**TECHNICAL REPORT**
**NATICK/TR-10/010**

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# IDENTIFICATION OF SOLDIER BEHAVIORS ASSOCIATED WITH SEARCH AND TARGET ACQUISITION (STA)

**by**
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May 2010

Final Report
July 2008 – March 2009



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# REPORT DOCUMENTATION PAGE

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| 1. REPORT DATE *(DD-MM-YYYY)* | 2. REPORT TYPE | 3. DATES COVERED *(From - To)* |
|---|---|---|
| 07-05-2010 | Final | July 2008 – March 2009 |

**4. TITLE AND SUBTITLE**

IDENTIFICATION OF SOLDIER BEHAVIORS ASSOCIATED WITH SEARCH AND TARGET ACQUISITION (STA)

**5a. CONTRACT NUMBER**

**5b. GRANT NUMBER**

**5c. PROGRAM ELEMENT NUMBER**

**6. AUTHOR(S)**

Dean-Michael Sutherland

**5d. PROJECT NUMBER**
ACR08-Soldier-025

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

U.S. Army Natick Soldier Research, Development and Engineering Center
ATTN: RDNS-TSM
Kansas St., Natick, MA 01760-5019

**8. PERFORMING ORGANIZATION REPORT NUMBER**

NATICK/TR-10/010

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

U.S. Army Training and Doctrine Command (TRADOC) Analysis Center
PO Box 8695
Monterey, CA 93943-0692

**10. SPONSOR/MONITOR'S ACRONYM(S)**
TRAC-MTRY

**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

**12. DISTRIBUTION / AVAILABILITY STATEMENT**

Approved for public release; distribution is unlimited.

**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**

This report provides details on the work conducted to construct a decision map supporting the representation of search and target Acquisition (STA) behaviors within the Infantry Warrior Simulation (IWARS) model. The objective was to identify the STA behaviors a Soldier may use after detecting a battlefield cue to improve his level of target discrimination. The impact of these cues on a Soldier's behavior are not included in the models currently used. The research was funded by the Soldier Focus Area Collaborative Team (FACT) at the U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC)—Monterrey. It was conducted by the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) between July 2008 and March 2009. The results of this work will be provided to the developers of IWARS for incorporation into the model. Their inclusion will significantly enhance the model's ability to represent real-world STA. The results will also be transitioned to other constructive simulations for their use, thereby enabling them to better assess the impact of net-centric warfare and/or new information technology on STA and situation awareness.

**15. SUBJECT TERMS**

| | | | |
|---|---|---|---|
| HUMANS | VALIDATION | TARGET DETECTION | COMBAT SIMULATION |
| MODELS | PREDICTIONS | VISUAL PERCEPTION | PERFORMANCE(HUMAN) |
| BEHAVIOR | VERIFICATION | SENSES(PHYSIOLOGY) | SITUATIONAL AWARENESS |
| COGNITION | DECISION MAKING | SPEECH RECOGNITION | INFORMATION PROCESSING |
| SIMULATION | DATA ACQUISITION | TARGET RECOGNITION | BATTLEFIELD INFORMATION |
| STA(SEARCH AND TARGET ACQUISITION) | | | NETWORK CENTRIC WARFARE |

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | Dean-Michael Sutherland |
| U | U | U | SAR | 64 | 19b. TELEPHONE NUMBER *(include area code)* 508-233-5558 |

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## Preface

The Soldier Focus Area Collaborative Team (FACT) ) at the U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC)—Monterrey funded this effort to identify the search and target acquisition (STA) behaviors that a Soldier may use after detecting a battlefield cue to improve his level of target discrimination. Research was conducted under Soldier FACT Project Number ACR08-Soldier-025 during the period July 2008 through March 2009 by the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC). This report provides details on the work conducted to construct a decision map supporting the representation of STA behaviors within the Infantry Warrior Simulation (IWARS) required to achieve the project's goal.

The author would like to thank Joseph Venezia, NSRDEC Modeling and Analysis Team, for sharing his knowledge on the STA process and the ACQUIRE model. In addition, the author thanks Chris King, NSRDEC Battle Lab Integration Team, for his invaluable assistance in the development of the decision map.

# IDENTIFICATION OF SOLDIER BEHAVIORS ASSOCIATED WITH SEARCH AND TARGET ACQUISITION (STA)

## 1. Introduction

On the battlefield, a Soldier constantly searches for targets using a search and target acquisition (STA) process. Sometimes the Soldier will not be able to identify the target directly, but only indirectly through the detection of battlefield cues (i.e., target signatures). A battlefield cue/target signature is an indicator or clue that aids a Soldier in the search to detect the presence of potential targets. Many constructive simulations, e.g., One Semi-Automated Forces (SAF) Objective System (OOS), Combat XXI, JCATS, and the Infantry Warrior Simulation (IWARS), represent the STA by using a modeling methodology similar to the Target Acquisition Decision Model (TADM) (Figure 1) used by IWARS. This methodology focuses primarily on the visual target *detection* portion of target discrimination and much less on the *classification*, *recognition*, and *identification* aspects of STA. The TADM considers having a *detection* to also mean having *classification* because IWARS agents tend to be limited to humans and classification is not needed. This is why there is no classification triangle in Figure 1.

Frequently in the real world, Soldiers do not see the target directly, but rely on battlefield cues to help them locate and identify the target. In addition, quite often the Soldier becomes aware of only one cue at a time, which alone does not provide enough information for him to positively identify the target and prevents him from deciding on his next course of action. When this happens, a Soldier may decide to perform some behavior to obtain more information in order to improve his target *identification*. These behaviors and their associated decisions are not represented in the constructive simulations that are currently used. Instead, simulations have historically used the ACQUIRE model. The current version is Target Task Performance Metric (ACQUIRE TTPM). It determines if a *detection* and the higher levels of target discrimination are made by making a random draw against a generated probability that takes into consideration relevant variables such as target posture, range, movement state, light level, background contrast, etc., but it does not account for the impact of battlefield cues.

This report documents the work and results of an effort funded by the Soldier Focus Area Collaborative Team (FACT) at the U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC)—Monterrey to identify the STA behaviors that a Soldier may use after detecting a battlefield cue to improve his level of target discrimination. The work was performed by the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) Modeling and Analysis Team during the period July 2008 through March 2009. This work was intended to enhance the marked area in Figure 1. This report includes recommendations on areas for further investigation and possible methods for representing some of the decision map elements needed for representation of the results.

### *1.1 Focus Area Collaborative Teams*

FACTs were established at various TRACs, including Monterrey, to support efforts addressing capability gaps identified by the Soldier Modeling and Analysis Working Group related to improving current Soldier modeling and simulation. Several FACTs were formed targeting

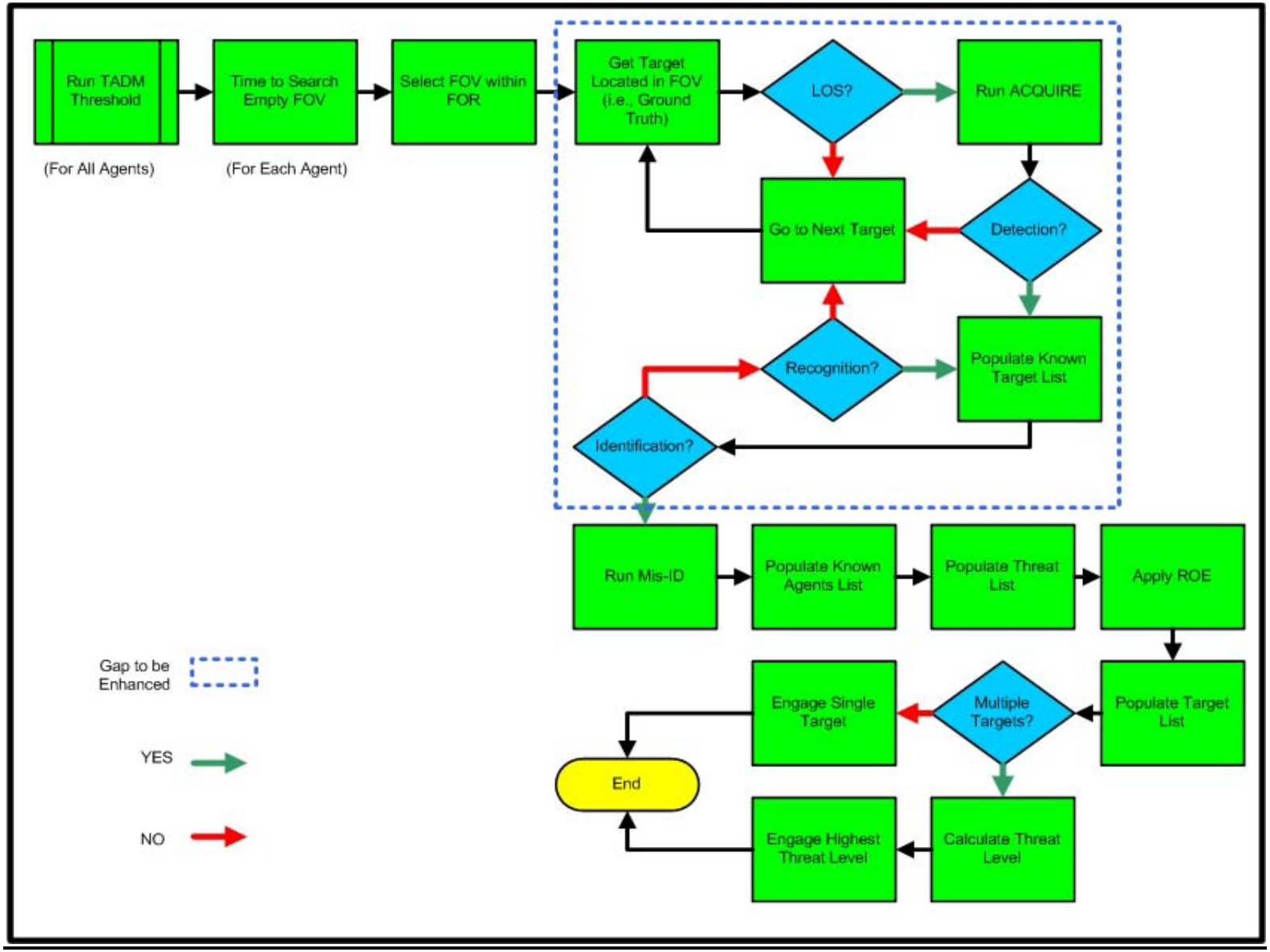



**Figure 1. TADM Used by IWARS**

different gaps. Each of these FACTs focused on several critical research areas (CRAs). The Fiscal Year (FY) 08 Soldier FACT Call for Proposals identified the following CRA:

> Soldier Search and Target Acquisition (STA): Determine validity of current Soldier STA processes for acquiring other personnel. Areas may include differences between dismounted and mounted search, various environments (day, night, weather), changing light and shadows, changing optical contrasts, and uniforms including distinguishing civilians from enemy, peripheral vision, search patterns, cognitive behaviors. If substantiated, develop algorithms, methodologies, and data to improve M&S [models and simulations] and analysis. Research should focus on how Soldier STA process differs from other STA processes, and should not focus on how Soldier STA may differ over range.

This effort specifically concentrated on representing Soldier and small unit behavior engaging "non-acquired" targets and "non-standard" entities, such as: muzzle flash, laser/tracers, passing of situation awareness (SA) information (e.g., target handoff - the exchange of target information), suppressive fires, and fire without detection/ aim points.

### *1.2 Scope and Objectives*

The overall scope of this project was identification and development of a methodology to enhance STA by incorporating the impact of battlefield cues. The objective was to identify the STA behaviors available to Soldiers after a detection or battlefield cue and when they would be used in order to enhance the realism of the TADM, shown in Figure 1.

This effort originally proposed two additional objectives: to determine and model behaviors which occur when the Soldier is presented with conflicting or ambiguous data, and to determine and model the behaviors that result from peripheral vision and low contrast battlefield cues. These objectives were eliminated due to funding limitations. There were also insufficient funds received to substantiate the results of this research in a model.

Other factors that affect STA, such as search patterns, peripheral vision, varying light levels and reduced visibility conditions, were not addressed. This effort focused on limiting the number of variables which could impact the STA process so the results would be applicable to a baseline or control case with the widest possible application. However, some recommendations on methods to account for some of these variables are provided where relevant. Also, the development of new methodologies/algorithms or modification of the existing ACQUIRE TTPM methodologies/ algorithms was not covered in this project.

## 2. Approach

The effort began by gaining a full understanding of the STA process for real Soldiers and how it was represented in models. This knowledge was then used to determine what information was needed to enhance the representation. Knowledge engineering (KE) tools were used to obtain the identified information and help incorporate it into a decision map. The KE tasks targeted the following areas:

- Identification of Soldier information needs related to target identification
- Identification and prioritization of battlefield cues
- Linkage of these battlefield cues to the target identification needs they satisfied
- Identification of the behaviors a Soldier could use to improve his STA
- Investigation of behavior costs
- Prioritization and selection of behavior use

This information was fed into decision maps (i.e., flowcharts) depicting the decision process a Soldier would go through to select which behavior(s) to use to help him identify a target after a battlefield cue had been detected. The decision maps linked the following information:

- Elements associated with target acquisition levels
- Common battlefield cues
- Elements provided by battlefield cues
- Behaviors available to improve the target acquisition level
- Expected cost of a behavior
- Behavior use prioritization and selection

The decision maps were constructed using a spiral development process (i.e., an iterative process of software development and testing). The development process consisted of the following elements (see Figure 2):

- Data collection:
  - Literature reviews of field manuals, current research, and model algorithm and user guides.
  - Discussions with subject matter experts (SMEs) in infantry operations, constructive model development, and vision representation
  - Results of 40 human centered target acquisition (HCTA) surveys from 2004-2005 of returning Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) Soldiers that sought information on several aspects of the target acquisition process
- KE to translate the data collection results into a representation of the decision making process.
- Understanding of the Soldier's STA decision making process based on the John Boyd's Observe-Orient-Decide and Act Loop.
- Validation of the representation to determine if it functioned as intended.

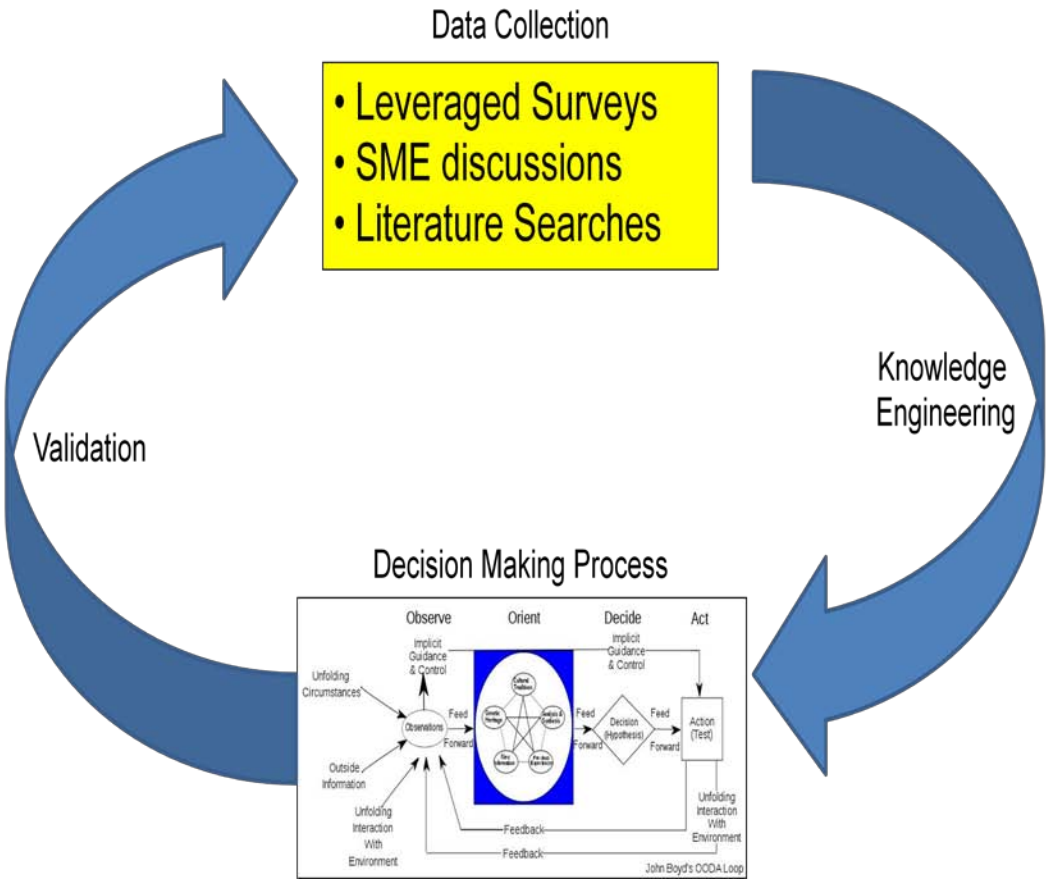



**Figure 2. Spiral Development Process**

During the performance of the various tasks, it became obvious there was a great deal of depth and breadth related to the various types of data sought. This was because typically the type of battlefield cue and amount and type of information used to identify a threat was different for each situation. To deal with this, the focus of data collection and use was kept at a generic level to provide the most flexibility and applicability. This was done by adhering to the following three criteria:

- Concentrate on the individual Soldier level.
- Focus on a Soldier trying to improve his STA, and not on his immediate reactions to cues, such as self-preservation behaviors (e.g., going prone).
- Assume the Soldier was searching for targets with the goal of *identification* so he could decide his next course of action.

### *2.1 Understanding the STA Process*

The STA process begins with a Soldier searching an area (specifically his field of view) for objects or individuals of military significance or battlefield cues (i.e., target signatures) that indicate these are in the area. A battlefield cue/target signature is an indicator or clue that aids a Soldier in the search to detect the presence of potential targets.

After the Soldier becomes aware of something significant, he goes through a series of steps in response that simultaneously prepares him to act/react and inform his unit members and leaders. These steps are depicted in Figure 3. In this effort, these steps were represented at a generic level, with the ones in red being those of specific interest. Work was concentrated on identifying the specific information needs and behaviors associated with these steps.

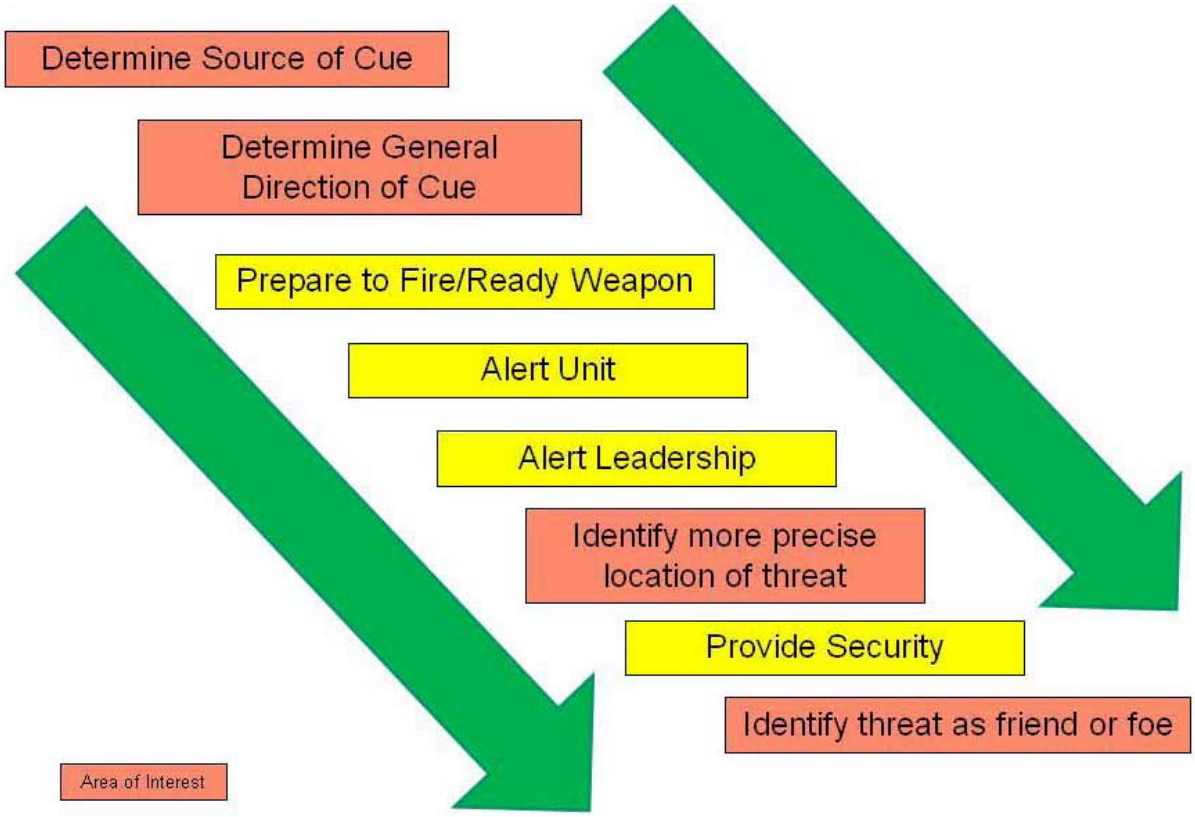
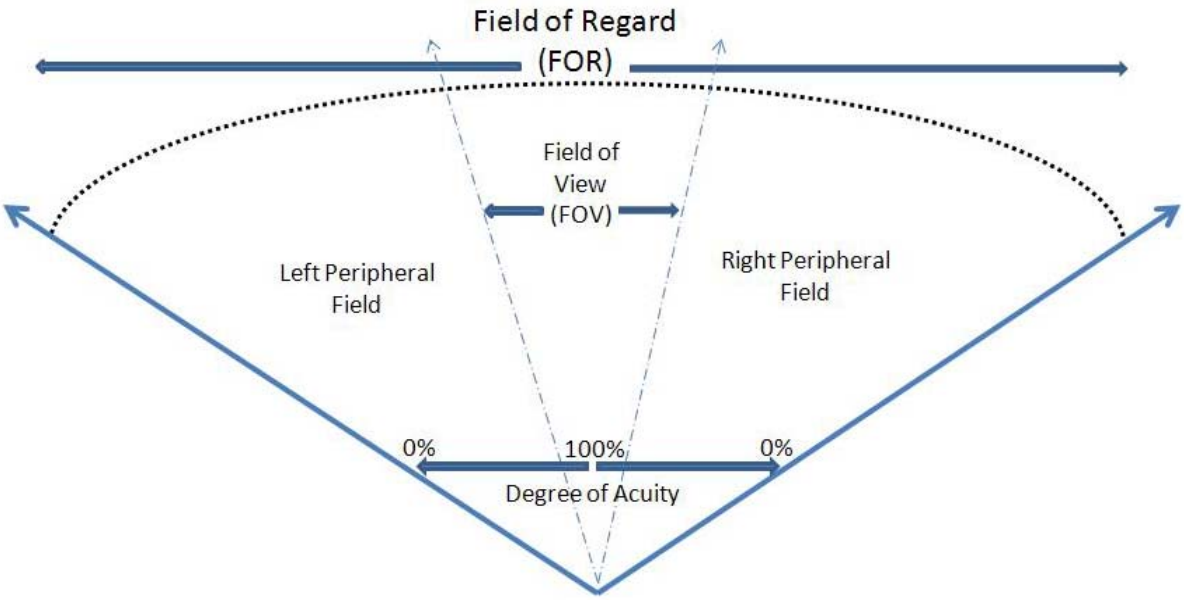



**Figure 3. Process after Initial Detection**

### *2.1.1 Field of View*

When searching, a Soldier can use any means available, such as listening, smelling, sensors, and communication, to assist him. However, constructive simulations tend to be limited to visual means only. When using visual means, the Soldier will search his field of regard (FOR). The FOR consists of the Soldier's field of view (FOV) and the peripheral fields to its sides. The FOV is the area where the Soldier can discriminate visually between the various things located in it; that is, he has a very high level of acuity (100% at the center of the FOR). The level of acuity decreases as the location of an object moves farther away from the center of the FOV. Eventually, in the left and right peripheral fields, the level of acuity decreases to a level where the Soldier cannot discriminate adequately what is seen. From the beginnings of the peripheral fields to the ends of the Soldier's FOR, he is limited to only noticing movement or flashing light. Figure 4 shows the described components of the FOR.




OTE: 100% at center of FOR denotes Degree of Acuity

**Figure 4: Components of the FOR**

Visual target acquisition is represented in constructive models and simulations using the ACQUIRE TTPM model, which was developed by the Communications-Electronics Research, Development and Engineering Center (CERDEC)'s Night Vision and Electronic Sensors Directorate. The ACQUIRE TTPM methodology only determines if detections are made in the designated FOV (the "get target located in FOV" step in the TADM). This has been acceptable up to now, but as the need to more accurately simulate the Soldier's STA process becomes commonplace, two potential issues must be accounted for:

1. Constructive simulations use some method (e.g., algorithm, formula, user defined) to divide the FOR into FOV increments. This is one of the first steps in the TADM. These FOV increments typically are much larger than a real Soldier's FOV, e.g., 45° to 10°. In conjunction with this, the ACQUIRE TTPM methodology has the same level of acuity throughout the entire FOV, i.e., is homogenous, and it does not decrease as an actual Soldier's acuity decreases. A real Soldier only has a high level of acuity in a small portion of his FOV. The result is the simulated Soldier can more quickly scan a larger FOR than a real Soldier can. The impact of this at short ranges is negligible, but as the range increases the simulated Soldier makes significantly quicker detections and identifications than a real Soldier. Additionally, having a wide homogenous FOV imposes a substantial computational load on the simulation.
2. The represented Soldier cannot detect any visual signatures or cues occurring in the peripheral fields. The "get target located in FOV" step in the TADM is associated with this limitation. Even though a real Soldier is not able to discriminate anything visually in the peripheral fields, he can detect it and turn towards it. Agents in constructive simulations cannot do this. Work is currently being conducted by the U.S. Army Research Laboratory's Human Research and

Engineering Directorate (HRED) and NSRDEC on reducing the represented FOV by increasing a Soldier's ability to make detections in the periphery. This will more accurately represent the Soldier's STA in simulations.

### *2.1.2 Scan*

In the search step, the Soldier is typically responsible for searching an assigned sector. While performing his search, the Soldier may use one of several techniques available to scan his FOR. The Soldier generally progresses through three ground-search techniques to locate targets quickly:

- *Rapid scan* – The Soldier quickly looks from near to far, then orients left or right and takes a quick look again, and repeats this until he has swept his entire FOR.
- *Slow scan (50 m strips)* – The Soldier slowly progresses laterally through his FOR in 50 m deep strips. When a strip is completed, he will search the next strip farther out, and repeat this until the entire FOR has been done.
- *Detailed search* – The Soldier has the time to focus his attention on specific locations (i.e., points of interest such as windows, etc.) and look for cues.

The Soldier searches continuously, as any target or cue missed on the first or second scan may be seen on the third or fourth scan. Modifications to these techniques exist when scanning at night or for air targets. Appendix A provides the description of these techniques obtained from Field Manual 17-12-8 - Light Cavalry Gunnery.

The methodology that constructive simulations use (i.e., ACQUIRE TTPM) approximates a detailed search. Instead of focusing on specific locations (because simulations have not advanced enough for agents to identify points of interest), ACQUIRE TTPM inspects the entire designated FOV with equal acuity everywhere. The FOV incrementally steps through the FOR, and at each step the FOV does a uniform inspection of that entire area. After a complete progression of the FOV through the FOR, the process is repeated. Figure 5 depicts this.

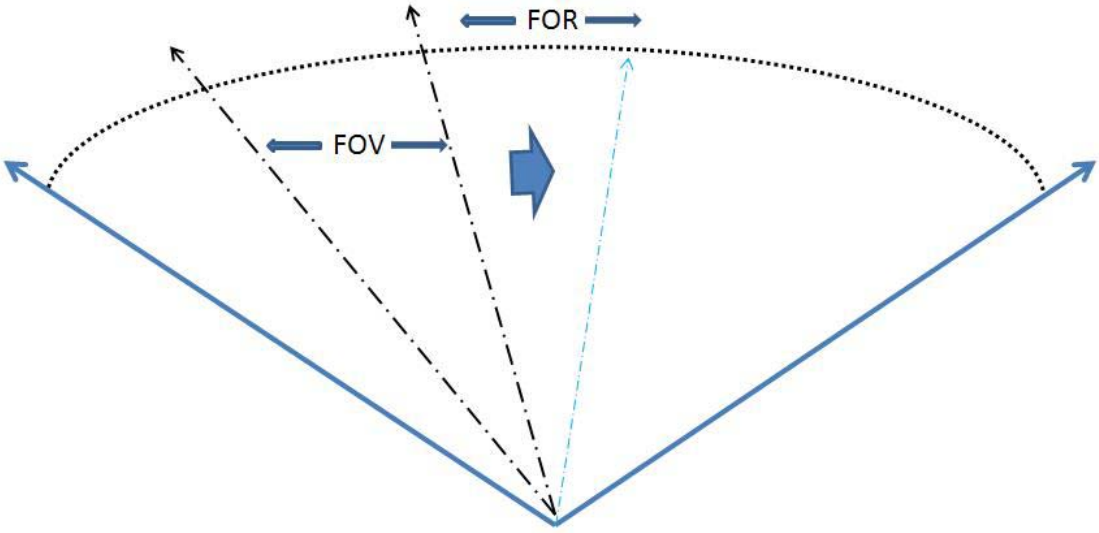



**Figure 5. Field of View Progression through FOR**

### *2.1.3 Levels of Target Discrimination*

When a Soldier becomes aware of an object or battlefield cue that indicates the presence of something in the area, he will attempt to determine its identity. To determine the identity of the target, the Soldier must progress through a series of discrete target acquisition levels (DCRI):

1. ***D****etection (D)* – A visual, audio, or other cue indicates "someone or something" (an object) is in the area.
2. ***C****lassification (C)* – The observer is able to distinguish the class of the object (e.g., vehicle or human).
3. ***R****ecognition (R)* – The observer is able to recognize the "someone" is of special military interest, i.e., a target.
4. ***I****dentification (I)* – The observer can identify this target as friend or foe.

In order to obtain a *detection* or higher level of target acquisition, a Soldier requires certain information. The information requirements are associated with satisfying the respective acquisition level descriptions provided above. The Soldier does not need to know all the information requirements associated with a level, but enough to satisfy the criteria for that level.

Each successive level is more difficult to reach than the one before, as the information required to satisfy it increases. Once the *identification* level is reached, the Soldier is able to decide on his next course of action.

The ACQUIRE TTPM methodology used by simulations does represent the different levels of target acquisition, but does not do this via information requirements. Instead, it uses an algorithm that generates a probability, taking into consideration variables such as target posture, range, movement state, light level, background contrast, etc. Initially, if an object is in the Soldier's FOV and a line of sight (LOS) exists, ACQUIRE TTPM makes a random draw against

the generated probability given the relevant variables for *detection* for that type of object, to determine if it has been detected. After *detection* occurs, another random draw is made to determine if *classification* occurred. This is repeated one level at a time until the *identification* level is reached. The probabilities in ACQUIRE TTPM for the higher levels of target acquisition (i.e., *classification, recognition,* and *identification*) assume the Soldier took action to focus his vision on the specific object. Thus the next higher level of target acquisition most likely has a higher probability of success than the proceeding level.

### *2.2 Information Elements Associated with Levels of Target Acquisition*

The information elements associated with the different target acquisition levels had never been defined before. Although most of these elements are obvious and/or intuitive to the Soldier, they need to be specifically identified so the models can represent target acquisition correctly. This was done primarily through literature reviews and discussions with dismounted infantry operations SMEs.

The information elements sought represented those required by the Soldier regardless of the battlefield environment, such as close quarter combat and the urban environment. The initial step was to investigate what kind of information the Soldier needed to have about a possible object. This process began with what the Army has identified as typical information requirements for the chain of command. One standard procedure is for a Soldier to pass information on observed enemy activity, significant terrain, and weather features up his chain of command. This is done using a Spot/SALUTE xx report. If the information is on enemy activity, he should use the SALUTE format:

***S****ize* – What is the size of the target/unit?
***A****ctivity* – What is it/they doing?
***L****ocation* – Where is it/they located?
***U****nit/uniform* – What unit does it/they belong to?
***T****ime* – What time of day/night was the observation made?
***E****quipment* – What type of equipment is also seen?

Another standard procedure is for the relaying of information associated with the commander's critical intelligence requirements (CCIR). As defined in Field Manual 101-5, Staff Organization and Operations, pages 5-9, "the CCIR is designed to feed important, time-sensitive information to the commander so he can make a decision that should dramatically affect the fight." A component of the CCIR of interest to this effort is information about the location and status of enemy forces and civilians. The SALUTE format was supplemented to account for the relevant CCIR information identified.

In addition, on the battlefield the information that Soldiers exchange has many attributes understood or implied by the recipients. Models and simulations do not have this ability; all information has to be discretely defined (called "metadata"). To account for this metadata, several of the SALUTE categories were expanded to provide the needed information to generate models and conduct simulations. For example, information on the "shape" of an object was added to the "size" category.

Additionally, another category named "prior intelligence on threat in area" was added. This was used to account for information that was relevant about the enemy and the area of operations (AO) that aided the STA process and typically was contained in the "situation" section of an operations order (OPORD) and fragmentary order (FRAGO). The supplemented SALUTE format is provided in Table 1.

**Table 1. Supplemented SALUTE Format**

| SALUTE Format | Supplemented SALUTE Format |
|---|---|
| Size | Size and Shape |
| Activity | Activity/Intent |
| Location | Location |
| Unit/Uniform | Unit/Uniform |
| Time | Time |
| Equipment | Equipment |
| | Prior Intelligence on Threat in Area |

The supplemented SALUTE format was then populated with specific information elements associated with each category. The information elements focused on were those generated or provided directly by the detected object. Efforts were made to limit the type of detected object to a Soldier and to exclude types such as aircraft, antitank, artillery, or mine and obstacle. The specific information elements were organized into groups for each category. For example, the groups for the "activity/intent" category were "hostile activity", "suspicious activity", and "not normal to environment". Then each information element was linked to the level of target acquisition it provided. For example, spotting a human in a uniform would provide up to *identification*, while the silhouette/shadow of the same human would only provide *classification*. This was not done for the information elements in the "time" and "prior intelligence on threat in area" categories because they indirectly provide information related to target acquisition. That is, they require the comparison of the new information to the existing knowledge in the Soldier's memory before they can be useful.

Most often a single information element does not provide *identification* alone, even the level of target discrimination is vague. It is typically used in combination with other information elements to try to produce *identification*. The determination of what combinations produce what level of target discrimination will require further investigation and will be difficult because they are situation dependent. Tables 2, 3, 4, and 5 show the identified information elements associated with target acquisition level. The red rows are the main categories, and the light blue rows are the groups within the particular category.

**Table 2. Information Elements Associated with Target Acquisition Level – Size and Shape**

| Information Element | Detection | Classification | Recognition | Identification |
|---|---|---|---|---|
| **Size & Shape – What is it?** | | | | |
| **Size of Object** | | | | |
| Larger than a Human | | | | |
| Smaller than Human | | | | |
| Human Size | | | | |
| Adult | | | | |
| Child | | | | |
| **Shape of Object** | | | | |
| Animated Object | | | | |
| Human Shape | | | | |
| Human Profile | | | | |
| Body Part | | | | |
| Animal Shape | | | | |
| Inanimate Object | | | | |
| Vehicle Shape (e.g., small unmanned ground Vehicle (SUGV), car, truck) | | | | |
| Artillery Shape (e.g., mortar, howitzer) | | | | |
| Aircraft Shape (e.g., unmanned aerial vehicle (UAV), helicopter, jet) | | | | |
| Defensive Positions (e.g., foxholes, sandbags) | | | | |
| Storage Containers/Conex | | | | |
| Terrain Out of Place (e.g., bunker) | | | | |
| **Object of Interest** | | | | |
| Object Out of the Ordinary for Environment (e.g., freshly moved dirt) | | | | |
| Threat for Area Higher than for Surroundings (e.g., windows) | | | | |

**Table 3. Information Elements Associated with Target Acquisition Level – Activity/Intent**

| Information Element | Detection | Classification | Recognition | Identification |
|---|---|---|---|---|
| **Activity/Intent – What is it doing?** | | | | |
| **Hostile Activity** | | | | |
| Firing towards My Location | | | | |
| Aiming Weapon at My Location | | | | |
| Orientation of Weapon towards My Location | | | | |
| Bullet Impacts in My Vicinity | | | | |
| Threat Patrolling | | | | |
| Approaching My Location | | | | |
| Using Cover and Concealment | | | | |
| Minimizing Exposure | | | | |
| Moving Rapidly | | | | |
| **Suspicious Activity** | | | | |
| Aiming Weapon at My Location | | | | |
| Orientation of Weapon towards My Location | | | | |
| Approaching My Location | | | | |
| Moving Moderately or Slowly | | | | |
| Concealing Oneself or Something | | | | |
| Has a Weapon | | | | |
| **Not Normal to Environment** | | | | |
| Object Not Associated with Environment (e.g., in business suit on a farm) | | | | |
| Visually (e.g., with briefcase on a farm) | | | | |
| Acoustically (e.g., digging sound in a quiet area) | | | | |
| Contrast with Immediate Background (e.g., glint in the woods) | | | | |
| Performing Unexpected Activity | | | | |

**Table 4. Information Elements Associated with Target Acquisition Level – Location, Unit/Uniform, and Equipment**

| Information Element | Detection | Classification | Recognition | Identification |
|---|---|---|---|---|
| **Location – Where is it located?** | | | | |
| **Exact Location** | | | | |
| XYZ Coordinates (i.e., direct sighting) | | | | |
| **Approximate Location (within 5 m)** | | | | |
| (X+/-5,Y+/-5,Z+/-5) Coordinates | | | | |
| Area Where Friendly Forces Are Targeting (e.g., weapon orientation, bullet impacts) | | | | |
| Area Where Fire Coming From (e.g., muzzle Flash) | | | | |
| Target Handoff Information (e.g., friendly communication) | | | | |
| Movement to Position with Blocked LOS | | | | |
| **General Location (Outside 5 m)** | | | | |
| Direction from My Location | | | | |
| Range from My Location | | | | |
| Movement Direction | | | | |
| Movement Direction in Relation to My Location | | | | |
| **Unit/Uniform - What force does it belong to?** | | | | |
| **Force Allegiance** | | | | |
| Wearing Uniform Associated with Foe (e.g., different camouflage pattern) | | | | |
| Equipped with Item Associated with Foe (e.g., distinctive headgear) | | | | |
| **Equipment - What type of equipment do you see?** | | | | |
| **Threat of Weapon** | | | | |
| Within Its Range and Immediate Threat to Me | | | | |
| Outside Its Range and Immediate Threat to Me | | | | |
| **Enemy Equipment** | | | | |
| Weapon | | | | |
| Protective Gear/Helmet | | | | |
| Ammunition Cans | | | | |
| Back Pack | | | | |
| Communication Devices | | | | |

**Table 5. Information Elements Associated with Target Acquisition Level – Prior Intelligence and Time**

| Additional Information Used in Target Acquisition Level Determination (Used in tandem with information provided by cues) |
|---|
| **Prior Intelligence on Threat in Area - What Is Known about Foe in Area?** |
| **Historical Information** |
| Foe Area of Operations (AO) |
| Historical Activities (e.g., TTPs used by foes) |
| **Objects of Interest** |
| Provides Cover and Concealment |
| Danger Area |
| Blocks LOS |
| **Location of Friendly Forces operating in Area** |
| **Time - Is the Information Current?** |
| How Long Ago Was the Information Received? |
| Was the Information from Day or Night? |
| How Long Is the Information Good for? |

### *2.3 Identification and Prioritization of Battlefield Cues*

Soldiers use cues on the battlefield to help them obtain the information elements they need to identify a target so a decision can be made on selecting their next course of action. Some cues are identifiable (e.g., sound of AK74), others are generic and only provide limited information (e.g., explosion), and some signatures are affected by factors such as visibility, temperature, and weather conditions (e.g., reduced range of sound in rain). The Soldier uses the information the cue provides to aid in identifying the target.

This effort was able to leverage 40 surveys conducted in 2004-05 on another target acquisition effort. The survey population consisted of returning Soldiers from OEF and OIF. These surveys were constructed to gather information on several facets of HCTA, such as cues and their characterization, the role of communications, the degree of target threat, and the behaviors used to avoid being acquired. Data were extrapolated from this survey and used where appropriate. Appendix B contains an example of this survey. The surveys provided useful information on the following:

1. The battlefield cues (visual, audio, and others) that were important as a source of information to the STA process
2. How valuable the battlefield cue was to the STA process
3. The behaviors that were taken in response to the cue

In the leveraged surveys, the participants were asked to rate a list of visual and audio cues on a high-to-low scale in terms of the value of each cue as a source of information and its impact on the Soldier's behavior. These ratings were converted to a 5-to-0 point scale. Both scores for

each cue were summed, resulting in a high-to low rating of 10 to 0 for each cue by each participant. The summed scores for each cue were then averaged, and the cues were ranked from highest to lowest. Tables 6 and 7 list the visual cues and audio cues, respectively, from highest to lowest average sum and the number of participants who rated each cue. Although it was assumed that some of the factors the participants based their ratings on were the same for both sets of ratings (source of information and impact on behavior) and thus were double counted, it was decided that this would not alter the resultant rankings because it just stressed their importance all the more. Some of the cues listed on the survey were general, such as "hostile behavior", which could include a number of more specific cues. Other cues were too open-ended, such as: Did "outgoing fire" mean outgoing fire from a threat or outgoing fire from friendly forces at a target?

**Table 6. Prioritization of Visual Cues from HCTA Surveys**

| Cue | Average Sum* | Participants |
|---|---|---|
| Muzzle Flash | 7.51 | 34 |
| Hostile Behaviors | 7.35 | 40 |
| Outgoing Fire | 7.22 | 18 |
| Suspicious Behaviors/Activities | 6.91 | 40 |
| Sight of the Weapons of Target | 6.46 | 40 |
| Bullet Impacts | 6.39 | 32 |
| Full Body Movement of Target | 6.35 | 36 |
| Physical Communication | 6.02 | 40 |
| Sight of Target Equipment | 5.78 | 38 |
| Spall/Blast | 5.21 | 30 |
| Dust Plumes | 5.13 | 32 |
| Illumination Devices | 5.02 | 34 |
| Target Body Shape Recognition | 5.01 | 40 |
| Partial Body Movement | 4.75 | 40 |
| Thermal Spots | 4.72 | 36 |
| Military Uniform Recognition | 4.69 | 34 |
| Smoke | 4.41 | 34 |
| Glint | 4.41 | 32 |
| Tracks | 3.81 | 34 |
| Shadows of Target | 3.57 | 34 |

*Average of the sum of the two 5-0 ratings where 10 = highest and 0 = lowest

**Table 7. Prioritization of Audio Cues from HCTA Surveys**

| Cue | Average Sum* | Participants |
|---|---|---|
| Gunfire | 8.30 | 22 |
| Radio Communications | 7.18 | 18 |
| Vehicle Noise | 6.61 | 20 |
| Verbal Communications | 6.21 | 18 |
| Sounds of Enemy Movement | 5.99 | 19 |
| Equipment Noise | 5.80 | 19 |
| Non-Verbal Communication | 5.74 | 18 |
| Animal Sounds | 3.88 | 18 |

*Average of the sum of the two 5-0 ratings where 10 = highest and 0 = lowest

The SME discussions were then used to more clearly characterize some of the highly ranked cues or to separate them into more definable cues. For example, "hostile behaviors" was characterized as having a weapon aimed at the observer's location. Using the leveraged surveys and SME input, a list of common battlefield cues was identified. The list included a wide range of possible cues. There were so many cues that the time required to incorporate all of them into the effort would prevent the completion of other key tasks. A decision was made to cull the list of cues down to a manageable set that would still support the development of a useful product.

First, the prioritized list of cues from the HCTA surveys was culled to those that had a summed score (for source of information and impact) of 6.00 and above, assuming that was the minimum score that signified detection of the cue was important and useful. Those cues were further scrubbed based on the following criteria:

- Easily detectable by Soldiers and their equipment
- Frequent occurrence on the battlefield
- High impact on detection
- A direct source of information
- Representation supportable by data and a capability (i.e., could be determined if something was out of place)
- Associated with a Soldier or his weapon/equipment (such as vehicle sound versus barking dog).

The selected battlefield cues were then grouped according to type: visual, audio, and other senses (to include smell, feel, and taste). However, the title of the "other senses" group was changed to "received friendly communications", which accounts for the exchange of information (i.e., target handoff) between Soldiers. The exchange could be conveyed by any means possible, such as voice, hand and arm signals, or radio message. Although it is not truly a cue coming from a potential target, it was substituted for "other senses" because of its importance to the STA process and because there were no cues in "other senses" group other than the "friendly communications" cues. Table 8 lists the cues, by group, that were selected to support the building of the decision maps. The table can be used by the modeling and simulation community to serve as a guide to the order and types of cues that should be included for representation.

**Table 8. Selected Battlefield Cues for Representation**

| **Visual Cues** |
|---|
| Muzzle Flash |
| Sight of Weapon |
| Weapon Aimed towards My Location |
| Bullet Impacts Near My Area |
| Full Body Movement |
| Area Friendly Outgoing Fire Targeting |
| Target Marking (i.e., smoke, tracers) |
| **Audio Cues** |
| Gunfire (i.e., weapon discharge, bullet flyby) |
| Electronic Communication (i.e., increased radio traffic) |
| Military Vehicle Sound |
| Verbal (i.e., foreign language) |
| **Received Friendly Communication** |
| Target Handoff Information |

### *2.4 Information Elements Provided by Battlefield Cues*

The information elements provided by the selected battlefield cues were then identified and matched to the appropriate category and group related to the previously identified information elements associated with the target acquisition levels in Tables 2, 3, and 4. Table 9 displays this matrix.

**Table 9. Information Elements Provided by Battlefield Cues**

| | Size & Shape | | | Activity/Intent | | | Location | | | Unit | Equipment | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Size of Object | Shape of Object | Object of Interest | Hostile Activity | Suspicious Activity | Not Normal to Environment | Exact Location | Approximate Location | General Location | Force Allegiance | Threat of Weapon | Enemy Equipment |
| **Visual Cues** | | | | | | | | | | | | |
| Muzzle Flash | | | | | | | | | | | | |
| Sight of Weapon | | | | | | | | | | | | |
| Weapon Aimed Towards My Location | | | | | | | | | | | | |
| Bullet Impacts in My Area | | | | | | | | | | | | |
| Full Body Movement | | | | | | | | | | | | |
| Area Friendly Outgoing Fire Targeting | | | | | | | | | | | | |
| Target Marking (i.e., tracers) | | | | | | | | | | | | |
| **Audio Cues** | | | | | | | | | | | | |
| Gunfire | | | | | | | | | | | | |
| Electronic Communication (i.e., increased radio traffic) | | | | | | | | | | | | |
| Military Vehicle | | | | | | | | | | | | |
| Verbal (i.e., foreign language) | | | | | | | | | | | | |
| **Friendly Communication** | | | | | | | | | | | | |
| Target Handoff Information | | | | | | | | | | | | |

Cue provides this information element.

### *2.5 Behaviors Available to Improve STA*

The data sources were used to produce a list of behaviors available to a Soldier to improve his STA. It must be noted that the ACQUIRE TTPM methodology considers eyes as simply another type of sensor and that constructive simulations represent human vision as sensor output. Therefore, this list represents a Soldier's eyes as a sensor. The list was organized into sets of generic behaviors, with some of these being further broken down into more specific behaviors:

- Listen.
  - Go silent (e.g., stop movement).
  - Tell unit to freeze.
    - Indicate direction.
- Modify search behaviors.
  - Focus attention (e.g., narrow FOV and FOR).
  - Change search pattern/method.
    - Aimed quick fire
    - Pattern
- Change orientation.
- Change characteristic of sensor.
  - Magnification
  - Sensitivity, i.e., light
  - Stabilize
  - FOV
  - Mode (i.e., IR vs. $I^2$)
- Change sensor.
- Query Identification, Friend or Foe (IFF) System/Combat Identification (CID) System (i.e., AN/VSC-9).
- Communication
  - Query immediate (i.e., nearby) unit members.
  - Radio call.
  - Query sensors/display/Common Operating Picture (COP).
    - Sniper Detection System
    - Unattended Ground Sensor (UGS)
    - Ground Surveillance Radar (GSR)
    - Enhanced night vision goggles
- Trigger target behavior
  - Instruct to come out if civilians.
  - Sound decoy (e.g., throw rock).
  - Challenge – password.
  - Hands up, weapons down.
  - Identify yourself.
- Change vantage point.
  - Alter posture.
  - Move to establish better vantage point (LOS to individual or area).
  - Direct associated element to maneuver.
  - Change movement rate/halt.

### *2.6 Expected Costs of Behaviors*

The next step was to determine the costs of the behaviors. Some of the costs identified (e.g., time delay) were imposed on the Soldier performing the behavior, some made him an easier target to detect and hit, and others were related to battlefield cues he generated that would help the enemy to detect and identify him. The costs identified were separated into four types:

- Increased Detection
  - Generates movement cue.
  - Generates sound cue.
- Increased Exposure
  - Increases probability of detection.
  - Increases probability of hit.
- Ease of Identification
  - Provides information element to others in their identification of the Soldier.
- Time Delay (resulting from time needed to perform behavior)

These expected costs were then linked to the previously identified list of behaviors available to improve one's STA. Each behavior was evaluated to determine its cost for each cost type. The evaluations only determined what a typical cost would be. The cost was scored on a scale from none to high, as shown in Table 10. For implementation, a more precise cost determination is needed, and further investigation is required to calculate more precise costs.

### *2.7 Order of Behaviors*

The identified available behaviors and their expected costs were linked to the selected list of battlefield cues (Table 8). Based on SME input and feedback, the order a Soldier would use the behaviors was determined for each cue. The order of behaviors matrix is Table 11. The order generally followed the rule of starting at no or low cost and keeping succeeding behaviors as low as possible. Occasionally, some behaviors would be performed simultaneously, and this was indicated by multiples of the same order number. The behavior selected was sometimes at the generic level, and at other times it was at the specific level. If it was at the generic level, the Soldier could use any of the specific behaviors available under that generic behavior. For example, he could change the sensors characteristics by either adjusting the magnification or changing the mode.

As can be seen in Table 11, the sequences of behaviors for "audio cues" and "friendly communications" are much shorter than for "visual cues". Typically, the goal of any STA behavior a Soldier takes is to place him in a position where he can engage any threats (i.e., can see where to aim and shoot). The order of behaviors for "audio cues" and "friendly communications" reflect the goal described. That is, once a Soldier performs the appropriate behaviors, he is in a position to detect or observe any visual cues and then follow the relevant behavior order for "visual cues".

## Table 10. Expected Costs of Behaviors

| IF ACTION DOES NOT RESULT IN ENOUGH INFORMATION TO DETERMINE FRIEND OR FOE, NEXT ACTION DOWN IS TAKEN | Increased Detection | Increased Exposure | Ease of Identification | Time Delay |
|---|---|---|---|---|
| Listen | none | none | none | minimal |
| Go silent (e.g., stop movement) | none | none | none | minimal |
| Tell unit to freeze (e.g., hand gestures) | none | minimal | none | minimal |
| Indicate direction | none | minimal | none | minimal |
| Modify Search behaviors | none | none | none | minimal |
| Focus attention (e.g., narrow FOV and FOR) | none | none | none | minimal |
| Change search pattern/method | none | none | none | minimal |
| Pieing | none | none | none | minimal |
| Pattern | none | none | none | minimal |
| Change Orientation | low | low | none | low |
| Change Characteristic of Sensor | low | low | none | low |
| Magnification | low | low | none | low |
| Sensitivity, i.e., light | low | low | none | low |
| Stabilize | low | low | none | low |
| FOV | low | low | none | low |
| Mode (i.e., IR vs. I2) | low | low | none | low |
| Change Sensor | moderate | moderate | low | moderate |
| Query IFF System/Combat Identification System (i.e., AN/VSC-9) | moderate | moderate | low | moderate |
| Communication | moderate | moderate | moderate | moderate |
| Query immediate (i.e., nearby) unit members | moderate | moderate | moderate | moderate |
| Radio call | moderate | moderate | moderate | moderate |
| Query sensors/ display/ COP | moderate | moderate | moderate | moderate |
| Sniper Detection System | moderate | moderate | moderate | moderate |
| UGS | moderate | moderate | moderate | moderate |
| GSR | moderate | moderate | moderate | moderate |
| Enhanced Night Vision Goggles | moderate | moderate | moderate | moderate |
| Trigger Target Behavior | high | moderate | high | moderate |
| Instructions to come out if civilians | high | moderate | high | moderate |
| Sound decoy (e.g., throw rock) | high | moderate | high | moderate |
| Challenge – Password | high | moderate | high | moderate |
| Hands-up Weapons Down | high | moderate | high | moderate |
| Identify yourself | high | moderate | high | moderate |
| Change Vantage Point | high | high | moderate | high |
| Posture | high | high | moderate | high |
| Move to establish better vantage point (LOS to individual or area) | high | high | moderate | high |
| Direct associated element to maneuver | high | high | moderate | high |
| Change movement rate/halt | high | high | moderate | high |

## Table 11. Order of Behaviors Matrix

| IF ACTION DOES NOT RESULT IN ENOUGH INFORMATION TO DETERMINE FRIEND OR FOE, NEXT ACTION DOWN IS TAKEN | Visual Cues | Muzzle Flash | Sight of Weapon | Weapon Aimed towards My Area | Bullet Impacts in My Area | Full Body Movement | Area Friendly Outgoing Fire Targeting | Bullet Impacts in Target Area | Audio Cues | Gunfire | Foe Radio Communication (i.e., foreign | Vehicular | Verbal (i.e., shouting) | Received Friendly Communication | Target Handoff Information |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Change Orientation | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 3 | 3 | 3 | 3 | | 1 |
| Modify Search behaviors | | | | | | | | | | | | | | | |
| Focus attention (i.e., narrow FOV and FOR) | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | |
| Change search pattern/method | | | | | | | | | | | | | | | |
| Pieing | | | | | | | | | | | | | | | |
| Pattern | | | | | | | | | | | | | | | |
| Listen | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | 1 | 1 | 1 | 1 | | |
| Go silent (i.e., stop movement) | | | | | | | | | | 2 | 2 | 2 | 2 | | |
| Change Characteristic of Sensor (if ability to) | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | | | | | | | |
| Magnification | | | | | | | | | | | | | | | |
| Sensitivity, i.e., light | | | | | | | | | | | | | | | |
| Stabilize | | | | | | | | | | | | | | | |
| FOV | | | | | | | | | | | | | | | |
| Mode (i.e., IR vs. I2) | | | | | | | | | | | | | | | |
| Communication | | | | | | | | | | | | | | | |
| Query immediate (i.e., nearby) unit members | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | | | | | | | |
| Radio call | | | | | | | | | | | | | | | |
| Tell unit to freeze (i.e., hand gestures) | | | | | | | | | | 4 | 4 | 4 | 4 | | |
| Indicate direction | | | | | | | | | | | | | | | |
| Change Sensor (if available) | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | |
| Query IFF | | | | | | | | | | | | | | | |
| Query sensors/ display/ COP | | | | | | | | | | | | | | | |
| Change Vantage Point | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | |
| Posture | | | | | | | | | | | | | | | |
| Move to establish better vantage point (LOS to individual or area) | | | | | | | | | | | | | | | |
| Direct associated element to maneuver | | | | | | | | | | | | | | | |
| Change movement rate/halt | | | | | | | | | | | | | | | |
| Trigger Target Behavior | | 6 | 6 | 6 | 6 | 6 | 6 | 6 | | | | | | | |
| Instructions to come out if civilians | | | | | | | | | | | | | | | |
| Sound decoy (i.e., throw rock) | | | | | | | | | | | | | | | |
| Challenge – Password | | | | | | | | | | | | | | | |
| Hands-up Weapons Down | | | | | | | | | | | | | | | |
| Identify yourself | | | | | | | | | | | | | | | |

### *2.8 Decision Map*

The last step needed to meet the objective was to incorporate all of the previously completed tasks. This was accomplished with the development of an STA behavior decision map (see Figure 6). The decision map is a flowchart that depicts how a Soldier represented in a model proceeds through the STA process in order to obtain target *identification* after a battlefield cue is detected. The process depicted in the decision map includes elements which link to the completed tasks.

The decision map starts with the Soldier in the process of searching for targets. An event occurs in the simulation that produces a battlefield cue (see Table 8). Then the model evaluates if the Soldier detected the cue. If the Soldier did detect the cue, he goes through a series of decisions to determine the type of cue (e.g., visual, audio, or friendly communication cue) (see Table 8). Each type has a different decision path. The different paths are enclosed by grey dotted lines in Figure 6.

The three decision paths are described in detail, proceeding from the simplest to most detailed. They all have the ultimate objective of getting "eyes-on-target". That is, they all have the Soldier perform behaviors which will put him in a better position to visually acquire and identify any potential targets. If after completing the prescribed behaviors the Soldier achieves *identification*, he decides his next course of action: otherwise, he returns to the start and continues searching for cues.

For each decision path the first two steps are the same. For the first step, the information associated with the detected cue (see Table 9) is added to the represented Soldier's knowledge (i.e., SA). For the second step, the Soldier determines if he has enough information to obtain *identification* (see Tables 2, 3, 4, and 5). After this, the decision paths vary.

The first path discussed is when "friendly communications" provides additional information. If the additional information obtained does not provide *identification* (the first and second steps described previously), the Soldier changes his orientation towards the estimated location of the cue. This behavior results in some cost to the Soldier (Table 10), which is represented by the simulation. After this is done, the Soldier returns to the start (process of searching for targets and cues) and steps through the decision map again for any newly detected cues.

The next decision path discussed is for "audio cues". If the audio cue does not provide enough information to obtain *identification*, the Soldier undertakes a series of behaviors (see Table 11). The Soldier concentrates on listening for more sounds, stops his movement to decrease the amount of noise he is creating, changes his orientation so he can listen better, tells his fellow unit members to freeze, and informs them of the cue. These behaviors put the Soldier in a better situation to detect the target, but they result in some cost to the Soldier (Table 10), which is represented by the simulation. After this is done the Soldier returns to the start (process of searching for targets and cues), and steps through the decision map again for any newly detected cues.

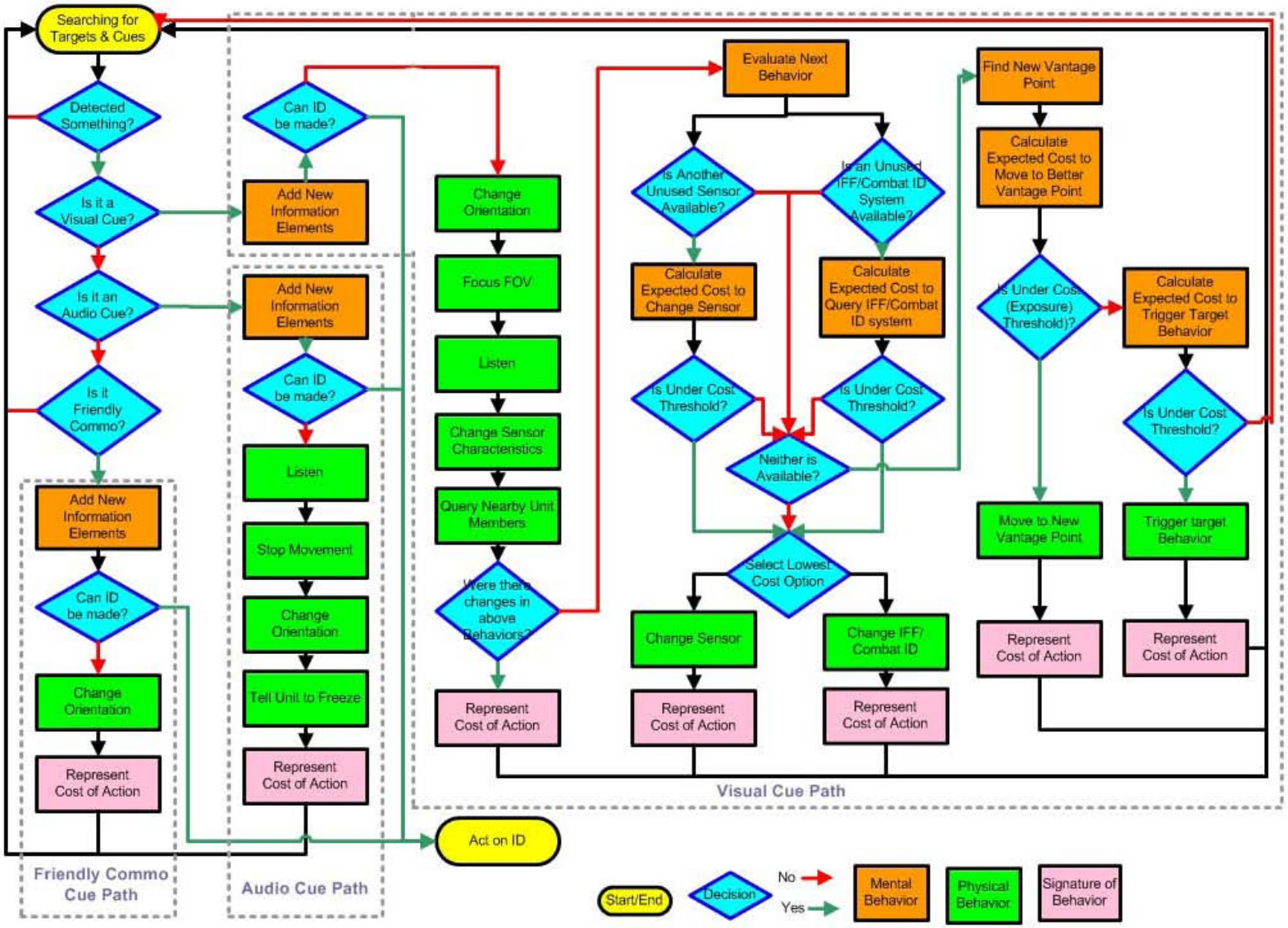



**Figure 6. STA Behavior Decision Map**

The last path is for visual cues. If the visual cue does not provide enough information to obtain *identification,* the Soldier undertakes a series of behaviors (see Table 11). First, the Soldier changes his orientation to place the cue's location in the middle of his FOR and focuses (i.e., narrows) his FOV on to the cue's location. He concentrate on listening for audio cues from the vicinity of the target. The Soldier then changes his sensor characteristics (i.e., changes mode) to help him focus on the target, and he queries fellow unit members if they have more information on the target. If the Soldier does not change any of these, he proceeds to the next major step of determining if he has other equipment available to assist him (discussed further in the next paragraph). If there are changes associated with these behaviors they result in some cost to the Soldier (Table 10), which is represented by the simulation. To reiterate, the purpose of these behaviors is to put the Soldier in a better situation to see the target. If these behaviors provide new information to the Soldier, it is added to his knowledge. The Soldier determines if it provides *identification,* and if it does he plans his next course of action. If no new information is obtained, the Soldier evaluates his next behavior choice.

If the Soldier has not changed any of the identified behaviors, he determines if he has any other unused sensors and IFF/CID systems available to use to provide him with more information. He determines availability of sensors and availability of IFF/CID systems concurrently. For each determination, if no specific type of sensor or system is available, the next step is if neither type is available. From there, the Soldier proceeds to the next major step of evaluating if he should move to a better vantage point (discussed further in the next paragraph). If any unused sensors or IFF/CID systems are available, the Soldier calculates the expected cost of changing a sensor or employing a system (Table 10). If the cost is below a predetermined threshold, it is a viable option for use. If it is above the threshold, the path proceeds to the previously mentioned step that evaluates if both types are unavailable. If no other unused sensors or systems are available, the path flows to the next major step, which is determining if a better vantage point or triggering some behavior in the target is an option (discussed further in the next paragraph). If there is a viable option, the Soldier determines and selects the one with the lowest cost. Based on the result, he switches to the selected sensor or queries the desired system. Either action results in some cost to the Soldier (Table 10), which is represented by the simulation. If the change or query provides new information to the Soldier, it is added do his knowledge. The Soldier determines if it provides *identification,* and if it does he decides his next course of action. If no new information is obtained, the Soldier once again determines if he has any other unused sensors IFF/CID systems available to use.

The last portion of the visual cue decision path is for the Soldier to evaluate if he should move to a better vantage point or try triggering some behavior in the target. The first step here is for the Soldier to search for any better vantage points; how this will be achieved in a model requires further investigation. The simplest method is to start at the estimated target's location and look for a new vantage point as close to the target as possible. If a suitable vantage point is not found then the model looks for a new point closer to the Soldier. Once a better vantage point is found, the expected cost to move to that location is calculated. The Soldier determines if the expected exposure cost is above some predefined threshold for exposure. This is to account for the fact that the Soldier would not expose himself to a level that makes the likelihood of being shot too great. If the exposure threshold is not exceeded, the Soldier moves to the new vantage point. This results in some cost to the Soldier (Table 10), which is represented by the simulation. Once

in this new vantage point, the Soldier returns to the start (process of searching for targets and cues), and steps through the decision map again for any newly detected cues. If the exposure threshold is exceeded, the Soldier has the option of looking for a new vantage point further from the target or trying to trigger some behavior in the target which will assist in *identification.*

For this option, the Soldier calculates the expected cost (Table 10) to him of performing a behavior (such as challenging the target for a password or identifying himself) that may produce a responding behavior by the target. If the expected cost is above a predefined threshold, the Soldier does not perform the behavior and returns to the start (the process of searching for targets and cues), and steps through the decision map again for any newly detected cues. If the expected cost is below the threshold, the Soldier performs the behavior, and the cost is imposed on him. He then returns to the start (the process of searching for targets and cues) and steps through the decision map again for any newly detected cues.

This decision map will serve as a useful tool in efforts to understand and represent the interplay of battlefield cues and Soldier behaviors in the STA process and SA.

## 3. Results and Conclusions

Several useful products (e.g., tables and matrixes) resulted from this effort to enhance to representation of STA behaviors in constructive simulations. These products were in the following areas:

- Information elements associated with target acquisition levels
- Identification of common battlefield cues
- Information elements provided by battlefield cues
- Behaviors available to improve the target acquisition level
- Expected cost of a behavior
- Behavior use prioritization and selection

They were used to support the development of a decision map that depicts a decision process that can be used by a simulated Soldier to select which behavior(s) to take to improve his level of target acquisition after detecting a battlefield cue, depending on the type of cue detected (e.g., visual, audio, and received friendly communication).

This decision map can be inserted into the TADM methodology (as shown in Figure 7) to address the current gap in the methodology (i.e., the absence of the impact of battlefield cues, indicated in Figure 1 by the absence of a classification triangle). If the Soldier does not identify and recognize the target, he can go to the behavior decision map instead of immediately going on to the next target. This can even significantly enhance the representation of STA without changing the method for calculating the different target discrimination levels. As methods to determine the higher levels of target discrimination are improved, these improvements can be inserted where applicable.

The decision maps and other products resulting from this effort will greatly enhance the STA process and SA within constructive combat simulations, even though the reduced funding level for this effort limited the scope to identifying and developing a methodology instead of substantiating the findings. These products will be provided to the developers of IWARS for incorporation into the model. Their inclusion will significantly enhance the IWARS model's ability to represent real-world STA. They will also be made available to other combat simulations (e.g., Combat XXI, OOS, etc.), to improve assessment of the impact of net-centric warfare and/or new information technology on STA and SA.

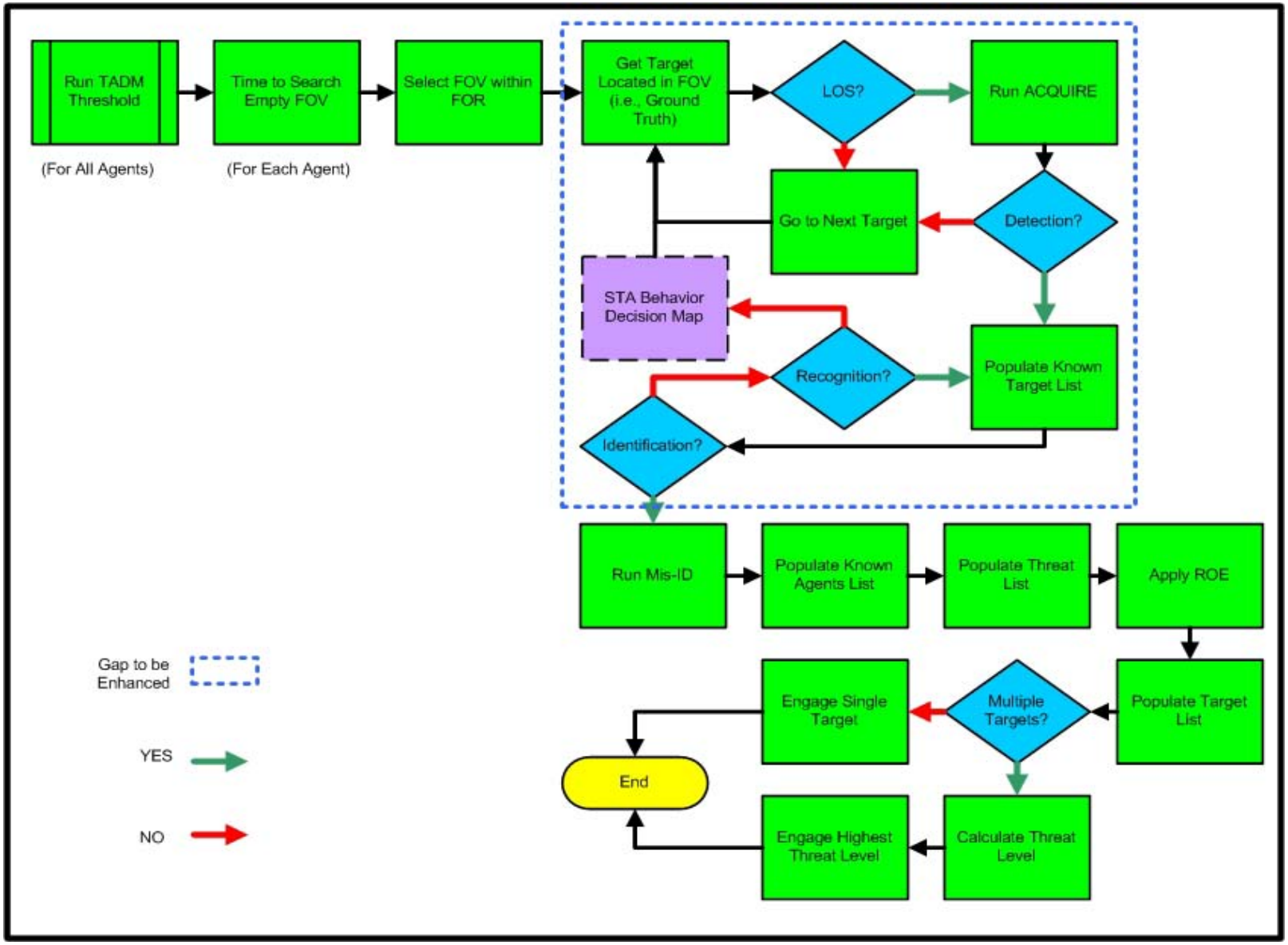



**Figure 7. Modified TADM with STA Behavior Decision Map**

## 4. Recommendations

In the process of conducting this effort, several areas were identified which would be beneficial in representing the results generated, but were either outside the scope of this effort or beyond the time and means available. They are worthy of further investigation. These areas include the following :

- *Representation of the level of accuracy in the peripheral fields* – Constructive simulations represent the entire FOR with the same level of visual accuracy instead of decreasing levels as the location of an object one moves to the extreme edges of the FOR. This greatly exaggerates the level of accuracy in the peripheral fields.
  *Recommendation:* Represent objects located in the peripheral fields in a way that the Soldier will react to them in a similar manner as he reacts to audio cues. This could be achieved by providing the cue with a marker that triggers the Soldier to skip the use of the ACQUIRE TTPM methodology when the location of the marker is outside the FOV and follow the audio cue decision path on the decision map.

- *Levels of target discrimination* – The ability to discriminate different levels of targets, especially *identification,* is needed. Increased accuracy in determining the combinations of information elements on a target is required to provide this capability. As the robustness of methods (e.g., Bayesian networks, fuzzy logic, etc.) of representing artificial intelligence increases, the ability to represent these information combinations will improve.
  *Recommendation:* Identify what information combinations provide *identification* to support the methods of representing artificial intelligence.

- *Calculation of expected costs* – For model representation, a more precise cost determination (than the scale of none to high shown in Table 10) of the expected cost of performing one of the described behaviors is needed.
  *Recommendation:* Investigate methods (e.g., algorithms, tables) for calculating these costs that would increase their precision.

- *Representation of how a Soldier looks for and determines a better vantage point* – One of the possible behaviors available to the Soldier is to evaluate if he should move to another vantage point. Representing how a Soldier looks for and determines if a better vantage point is available is very difficult. When an actual Soldier does this, there are many criteria he bases his decision on. The criteria are pretty straight forward; the main issue is how to represent these in a constructive simulation. More research is needed to represent this ability.
  *Recommendation:* Use an algorithm that has the Soldier find cover as close to the target as possible while ignoring all other criteria. This could be done by having the Soldier start to search for cover at the estimated target's location, increase the distance from the target if nothing is found, and search again.


This document reports research undertaken at the U.S. Army Natick Soldier Research, Development and Engineering Center, Natick, MA, and has been assigned No. NATICK/TR- 10/010 in a series of reports approved for publication.

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# Appendix A
# GROUND – SEARCH TECHNIQUES FROM FIELD MANUAL – 17-12-8 LIGHT CAVARLY GUNNERY

(Reprint from the field manual)

## GROUND-SEARCH TECHNIQUES

### Rapid-Scan Technique

The rapid-scan technique is used to detect obvious signs of enemy activity quickly (see Figure 2). It is usually the first method used, whether stationary or moving. The vehicle commander may use optics or the unaided eye; the gunner may use TOW sights (day or thermal mode), if available, in low magnification, or the unaided eye. To search using the rapid-scan technique--

- Start in the center of the sector, and rapidly scan from the nearest to the farthest visible point.
- Then, orient left or right, and conduct a rapid scan, near to far. (This sweep must overlap the center area of the previously scanned sector.)
- Once one side (front center) is completed, scan the remaining side in the same manner.

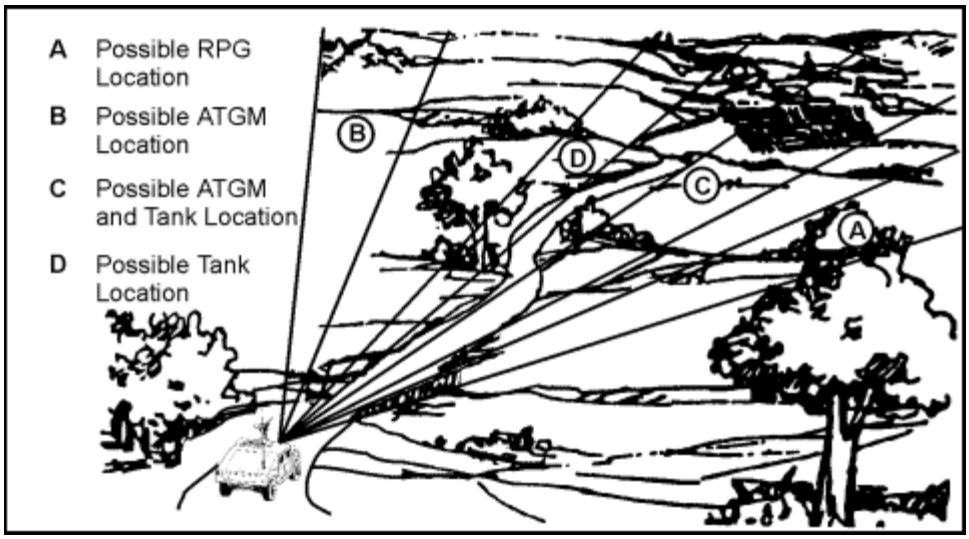


**Figure 2. Rapid-Scan Technique.**

### Slow-Scan (50-Meter) Technique

If no obvious targets are identified while using the rapid-scan technique, crew members will conduct a more deliberate scan of the terrain by using the optics (day or night mode) or binoculars--the slow-scan (50-meter) technique is used for this task (see Figure 3). Slow scan is best used by the vehicle commander or gunner when in a defensive position or from a short halt. To search using the slow-scan technique--

- Search a strip of the target area 50 meters deep from right to left, pausing at short intervals to give the eyes time to focus.
- Then, search a strip farther out from left to right, overlapping the first area scanned.
- Continue this method until the entire assigned sector has been searched.


**Figure 3. Slow-Scan (50-Meter) Technique.**

**Note.** Thoroughly search suspicious areas or possible target signatures using the detailed-search technique. High magnification is used for an intense observation of potential targets when using the UAS12 or AN/TAS 4A.

### Detailed-Search Technique

If no targets are found using the rapid-scan or slow-scan techniques, and time permits, crews should use the optics (day and night) to make a careful, deliberate, or more detailed search of specific areas in their assigned sector. This detailed-search technique is also used to search small areas or locations with likely or suspected avenues of approach (see Figure 4). To search using the detailed-search technique--

- Concentrate on one specific area or location, and study that area intensely.
- Look for direct and indirect target signatures, scanning clockwise around the focal point (terrain feature) of the area. The following are examples of target signatures:
  - Dust created by movement of vehicles.
  - Tracks or tire marks.
  - Reflections (flash) from glass or metal.
  - Angular objects that do not conform to the surrounding area.
  - Vegetation that appears out of place.
  - Flash or smoke from a weapon or missile.
  - Entrenchments or earthworks.

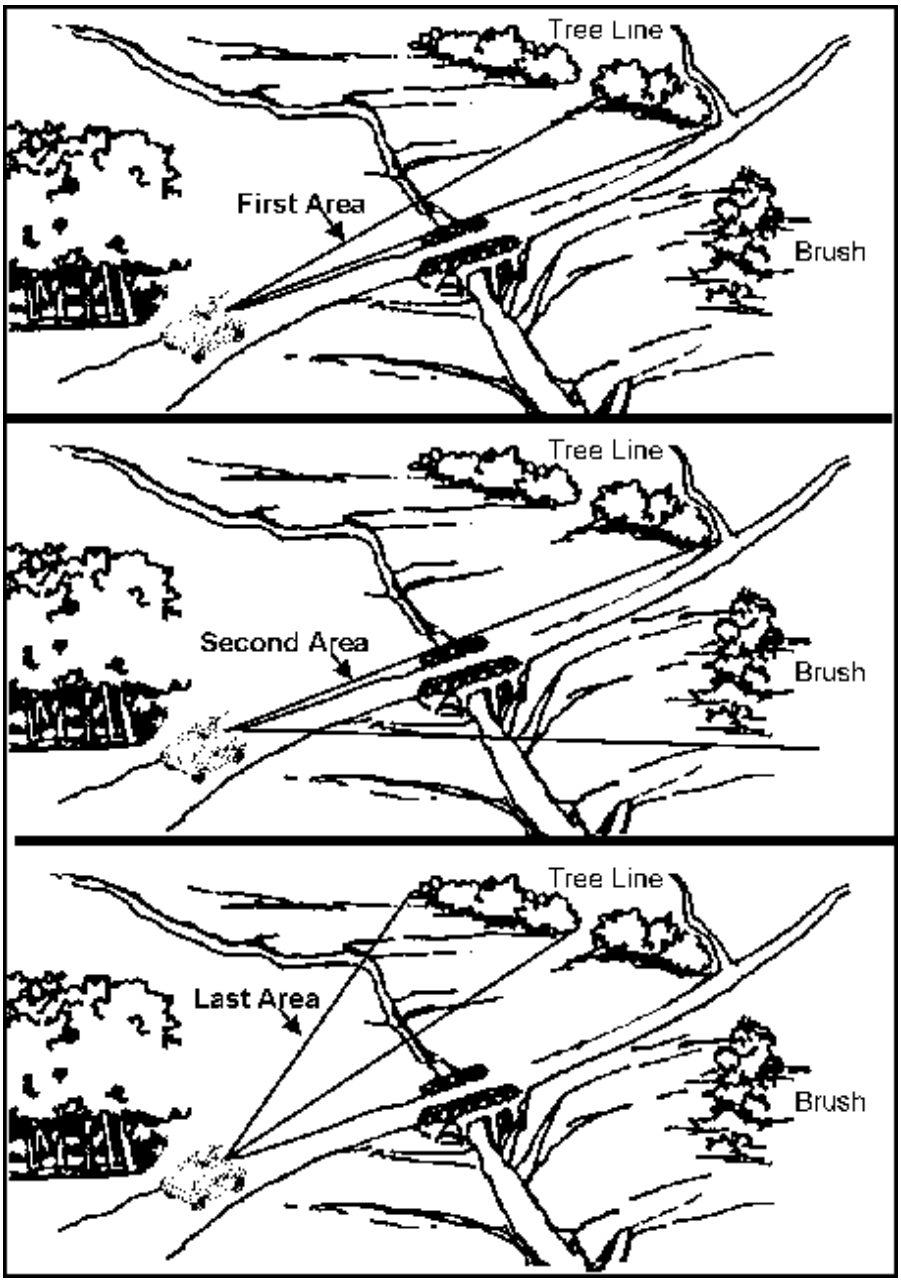


**Figure A4. Detailed-Search Technique.**

### Off-Center Vision Method

Day and night scanning techniques (rapid, slow, and detailed) are similar, with one exception. Do not look directly at an object using daylight optics or the unaided eye at night; look a few degrees off to the side of the target object. When scanning with off-center vision, move the eye in short, abrupt, irregular movements. Pause a few seconds at each likely target area to detect a target or any movement. If a possible target is detected, use off-center vision to observe it. Frequent eye movement is necessary to prevent object fade-out while observing the object. Cupping the hands around the eye will also increase night vision.

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## Appendix B
# Human-Centered Target Acquisition Survey
(Reprint of the original survey)

**OTHER ELEMENTS THAT MAY IMPACT UPON SEARCH AND TARGET ACQUISITION**

Which of the following elements had an impact upon your ability to search and acquire a target? Please circle NA for any sources of information that you did not encounter.

| | | Impact Low | Impact High |
|---|---|---|---|
| Environmental characteristics | NA | ]—— | ——[ |
| Lighting contrast (shadows) | NA | ]—— | ——[ |
| Direction of the light source | NA | ]—— | ——[ |
| Target shape or camouflage pattern | NA | ]—— | ——[ |
| Scene complexity & clutter | NA | ]—— | ——[ |
| Operational tempo (time pressures) | NA | ]—— | ——[ |
| Sensor capabilities (e.g range) | NA | ]—— | ——[ |
| Physical movement of sensor | NA | ]—— | ——[ |
| Depth perception with sensors | NA | ]—— | ——[ |
| Personal experience | NA | ]—— | ——[ |
| How well you recognized a cue e.g. sound of specific enemy weapon | NA | ]—— | ——[ |
| Familiarity with the location | NA | ]—— | ——[ |
| Assessment of threat i.e. an individuals perceived intent (hostile or not) based upon cues, weapon, actions or affiliation | NA | ]—— | ——[ |
| Your expectations | NA | ]—— | ——[ |
| History of target presentation(s) | NA | ]—— | ——[ |
| Enemy deception | NA | ]—— | ——[ |
| Use of obscuration (e.g. smoke or peep holes) | NA | ]—— | ——[ |
| Rules of engagement | NA | ]—— | ——[ |
| Conflicting information on enemy (or potentially conflicting, e.g. two sources provide differing locations) | NA | ]—— | ——[ |
| Effects of fatigue | NA | ]—— | ——[ |
| Suppression (incoming fire) | NA | ]—— | ——[ |
| Noises clutter (e.g. flash bang grenade) | NA | ]—— | ——[ |
| Obstructions to senses e.g. helmets, helmet mounted displays, ear plugs, goggles etc. | NA | ]—— | ——[ |
| Individual workload cognitive or physical demands as a result of trying to accomplish several actions at the same time, e.g. conduct movement, communicate, assess equipment, etc. | NA | ]—— | ——[ |

**SEARCH AND DETECTION**

The purpose of this questionnaire and focus group is to gather information on your target acquisition process within force-on-force combat simulations focusing on the dismounted infantry. This information will allow for improved assessments of hardware systems and future conceptual systems, in addition to enhancing training simulations. In order to gather appropriate and accurate information, we need input from experienced soldiers to better understand the target search and detection process and to provide information that will be used to help prioritize the elements of the real world to include in the simulations.

Therefore, we need your input regarding how you and your unit went from "a state of not knowing, to one where you had sufficient information to potentially engage the enemy". This includes times when you may have some information about a potential target, but were trying to gain more. Areas of interest include:

- cues and their characterization
- role of communications
- identification of critical information elements
- targets types and their characterization
- target detection and discrimination (recognition and identification)
- target assessment (degree of threat)
- behaviors used to gain more information
- behaviors used to avoid being acquired
- elements that may have impacted your ability to acquire targets

The following questionnaire contains cues (visual, audio, & other), acquisition behaviors and other factors that may or may not pertain to the target acquisition process. It's up to you to tell us which factors are important and which are not. Some factors, cues or behaviors may not be included in the questionnaire. Please feel free to write them in for us. All comments regarding the process, which leads up to your decision to engage a target, are welcome.

There are three stages of target acquisition; Detection, Recognition, and Identification. Detection is when you detect 'something'. Recognition is when you recognize it as a target, finally identification is when you identify it as friend of foe.

This survey will be administered in several parts. One part relates to background information concerning you, your experience and the operational environment in which you were operating. Another part relates to your perception of the value of numerous factors potentially relevant to the search and target acquisition process. The third part is an open-ended discussion aimed at better understanding the process that you went through to acquire targets and to filter through other elements in the environment.

Thank you for your time!

## SECTION I

In this section, please check off the best descriptive(s) for the conflict you were involved in. If you were involved in more than one conflict, please let the questionnaire administrator know.

**Location of Conflict:**
- ✓ Inside city limits
- ✓ Heart of city
- ✓ Outskirt of city
- ✓ Small town
- _____ Middle of desert (very open area)
- _____ Other _____

**Purpose**
- _____ Secure Area
- _____ Rescue mission
- _____ Gather Information
- _____ Destroy Building
- _____ Block roads
- _____ Halt Communication
- _____ Other _____

**Types of Targets encountered**
- ✓ Human targets
  - _____ snipers
  - ✓ ambush
  - ✓ local civilians
- _____ Vehicle targets
- ✓ Building targets
- ✓ Bridges
- _____ Radio
- _____ Television
- _____ Govt Center
- ✓ Major Roads
- _____ Sewers
- ✓ Chemical
- _____ Open Fields
- _____ Other _____
- _____ Other _____

**Observation Fields Before Combat**
- ✓ Inside building from windows
- _____ Inside buildings from doorways
- ✓ From roof Tops
- ✓ Inside building upper floors
- ✓ From ground level, around corner
- _____ In shadows
- _____ From field
- _____ Other _____
- _____ Other _____

**Avenues of Approach**
- ✓ Street
- ✓ Buildings
- _____ Shadows
- _____ Water
- ✓ Roof Tops
- _____ Other _____

**High Technology**
- _____ Robots
- ✓ Binoculars
- _____ Nigh Vision Goggles
- ✓ Thermal Sensors
- _____ Unmanned Vehicles
- _____ Other _____
- _____ Other _____

**Weather**
- ✓ Rain
- _____ Snow
- _____ Sleet
- ✓ Wind
- _____ Fog
- ✓ Cold
- ✓ Hot

**Light Levels**
- ✓ Day attacks
- ✓ night movements
- _____ location of light source
- ✓ High moon
- ✓ Low Moon
- ✓ Mid Day
- ✓ Day break
- ✓ Sunset
- _____ Shadows
- _____ Other _____
- _____ Other _____

**Patrolling techniques in Urban**
- _____ Duck
- _____ Bunch
- ✓ Parallel
- ✓ V Formation
- _____ Other _____

**What type of weapons were you carrying?**
M4, 203, SAW & RADIO

**What weapons would you have liked to have with you?**
Any of the ones carried and for MOUNT a MK5

**Search Patterns**
Inside Buildings
- ✓ Pie Pattern
- ✓ Other High Low

Outside Buildings
- ✓ Pie Pattern
- ✓ Other CLOVER

**FOV used in Urban**
- _____ NFOV
- _____ WFOV

**Length of Mission**
- ✓ To get to objective
- ✓ To acquire target
- ✓ Miles to objective
- ✓ Miles to target

**Conflict**
- ✓ Encountered gun fire
- ✓ Encountered conflict

**Target Encounter**

What told you that a target was in your location of search:

- ✓ Intel Information
- ✓ Gun Fire
- ✓ Cues
- _____ Other, Please describe

Please list the familiar and unfamiliar cues that you encountered during your target search and detection. These are cues that helped you find the target during target search and acquisition.

Familiar or Expected Cues:
Expender rounds, military used equpt.
Locals telling, gun fire, or just
Actions or jestures from INDIVIDUALS

Unfamiliar or Unexpected Cues: IED, AMBUSH,

## VISUAL CUES

How much of an impact did the following visual cues have on target search and acquisition. Please circle NA for any cues that you did not encounter.

| | | Low Impact | High Impact |
|---|---|---|---|
| Cue recognition | NA | ]——————×——————[ | |
| Shadows of target | NA | ]——————×——————[ | |
| Physical communication | NA | ]——————————————X | |
| (did hand signals, etc from fellow soldiers have an impact on your detection of a target) | | | |
| Sight of the weapons of target | NA | ]——————————————X | |
| Muzzle flash | NA | ]——————————————X | |
| Outgoing fire | NA | ]——————————————X | |
| Full body movement of target | NA | ]——————————————X | |
| Partial Body movements of target (ie Hand, limbs) | NA | ]——————————————X | |
| Glint | NA | ]——————×——————[ | |
| Smoke | NA | ]——————×——————[ | |
| Illumination devices | NA | ]——————×——————[ | |
| Tracks | NA | ]——————×——————[ | |
| Sight of target equipment | NA | ]——————————————X | |
| Bullet impacts | NA | ]——————————————X | |
| Target body shape recognition | NA | ]——————————————X | |
| Military uniform recognition | NA | ]——————×——————[ | |
| Spall/blast | NA | ]——————————————X | |
| Dust plumes | NA | ]——————×——————[ | |
| Thermal spots | NA | ]——————×——————[ | |
| Suspicious behavior/actions | NA | ]——————————————X | |
| Hostile behaviors/actions | NA | ]——————————————X | |
| Other_____ | NA | ]——————————————[ | |

Please give a brief description of what immediate action you took when you encountered the following visual cues during target search and acquisition. If there were visual cues you encountered that are not listed below, please add to the end of the list.

| | |
|---|---|
| Cue recognition | Depended on cue and situation |
| Shadows of target | Stop look listen and prepared. MET Depend |
| Physical communication (did hand signals, etc from fellow soldiers have an impact on your detection of a target) | |
| Sight of the weapons of target | Took Agressive posture Ready to Fire |
| Muzzle flash | Reacted as if were in contact |
| Outgoing fire | Followed all instructions From team Ld REACT TOC or 1A |
| Full body movement of target | watched closely or even behind |
| Partial body movements of target (ie Hand, limbs) | same as Above |
| Glint | if of wepon prepared to take target down |
| Smoke | Became more Alert |
| Illumination devices | tried to stay out of direct light at nigh |
| Tracks | watched |
| Sight of target equipment | Prepared to Attack, Detain |
| Bullet impact | got general direction round came from and watched |

(cont) Please give a brief description of what immediate action you took when you encountered the following visual cues during target search and acquisition. If there were visual cues you encountered that are not listed below, please add to the end of the list.

| | |
|---|---|
| Target body shape recognition | Prepared to ENGAGE or Detain |
| Military uniform recognition | Detained or if Armed ENGAGED if threat |
| Spall/blast | React Accordingly |
| Dust plumes | watched |
| Thermal hot spots | watched |
| Suspicious Behavior/actions | Detained |
| Hostile behavior/actions | RESPONDED with AGRESSION |
| Other: | |

During the situation discussed, you did not encounter all visual cues possible. Below is a list of some cues you may or may not have encountered. Please rate how likely these visual cues are to be a source of information in any situation which you may be attempting to search and detect a target. Please add any visual cues that may be important in target search and detection that are not listed.

| | | Low Probability A Source of Information | High Probability A Source of Information |
|---|---|---|---|
| Cue recognition | NA | ]——— | ———[ |
| Shadows of target | NA | ]——— | ———[ |
| Physical communication | NA | ]——— | ———[ |
| (did hand signals, etc from fellow soldiers have an impact on your detection of a target) | | | |
| Sight of the weapons of target | NA | ]——— | ———[ |
| Muzzle flash | NA | ]——— | ———[ |
| Outgoing fire | | | |
| Full body movement of target | NA | ]——— | ———[ |
| Partial Body movements of target | | | |
| (ie Hand, limbs) | NA | ]——— | ———[ |
| Glint | NA | ]——— | ———[ |
| Smoke | NA | ]——— | ———[ |
| Illumination | NA | ]——— | ———[ |
| Tracks | NA | ]——— | ———[ |
| Sight of target equipment | NA | ]——— | ———[ |
| Bullet impacts | NA | ]——— | ———[ |
| Target body shape recognition | NA | ]——— | ———[ |
| Military uniform recognition | NA | ]——— | ———[ |
| Spall/blast | NA | ]——— | ———[ |
| Dust/plumes | NA | ]——— | ———[ |
| Thermal hot spots | NA | ]——— | ———[ |
| Suspicious behavior/actions | NA | ]——— | ———[ |
| Hostile behavior/actions | NA | ]——— | ———[ |
| Other: | NA | ]——— | ———[ |

## AUDITORY CUES

How much of an impact did the following auditory cues have on target search and acquisition. Please circle NA for any cues that you did not encounter.

| | | Low Impact | High Impact |
|---|---|---|---|
| Vehicle noise | NA | ]—— x ——[ | |
| Equipment noise | NA | ]—— x ——[ | |
| Sounds of enemy movement | NA | ]—— x | |
| Radio communication of enemy | NA | ]—— x | |
| Verbal communication of enemy | NA | ]—— x | |
| Verbal communication with own unit | NA | ]—— x ——[ | |
| Gun fire | NA | ]—— x | |
| Animal sounds | NA | ]—— x ——[ | |
| Other _____ | NA | ]——[ | |

Please give a brief description of what immediate action you took when you encountered the following auditory cues during target search and detection. If there were auditory cues you encountered that are not listed below, please add to the end of the list.

| | |
|---|---|
| Vehicle noise | move ought of sight and watcher |
| Equipment noise | watched and prepare for CONTACT |
| Sounds of enemy movement | prepared for contact |
| Radio communication of enemy | listed and Relaid INFO |
| Verbal communication of enemy | listened and Relayed INFO |
| Verbal communication with own unit | done quietly |
| Gun fire | REACT to contact |
| Animal sounds | looked |
| Other: | |

During the situation discussed, you did not encounter all auditory cues possible. Below is a list of some cues you may or may not have encountered. Please rate how likely these auditory cues are to be a source of information in any situation in which you may be attempting to search and detect a target. Please add any auditory cues that may be important in target search and detection that are not listed.

| | | Low Probability A Source of Information | High Probability A Source of Information |
|---|---|---|---|
| Vehicle noise | NA | ] | [ |
| Equipment noise | NA | ] | [ |
| Sounds of human movement | NA | ] | [ |
| Radio communication | NA | ] | [ |
| Verbal communication | NA | ] | [ |
| Non-verbal communication | NA | ] | [ |
| Gun fire | NA | ] | [ |
| Animal sounds | NA | ] | [ |
| Other _____ | NA | ] | [ |
| Other _____ | NA | ] | [ |

**Physical Factors**

How much of an impact did the following physical factors have on your ability to search and acquire the target. Please circle NA for any physical factors that you did not encounter.

| | | Low Impact | High Impact |
|---|---|---|---|
| Alertness | NA | ]——————X——————[ | |
| Mood | NA | ]——————X——————[ | |
| Shooting Accuracy | NA | ]————————————X[ | |
| Shooting Speed | NA | ]————————————X[ | |
| Physical Strength | NA | ]————————————X[ | |
| Searching | NA | ]————————————X[ | |
| Tension | NA | ]——————————X——[ | |
| Depression | NA | ]——————X——————[ | |
| Anger | NA | ]——————X——————[ | |
| Vigor | NA | ]——————X——————[ | |
| Fatigue | NA | ]————X———————[ | |
| Confusion | NA | ]X———————————[ | |
| Other _____ | NA | ]————————————[ | |

Please give a brief description of what immediate action you took when you experienced the following physical factors during your target search and detection. If there were physical factors you encountered that are not listed below, please add to the end of the list.

| | |
|---|---|
| Alertness | I stayed Alert or I can could DIE |
| Mood | I had a job to do + did it |
| Shooting Accuracy | It Not Accurate then your Dead |
| Shooting Speed | Regulated Round expenditure |
| Physical Strength | maintained pt and strength |
| Searching | looked where I wouldn't want others to look |
| Tension | Tense due to Fact of being in combat |
| Depression | No time to be depressed |
| Anger | ANGRY For loosing Friends and turned that into motivation |
| Vigor | — |
| Fatigue | tired but Kept moving and do your job to come home |
| Confusion | Not good planning + leader ship |
| Other: | |

During the situation discussed, you did not use all possible factors. Below is a list of some factors you may or may not have used. Please rate how these factors affected your ability to search and detect a target. Please add any factors that may be important in target detection that are not listed.

| | | No affect | A Large affect |
|---|---|---|---|
| Alertness | NA | ]——————X——————[ | |
| Mood | NA | ]——————X——————[ | |
| Shooting Accuracy | NA | ]————————————X[ | |
| Shooting Speed | NA | ]————————————X[ | |
| Physical Strength | NA | ]————————————X[ | |
| Searching | NA | ]————————————X[ | |
| Tension | NA | ]——————X——————[ | |
| Depression | NA | ]————X———————[ | |
| Anger | NA | ]————X———————[ | |
| Vigor | NA | ]————X———————[ | |
| Fatigue | NA | ]————X———————[ | |
| Confusion | NA | X————————————[ | |
| Other _____ | NA | ]————————————[ | |

**SCENE/SITUATION COMPLEXITY**

How much of an impact did the following factors have on your ability to search and acquire the target. Please circle NA for any factor that you did not encounter.

| | | Low Impact | High Impact |
|---|---|---|---|
| Memory of scene clutter | NA | | |
| Ability to decipher erroneous information during hostile situations | NA | | |
| Ability to manage all task | NA | | |
| Control of radio communication | NA | | |
| Teammate coordination | NA | | |
| FOV monitoring | NA | | |
| Scene Complexity | NA | | |
| Knowledge of enemy location | NA | | |
| FOR monitoring | NA | | |
| Lost location | NA | | |
| Misfire | NA | | |
| Situational stress | NA | | |
| Situational pressure | NA | | |
| Confidence in teammates | NA | | |
| Confidence of target identification | NA | | |
| Unusual events or series of Events | NA | | |
| Other: _____ | NA | | |

Please give a brief description of what immediate action you took when you experienced the following factors during your target search and detection. If there were factors you encountered that are not listed below, please add to the end of the list.

| | |
|---|---|
| Memory of scene clutter | N/A |
| Ability to decipher erroneous information during hostile situations | Good |
| Ability to manage all task | Good |
| Control of radio communication | D.I with no problem |
| Teammate coordination | Good |
| FOV monitoring | N/A |
| Scene Complexity | some mission were complex |
| Knowledge of enemy location | Direct mission |
| FOR monitoring | N/A |
| Lost location | N/A |
| Misfire | correct it if it happens |
| Situational stress | constan |
| Situational pressure | constant |
| Confidence in teammates | Full confidence |
| Confidence of target identification | Know what your looking for & find it |
| Unusual events or series of events | |
| Other: | |

During the situation discussed, you did not encounter all possible factors. Below is a list of some factors you may or may not have encountered. Please rate how these factors affected your ability to search and detect a target. Please add any factors that may be important in target search and detection that are not listed.

| | | No Affect | A Large Affect |
|---|---|---|---|
| Memory of scene clutter | NA | | |
| Ability to decipher erroneous information during hostile situations | NA | | |
| Ability to manage all task | NA | | |
| Control of radio communication | NA | | |
| Teammate coordination | NA | | |
| FOV monitoring | NA | | |
| Scene Complexity | NA | | |
| Knowledge of enemy location | NA | | |
| FOR monitoring | NA | | |
| Lost location | NA | | |
| Misfire | NA | | |
| Situational stress | NA | | |
| Situational pressure | NA | | |
| Confidence in teammates | NA | | |
| Confidence of target identification | NA | | |
| Unusual events or series of events | NA | | |
| Other: _____ | NA | | |

## SCANNING METHODS

How much did you use the following scanning methods during your target search and detection mission.

| | | Did Not Use | Used All The Time |
|---|---|---|---|
| Scanning | NA | ] | [X |
| Rotational scanning | NA | ] | [X |
| Quick scan | NA | ] | [X |
| Pieing | NA | ] x | [ |
| Paying particular attention to the part of the scene that is new during movement ops | NA | ] | [X |
| Looking vertical | NA | ] x | [ |

Below is a list of several scanning methods that can be used during search and detection. Please describe how and when you used each method during the discussed situation. If you used other search techniques, please add to the bottom of the list.

| |
|---|
| Rotational scanning<br>often |
| Quick scan (looking from one potential danger area to another)<br>used a lot |
| Pieing a MOUT environment<br>often |
| Paying particular attention to the part of the scene that is new during movement ops<br>used a lot |
| Looking vertical<br>when needed |
| Other: |

## NETWORK SOURCES OF INFORMATION

How much of an impact did the following sources of information have on target search and acquisition? Please circle NA for any sources of information that you did not encounter.

| | | Impact Low | Impact High |
|---|---|---|---|
| Intelligence reports | NA | ]——X——[ | |
| Alarm from remote sensor | NA | ]——X——[ | |
| Radio communications with elements of own force | NA | ]——X——[ | |
| Display with common operating picture or narrative report | NA | ]——X——[ | |
| Other network information sources | NA | ]——X——[ | |
| Other: | NA | ]——————[ | |

**OTHER ELEMENTS THAT MAY IMPACT UPON SEARCH AND TARGET ACQUISITION**

Which of the following elements had an impact upon your ability to search and acquire a target? Please circle NA for any sources of information that you did not encounter.

| | | Impact Low | Impact High |
|---|---|---|---|
| Environmental characteristics | NA | ]—×— | [ |
| Lighting contrast (shadows) | NA | ]—×— | [ |
| Direction of the light source | NA | ]—×— | [ |
| Target shape or camouflage pattern | NA | ]—×— | [ |
| Scene complexity & clutter | NA | ]—×— | [ |
| Operational tempo (time pressures) | NA | ]—×— | [ |
| Sensor capabilities (e.g range) | NA | ]—×— | [ |
| Physical movement of sensor | NA | ]—×— | [ |
| Depth perception with sensors | NA | ]—×— | [ |
| Personal experience | NA | ]—×— | [ |
| How well you recognized a cue e.g. sound of specific enemy weapon | NA | ]—×— | [ |
| Familiarity with the location | NA | ]—×— | [ |
| Assessment of threat i.e. an individuals perceived intent (hostile or not) based upon cues, weapon, actions or affiliation | NA | ]—×— | [ |
| Your expectations | NA | ]—×— | [ |
| History of target presentation(s) | NA | ]—×— | [ |
| Enemy deception | NA | ]—×— | [ |
| Use of obscuration (e.g. smoke or peep holes) | NA | ]—×— | [ |
| Rules of engagement | NA | ]—×— | [ |
| Conflicting information on enemy (or potentially conflicting, e.g. two sources provide differing locations) | NA | ]—×— | [ |
| Effects of fatigue | NA | ]—×— | [ |
| Suppression (incoming fire) | NA | ]—×— | [ |
| Noises clutter (e.g. flash bang grenade) | NA | ]—×— | [ |
| Obstructions to senses e.g. helmets, helmet mounted displays, ear plugs, goggles etc. | NA | ]—×— | [ |
| Individual workload cognitive or physical demands as a result of trying to accomplish several actions at the same time, e.g. conduct movement, communicate, assess equipment, etc. | NA | ]—×— | [ |