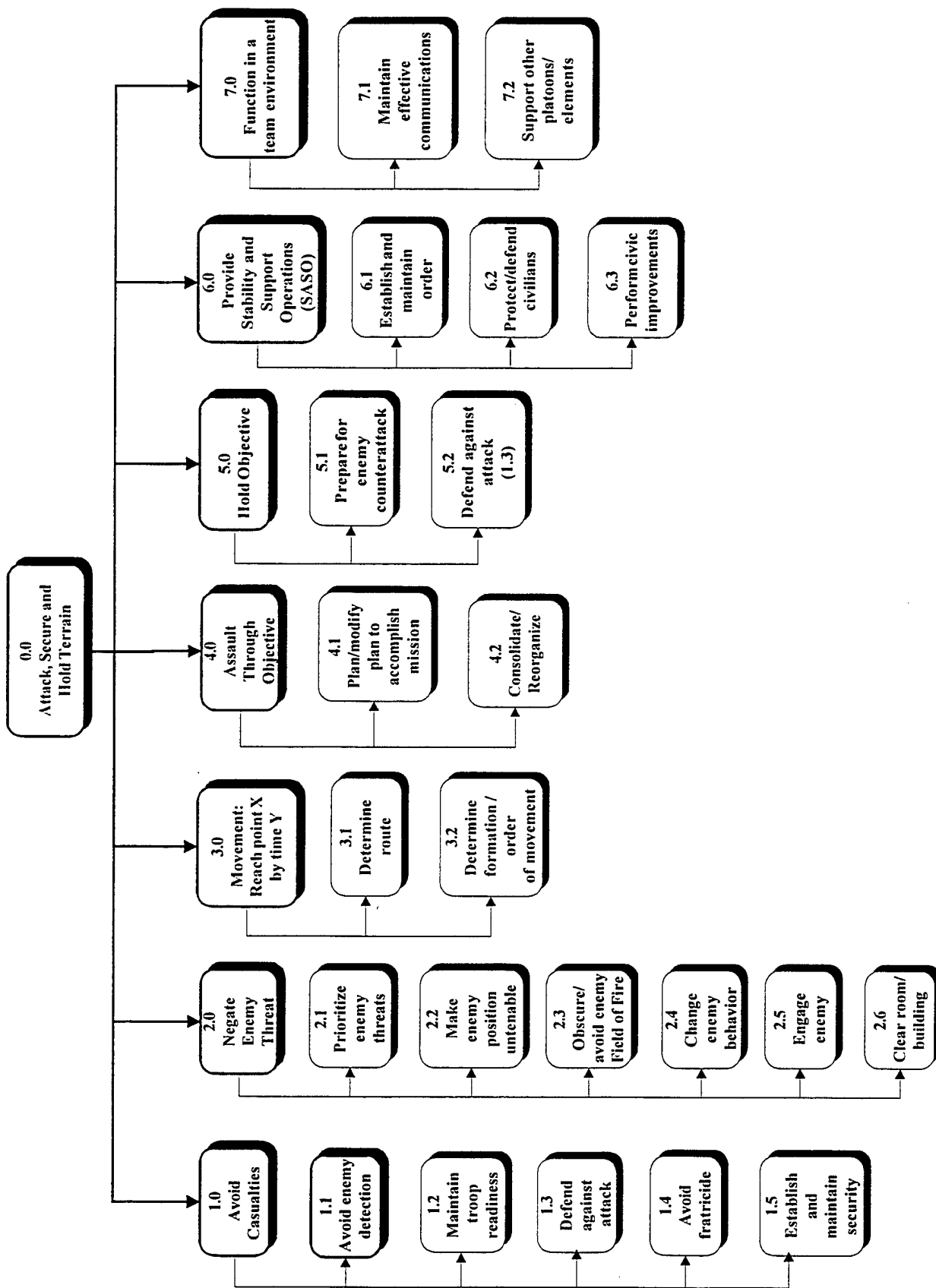
Pleban, R. J., Eakin, D. E., Salter, M. S., & Matthews, M. D. (2001). Training and assessment of decision-making skills in virtual environments. Manuscript in preparation. (ARI Research Report). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

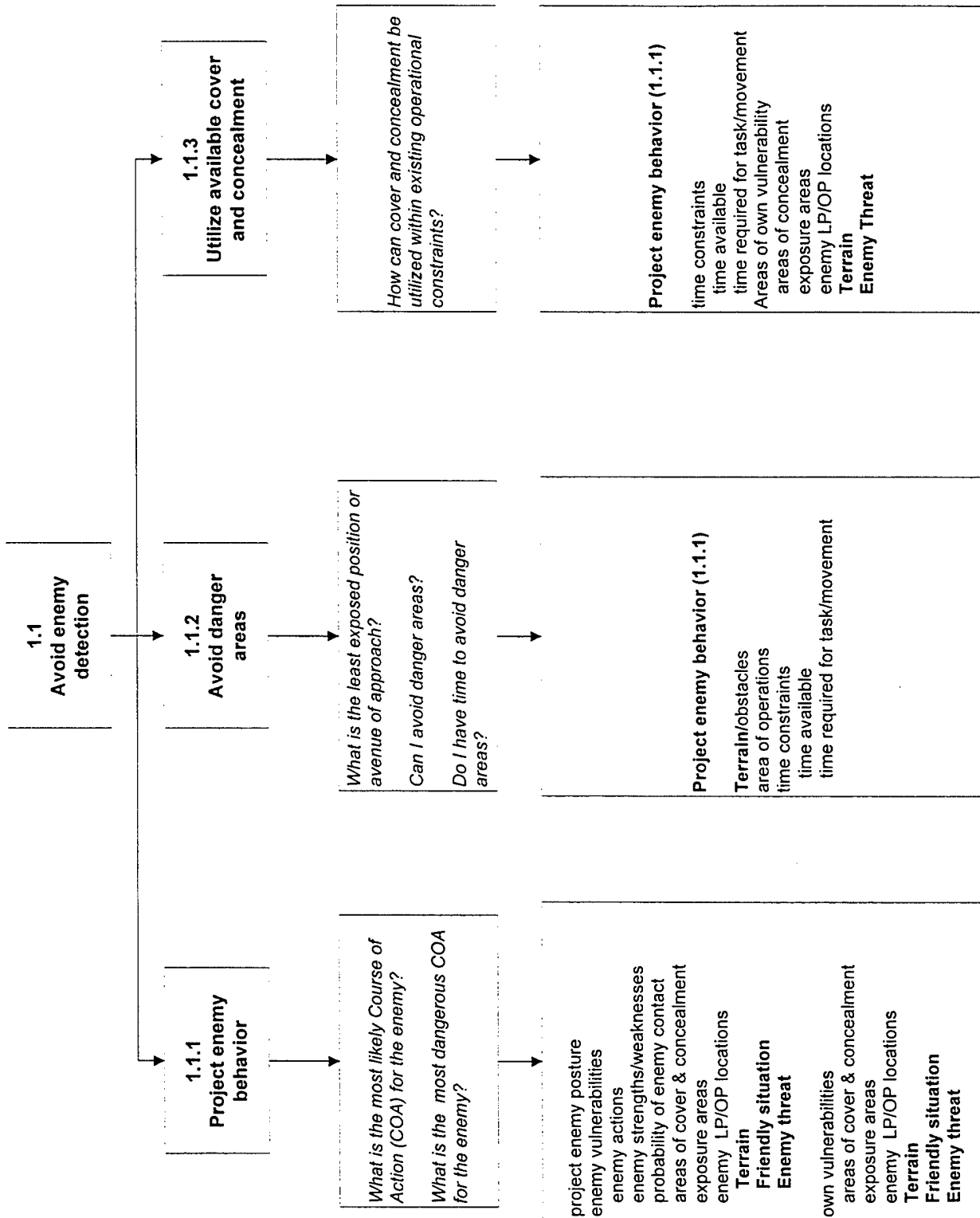
Shattuck, L., Graham, J., Merlo, J., & Hah, S. (2000). Cognitive Integration: An investigation of how expert and novice commanders process battlefield data. In M. E. Benedict (Ed.), Proceedings, Fourth Annual Federated Laboratory Symposium on Advanced Displays and Interactive Displays Consortium. Adelphi, MD: U.S. Army Research Laboratory.

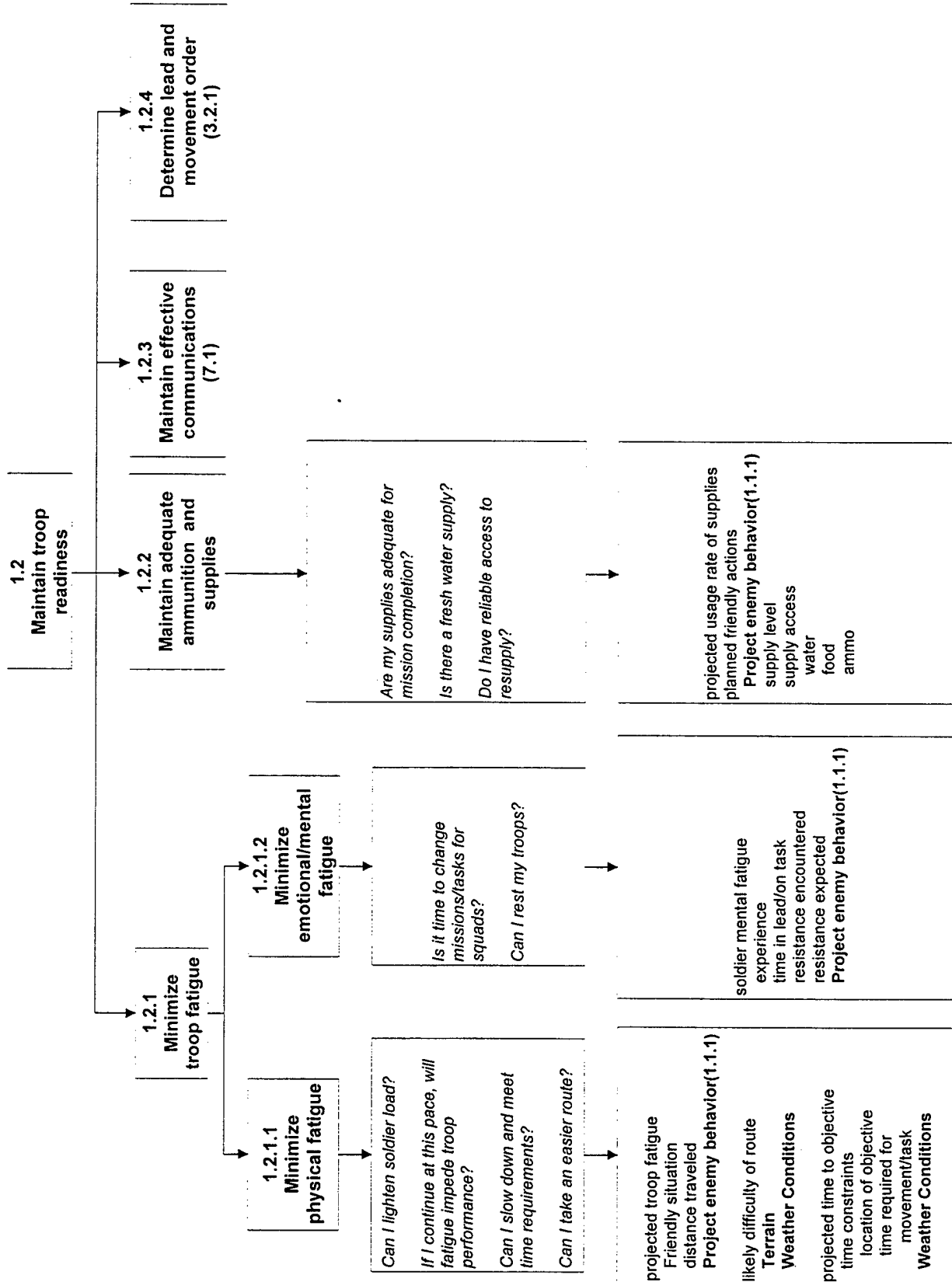
Appendix A: Detailed Results of the SA Requirements Analysis

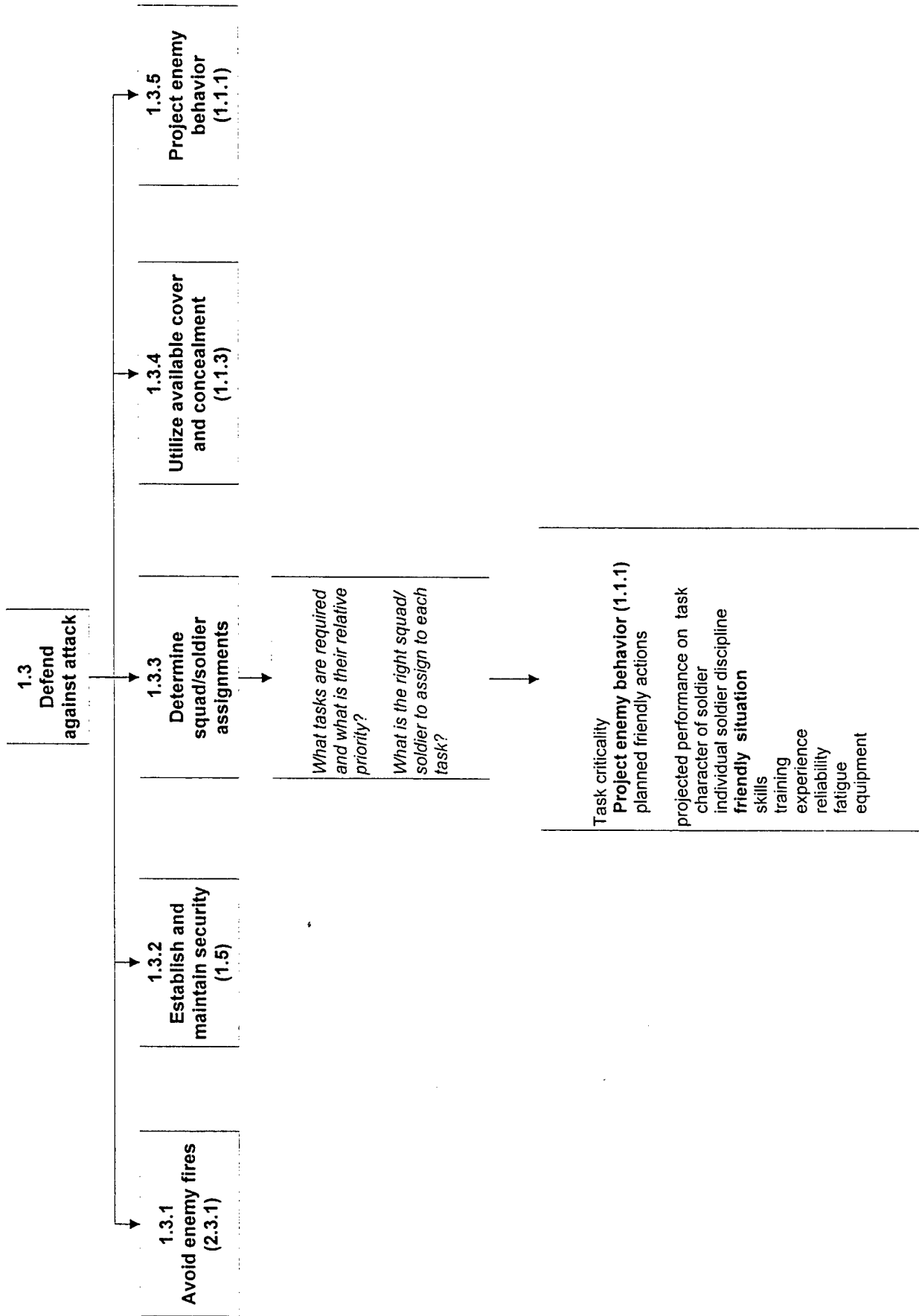
The chart shown on the following pages is the result of an SA Requirements Analysis for platoon leaders during a MOUT mission. The methods used to conduct this analysis and additional description of the results are given on pages 7 through 10 of the main report. The first page of the chart shows the hierarchical structure of the analysis, with Attack, Secure and Hold Terrain (0.0) as the overall objective. Seven primary goals, numbered 1.0 to 7.0, are listed beneath this objective, with secondary goals identified beneath each of the primary goals. These secondary goals share the whole number of the primary goal they fall below (i.e. items under goal 1.0 would be 1.1, 1.2, etc.). Subsequent pages each list one secondary goal with all subgoals commonly associated with the secondary goal. The final page of the requirements analysis shows six categories of SA needs, which SMEs identified as important in many situations. These are listed separately to avoid the redundancy of frequent repetition.

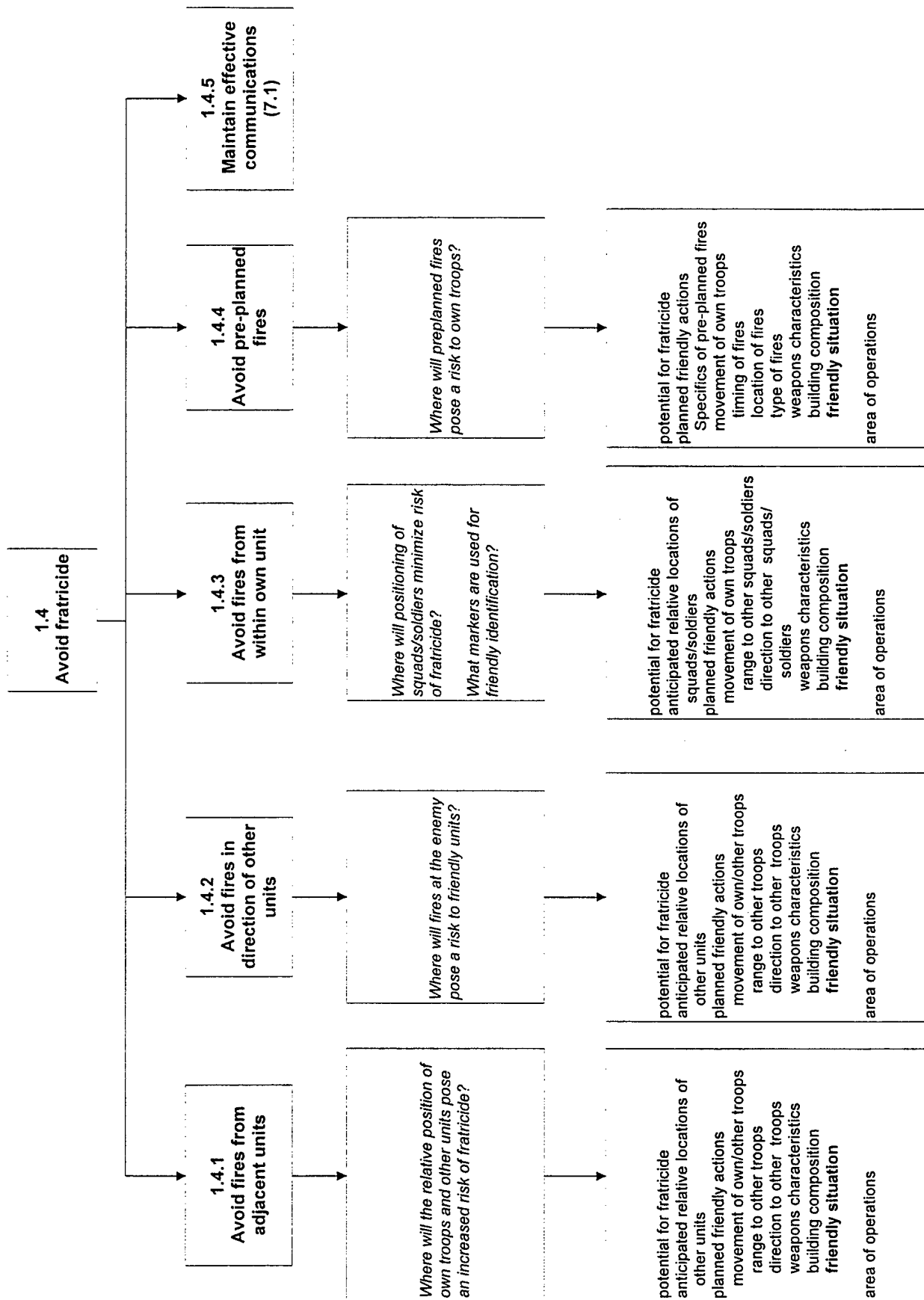
Each page that lists a secondary goal (A-3 to A-23) shows the secondary goal at the top of the page, with the subgoals listed directly beneath. Some subgoals are called into play in meeting more than one secondary goal. For brevity, subgoals that are listed under more than one secondary goal are only fully described in one location in the analysis. Where these subgoals are referred to on other pages, the subgoal number where the complete description can be found is shown in parentheses beneath the name of the subgoal. Below each subgoal is a box listing questions that platoon leaders might ask themselves to assist in meeting the subgoal. At the bottom of the page, beneath the questions, is a list of information that the platoon leader would like to have in order to answer the questions and meet the subgoal. Indentation of the SA information serves two functions: first as a general indicator of level of SA, with Level 3, projection, information flush against the left side of the box, Level 2, comprehension, information indented once, and Level 1, perception, information indented twice, and second to illustrate information that feeds into the higher level information processing required for the subgoal. Therefore, a Level 3 SA item could be indented once or even twice if it is used to develop another higher level comprehension or projection element more specific to the goal in question. In addition, items that are found in other portions of the requirements analysis are shown in bold. Therefore, items listed more completely in the categories on the final page of the analysis are shown in bold, as are references back to items listed under a different subgoal.











**1.5
Establish and
maintain security**

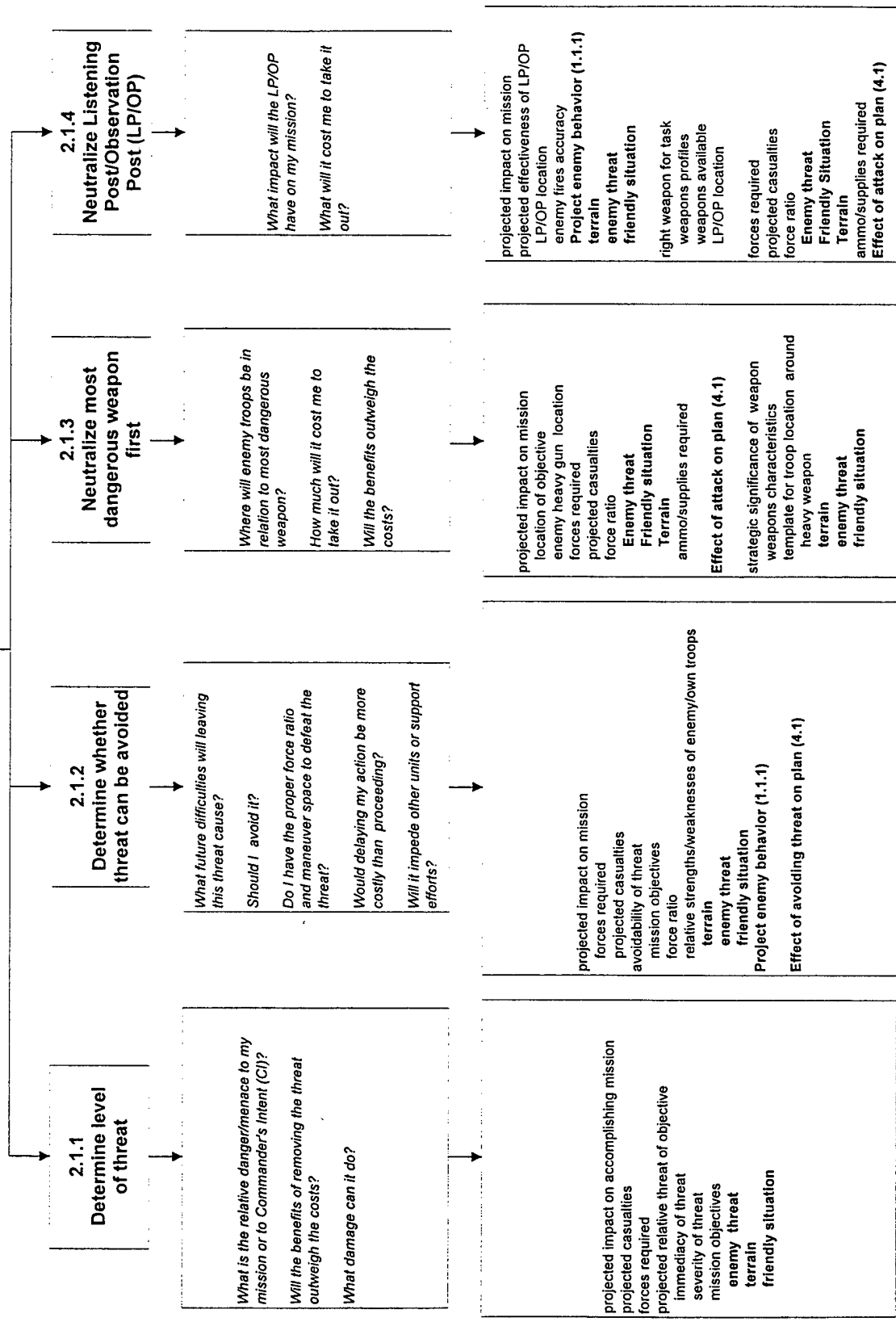


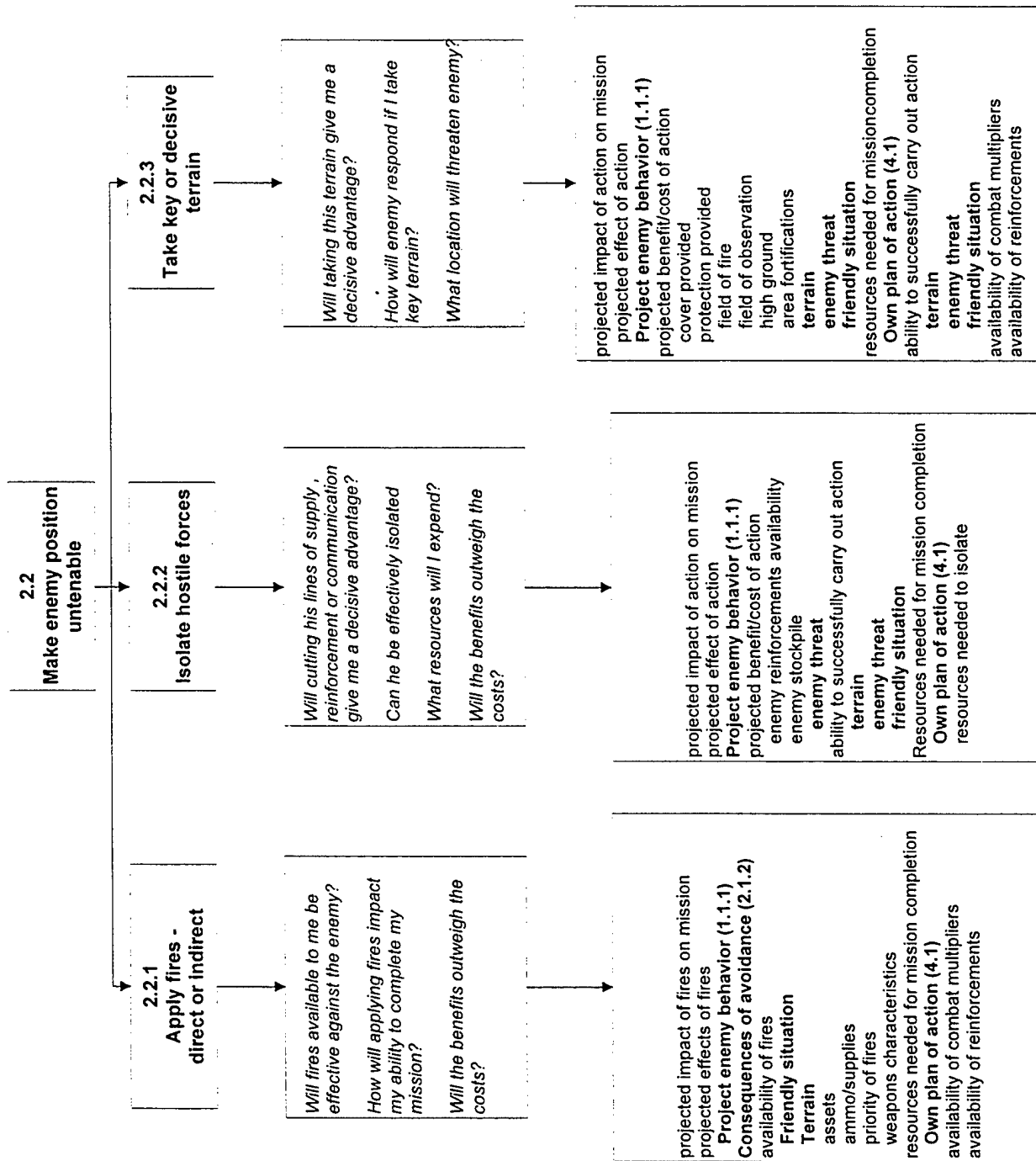
*Where should I establish
early warning means?*
*What movement technique
should I employ?*
*Where should I establish
security patrols and recon?*



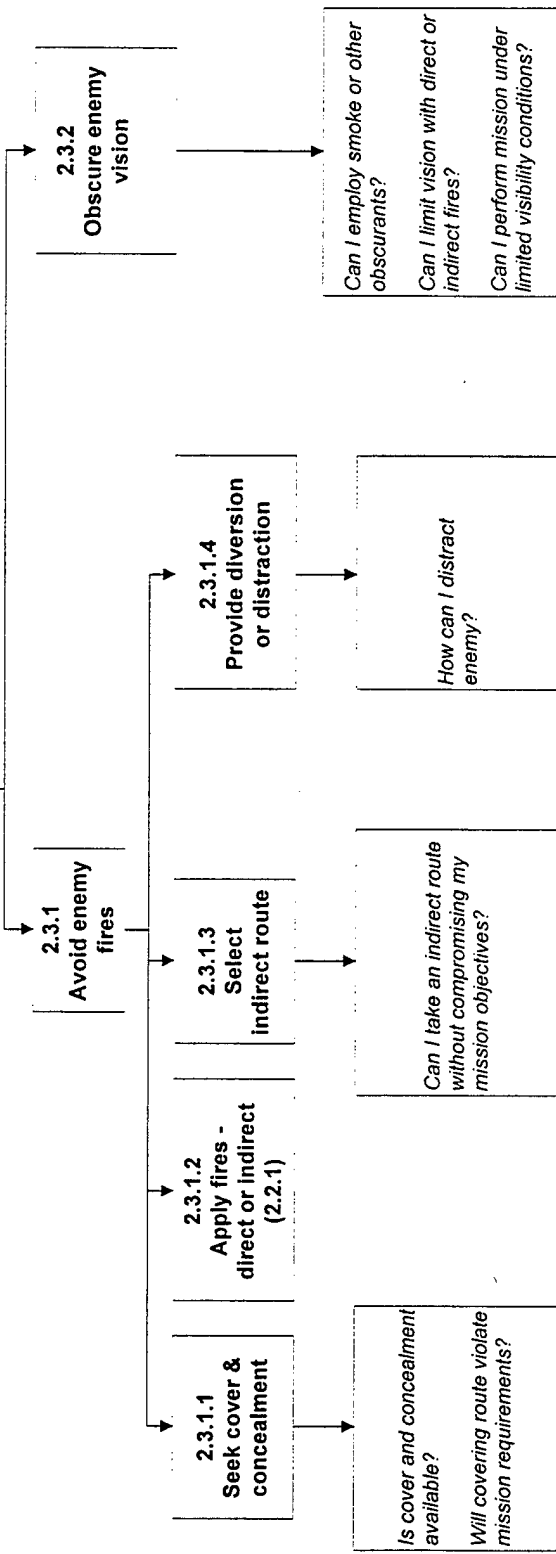
Project enemy behavior (1.1.1)
enemy strengths vs. weaknesses
enemy threat
confidence in intelligence information
own strengths vs. weaknesses
friendly situation
time constraints
time required for task

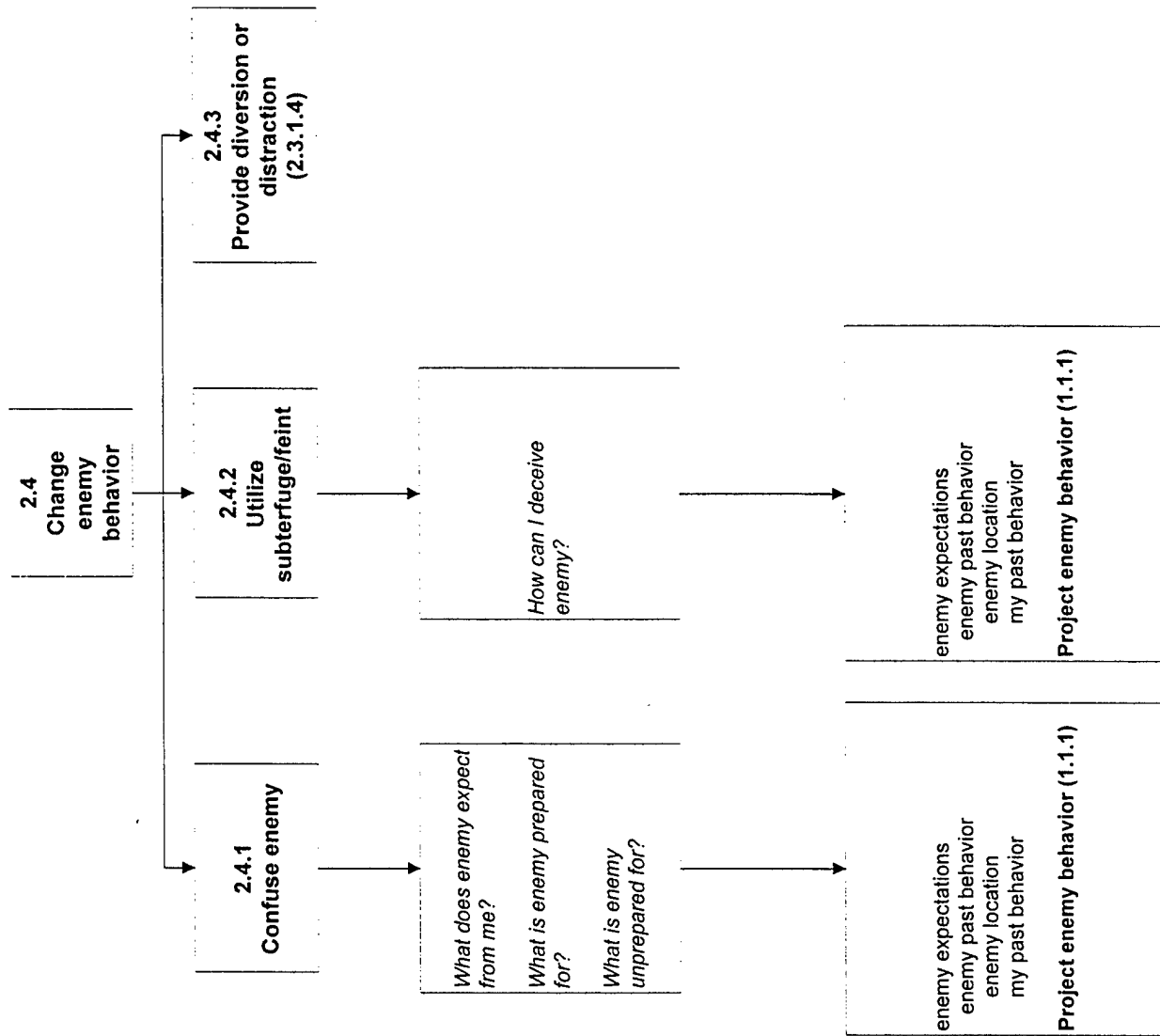
**2.1
Prioritize enemy threats**





**2.3
Obscure/avoid
enemy Field of Fire**





2.5

Engage enemy

How can I avoid his fires?

How can I get my maximum firepower to his weakest area?

What movement will create the least exposure?

projected effects on mission objectives

projected enemy casualties

projected civilian casualties

projected friendly casualties

projected outcome of engagement

likelihood of attack

projected enemy weak points/strengths

own weak points/strengths

projected combat readiness

projected element of surprise

holes in FOF and FOO

availability of combat multipliers

area where enemy can't engage

ability to reposition

time constraints

location of objective

Enemy threat

Friendly situation

Terrain

areas of cover

areas of concealment

Terrain

Project enemy behavior (1.1.1)

projected surprise available

time of day

enemy expectations

availability of combat multipliers

availability of reinforcements

2.6

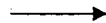
Clear room/
building



*What is the right method/technique
for cleaning the room/building?*

Are the correct assets available?

*Does the method/technique comply
with ROE (collateral damage/
civilians/etc.)?*



Ability to carry out technique

projected vulnerability

level of light

size/type of room

construction

activities/personnel in adjacent rooms

smoke/NBC in room

technologies available (NVG, laser, ...)

weapons present

weapons type

weapons number

fortifications/obstacles

enemy threat

troop training/experience/skills

friendly situation

civilian location

3.1 Determine route

3.1.1 Determine entry point to objective

*What routes of ingress and egress are available?
Where are the areas of vulnerability?
Where will the enemy expect me?
What are the potential entry points?
Is my route defensible?*

enemy vulnerability
enemy expectations of our movement
Project enemy behavior (1.1.1)
projected enemy strong/weak points
Enemy threat
projected entry time
threat of collateral damage
building accessibility
mechanical entry points
explosive entry points
building type
building construction
availability of assets
(ladders, helicopters, trees)
building usage
exposure on ingress path
areas of cover
areas of concealment
Terrain
Egress route available
areas of cover
areas of concealment
Terrain
troop skills/expertise/training
reliability
fatigue
equipment

3.1.2 Minimize troop fatigue (1.2.1)

3.1.3 Move within assigned Area of Operations

Will this route stay in my Area of Operations?

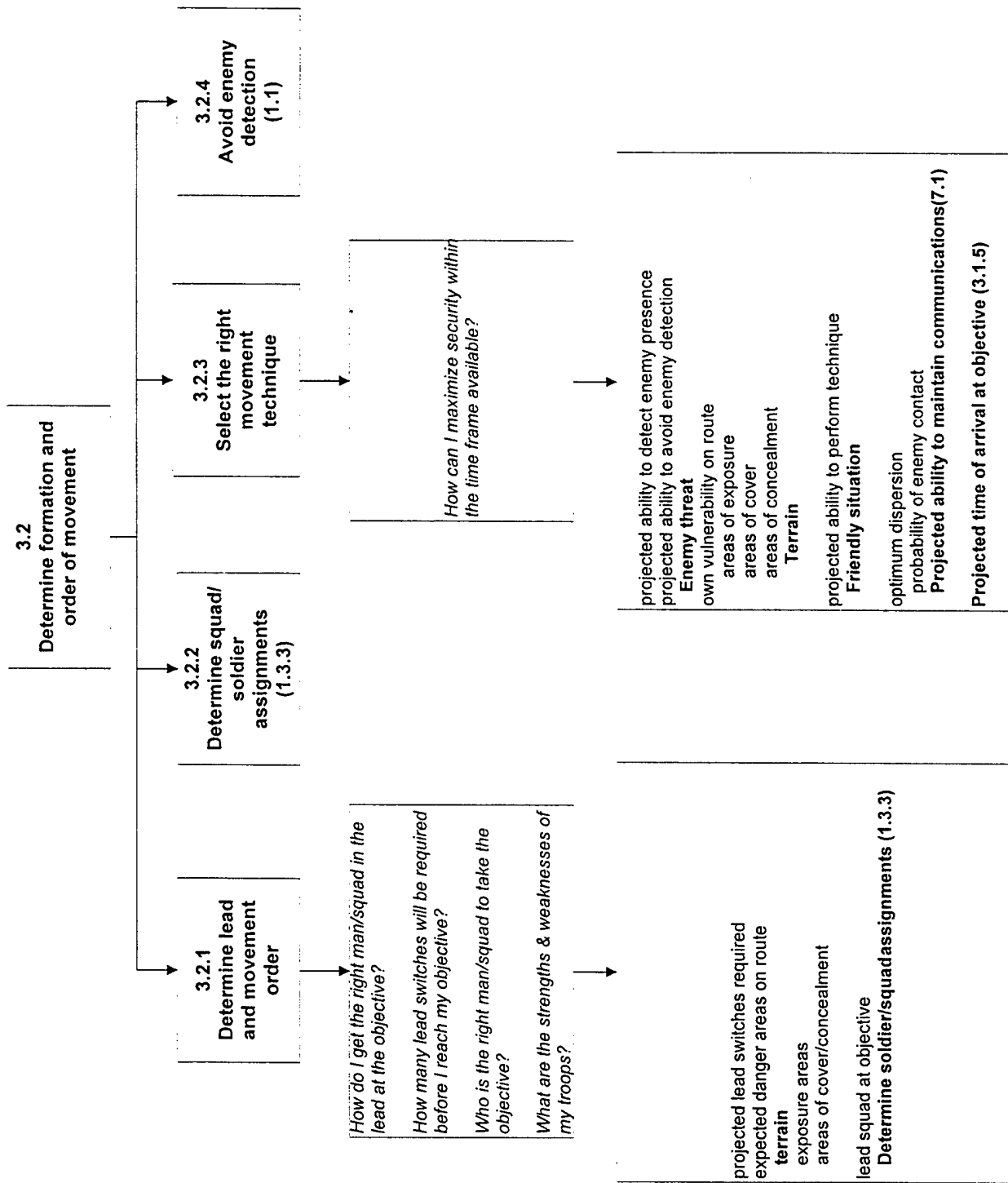
assigned Area of Operations
boundaries of AO
other units AO
projected routes
obstacles
terrain

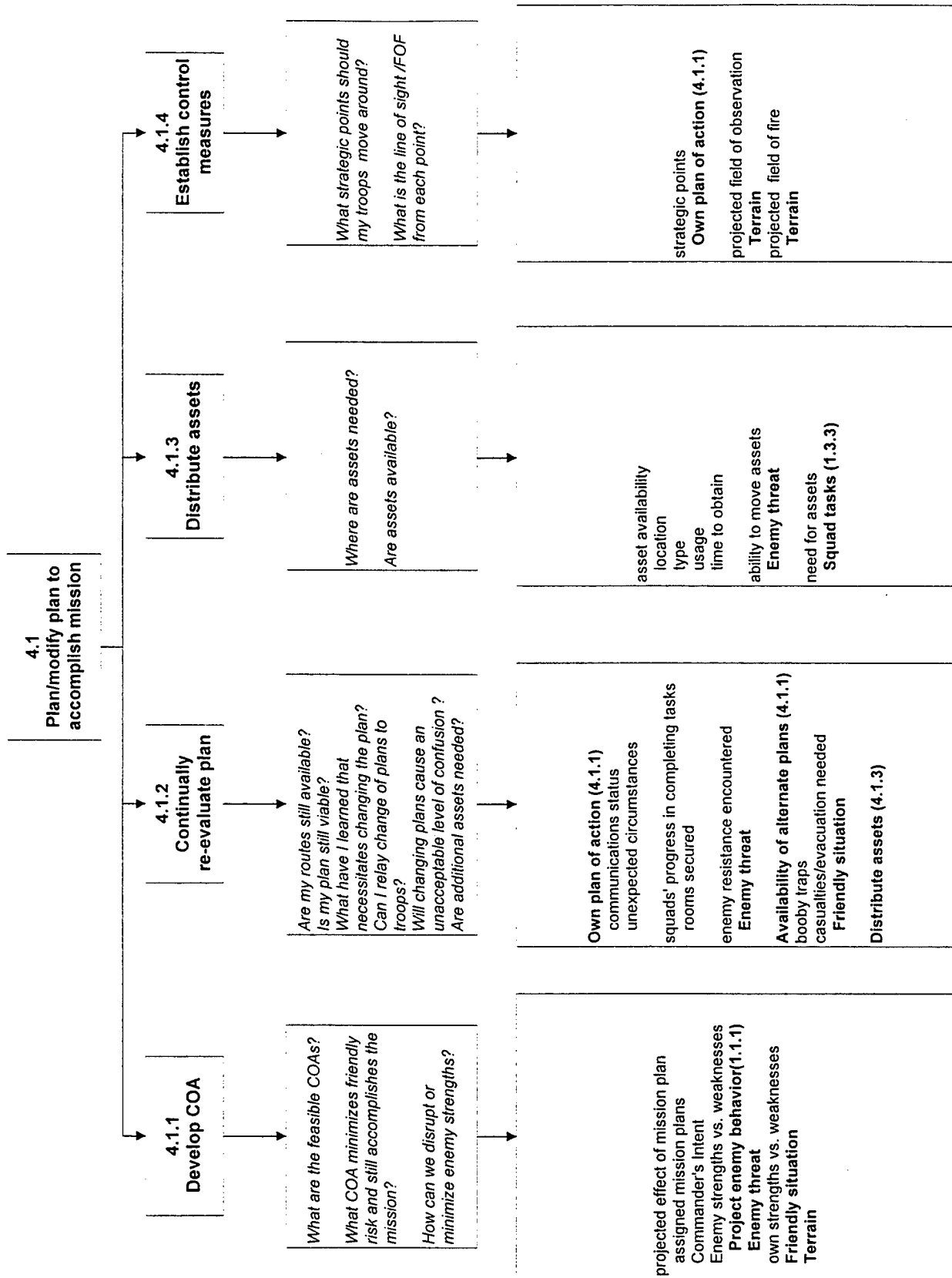
3.1.4 Avoid enemy detection (1.1)

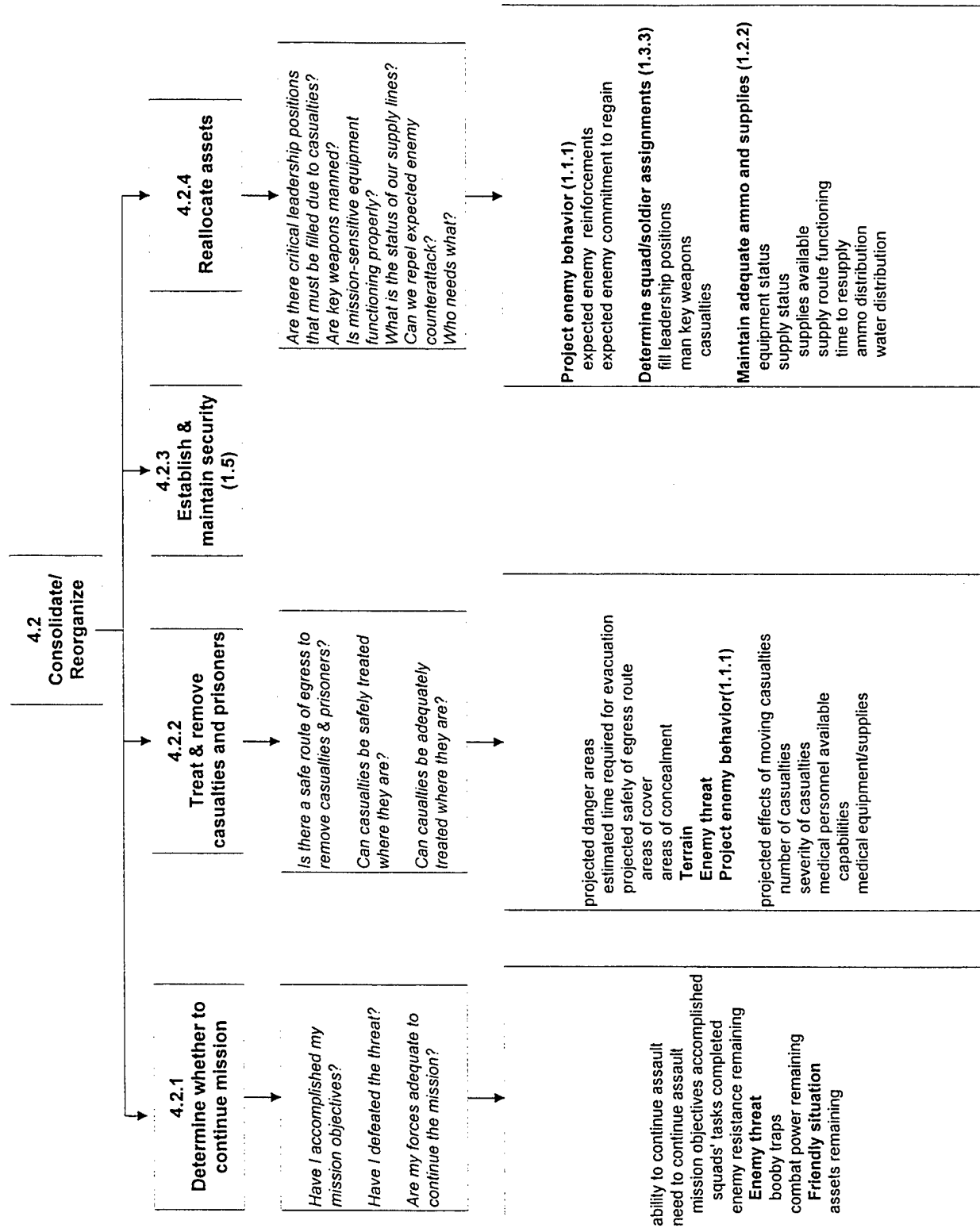
3.1.5 Arrive at objective on time

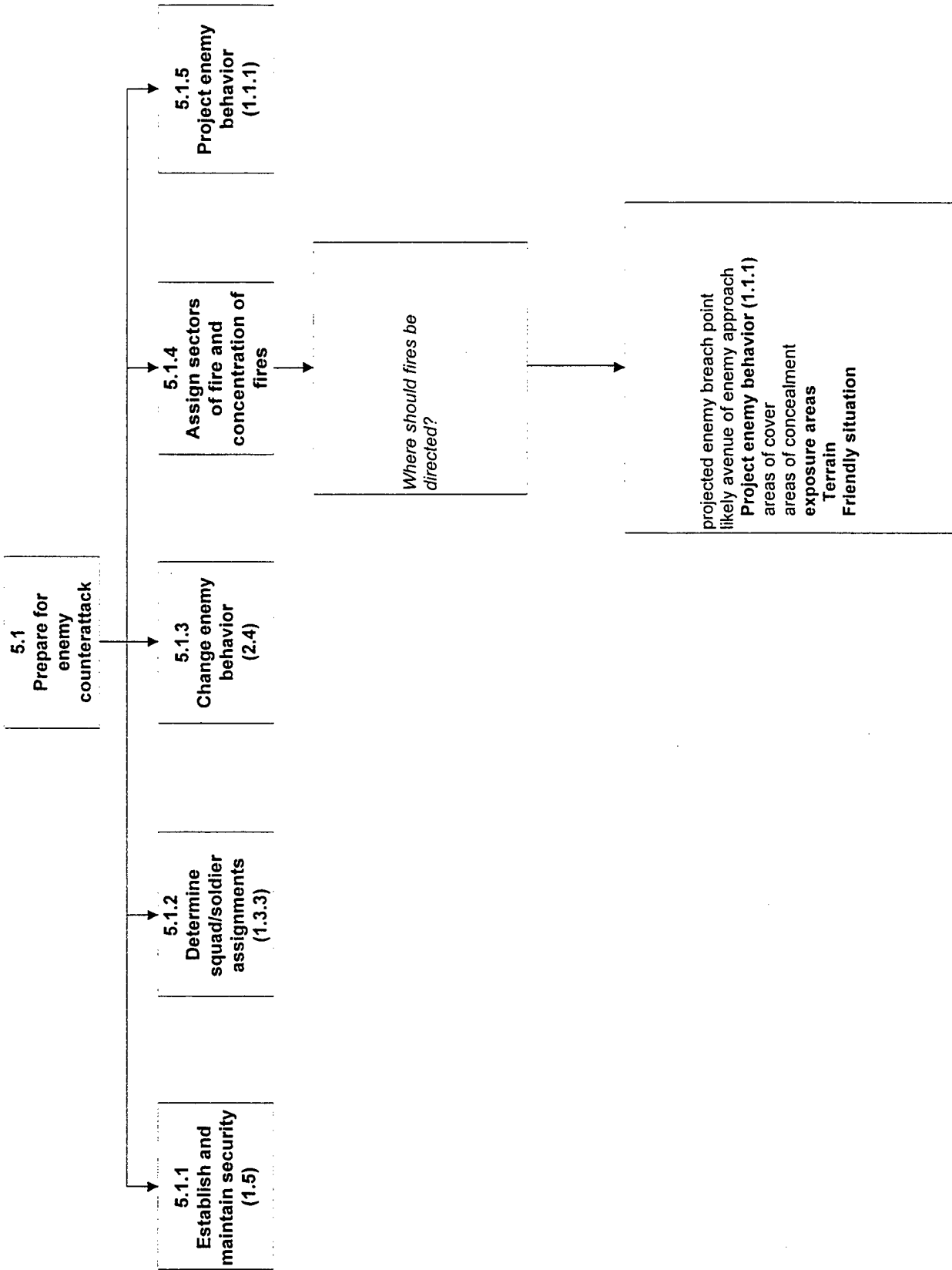
Can I get to objective on time taking this route?

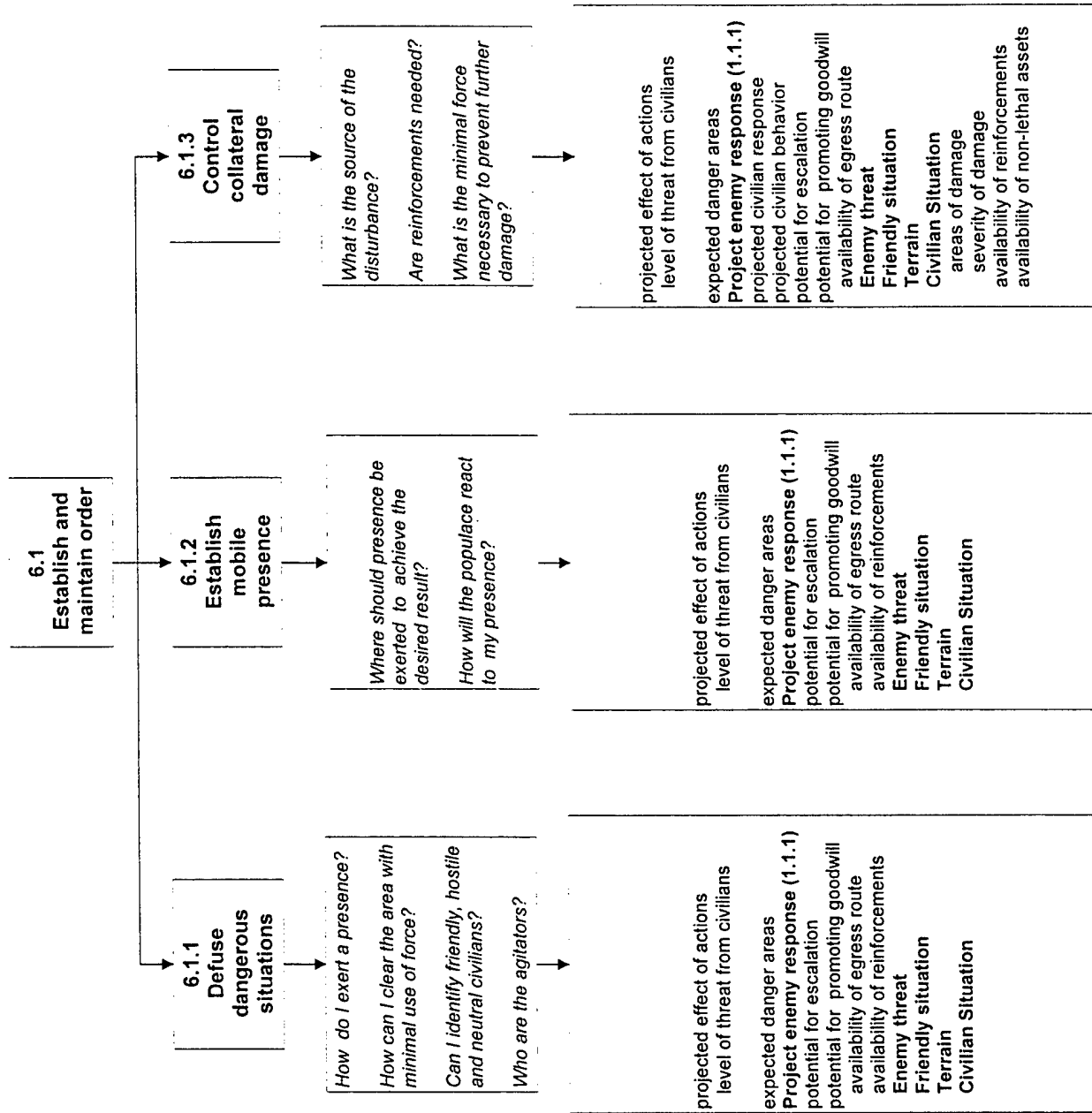
projected time of arrival at objective
projected time required for tasks
projected activities required
likelihood of error, mislocation
time available
current time
time due at objective
projected speed of movement
time required for movement
weather conditions
(heat, light, rain, snow)
Friendly Situation
Formation/movement technique(3.2)
physical requirements of route
Terrain
mental requirements of route
exposure areas
number of key points

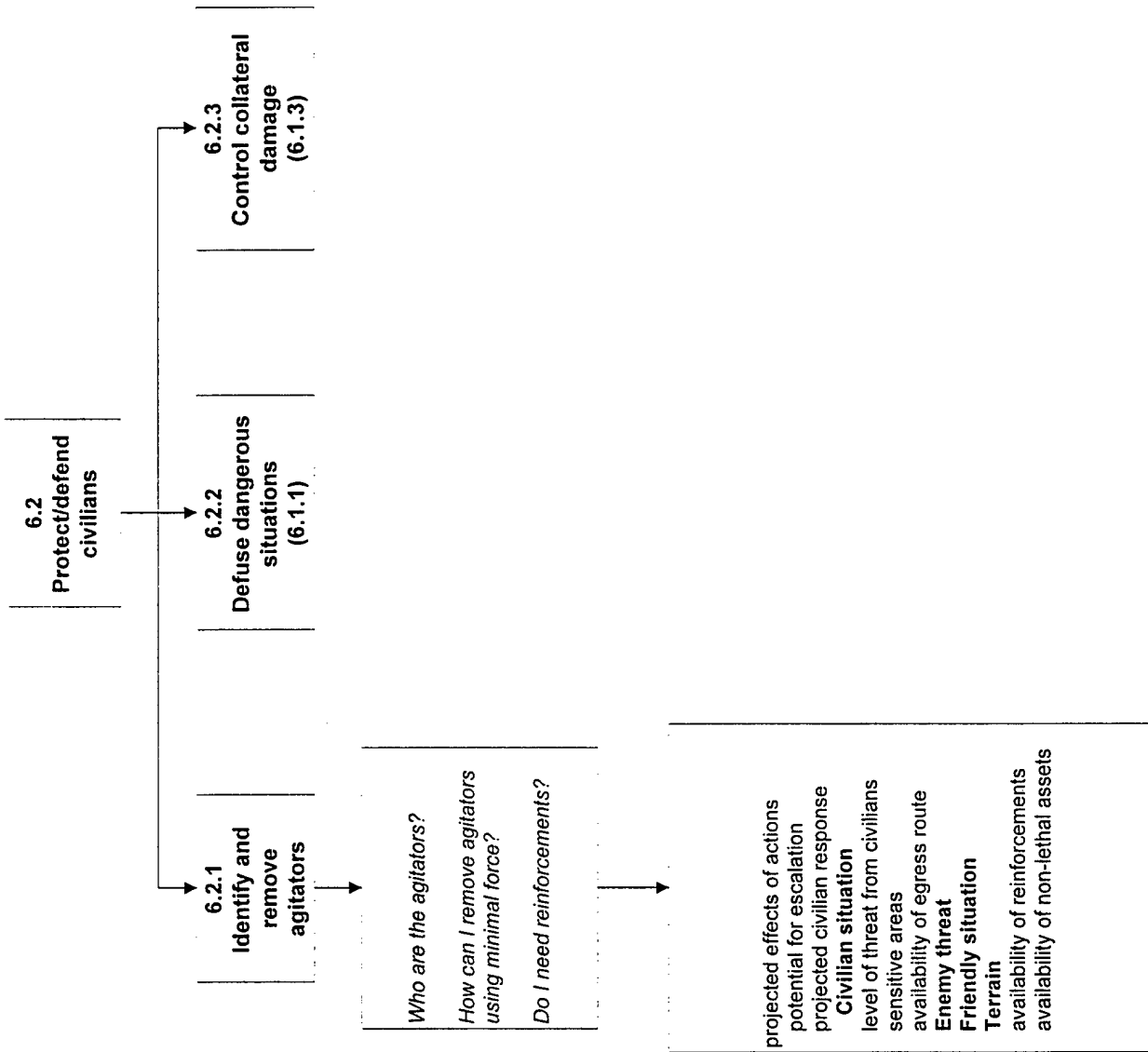


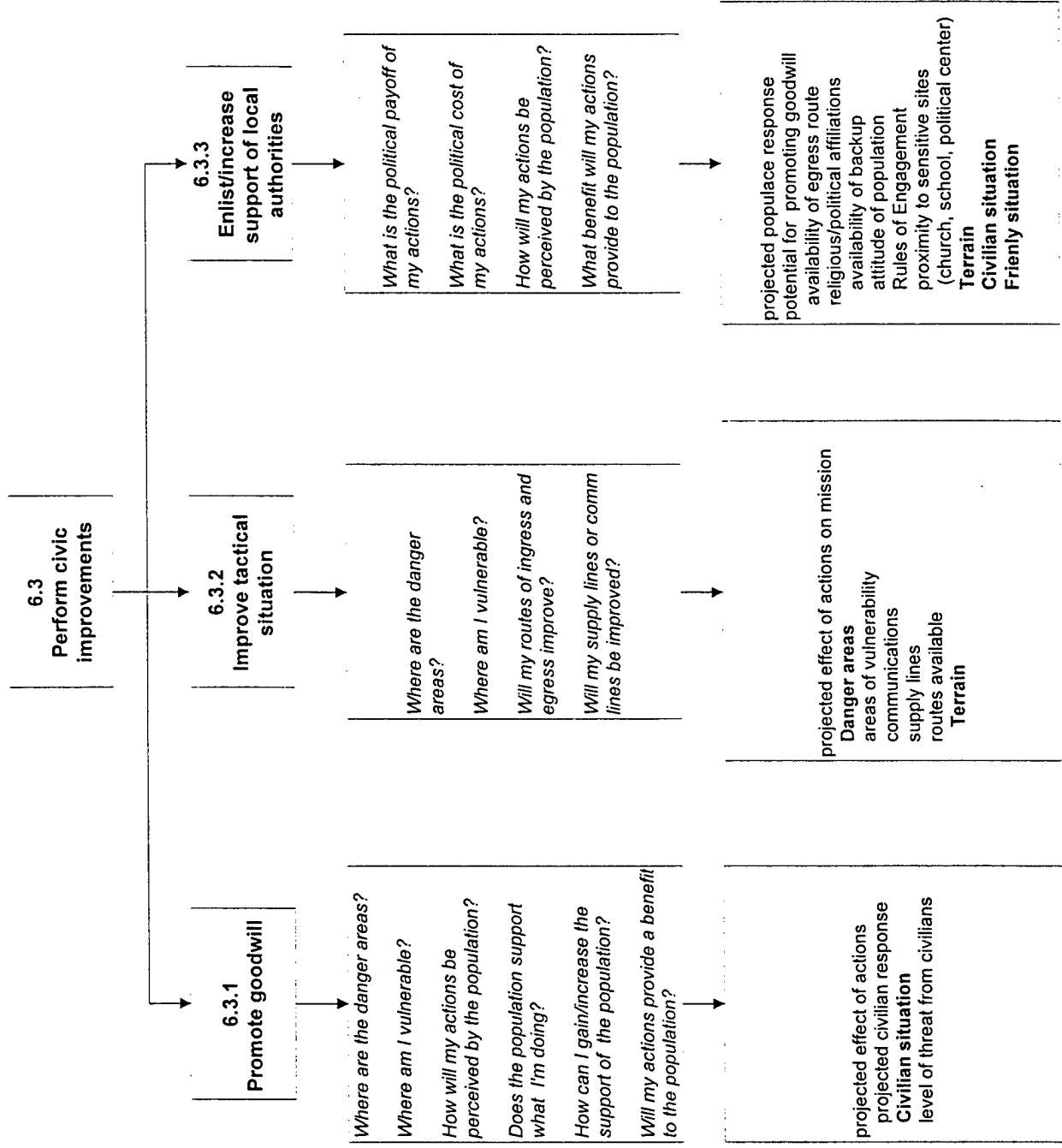


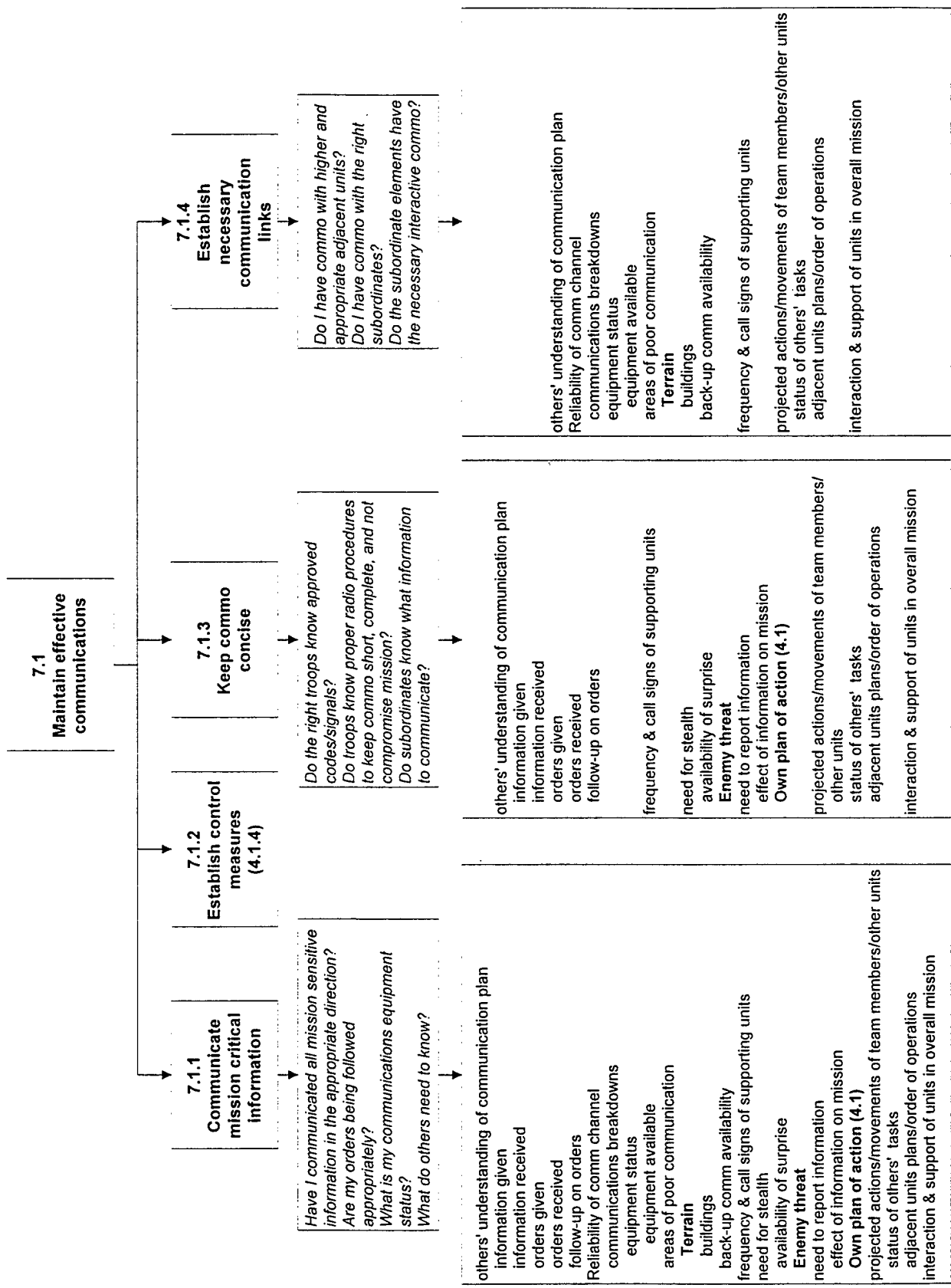


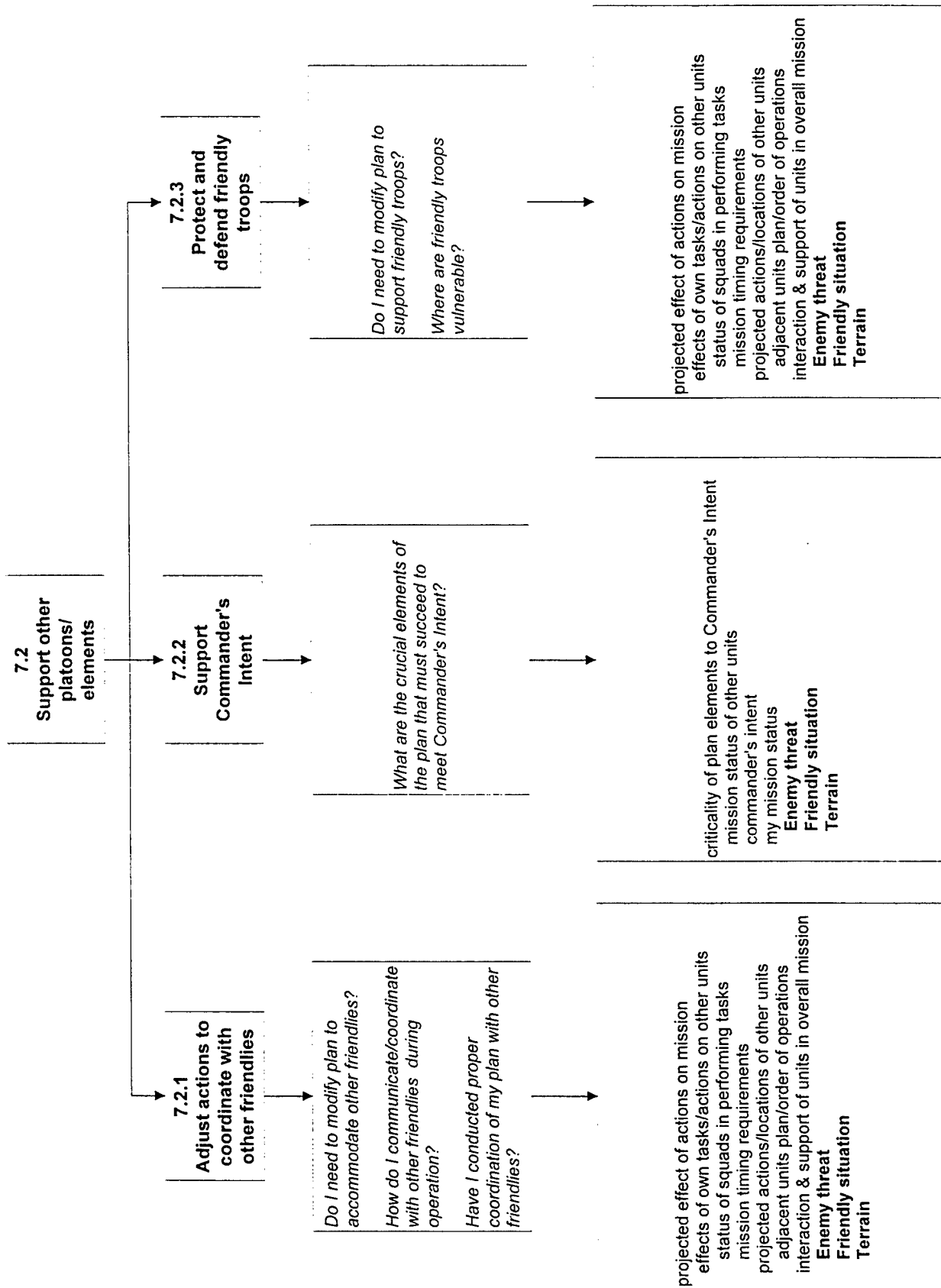












Situation Awareness Categories for Platoon Leaders in MOUT

<p>ENEMY THREAT</p> <ul style="list-style-type: none"> Anticipated enemy actions enemy intent enemy objective enemy composition unit type equipment experience level morale/commitment vehicle capabilities/skills/training recent actions enemy patterns of movement locations of ammo/supplies movement of weapons security/patrol formations & schedule enemy center of gravity enemy disposition location dispersion numbers weapons ammo/supplies objective enemy psychology enemy doctrine past behavior/actions religious/political beliefs enemy field of observation enemy field of fire building vantage points windows doorways rooftops funnel areas 	<p>CIVILIAN SITUATION</p> <ul style="list-style-type: none"> projected civilian behavior location number level of organization mood of crowd religious/political beliefs agitators present threatening actions weapons morale/commitment training/skills intent Rules of Engagement 	<p>TERRAIN</p> <ul style="list-style-type: none"> Type of terrain hilly flat mountainous urban conditions rubble mud day/night features vegetation obstacles buildings usage construction mass construction framed construction heavy clad light clad open entry points vantage points
<p>FRIENDLY SITUATION</p> <ul style="list-style-type: none"> Anticipated friendly actions Commander's Intent unit objective friendly composition unit type equipment experience level morale/commitment vehicle capabilities/skills/training fatigue/soldier load troop disposition location dispersion numbers weapons ammo/supplies troop psychology troop doctrine past behavior/actions religious/political beliefs friendly field of observation friendly field of fire building vantage points windows doorways rooftops funnel areas 	<p>WEATHER CONDITIONS</p> <ul style="list-style-type: none"> temperature precipitation wind visibility ambient noise 	<p>DANGER AREAS</p> <ul style="list-style-type: none"> roads streams open areas railroad tracks corridors stairwells windows doorways funnel areas

Descriptives

NEWRANK = enlisted

Descriptive Statistics^a

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	445	18.00	37.00	22.0899	3.1481
Valid N (listwise)	445				

a. NEWRANK = enlisted

NEWRANK = NCO

Descriptive Statistics^a

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	193	20.00	49.00	30.3523	5.5284
Valid N (listwise)	193				

a. NEWRANK = NCO

NEWRANK = officer

Descriptive Statistics^a

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	46	22.00	40.00	28.5435	4.6462
Valid N (listwise)	46				

a. NEWRANK = officer

Appendix B: SAGAT Instructions to Platoon Leaders

SAGAT INSTRUCTIONS TO SUBJECTS

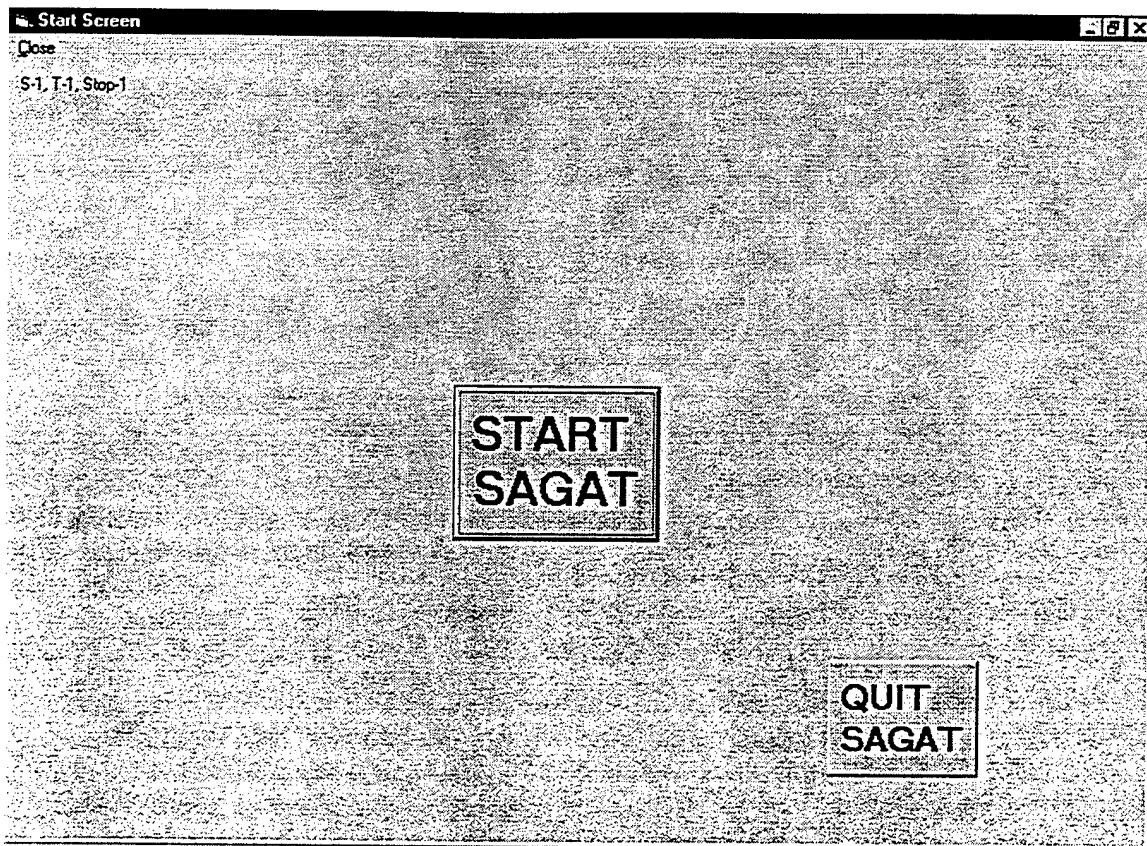
Situation awareness (SA) is critical to directing and executing Infantry operations. For the purpose of this test, situation awareness is formally defined as: *the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.* This means your perception of what is happening in the situation, including friendly, enemy, neutral, and non-combatant disposition, actions and intentions, and what that all means to you as a platoon leader.

The Situation Awareness Global Assessment Technique (SAGAT) has been developed to objectively measure situation awareness (SA) in manned simulations.

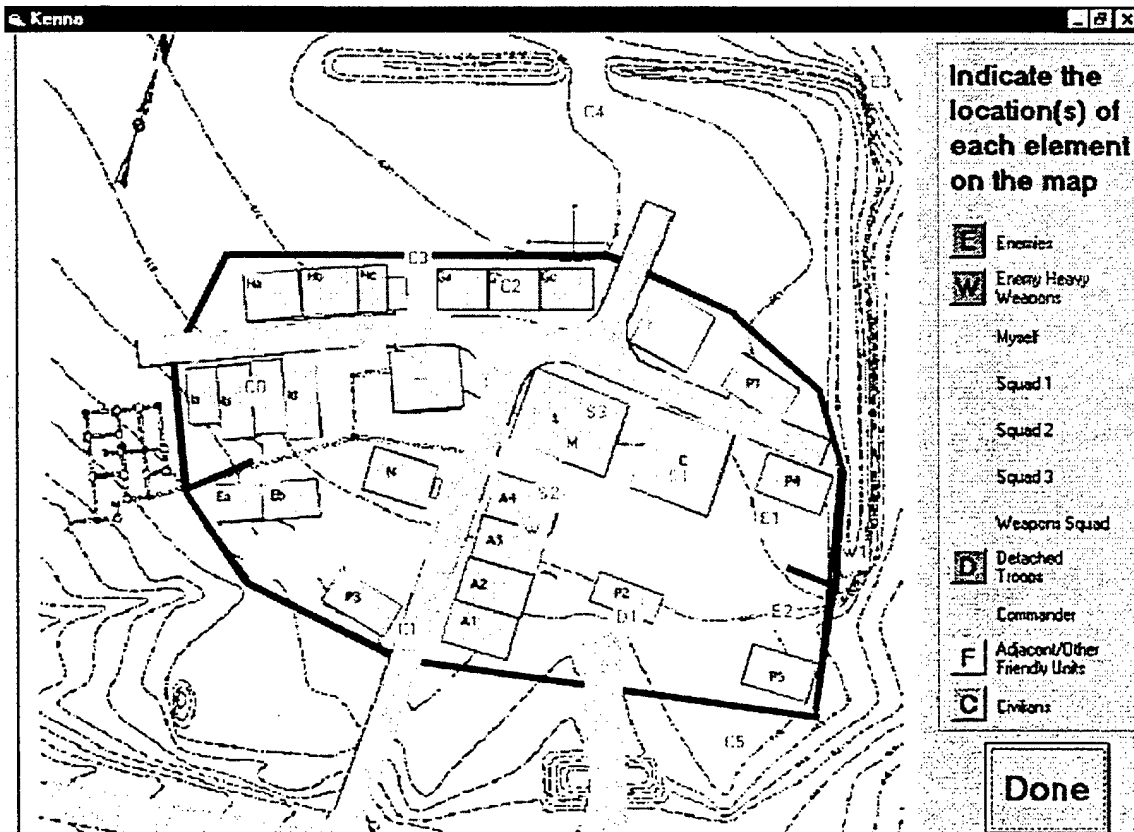
- During the trial, the simulation will be frozen at randomly determined intervals and the visual scene blanked.
- You will be asked about your knowledge of specific SA components, as you perceive them, at that point in time.
- The questions will be presented on a PC. The questions have been created to allow for quick and easy data input using the cursor.
- You will not be allowed to talk to anyone other than the Test Director when completing the questions.
- The questions should be answered as rapidly as possible.
- Even if you do not know some of the information exactly, you should make your best guess. There is no penalty for guessing. If you really have no idea at all of the answer to a question, you may simply click on the "done" box on the screen to go on to the next question. You are generally better off making your best guess, however.
- Following the SAGAT session you will resume the trial exactly where you left off. You will turn around and when ready the simulation will be resumed.

The purpose of SAGAT is to evaluate systems and training concepts, not to evaluate you as an individual. You may not be able to answer many of the questions you will be asked. Don't worry about this, as the questions are intended to assess ideal SA. Some of this information may not be available or may not be adequately accurate.

You will have the opportunity to practice answering the SAGAT questions before testing begins. Please direct any questions you may have to the Test Director.



To begin the program click on the button marked "START SAGAT".



Click on the symbol next to each element that is currently alive and present in the battlefield and drag it to its current location. (You may move the symbols on the map if they are not placed correctly). Indicate the location of yourself, your commander, the main squad locations (with their squad leader), weapons squad location and any teams that have become detached from their main squads and are located separately. In addition indicate the location of any known enemies, enemy heavy weapons locations, other friendly units (outside of your platoon) and civilians. Click on the Done button when you are finished indicating the location of all known parties.

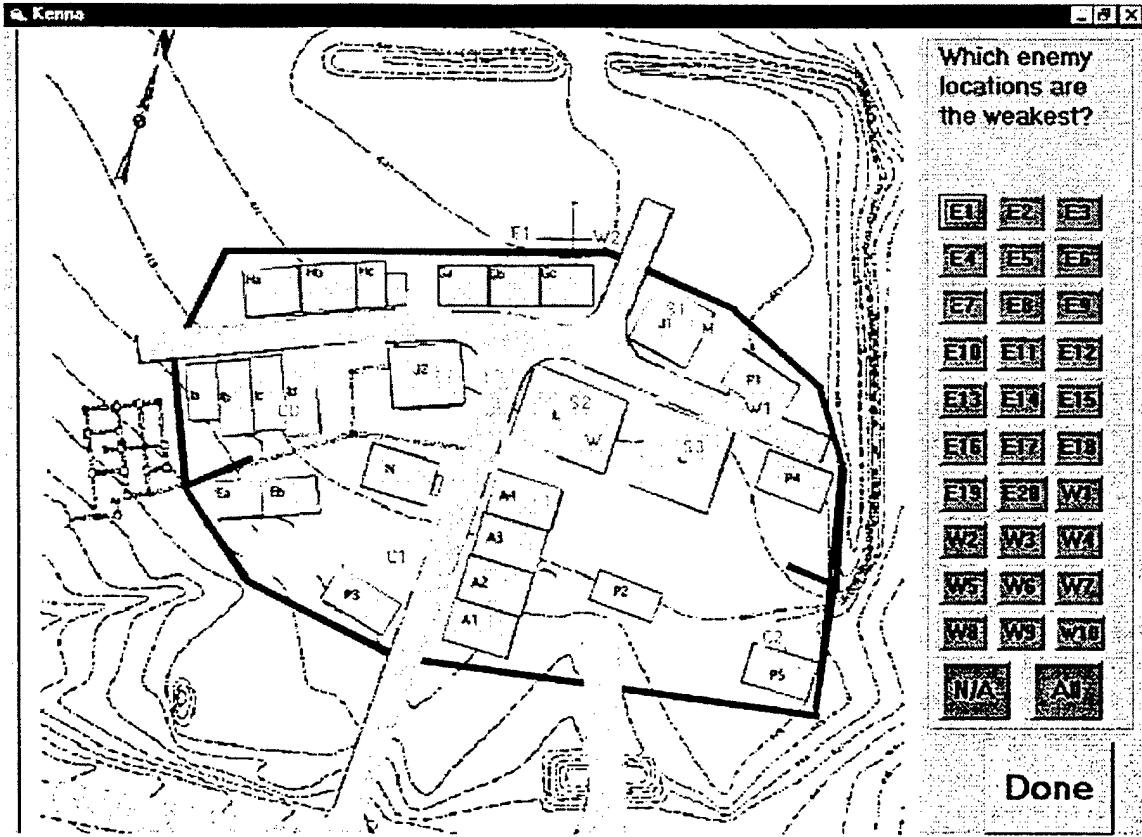
Kenna

Which enemy element is your highest level threat?

E1	E2	E3
E4	E5	E6
E7	E8	E9
E10	E11	E12
E13	E14	E15
E16	E17	E18
E19	E20	W1
W2	W3	W4
W5	W6	W7
W8	W9	W10

Done

The location of all the elements you indicated in the first question are presented on the left. Click on the button that corresponds to the enemy unit that is the highest level threat to your platoon at this time. Click on the Done button when you are finished.



The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the enemy units with the weakest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

Kenna

Which enemy locations are the strongest?

E1	E2	E3
E4	E5	E6
E7	E8	E9
E10	E11	E12
E13	E14	E15
E16	E17	E18
E19	E20	E21
E22	E23	E24
E25	E26	E27
E28	E29	E30

Done

The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the enemy units with the strongest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

Kenna

Which friendly locations are the weakest?

M	S1	S2
S3	W	D1
D2	D3	D4
D5	D6	D7
D8	D9	D10
C0	F1	F2
F3	F4	F5
F6	F7	F8
F9	F10	

Done

The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units with the weakest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

Kenna

Which friendly locations are the strongest?

M	S1	S2
S3	W	D1
D2	D3	D4
D5	D6	D7
D8	D9	D10
C0	F1	F2
F3	F4	F5
F6	F7	F8
F9	F10	

Done

The location of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units with the strongest locations at this time. You may indicate more than one. Click on the Done button when you are finished.

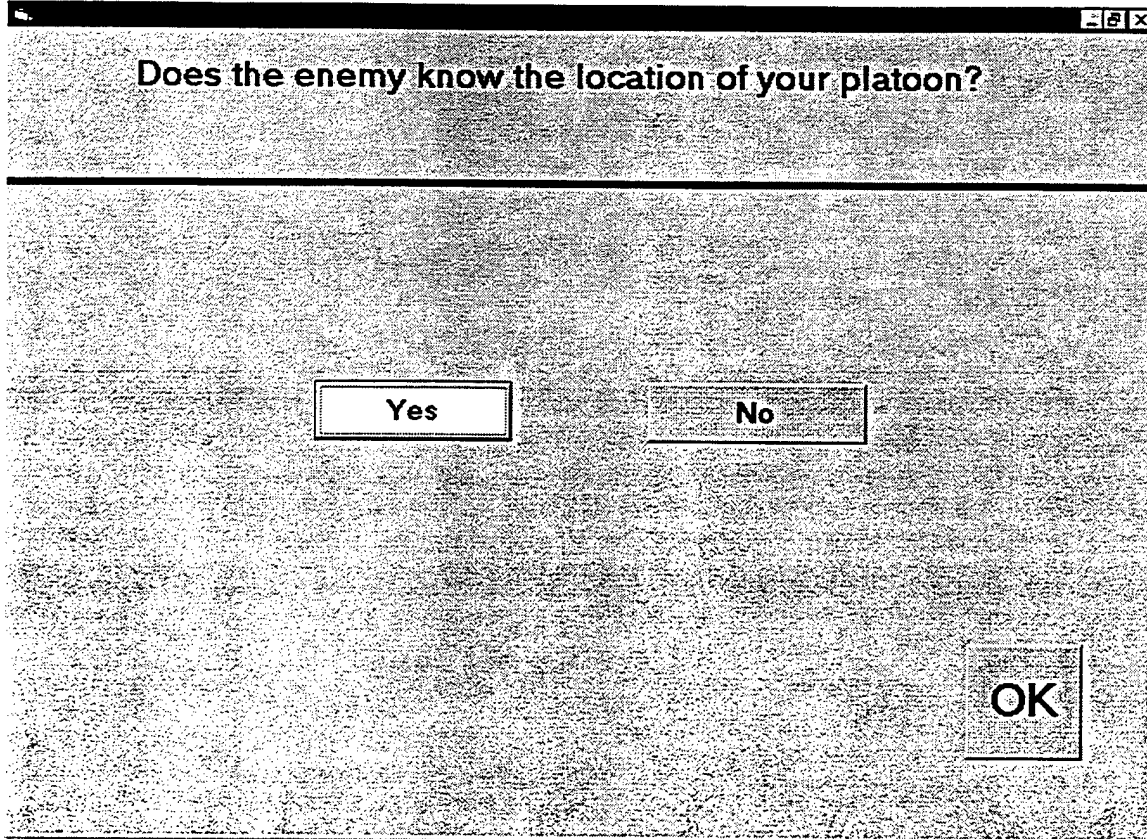
Kenna

Which friendly forces are currently exposed to enemy fire/attack?

M	S1	S2
S3	W	D1
D2	D3	D4
D5	D6	D7
D8	D9	D10
CO	F1	F2
F3	F4	F5
F6	F7	F8
F9	F10	None

Done

The locations of all the elements you indicated in the first question are presented on the left. Click on the button(s) that corresponds to the friendly units who are currently exposed to enemy fire/attack. You may indicate more than one. Click on the Done button when finished.



Indicate whether any enemy troops currently are aware of your location or that of any of your platoon. Click on the OK button when you are done.

The screenshot shows a software window with a title bar containing a maximize button, a refresh button, and a close button. The main content area has a title "How many casualties has your platoon suffered?" and a sub-instruction "(Click on arrow and select number from list)". Below this is a vertical pull-down menu with a list of numbers: 8, 9, 10, 11, 12, 13, 14, and 15. The number 13 is currently selected and highlighted. To the right of the menu is an "OK" button.

How many casualties has your platoon suffered?

(Click on arrow and select number from list)

13

8

9

10

11

12

13

14

15

OK

Indicate how many casualties your platoon has suffered up to this point by using the pull down menu. Click on the OK button when you are done.

What do you expect the enemy to do in the next five minutes?

(Select all that apply)

Attack	Defend	Other
Move positions	Retreat	Nothing

OK

Indicate what actions you expect the enemy troops in this scenario to take in the next five minutes. Click on the OK button when you are done.

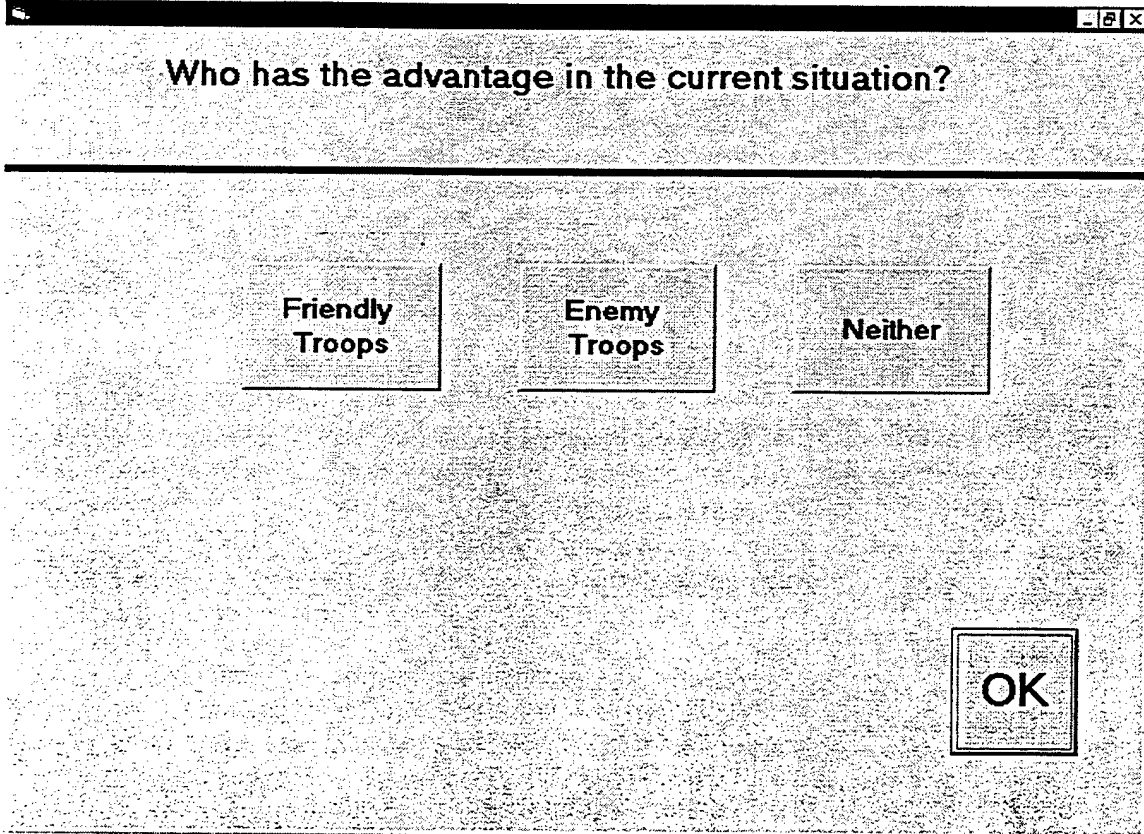
What do you expect civilians to do in the next five minutes?

(Select all that apply)

Become hostile	Form a crowd	Move positions	Riot/Attack
Disperse	Other	Get in the way	Nothing

OK

Indicate what actions you expect the civilians in this scenario to take in the next five minutes. Click on the OK button when you are done.

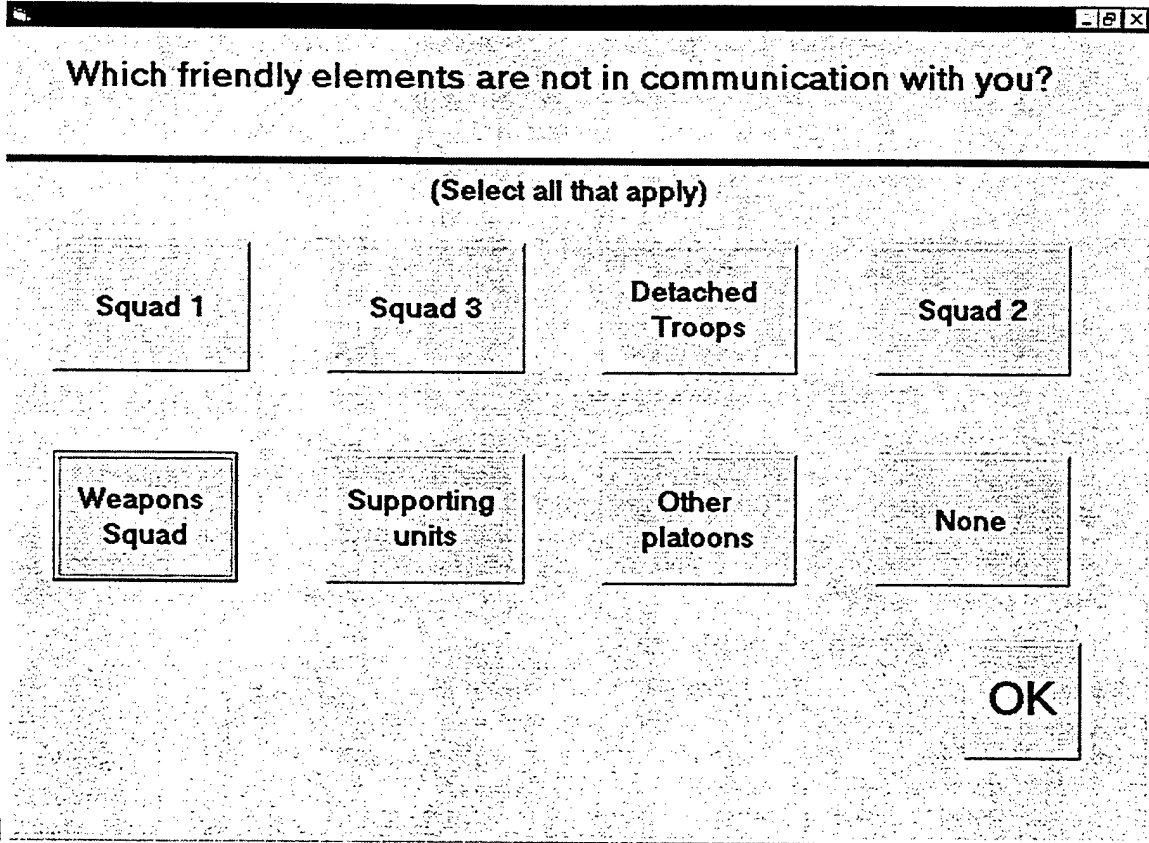


Who has the advantage in the current situation?

Friendly Troops **Enemy Troops** **Neither**

OK

Indicate whether friendly or enemy troops (or neither) currently have the advantage by clicking on the appropriate button. Click on the OK button when you are done.



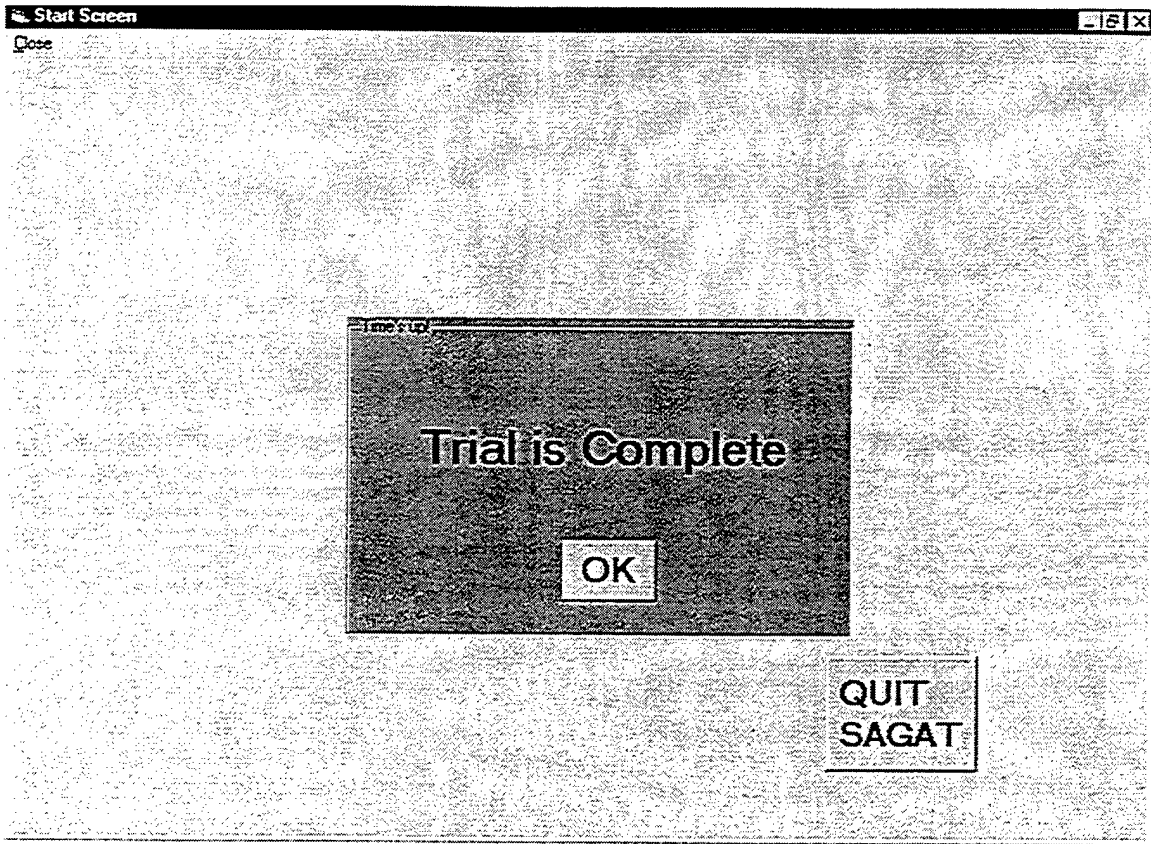
Which friendly elements are not in communication with you?

(Select all that apply)

Squad 1	Squad 3	Detached Troops	Squad 2
Weapons Squad	Supporting units	Other platoons	None
			OK

1

Indicate whether any of the above friendly troops have lost communications with you. If all are in communication with you, click on the None button. Click on the OK button when you are done.



When you see this screen, you are finished answering the SAGAT questions. You will return to the simulation trial, following input from the test director.

Appendix C: SABARS Instrument

Situation Awareness Behaviorally Anchored Rating Scale (SABARS)

<i>Rating Items</i>	<i>Very Poor</i>			<i>Very Good</i>		<i>Not Applicable</i>
	<i>Poor</i>	<i>Borderline</i>	<i>Good</i>	<i>Good</i>		
1. Sets appropriate levels of alert	1	2	3	4	5	0
2. Solicits information from squad leaders	1	2	3	4	5	0
3. Solicits information from civilians (*)	1	2	3	4	5	0
4. Solicits information from commanders	1	2	3	4	5	0
5. Effects coordination with other platoon leaders (*)	1	2	3	4	5	0
6. Communicates key information to commander	1	2	3	4	5	0
7. Communicates key information to squad leaders	1	2	3	4	5	0
8. Communicates key information to other platoon leaders (*)	1	2	3	4	5	0
9. Monitors company net	1	2	3	4	5	0
10. Assesses information received	1	2	3	4	5	0
11. Asks for pertinent intelligence information	1	2	3	4	5	0
12. Employs squads tactically to gather needed information	1	2	3	4	5	0
13. Employs graphic or other control measures for squad execution (*)	1	2	3	4	5	0
14. Communicates to squads, situation and commander's intent	1	2	3	4	5	0
15. Utilizes a standard reporting procedure	1	2	3	4	5	0
16. Identifies critical mission tasks to squad leaders	1	2	3	4	5	0
17. Ensures avenues of approach are covered	1	2	3	4	5	0
18. Locates self at vantage point to observe main effort	1	2	3	4	5	0
19. Deploys troops to maintain platoon communications (*)	1	2	3	4	5	0
20. Uses assets to effectively assess environment	1	2	3	4	5	0
21. Performs a leader's recon to assess terrain and situation (*)	1	2	3	4	5	0
22. Identifies observation points, avenues of approach, key terrain, obstacles, cover and concealment	1	2	3	4	5	0
23. Assesses key finds and unusual events	1	2	3	4	5	0
24. Discerns key/critical information from maps, records, and supporting site information (*)	1	2	3	4	5	0
25. Discerns key/critical information from reports received	1	2	3	4	5	0
26. Projects future possibilities and creates contingency plans (*)	1	2	3	4	5	0
27. Gathers follow up information when needed	1	2	3	4	5	0
28. Overall Situation Awareness Rating	1	2	3	4	5	0

* Designates items not applicable in the present simulated missions

Appendix D: PSAQ Instrument

Post Trial Participant Subjective Questionnaire

1. Please circle the number below that best describes how hard you were working during this scenario.	not hard	1	2	3	4	5	extremely hard
Comments:	_____						

2. Please circle the number that best describes how well you performed during this scenario	extremely poor	1	2	3	4	5	extremely well
Comments:	_____						

3. Please circle the number that best describes how aware of the evolving situation you were during the scenario.	Not aware of situation	1	2	3	4	5	Completely aware of situation
Comments:	_____						

Comments:	_____						

Appendix E: Biographical Information Questionnaire

Biographical Information Questionnaire

Name _____ Unit _____ Date _____

Please fill in the blank or mark or circle the appropriate response.

1. What is your age? _____ Years
2. MOS _____
3. Rank _____
4. Time in service Years _____ Months _____
5. What is the source of your commission?
_____ ROTC _____ USMA _____ OCS
6. What is your current (or most recent) duty position? _____
How long in this position? _____
7. What Army training courses have you completed? Check all that apply.
_____ OSUT/AIT _____ PLDC _____ BNCOC _____ IOBC
_____ BFV Leader Course _____ Airborne _____ Ranger
_____ Air Assault _____ Combat Life Saver Course
_____ Other (please specify) _____
8. How susceptible to motion or car sickness do you feel you are?

1	2	3	4	5	6	7
not susceptible			moderately susceptible			highly susceptible
9. Do you have normal or corrected to normal 20/20 vision? _____ Yes _____ No

10. Are you color blind? Yes No

11. Are you right handed? left handed?

12. My level of confidence in using computers is

1 2 3 4 5
low average high

13. How many hours per week do you use computers? hours per week

14. How many times in the last year have you experienced a virtual reality game or entertainment?

0 1 2 3 4 5 6 7 8 9 10 11 12+

15. How often have you trained at the McKenna MOUT site (not including demos)?

not since basic training 1-3 times more than 3 times

16. Have you ever been in a Virtual Individual Combatant (VIC) simulator at the Land Warrior Test Bed before?

Yes No

If YES, which one(s)? (Describe if you cannot remember the name)

17. Have you had any other experience with military computer simulations?

Yes No

If yes, please describe briefly or give the names of the simulators.

Appendix F: Assault Scenario Flow Chart

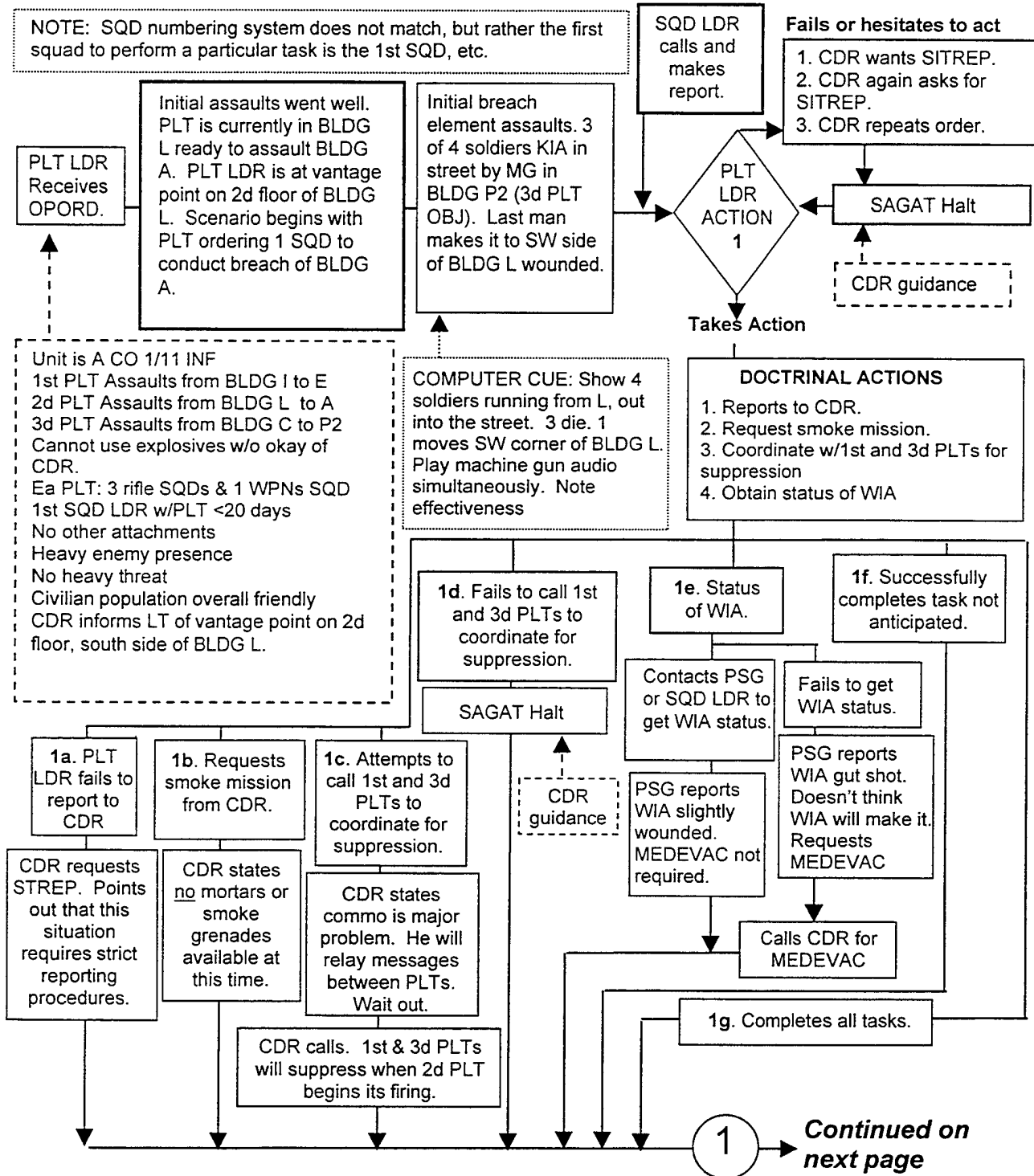
Scenario B: Company Assault 2d PLT Mission from Building L to A4

1. Co A, 1-11th Infantry is conducting a company assault on the town of Kenna. The company is attacking the town from north to south. The initial assault was successful. The 1st Platoon attacked the H-series buildings and has successfully cleared BLDGs J2 and the I-series buildings. They are currently in the I-series building preparing to assault the E-series buildings. Their follow-on objectives are BLDGs N and P3. The 3d Platoon successfully attacked and cleared BLDGs P1, P4, and C. They are currently in BLDG C, preparing to attack BLDG P2. Their follow-on objective is BLDG P5.
2. The 2d Platoon, your platoon, is in the center. Your platoon has successfully cleared the G-series buildings and is currently located in BLDG L. You are at 100% strength. You are preparing to assault BLDGs A4 then A3, A2, and A1 respectively. The commander has directed you to observe the assault from a vantage point from the 2d floor of BLDG L. Your platoon has 3 rifle squads and 1 weapons squad. The Weapons Squad Leader, SSG Castro, is presently in the hospital recovering from wounds. Since the Weapons Squad has no team leaders, you have attached the Weapons Squad to the 3 line squads. There are no other attachments to the platoon.
3. The enemy is expected to provide stiff resistance as he withdraws his forces to follow-on positions to the southern part of town. The enemy is estimated at platoon strength. He has mortars, but has not yet employed them. He is fighting from well-fortified, prepared positions.
4. Ration cycle is C, C, T. MEDEVAC is restricted to escorted ground ambulances. Ambulances are coordinated through the company commander. Injured civilians will receive medical assistance. Captured enemy personnel or civilian detainees will be handled through company channels.
5. Rules of Engagement (ROE). Since the local civilian population is considered friendly, the rules of engagement are very restrictive. There will be no weapon firing within the town limits except against confirmed enemy locations. Targets must be clearly identified as hostile. Every effort must be made to avoid civilian casualties. Explosives cannot be used without permission of the company commander. Weapons control status is yellow.
6. Your immediate task is to plan the assault on BLDG A4 and brief your squad leaders.
7. What are your questions?
8. The scenario will begin when you occupy the vantage point in BLDG L.

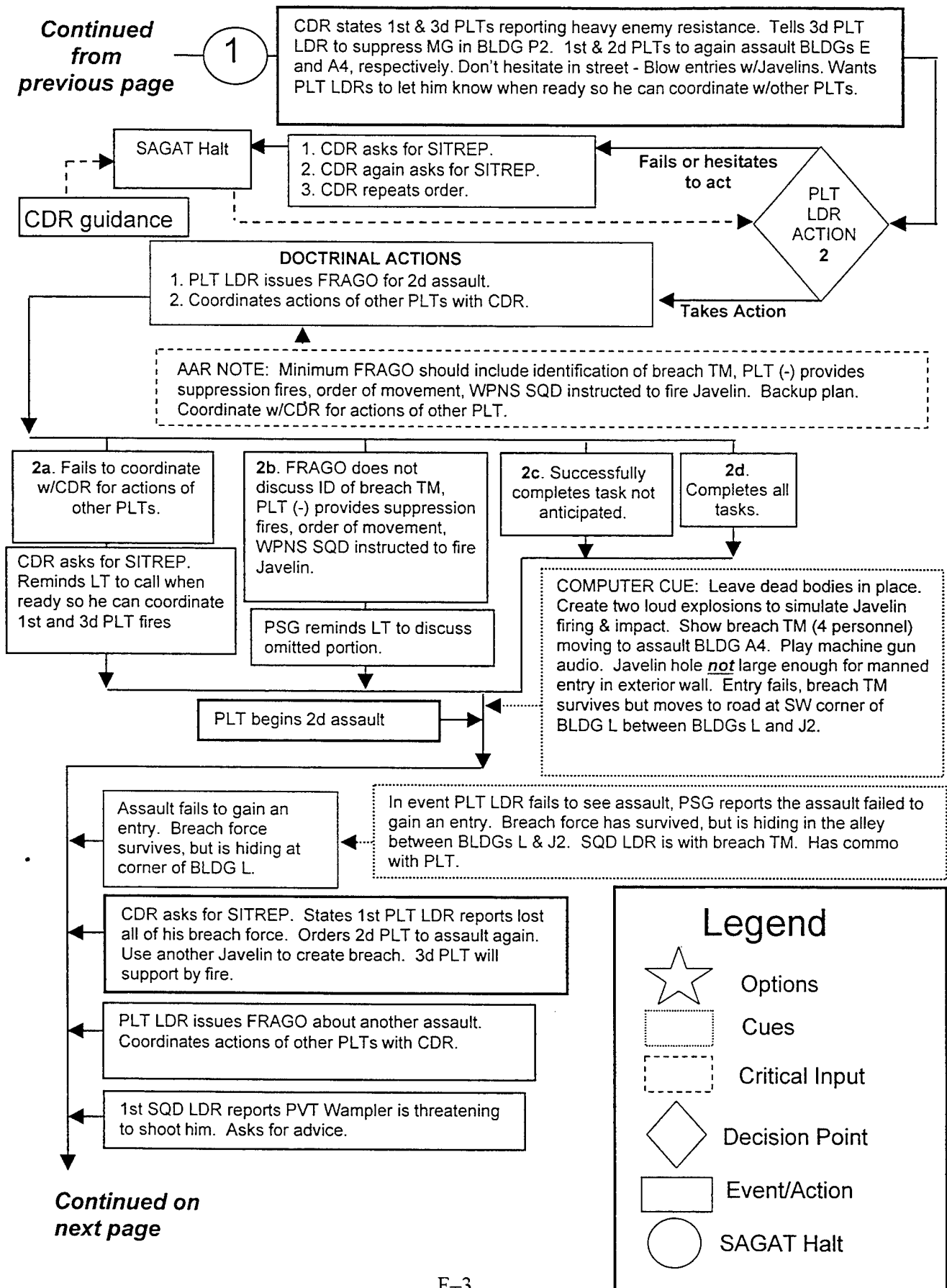
SET-UP

1. Enemy machine gun in NE corner of BLDG P2 orientated NW to N.
2. Need 1 small hole blown in N side of BLDG A4 (see computer cue).
3. Need second hole blown adjacent to 1st hole. The combination of the two will make a hole large enough for soldiers to enter the BLDG (see computer cue).
4. Need machine gun audio 2 times (see computer cue and scenario for effectiveness).
5. Need 4 dead civilians *in* BLDG A4 w/marketed chemical containers located on the floor, in adjacent room to the (entry point). Need abandoned enemy tank *in* or beside the east side of BLDG A4.




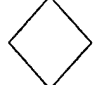


NOTE: SQD numbering system does not match, but rather the first squad to perform a particular task is the 1st SQD, etc.



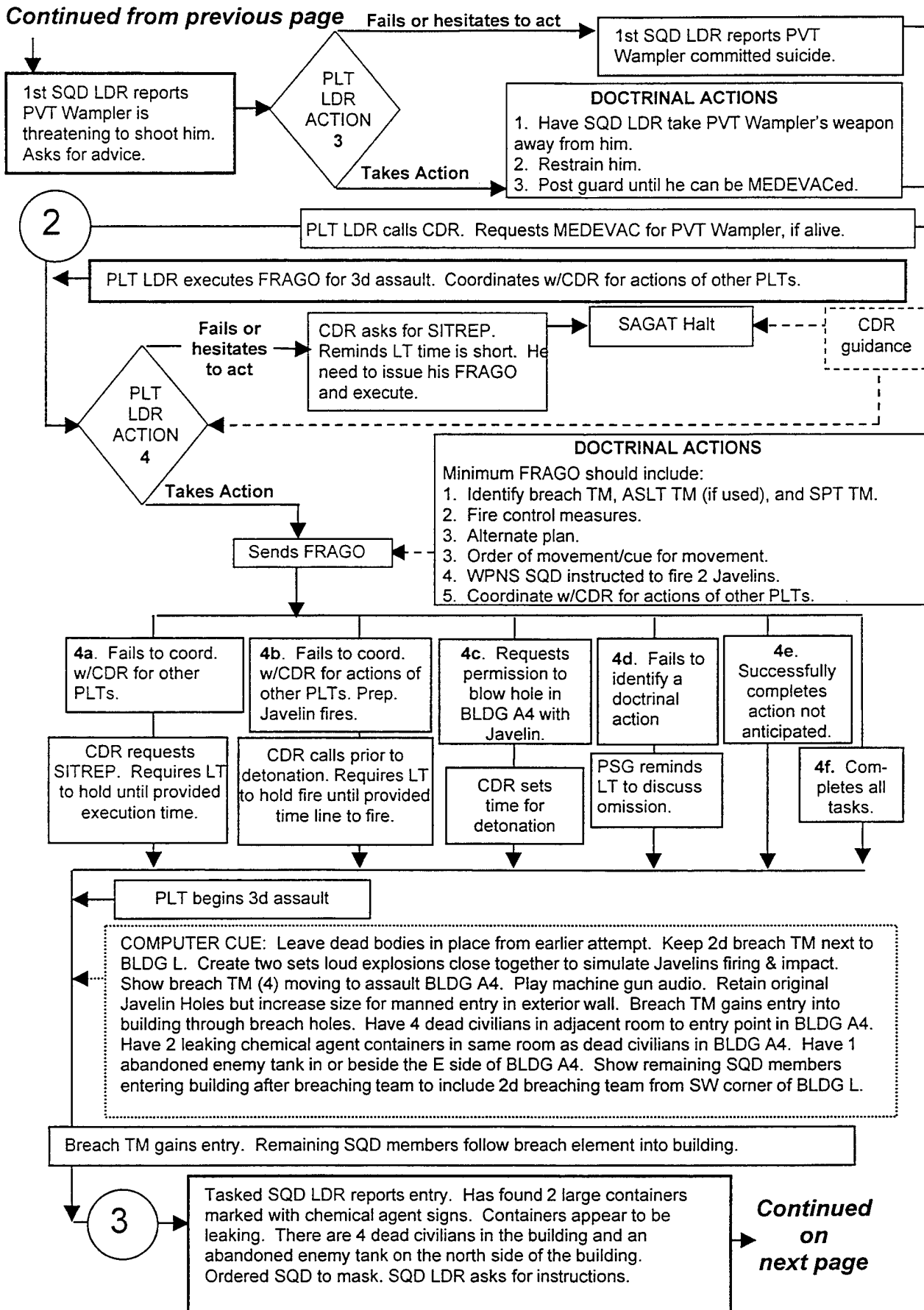
Continued from previous page



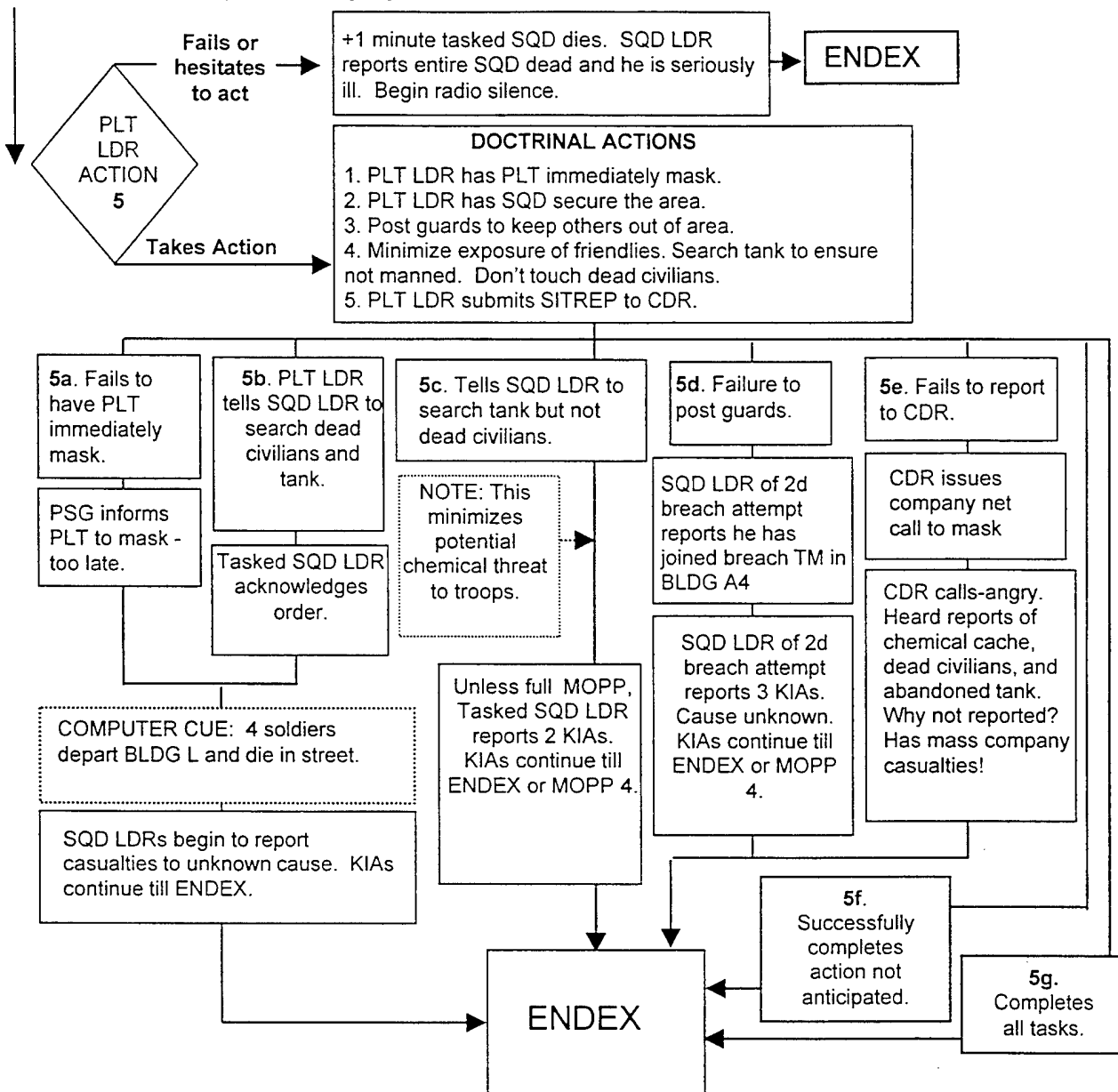
Legend

-  Options
-  Cues
-  Critical Input
-  Decision Point
-  Event/Action
-  SAGAT Halt

Continued from previous page



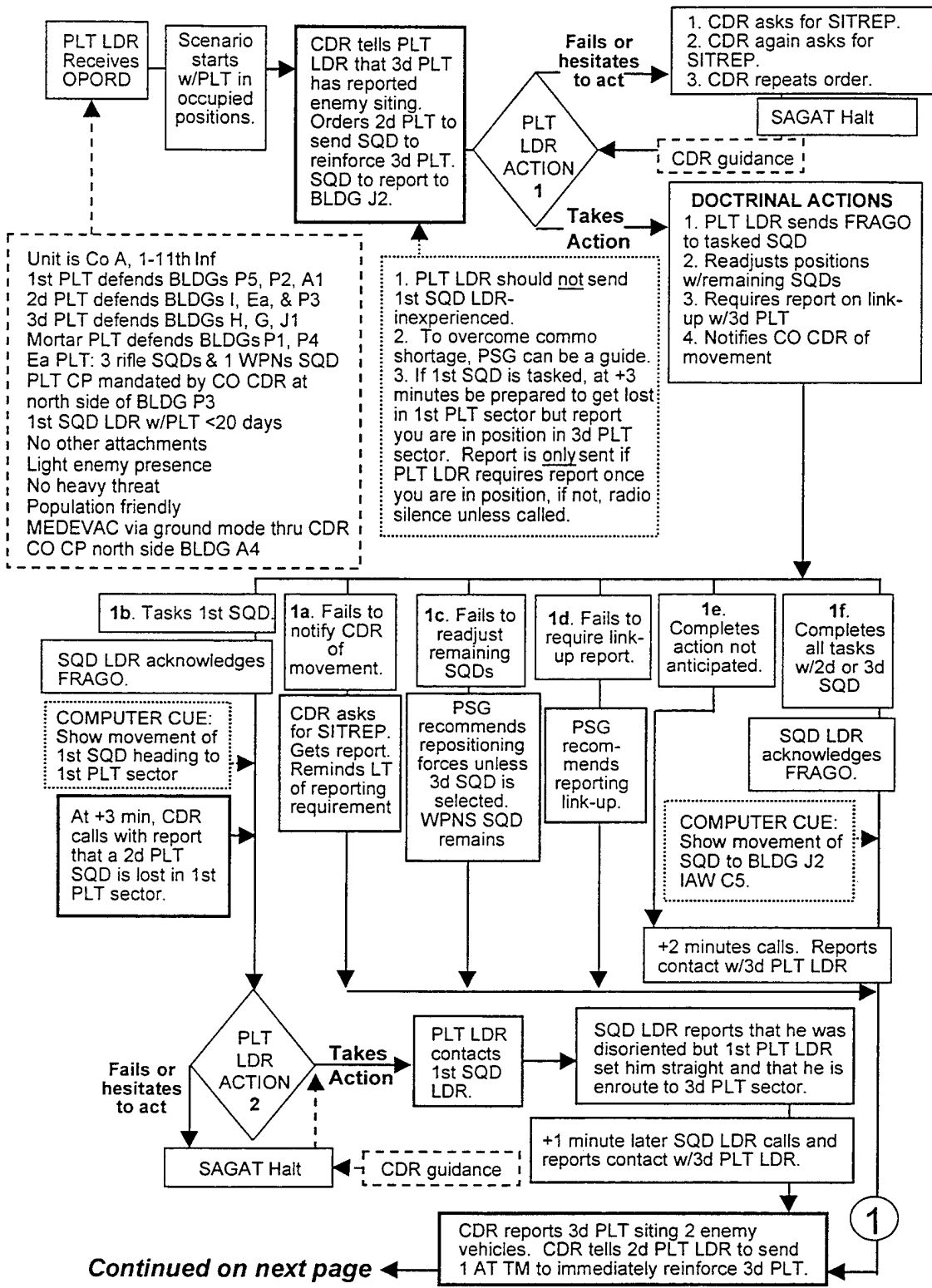
Continued from previous page



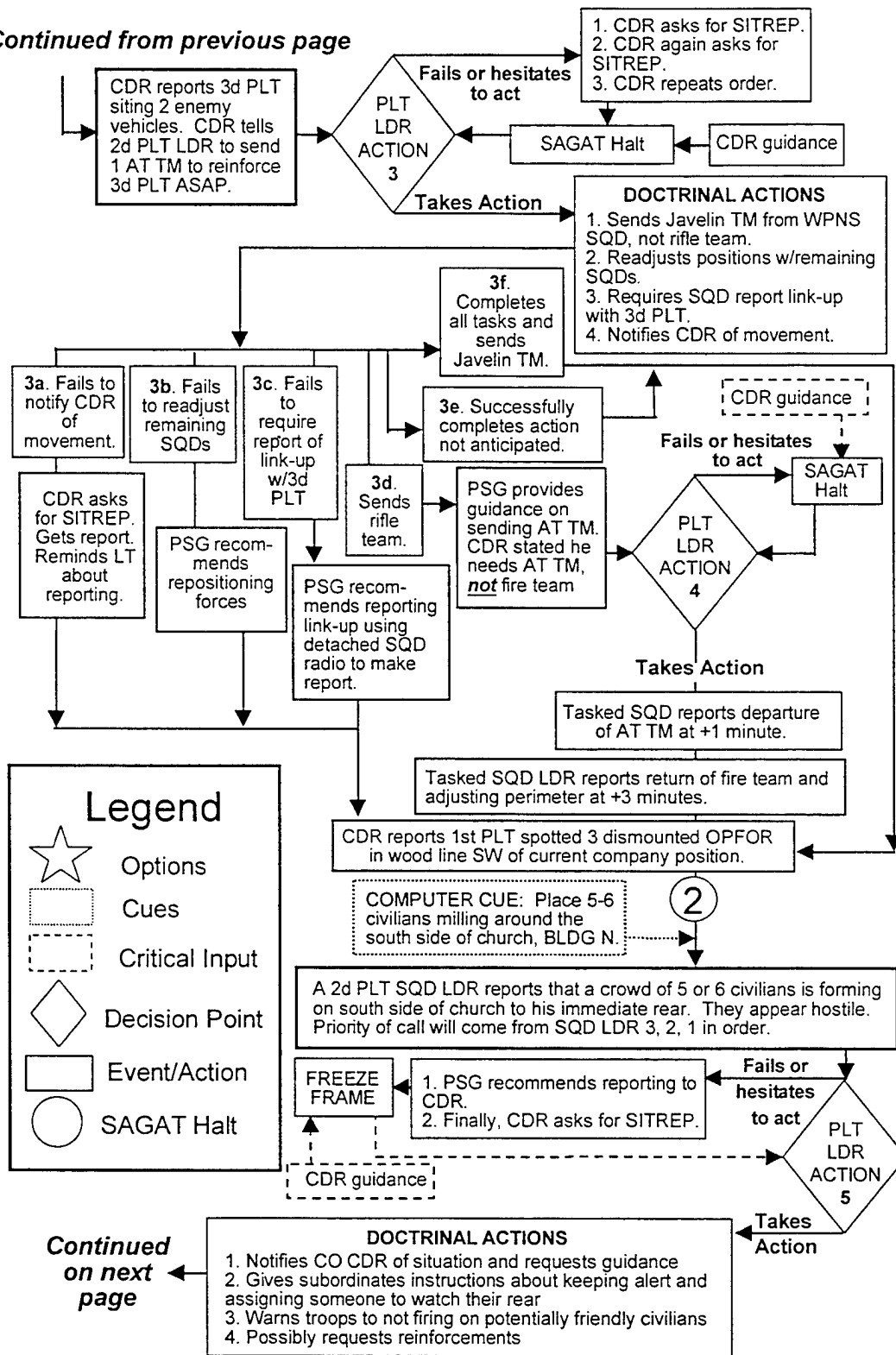
Appendix G: Defend Scenario Flow Chart

Scenario C: Defend Town, 2d PLT Mission

1. Co A, 1-11th Infantry is in the first day of occupying the town of Kenna. The company has the mission to defend the town. The enemy presence is considered light, capable of conducting military operations in the immediate region with forces less than company-size, supported by mortars. There is no heavy threat. Last reported enemy activity in the region was a platoon-sized raid conducted in the neighboring town of Polo, 3 kilometers to the northwest, 2 nights ago. The town population of Kenna is considered to be friendly. However, there may be insurgents and insurgent sympathizers within the town's population.
2. The company has established a defensive perimeter with 1st Platoon defending in the southeast quadrant of the town from BLDGs P5, P2, and A1. Your platoon, the 2d Platoon, defends the southwest quadrant of the town from BLDGs Ia-Id, Ea, and P3. 3d PLT defends the northwest quadrant from BLDGs H, G, and J1. Company A Mortars defends the northeast quadrant from BLDGs P1 and P4. The company CP is located in the north side BLDG A4.
3. Your platoon has 3 rifle squads and 1 weapons squad. The Weapons Squad Leader, SSG Castro, is presently in the hospital recovering from wounds. Since the Weapons Squad has no team leaders, you have attached the Weapons Squad to the 3d Squad to take advantage of the height of Building Id. There are no attachments to the platoon.
4. The 2d Platoon has been in position for 6 hours. The squads are positioned as shown in the accompanying graphic. The company commander selected the north side of BLDG P3 for the 2d Platoon CP. He has directed that all platoon leaders remain in the general vicinity of their respective CPs for communications purposes. He has directed that the platoons use their platoon sergeants as much as possible to realign positions, if necessary.
5. Ration cycle is C, C, A. MEDEVAC is restricted to escorted ground ambulances. Ambulances are coordinated through the company commander. Injured civilians will receive medical assistance. Captured enemy personnel or civilian detainees will be handled through company channels.
6. Rules of Engagement (ROE). Since the overall town population is considered friendly, the rules of engagement are very restrictive. There will be no weapon firing within the town limits except in self-defense or in defense of the town against a confirmed enemy presence. Self-defense is defined as a serious threat to life or limb. A serious threat is considered gunfire or the presence of an uncontrolled mob armed with life-threatening weapons such as knives, pikes, metal poles, etc. Every effort must be made to disarm the situation prior to the use of deadly force. Weapons control status is white.
7. Your immediate task is to brief your squad leaders as to the current situation.
8. What are your questions?

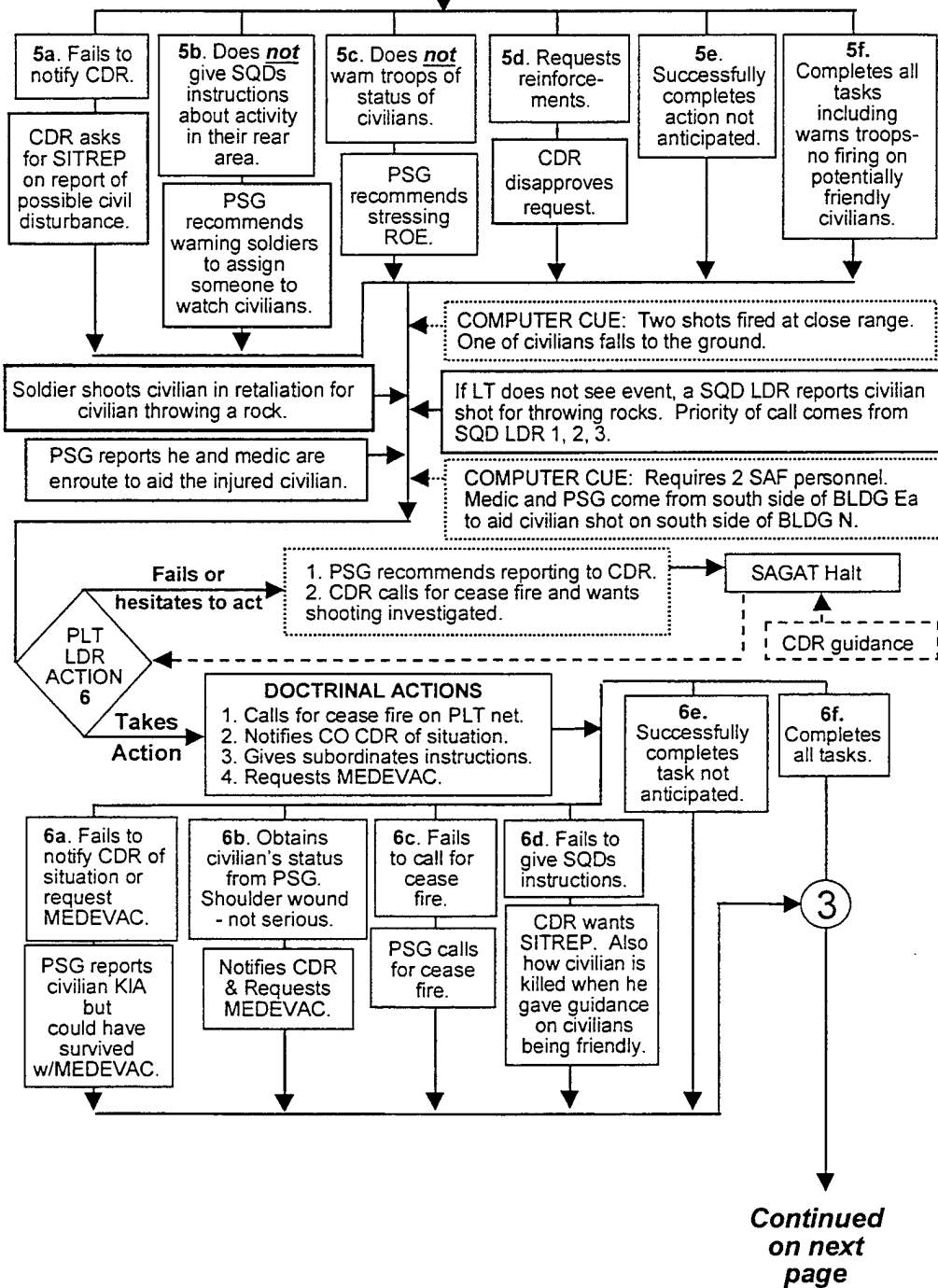


Continued from previous page

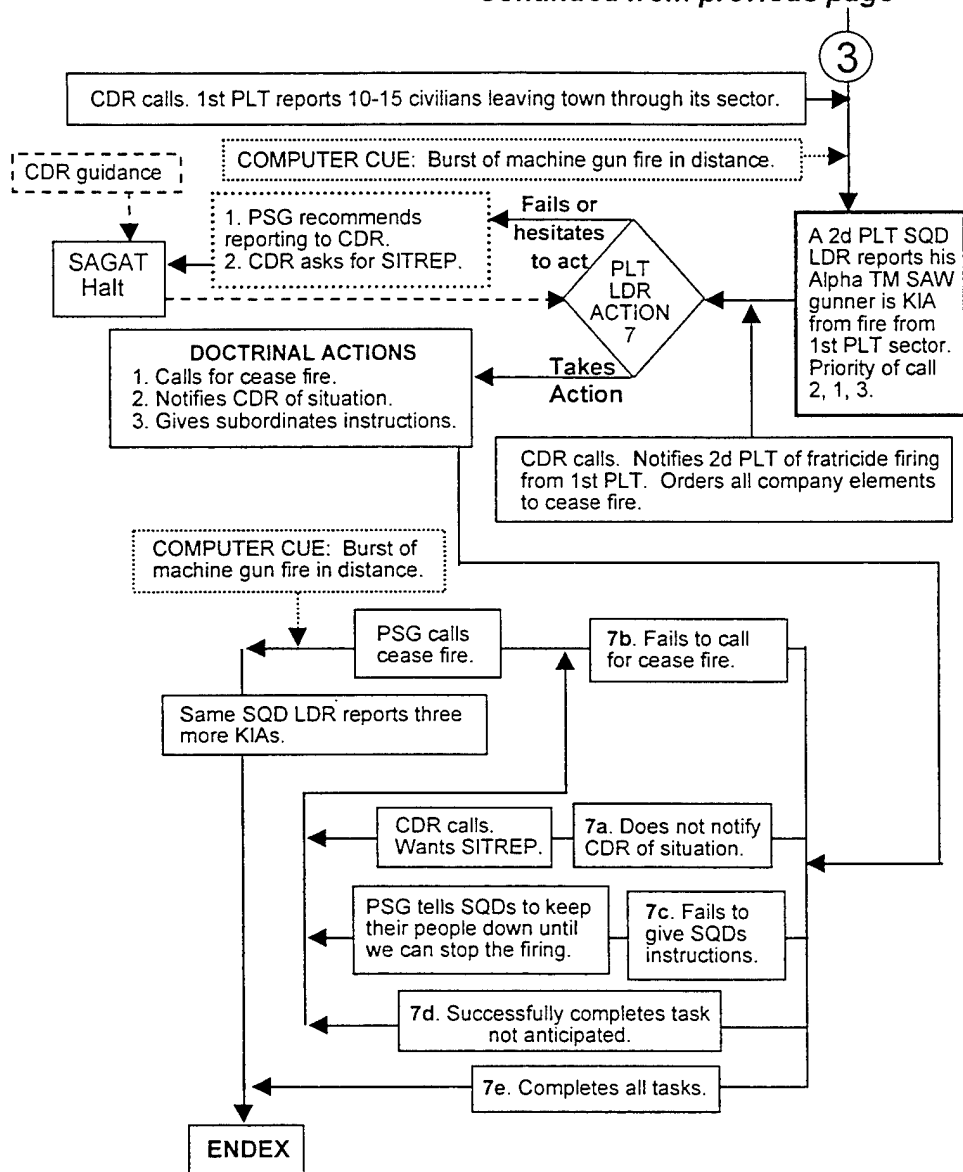


Continued on next page

Continued from previous page



Continued from previous page



Appendix H: Data Analysis Results

Table H-1. Anova Table for Enemy Location

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	3991.059	3991.059	4.809	0.032
Scenario	1	101.264	101.264	0.122	0.728
Halt	2	949.122	474.561	0.572	0.567
Experience * Scenario	1	15.962	15.962	0.019	0.890
Experience * Halt	2	37.466	18.733	0.023	0.978
Scenario * Halt	2	4720.104	2360.052	2.844	0.065
Experience * Scenario * Halt	2	142.150	71.075	0.086	0.918
Residual	69	57265.829	829.940		

Table H-2. Table of Means for Enemy Location

	Mean
Experienced, Assault, 1	69.347
Experienced, Assault, 2	58.127
Experienced, Assault, 3	60.154
Experienced, Defend, 1	44.880
Experienced, Defend, 2	64.751
Experienced, Defend, 3	73.943
Novice, Assault, 1	54.725
Novice, Assault, 2	49.362
Novice, Assault, 3	44.000
Novice, Defend, 1	33.660
Novice, Defend, 2	46.907
Novice, Defend, 3	58.127

Table H-3. Anova Table for Own Platoon Location

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	277.754	277.754	5.190	0.026
Scenario	1	18.390	18.390	0.344	0.560
Halt	2	220.808	110.404	2.063	0.135
Experience * Scenario	1	156.226	156.226	2.919	0.092
Experience * Halt	2	117.075	58.537	1.094	0.341
Scenario * Halt	2	73.749	36.874	0.689	0.506
Experience * Scenario * Halt	2	224.197	112.098	2.095	0.131
Residual	69	3692.499	53.514		

Table H-4. Table of Means for Own Platoon Location

	Mean
Experienced, Assault, 1	75.378
Experienced, Assault, 2	68.717
Experienced, Assault, 3	73.797
Experienced, Defend, 1	78.540
Experienced, Defend, 2	74.846
Experienced, Defend, 3	69.993
Novice, Assault, 1	74.851
Novice, Assault, 2	72.613
Novice, Assault, 3	67.644
Novice, Defend, 1	66.404
Novice, Defend, 2	69.922
Novice, Defend, 3	67.566

Table H-5. Anova Table for Friendly Location

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	732.506	732.506	1.103	0.297
Scenario	1	4737.692	4737.692	7.134	0.009
Halt	2	400.877	200.439	0.302	0.740
Experience * Scenario	1	2127.708	2127.708	3.204	0.078
Experience * Halt	2	157.374	78.687	0.118	0.888
Scenario * Halt	2	1021.989	510.995	0.769	0.467
Experience * Scenario * Halt	2	472.124	236.062	0.355	0.702
Residual	69	45823.548	664.109		

Table H-6. Table of Means for Friendly Location

	Mean
Experienced, Assault, 1	40.028
Experienced, Assault, 2	56.834
Experienced, Assault, 3	44.620
Experienced, Defend, 1	40.358
Experienced, Defend, 2	35.321
Experienced, Defend, 3	50.632
Novice, Assault, 1	63.075
Novice, Assault, 2	63.075
Novice, Assault, 3	64.235
Novice, Defend, 1	36.548
Novice, Defend, 2	34.690
Novice, Defend, 3	42.338

Table H-7. Anova Table for Total Elements Located

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	66.796	66.796	0.440	0.509
Scenario	1	2299.593	2299.593	15.151	<0.001
Halt	2	41.967	20.983	0.138	0.871
Experience * Scenario	1	241.930	241.930	1.594	0.211
Experience * Halt	2	18.225	9.112	0.060	0.942
Scenario * Halt	2	229.871	114.936	0.757	0.473
Experience * Scenario * Halt	2	56.010	28.005	0.185	0.832
Residual	69	10472.702	151.778		

Table H-8. Table of Means for Total Elements Located

	Mean
Experienced, Assault, 1	65.870
Experienced, Assault, 2	63.965
Experienced, Assault, 3	63.965
Experienced, Defend, 1	56.427
Experienced, Defend, 2	57.036
Experienced, Defend, 3	58.688
Novice, Assault, 1	68.704
Novice, Assault, 2	65.094
Novice, Assault, 3	64.933
Novice, Defend, 1	48.158
Novice, Defend, 2	51.428
Novice, Defend, 3	56.711

Table H-9. Anova Table for Highest Threat

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	12200.906	12200.906	9.362	0.003
Scenario	1	3008.755	3008.755	2.309	0.133
Halt	2	371.754	185.877	0.143	0.867
Experience * Scenario	1	23.108	23.108	0.018	0.895
Experience * Halt	2	2076.151	1038.075	0.797	0.455
Scenario * Halt	2	3095.797	1547.899	1.188	0.311
Experience * Scenario * Halt	2	2751.750	1375.875	1.056	0.354
Residual	68	88617.560	1303.199		

Table H-10. Table of Means for Highest Threat

	Mean
Experience, Assault, 1	78.540
Experience, Assault, 2	78.540
Experience, Assault, 3	44.880
Experience, Defend, 1	44.880
Experience, Defend, 2	56.100
Experience, Defend, 3	67.320
Novice, Assault, 1	39.270
Novice, Assault, 2	39.270
Novice, Assault, 3	52.360
Novice, Defend, 1	22.440
Novice, Defend, 2	29.063
Novice, Defend, 3	39.270

Table H-11. Anova Table for Weakest Enemy

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	440.816	440.816	0.347	0.558
Scenario	1	14823.240	14823.240	11.666	0.001
Halt	2	3947.675	1973.838	1.553	0.219
Experience * Scenario	1	17.666	17.666	0.014	0.907
Experience * Halt	2	1691.432	845.716	0.666	0.517
Scenario * Halt	2	6767.729	3383.864	2.663	0.077
Experience * Scenario * Halt	2	2256.577	1128.288	0.888	0.416
Residual	69	87675.650	1270.662		

Table H-12. Table of Means for Weakest Enemy

	Mean
Experience, Assault, 1	11.220
Experience, Assault, 2	22.440
Experience, Assault, 3	22.440
Experience, Defend, 1	67.320
Experience, Defend, 2	33.660
Experience, Defend, 3	33.660
Novice, Assault, 1	13.090
Novice, Assault, 2	13.090
Novice, Assault, 3	13.083
Novice, Defend, 1	56.100
Novice, Defend, 2	11.220
Novice, Defend, 3	56.100

Table H-13. Anova Table for Strongest Enemy

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	11915.107	11915.107	9.361	0.003
Scenario	1	70.414	70.414	0.055	0.815
Halt	2	1139.829	569.915	0.448	0.641
Experience * Scenario	1	3454.945	3454.945	2.714	0.104
Experience * Halt	2	857.340	428.670	0.337	0.715
Scenario * Halt	2	16368.887	8184.443	6.430	0.003
Experience * Scenario * Halt	2	857.340	428.670	0.337	0.715
Residual	69	87822.519	1272.790		

Table H-14. Table of Means for Strongest Enemy

	Mean
Experience, Assault, 1	78.540
Experience, Assault, 2	78.540
Experience, Assault, 3	33.660
Experience, Defend, 1	33.660
Experience, Defend, 2	44.880
Experience, Defend, 3	67.320
Novice, Assault, 1	26.180
Novice, Assault, 2	39.270
Novice, Assault, 3	13.083
Novice, Defend, 1	22.440
Novice, Defend, 2	33.660
Novice, Defend, 3	56.100

Table H-15. Anova Table for Weakest Friendly

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	580.283	580.283	0.381	0.539
Scenario	1	4053.395	4053.395	2.662	0.108
Halt	2	622.439	311.220	0.204	0.816
Experience * Scenario	1	1641.337	1641.337	1.078	0.303
Experience * Halt	2	920.574	460.287	0.302	0.740
Scenario * Halt	2	7824.712	3912.356	2.570	0.084
Experience * Scenario * Halt	2	936.467	468.233	0.308	0.736
Residual	66	100486.018	1522.515		

Table H-16. Table of Means for Weakest Friendly

	Mean
Experience, Assault, 1	52.360
Experience, Assault, 2	26.180
Experience, Assault, 3	44.880
Experience, Defend, 1	11.220
Experience, Defend, 2	51.503
Experience, Defend, 3	44.880
Novice, Assault, 1	62.832
Novice, Assault, 2	52.360
Novice, Assault, 3	52.360
Novice, Defend, 1	22.440
Novice, Defend, 2	44.880
Novice, Defend, 3	29.063

Table H-17. Anova Table for Strongest Friendly

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	4537.133	4537.133	6.504	0.013
Scenario	1	8812.172	8812.172	12.633	0.001
Halt	2	1115.704	557.852	0.800	0.454
Experience * Scenario	1	286.450	286.450	0.411	0.524
Experience * Halt	2	536.748	268.374	0.385	0.682
Scenario * Halt	2	1861.895	930.948	1.335	0.270
Experience * Scenario * Halt	2	1489.227	744.613	1.067	0.350
Residual	65	45342.033	697.570		

Table H-18. Table of Means for Strongest Friendly

	Mean
Experience, Assault, 1	54.725
Experience, Assault, 2	28.545
Experience, Assault, 3	65.450
Experience, Defend, 1	33.118
Experience, Defend, 2	35.678
Experience, Defend, 3	27.024
Novice, Assault, 1	73.177
Novice, Assault, 2	65.670
Novice, Assault, 3	67.815
Novice, Defend, 1	45.870
Novice, Defend, 2	42.311
Novice, Defend, 3	42.311

Table H-19. Anova Table for Exposed Friendly

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	1022.286	1022.286	0.817	0.369
Scenario	1	28293.562	28293.562	22.625	<.0001
Halt	2	1012.748	506.374	0.405	0.669
Experience * Scenario	1	233.831	233.831	0.187	0.667
Experience * Halt	2	349.892	174.946	0.140	0.870
Scenario * Halt	2	5634.433	2817.217	2.253	0.113
Experience * Scenario * Halt	2	1012.748	506.374	0.405	0.669
Residual	68	85037.216	1250.547		

Table H-20. Table of Means for Exposed Friendly

	Mean
Experience, Assault, 1	11.220
Experience, Assault, 2	0.000
Experience, Assault, 3	22.440
Experience, Defend, 1	67.320
Experience, Defend, 2	56.100
Experience, Defend, 3	33.660
Novice, Assault, 1	26.180
Novice, Assault, 2	13.090
Novice, Assault, 3	26.180
Novice, Defend, 1	56.100
Novice, Defend, 2	67.320
Novice, Defend, 3	44.880

Table H-21. Anova Table for My Location Known

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	634.475	634.475	1.553	0.217
Scenario	1	3454.362	3454.362	8.453	0.005
Halt	2	2678.893	1339.446	3.278	0.044
Experience * Scenario	1	634.475	634.475	1.553	0.217
Experience * Halt	2	422.983	211.492	0.518	0.598
Scenario * Halt	2	2678.893	1339.446	3.278	0.044
Experience * Scenario * Halt	2	422.983	211.492	0.518	0.598
Residual	69	28198.870	408.679		

Table H-22. Table of Means for My Location Known

	Mean
Experience, Assault, 1	78.540
Experience, Assault, 2	78.540
Experience, Assault, 3	78.540
Experience, Defend, 1	78.540
Experience, Defend, 2	78.540
Experience, Defend, 3	56.100
Novice, Assault, 1	78.540
Novice, Assault, 2	78.540
Novice, Assault, 3	78.540
Novice, Defend, 1	78.540
Novice, Defend, 2	56.100
Novice, Defend, 3	44.880

Table H-23. Anova Table for Number of Casualties

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	158.619	158.619	0.197	0.659
Scenario	1	26806.551	26806.551	33.229	<.0001
Halt	2	505.230	252.615	0.313	0.732
Experience * Scenario	1	158.619	158.619	0.197	0.659
Experience * Halt	2	1492.190	746.095	0.925	0.401
Scenario * Halt	2	505.230	252.615	0.313	0.732
Experience * Scenario * Halt	2	1492.190	746.095	0.925	0.401
Residual	69	55663.394	806.716		

Table H-24. Table of Means for Number of Casualties

	Mean
Experience, Assault, 1	44.880
Experience, Assault, 2	33.660
Experience, Assault, 3	56.100
Experience, Defend, 1	78.540
Experience, Defend, 2	78.540
Experience, Defend, 3	78.540
Novice, Assault, 1	26.180
Novice, Assault, 2	52.360
Novice, Assault, 3	39.270
Novice, Defend, 1	78.540
Novice, Defend, 2	78.540
Novice, Defend, 3	78.540

Table H-25. Anova Table for Next Enemy Action

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	7.094	7.094	0.009	0.924
Scenario	1	25965.910	25965.910	33.217	<.0001
Halt	2	21189.457	10594.729	13.553	<.0001
Experience * Scenario	1	1120.920	1120.920	1.434	0.235
Experience * Halt	2	1741.582	870.791	1.114	0.334
Scenario * Halt	2	12480.671	6240.335	7.983	0.001
Experience * Scenario * Halt	2	1463.845	731.923	0.936	0.397
Residual	68	53155.398	781.697		

Table H-26. Table of Means for Next Enemy Action

	Mean
Experience, Assault, 1	78.540
Experience, Assault, 2	78.540
Experience, Assault, 3	11.220
Experience, Defend, 1	26.180
Experience, Defend, 2	11.220
Experience, Defend, 3	0.000
Novice, Assault, 1	78.540
Novice, Assault, 2	52.360
Novice, Assault, 3	13.090
Novice, Defend, 1	17.844
Novice, Defend, 2	17.844
Novice, Defend, 3	22.440

Table H-27. Anova Table for Next Civilian Action

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	4143.667	4143.667	3.051	0.085
Scenario	1	1323.780	1323.780	0.975	0.327
Halt	2	13022.395	6511.197	4.795	0.011
Experience * Scenario	1	195.825	195.825	0.144	0.705
Experience * Halt	2	426.900	213.450	0.157	0.855
Scenario * Halt	2	10578.493	5289.246	3.895	0.025
Experience * Scenario * Halt	2	426.900	213.450	0.157	0.855
Residual	69	93702.494	1358.007		

Table H-28. Table of Means for Next Civilian Action

	Mean
Experience, Assault, 1	56.100
Experience, Assault, 2	56.100
Experience, Assault, 3	44.880
Experience, Defend, 1	78.540
Experience, Defend, 2	11.220
Experience, Defend, 3	33.660
Novice, Assault, 1	39.270
Novice, Assault, 2	39.270
Novice, Assault, 3	26.180
Novice, Defend, 1	56.100
Novice, Defend, 2	11.220
Novice, Defend, 3	22.440

Table H-29. Anova Table for Advantage

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	565.936	565.936	0.417	0.520
Scenario	1	565.936	565.936	0.417	0.520
Halt	2	3399.530	1699.765	1.254	0.292
Experience * Scenario	1	3620.813	3620.813	2.670	0.107
Experience * Halt	2	203.659	101.829	0.075	0.928
Scenario * Halt	2	2177.579	1088.790	0.803	0.452
Experience * Scenario * Halt	2	109.662	54.831	0.040	0.960
Residual	69	93555.625	1355.879		

Table H-30. Table of Means for Advantage

	Mean
Experience, Assault, 1	56.100
Experience, Assault, 2	56.100
Experience, Assault, 3	33.660
Experience, Defend, 1	67.320
Experience, Defend, 2	67.320
Experience, Defend, 3	67.320
Novice, Assault, 1	65.450
Novice, Assault, 2	65.450
Novice, Assault, 3	39.270
Novice, Defend, 1	56.100
Novice, Defend, 2	44.880
Novice, Defend, 3	44.880

Table H-31. Anova Table for Not in Communication

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	1810.630	1810.630	1.563	0.215
Scenario	1	103.115	103.115	0.089	0.766
Halt	2	1488.758	744.379	0.643	0.529
Experience * Scenario	1	6954.292	6954.292	6.005	0.017
Experience * Halt	2	132.434	66.217	0.057	0.945
Scenario * Halt	2	1488.758	744.379	0.643	0.529
Experience * Scenario * Halt	2	132.434	66.217	0.057	0.945
Residual	69	79908.919	1158.100		

Table H-32. Table of Means for Not in Communication

	Mean
Experience, Assault, 1	11.220
Experience, Assault, 2	11.220
Experience, Assault, 3	11.220
Experience, Defend, 1	29.063
Experience, Defend, 2	13.247
Experience, Defend, 3	40.283
Novice, Assault, 1	39.270
Novice, Assault, 2	39.270
Novice, Assault, 3	39.270
Novice, Defend, 1	17.844
Novice, Defend, 2	11.216
Novice, Defend, 3	26.247

Table H-33. SABARS Factor Analysis – Factor Loadings

	Factor 1- Gathering Information	Factor 2–Focusing Out Vs In	Factor 3–Seeking Key Information	Factor 4–Focusing on Big Picture
Alert Level	0.653	-0.037	-0.072	0.160
SL Info	0.037	-0.778	0.020	0.250
CO Info	-0.178	0.274	0.440	0.588
Commo to CO	0.248	0.751	0.185	0.304
Commo to SL	0.176	0.040	0.212	0.634
Monitors net	0.567	0.208	-0.174	0.489
Assess Info	0.603	0.173	0.388	0.267
Intel requested	<.001	0.576	0.256	0.337
Intel gathered	-0.027	-0.129	0.824	-0.118
Give CI & big pic	0.131	-0.167	-0.027	0.605
Uses SRP	0.825	0.187	-0.197	0.264
Ids Critical tasks	-0.038	-0.817	0.011	0.077
Cover Approach	-0.170	-0.105	0.629	0.215
Vantage Pt	0.117	0.183	0.629	0.062
Asset recon	0.862	<.001	0.169	-0.004
OCOKA	0.695	-0.037	0.329	-0.264
Key finds	0.339	0.405	0.603	0.205
Key info-reports	0.246	0.403	0.654	0.175
Follow up info	0.611	0.605	0.051	<.001
Overall SA	0.547	0.249	0.558	-0.009

* all items with loadings > .30 included in combined factor score

Table H-34. SABARS Factor Analysis -Eigenvalues and percent of variance accounted for by factors

Eigenvalues

	Magnitude	Variance Prop.
Factor 1 - Gathering Information	7.113	0.356
Factor 2 - Focusing Out Vs. In	2.361	0.118
Factor 3 - Seeking Key Information	2.32	0.116
Factor 4 - Focusing on Big Picture	1.521	0.076

Table H-35. Correlation Matrix for all SA Measures

	1-Info Gather	2-Focus Out v. In	3-Seek Key Info	4-Big Picture	PSAQ Workload	PSAQ Performance	PSAQ SA	Enemy ID
1-Info Gathering	1	0.557	0.685	0.623	-0.016	0.097	0.339	0.413
2-Focus Out v. In	0.557	1	0.368	0.56	0.304	-0.226	0.106	0.153
3-Seeks Key Info	0.685	0.368	1	0.367	0.113	0.161	0.471	0.269
4-Big Picture Focus	0.623	0.56	0.367	1	0.045	-0.085	0.001	0.558
Self-Rated Workload	-0.016	0.304	0.113	0.045	1	-0.375	-0.143	-0.287
Self -Rated Performance	0.097	-0.226	0.161	-0.085	-0.375	1	0.26	0.167
Self - Rated SA	0.339	0.106	0.471	0.001	-0.143	0.26	1	0.14
Enemies Located	0.413	0.153	0.269	0.558	-0.287	0.167	0.14	1
Own Platoon Located	0.102	0.121	0.129	0.141	0.188	0.155	0.077	0.37
Other Friendlies Located	-0.093	0.183	-0.036	0.247	0.388	-0.21	-0.027	0.263
Total Elements Located	0.032	0.262	-0.038	0.322	0.354	-0.214	-0.06	0.436
Highest Threat	0.09	-0.155	0.202	0.146	0.039	0.111	-0.074	0.453
Weakest Enemy	0.028	0.046	0.115	-0.015	-0.239	0.21	0.262	0.193
Strongest Enemy	0.282	0.081	0.299	0.334	0.2	0.166	-0.04	0.458
Weakest Friendly	-0.298	-0.088	-0.233	-0.062	0.268	0.017	-0.166	-0.003
Strongest Friendly	-0.455	-0.078	-0.464	-0.2	0.162	-0.139	-0.11	-0.199
Exposed Friendly	0.031	0.22	0.052	-0.258	-0.157	0.205	0.346	-0.344
F Location Known	-0.166	0.218	-0.255	-0.249	0.139	-0.132	-0.189	-0.215
# Casualties	0.371	0.284	0.551	0.219	-0.008	0.369	0.551	-0.122
Expected Enemy Actions	-0.124	-0.057	-0.349	0.02	0.314	-0.145	-0.37	-0.119
Expected Civilian Actions	0.255	0.314	-0.04	0.18	-0.184	-0.125	-0.004	0.276
Advantage	0.105	-0.173	0.08	0.067	-0.479	0.299	0.23	0.366
Not in Communication	-0.175	-0.07	-0.225	0.1	-0.354	0.261	-0.243	0.268

Table H-35 (continued) Correlation Matrix for all SA Measures

	Own Troop ID	Adj. Friendly ID	Total ID	Highest Threat	Weakest Enemy	Strongest Enemy	Weakest Friendly	Strongest Friendly
1-Info Gathering	0.102	-0.093	0.032	0.09	0.028	0.282	-0.298	-0.455
2-Focus Out v. In	0.121	0.183	0.262	-0.155	0.046	0.081	-0.088	-0.078
3-Seeks Key Info	0.129	-0.036	-0.038	0.202	0.115	0.299	-0.233	-0.464
4-Big Picture Focus	0.141	0.247	0.322	0.146	-0.015	0.334	-0.062	-0.2
Self-Rated Workload	0.188	0.388	0.354	0.039	-0.239	0.2	0.268	0.162
Self -Rated Performance	0.155	-0.21	-0.214	0.111	0.21	0.166	0.017	-0.139
Self - Rated SA	0.077	-0.027	-0.06	-0.074	0.262	-0.04	-0.166	-0.11
Enemies Located	0.37	0.263	0.436	0.453	0.193	0.458	-0.003	-0.199
Own Platoon Located	1	0.339	0.5	0.508	0.271	0.464	-0.139	-0.013
Other Friendlies Located	0.339	1	0.902	0.15	-0.147	0.244	-0.041	0.212
Total Elements Located	0.5	0.902	1	0.295	-0.057	0.398	-0.086	0.201
Highest Threat	0.508	0.15	0.295	1	-0.01	0.699	0.049	-0.446
Weakest Enemy	0.271	-0.147	-0.057	-0.01	1	0.268	-0.278	-0.044
Strongest Enemy	0.464	0.244	0.398	0.699	0.268	1	-0.212	-0.442
Weakest Friendly	-0.139	-0.041	-0.086	0.049	-0.278	-0.212	1	0.254
Strongest Friendly	-0.013	0.212	0.201	-0.446	-0.044	-0.442	0.254	1
Exposed Friendly	-0.276	-0.289	-0.346	-0.583	0.277	-0.323	-0.129	-0.012
F Location Known	0.103	0.052	0.119	0.05	-0.284	-0.146	0.021	0.198
# Casualties	-0.119	-0.151	-0.285	-0.204	0.312	-0.021	-0.054	-0.302
Expected Enemy Actions	-0.153	0.299	0.339	0.137	-0.676	0.027	0.293	0.245
Expected Civilian Actions	-0.22	0.123	0.217	-0.063	0.115	0.007	-0.211	0.041
Advantage	0.123	-0.186	-0.155	0.305	0.125	0.077	0.017	-0.197
Not in Communication	-0.059	0.178	0.131	-0.014	-0.094	-0.073	0.152	0.1

Table H-35 (continued) Correlation Matrix for all SA Measures

	Exposed Friendly	F Location Known	# Casualties	Next Enemy Actions	Next Civilian Actions	Advantage	Not in Communication
1-Info Gathering	0.031	-0.166	0.371	-0.124	0.255	0.105	-0.175
2-Focus Out v. In	0.22	0.218	0.284	-0.057	0.314	-0.173	-0.07
3-Seeks Key Info	0.052	-0.255	0.551	-0.349	-0.04	0.08	-0.225
4-Big Picture Focus	-0.258	-0.249	0.219	0.02	0.18	0.067	0.1
Self-Rated Workload	-0.157	0.139	-0.008	0.314	-0.184	-0.479	-0.354
Self -Rated Performance	0.205	-0.132	0.369	-0.145	-0.125	0.299	0.261
Self - Rated SA	0.346	-0.189	0.551	-0.37	-0.004	0.23	-0.243
Enemies Located	-0.344	-0.215	-0.122	-0.119	0.276	0.366	0.268
Own Platoon Located	-0.276	0.103	-0.119	-0.153	-0.22	0.123	-0.059
Other Friendlies Located	-0.289	0.052	-0.151	0.299	0.123	-0.186	0.178
Total Elements Located	-0.346	0.119	-0.285	0.339	0.217	-0.155	0.131
Highest Threat	-0.583	0.05	-0.204	0.137	-0.063	0.305	-0.014
Weakest Enemy	0.277	-0.284	0.312	-0.676	0.115	0.125	-0.094
Strongest Enemy	-0.323	-0.146	-0.021	0.027	0.007	0.077	-0.073
Weakest Friendly	-0.129	0.021	-0.054	0.293	-0.211	0.017	0.152
Strongest Friendly	-0.012	0.198	-0.302	0.245	0.041	-0.197	0.1
Exposed Friendly	1	-0.045	0.547	-0.305	-0.017	-0.069	-0.115
F Location Known	-0.045	1	-0.253	0.102	0.281	-0.201	0.085
# Casualties	0.547	-0.253	1	-0.374	-0.172	0.132	-0.214
Expected Enemy Actions	-0.305	0.102	-0.374	1	-0.007	-0.156	-0.03
Expected Civilian Actions	-0.017	0.281	-0.172	-0.007	1	-0.139	0.047
Advantage	-0.069	-0.201	0.132	-0.156	-0.139	1	0.336
Not in Communication	-0.115	0.085	-0.214	-0.03	0.047	0.336	1

Table H-36. Anova table for SABARS Factor 1 – Gathering Information

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	33.423	33.423	7.763	0.008
SCENARIO	3	4.806	1.602	0.372	0.774
Experience * SCENARIO	3	15.067	5.022	1.167	0.332
Residual	48	206.650	4.305		

Table H-37. Anova Table for SABARS Factor 2 – Focusing Outward Vs. Inward

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	5.743	5.743	2.684	0.108
SCENARIO	3	0.975	0.325	0.152	0.928
Experience * SCENARIO	3	2.022	0.674	0.315	0.815
Residual	48	102.712	2.140		

Table H-38. Anova Table for SABARS Factor 3 – Proactively Seeking Key Information

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	19.091	19.091	3.411	0.071
SCENARIO	3	36.920	12.307	2.199	0.100
Experience * SCENARIO	3	19.396	6.465	1.155	0.337
Residual	48	268.635	5.597		

Table H-39. Anova Table for SABARS Factor 4 – Focusing on the Big Picture

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Experience	1	6.285	6.285	6.761	0.012
SCENARIO	3	0.334	0.111	0.120	0.948
Experience * SCENARIO	3	1.502	0.501	0.538	0.658
Residual	48	44.621	0.930		

Table H-40. Anova Table for PSAQ Workload

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Scenario	1	2.286	2.286	2.909	0.101
Experience	1	0.143	0.143	0.182	0.674
Scenario * Experience	1	0.143	0.143	0.182	0.674
Residual	24	18.857	0.786		

Table H-41. Anova Table for PSAQ Performance

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Scenario	1	1.750	1.750	2.227	0.149
Experience	1	0.321	0.321	0.409	0.529
Scenario * Experience	1	0.321	0.321	0.409	0.529
Residual	24	18.857	0.786		

Table H-42. Anova Table for PSAQ SA

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Scenario	1	2.286	2.286	3.048	0.094
Experience	1	0.143	0.143	0.190	0.666
Scenario * Experience	1	1.286	1.286	1.714	0.203
Residual	24	18.000	0.750		

Appendix I: Acronyms

AAR – After Action Review

ANOVA – Analysis of Variance

AO – Area of Operations

CI – Commander's Intent

CO – Commanding Officer

COA – Course of Action

FOF – Field of Fire

FOO – Field of Observation

LP/OP – Listening Post/Observation Post

MOUT – Military Operations on Urbanized Terrain

NBC – Nuclear, Biological, and Chemical

NVG – Night Vision Goggles

O/C – Observer/Controller

OCOKA – Observation, Cover and Concealment, Obstacles, Key Terrain, Avenues of Approach

PSAQ – Post-Trial Participant Subjective SA Questionnaire

ROE – Rules of Engagement

SA – Situation Awareness

SABARS – Situation Awareness Behaviorally Anchored Rating Scale

SAGAT – Situation Awareness Global Assessment Technique

SART – Situation Awareness Rating Technique

SASO – Stability and Support Operations

SME – Subject Matter Expert

SSE – Squad Synthetic Environment