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BATTLEFIELD BEHAVIOR OF NEUTRALS AND HOSTILES: MODELS FOR THE TEAM TACTICAL ENGAGEMENT SIMULATOR (TTES)

by

Judith H. Lind

September 1995

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Prepared for: U.S. Marine Corps Systems Command
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This study has been conducted to define typical battlefield behaviors for five groups of hostiles and neutrals who might be encountered in combat: (1) Standard Elite Troops, (2) Average Irregulars, (3) Isolated Criminals, (4) Frightened Civilians, and (5) Unfriendly Civilians. Results can be used in modeling computer-controlled hostiles and neutrals (CCH/Ns) in the joint Marine Corps-Navy Team Tactical Engagement Simulator (TTES), a deployable, flexible virtual reality training system. Military personnel and civilian law enforcement officers will use TTES under a wide variety of simulated urban and rural situations to enhance marksmanship skills and to learn to discriminate among possible adversaries, to determine intent and level of hostility, and to decide whether to engage or to withhold fire.

Thirty-five military and civilian subject matter experts were surveyed to obtain their judgments on the percentage of time each of several kinds of CCH/N behaviors typically will be observed for each of the five groups, in a given medium-level conflict scenario under specified combat conditions. The experts also provided characteristic levels of seven traits or skills for each type of CCH/N. The results have been used to develop frequency distributions that represent each group uniquely, for use in TTES behavior representations.

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Behavior representation, Combat behaviors, Computer-controlled hostiles, Computer-controlled neutrals, Discretionary decision making, Human behavior, Human factors, Marksmanship trainers, Modeling and simulation, Simulated humans, Tactical decision making, Team Tactical Engagement Simulator, TTES, Virtual reality

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ACRONYMS AND ABBREVIATIONS

CCH	Computer-controlled hostile
CCH/N	Computer-controlled hostile/neutral
CGF	Computer-generated force
DIS	Distributed Interactive Simulation
DSE	Dynamic synthetic environment
FSM	Finite state machine
IST	Institute for Simulation and Training, University of Central Florida, Orlando
JackML	*Jack* Motion Library
MOUT	Military Operations in Urban Terrain
NAWC-TSD	Naval Air Warfare Center, Training Systems Division, Orlando
SAFDI	Semi-Automated Forces Dismounted Infantry
SIMNET	Simulation Network
TTES	Team Tactical Engagement Simulator

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1.0 EXECUTIVE SUMMARY

A study has been conducted to define typical behaviors for five groups of hostiles and neutrals which might be encountered on the battlefield. The groups are (1) Standard Elite Troops, (2) Average Irregulars, (3) Isolated Criminals, (4) Frightened Civilians, and (5) Unfriendly Civilians. The results are intended for use in modeling computer-controlled hostiles and neutrals (CCH/Ns) that will serve as adversaries for those who train using the Team Tactical Engagement Simulator (TTES). TTES training is intended to enhance two skills: marksmanship and discretionary decision making. The latter skill is used to discriminate between hostiles and neutrals encountered on the battlefield and to decide whether to engage or to withhold fire.

Subject matter experts were surveyed to obtain their judgments on the percentage of time each of several kinds of CCH/N behaviors might be observed for each of the five groups, under specified combat conditions. Of the experts surveyed, 30 were military enlisted personnel and officers (25 with combat experience and five without), and five were civilian law enforcement officers. A modified *Delphi* method was used to collect expert judgments. The study participants used the current version of TTES (or observed it in use) and received a briefing on the capabilities the ultimate system will have, then completed a detailed survey form.

The survey form presented a simple combat scenario typical of those to be used for TTES training. The scenario was divided into six segments, beginning when a CCH/N comes into the view of a TTES trainee and ending when the CCH/N is wounded. Between five and nine *behaviors* that a CCH/N might exhibit were listed for each segment: seek cover and observe, seek cover and fire, raise hands in surrender, run away, etc. Seven *traits* or *skills* that CCH/Ns might exhibit also were listed on the survey form and the experts were asked to judge the level of each trait or skill for each type of CCH/N. These included awareness of surroundings, courage, judgment of risk, tactical skills, and marksmanship skills.

Respondents distributed 100 points among the five to nine listed behavioral options for each scenario segment and each type of CCH/N. Individual results then were averaged, to arrive at a matrix of frequencies with which each type of behavior should be modeled for each of the five CCH/N categories, for each segment. Respondents also distributed 100 points among four levels of "goodness" for each of the seven traits or skills, for each type of CCH/N, and similar matrices were constructed for these characteristics.

The surveyed experts were asked if the five types of CCH/Ns were sufficient to model for TTES training. The majority (58%) indicated that these five would provide an adequate representation of battlefield entities, while 19% indicated that five were more than adequate and 23% felt that more types were needed.

The behavioral frequency matrices obtained from the subject matter experts either can serve as rules of thumb for distributing behaviors among CCH/Ns or the actual numerical averages can be used in programming. What is important is that realistic combat behaviors be modeled that will result in correct training which is directly transferable to real-world battlefields — and to the varieties of hostiles and neutrals who may be encountered there.

2.0 INTRODUCTION

2.1 BACKGROUND

The Team Tactical Engagement Simulator (TTES) project is part of a service-wide effort to utilize advanced modeling and simulation techniques for training individual combatants. These individual combatants include infantry, security forces, special operations forces, and law enforcement personnel. The TTES research and development effort is sponsored by the U.S. Marine Corps and is being carried out under the leadership of the Naval Air Warfare Center Training Systems Division (NAWC-TSD), Orlando, Florida. Primary developer of the simulation software is the Institute for Simulation and Training (IST), University of Central Florida, Orlando, Florida.

The *TTES Advanced Technology Demonstration* effort was begun in fiscal year 1993 to develop core technology for individual combatant and small-unit force-on-force training devices, and will continue through fiscal year 1996. Two Defense Modeling and Simulation Office awards and associated teaming with other Department of Defense agencies have enhanced TTES contributions to joint *Individual Combat Simulation System* efforts.[1]

It is anticipated that the TTES training systems will be used by the U.S. Marine Corps, U.S. Army, U.S. Air Force, Security Police, Special Operations Forces, and various civilian law enforcement agencies such as the Federal Bureau of Investigation and the U.S. Drug Enforcement Agency. Thus it is important to ensure that the planned TTES simulations have the capability to meet the needs of both trainers and trainees in those various agencies.

TTES emphasizes tactical decision-making and close combat marksmanship skills in a *Dynamic Synthetic Environment* (DSE), complementing live-fire and field training. The DSE includes (a) a dynamic representation of the physical environment and (b) behavioral representation of friendlies, hostiles, and neutrals. That is, training can be conducted in a realistic simulated combat environment where trainees will encounter computer-controlled hostiles/neutrals (CCH/Ns) whose high-fidelity simulated combat behavior will closely emulate that of actual hostile and neutral units and individuals. CCH/Ns will not be simplistic "cartoons," but rather will be modeled to represent typical actions of real people in real-world combat situations.

TTES is not merely a marksmanship trainer, although it will provide both individuals and teams the opportunity to practice small arms and other weapons skills. More important, TTES will train *when* to shoot as well as *how* to shoot.[2] TTES eventually will be capable of emulating a variety of humans, ranging from desperate criminals and mobs, through well-trained or marginally-trained enemy forces, to neutral or unfriendly villagers. Trainees will have the opportunity to hone their skills related to recognizing the intent and level of hostility of individuals and groups, and to

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[1] Marine Corps System Command. *Team Tactical Engagement Simulator (TTES) Advanced Technology Demonstration*, by F.J. Wysocki and D.H. Fowlkes. Quantico, Va., Amphibious Warfare Technology Directorate, February 1994.

[2] Naval Air Warfare Center Weapons Division. *Team Tactical Engagement Simulator (TTES): Perceived Training Value*, by J.H. Lind and S.R. Adams. China Lake, Ca., NAWCWPNS, December 1994. (NAWCWPNS TM 7724.)

make intelligent decisions concerning when to engage and when to withhold fire. Indeed, it is anticipated that improved tactical and decision-making skills will be the most significant TTES training payoff.[3]

As noted by Hartley,[4] "If your business is war and you don't have a real war, you have an incentive to learn everything you can about all its aspects in the best way you can." He notes that immersion training is being developed that is so realistic that the trainee unconsciously absorbs peripheral implications — but warns that these unconscious lessons are the hardest to refute when wrong. "It has been said that it isn't the things you don't know that get you killed, but the things you know that ain't so." Training simulations carry assumptions about what to expect from the enemy. Thus it is critical that the trainees not be trained to do something wrong (referred to as negative training) simply because they have absorbed false impressions of their adversaries. Helping ensure that this does not happen is the purpose of this study.

2.1.1 Envisioned TTES System

TTES is a virtual reality training device under development in the Marine Corps technology base. TTES is intended as a supplement and complement to live-fire and field training, not as a substitute. The software developed in the effort can be applied as a modular upgrade to compatible small arms training systems for infantry, security force, and special operations units. The envisioned TTES product is projected for fielding in the 2002 to 2006 time frame.

The TTES training device will be deployable, affordable, and easy to produce. Oriented to individual combatants and small units, TTES technology will contribute to operational readiness by enabling mission preparation in operationally relevant synthetic environments. Trainees also will be able to utilize a variety of combat weapons in realistic tactical situations while traversing a simulated environment that includes open terrain, villages, and various kinds of buildings. When TTES is provided, an appropriate terrain database of an objective area will be available, along with CCH/Ns characterized to emulate the behaviors of the kinds of individuals who may be encountered on that particular battlefield. Such capabilities will enable mission previews and mission rehearsals specific to the expected combat situation, based on a realistic emulation of the objective area.

The envisioned TTES system will fully immerse fire team members in a common virtual reality using wide-area screens and/or helmet-mounted displays with audio capabilities, for training as a coordinated tactical unit in the same synthetic environment. Multiple trainees will be able to interact while linked via a radio frequency network using Distributed Interactive Simulation (DIS) protocols, so that they are not constrained by signal-carrying wires. Trainees also will be networked with CCH/Ns via DIS protocols, enabling emulation of force-on-force engagements in areas where neutral and friendly forces are present.

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[3] Naval Postgraduate School. *Perceived Usefulness of the Team Tactical Engagement Simulator (TTES): a Second Look*, by J.H. Lind. Monterey, Ca., NPS, September 1995 (NPSOR-95-005)

[4] D. Hartley. "A Revisionist View of Training Simulation Validity Requirements." *Phalanx*, March 1995.

The refinement of discretionary and tactical decision skills will be the most significant TTES payoff. Other payoffs include maintenance of perishable skills, realistic training in expeditionary situations such as during prolonged shipboard deployments, and weapon virtual prototyping.

2.1.2 Current TTES Emphasis

The current thrust of TTES is Military Operations in Urban Terrain (MOUT). This emphasis was chosen for mission relevance and for a sufficient challenge during technology evolution. Tactical decision skills and close combat marksmanship skills are the training facets emphasized at this time.

TTES development is focused initially on general purpose infantry. Scenarios for training security forces are next in line. Training for special operations units and rear-area security situations will follow. The basic technology will meet requirements for and be applicable to training programs for all military services. Near-term TTES capabilities also will be useful for various civilian law enforcement agencies.

2.1.3 TTES Equipment

The current TTES evaluation hardware suite is illustrated in Figure 1. Each TTES suite includes an 8- by 10-foot rear-projection display screen, a projector, an M16-A2 demilitarized rifle and weapon monitor, a head-position tracker, microphone and headphones, a foot pedal for movement control, and a computer graphics generator, along with the TTES software that runs the program. Two or more suites can be used concurrently for team training. The trainee aims the weapon as desired, looks through the sight, and pulls the trigger to fire a virtual round that follows a ballistic path through the virtual battle space.

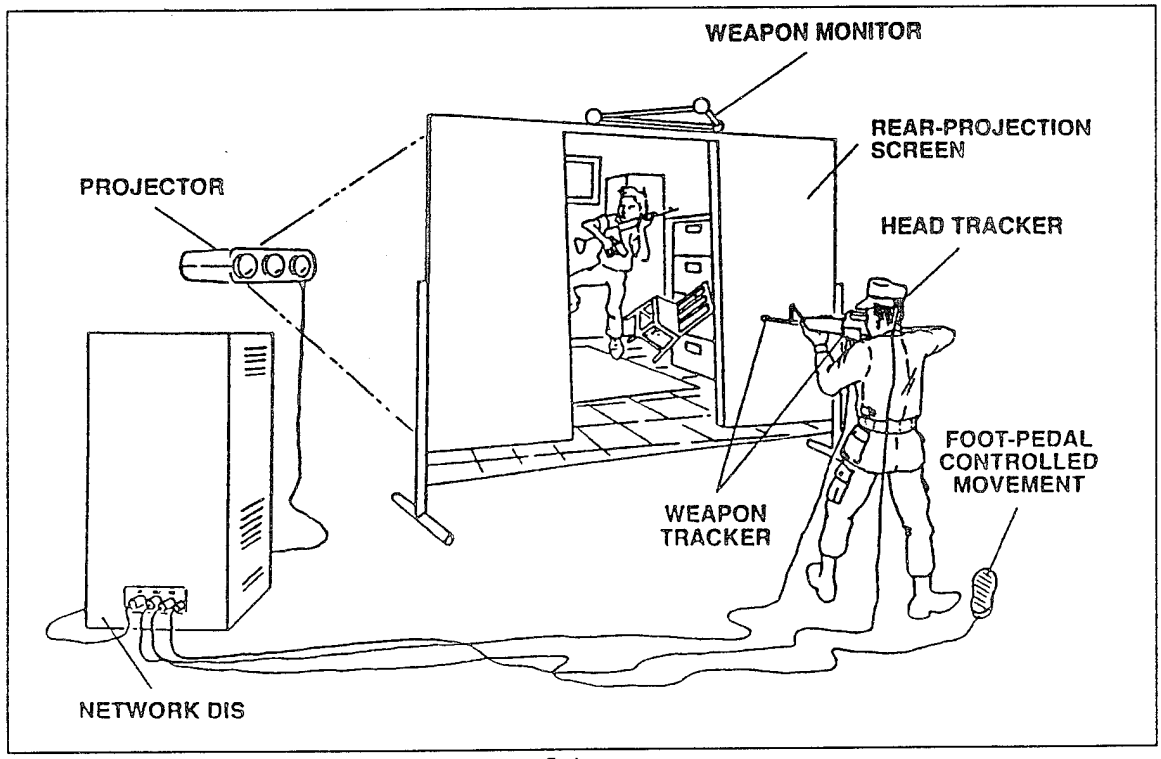

Figure 1. Current TTES Evaluation Hardware Suite.

Pressure on the forward end of the foot pedal causes the system to move the trainee forward through the environment at a rate proportional to the amount of pressure applied. Pressure on the back of the pedal results in the appearance of moving backward. The head-tracking device is attached to a helmet, worn during the training exercise. Moving the head left or right causes the projected scene to move appropriately to display new areas. Microphones and headphones enable communications among trainees in separate TTES stations who are practicing team exercises.

The envisioned TTES system for 2002, shown in Figure 2, includes weapon and body monitors, non-tethered tracking emitters that transmit signals related to human motion, a foot-controlled movement device, a head-mounted visual and audio display, a trainee computer pack, and a master computer with a radio frequency DIS network. Eventually (in the 2006 timeframe) DIS network technology will allow very localized combined arms training involving weapon platforms and aviation assets via their respective virtual reality simulators linked into a common virtual battle space. This ultimate system is illustrated in Figure 3.

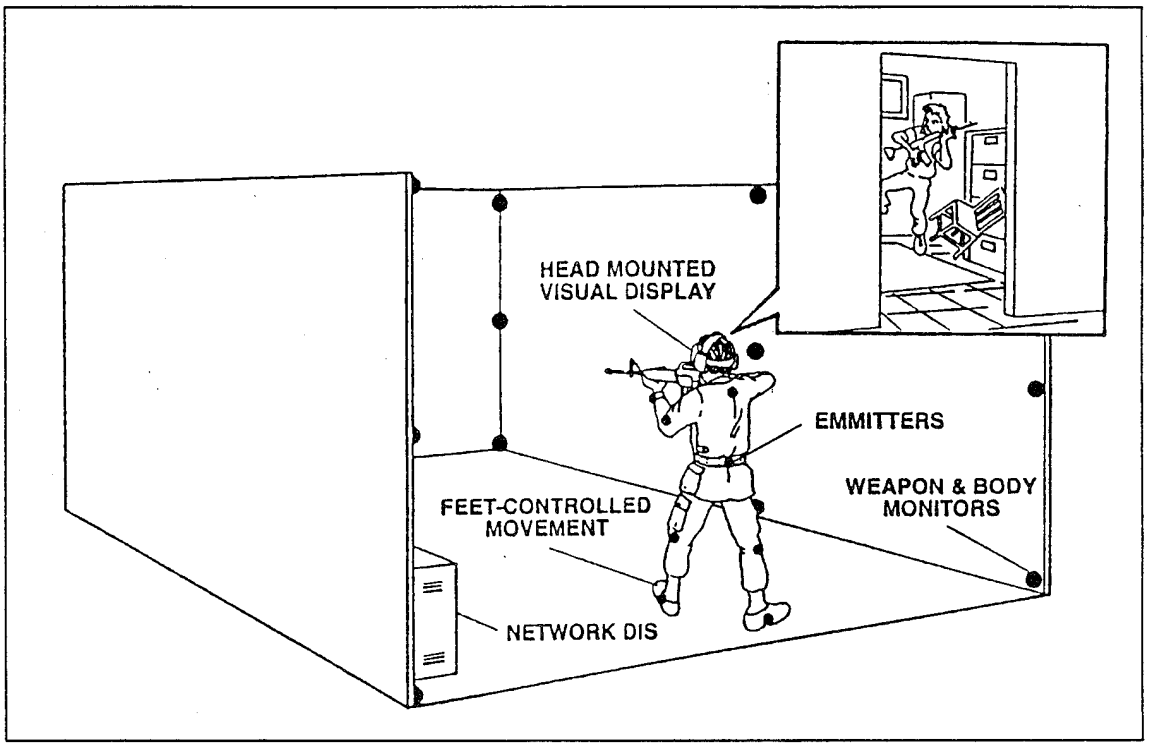

Figure 2. TTES Equipment Configuration for the 2002 Timeframe.

2.2 GOAL OF STUDY

A critical component of TTES is the accurate representation of adversaries for realistic training. Thus the goal of the present study is to define the kinds of behaviors that discriminate hostiles from neutrals and friendlies on the battlefield, whether that "battlefield" is located in a distant war-torn country or in a U.S. city besieged by an angry mob. Our hypothesis is that subject matter experts can define a range of "typical" behaviors that will distinguish various kinds of CCH/Ns and facilitate determination of intent. Resulting behavior representations must not be simplified to the point that the figures become cartoons. *Realism* is critical for satisfactory training in making appropriate decisions in combat.

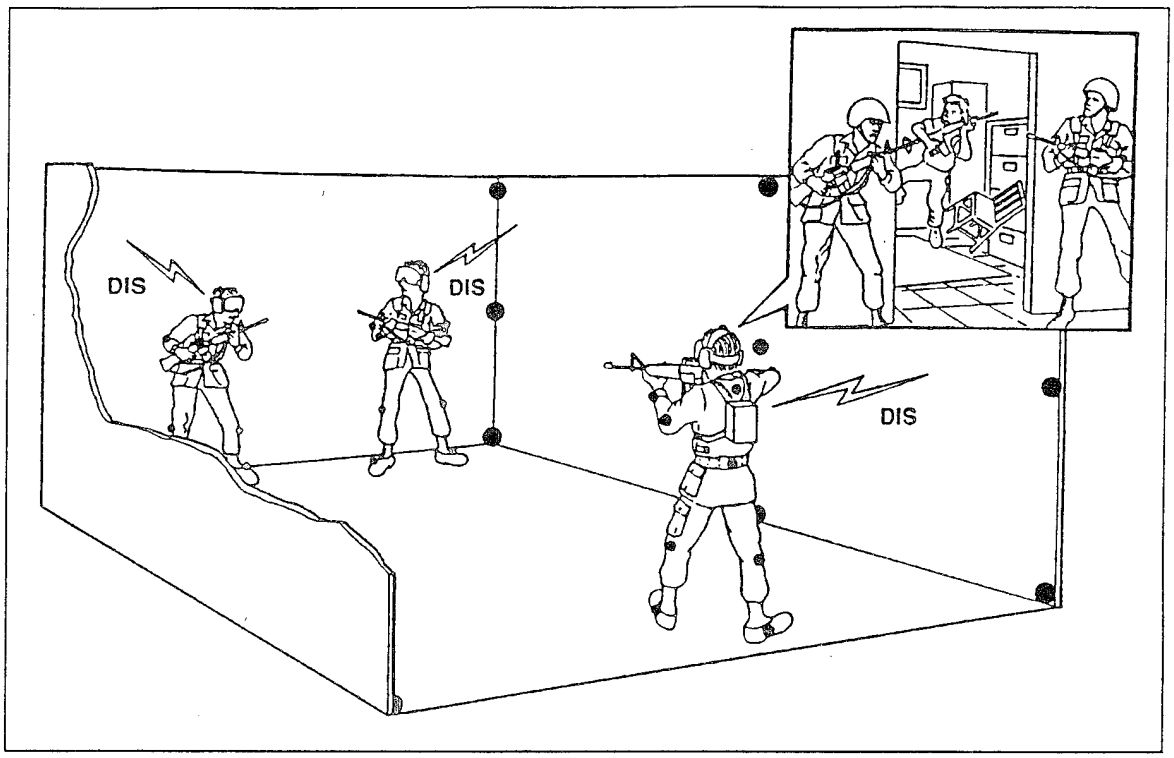

Figure 3. TTES Equipment Configuration Planned for 2006.

Individuals and groups observed in combat range from soldiers intent on killing to civilians who only want to escape. Yet all are humans, and will exhibit behaviors that are typically human. This makes it possible to model a wide range of individuals based on a relatively small repertoire of actions. Thus all CCH/Ns encountered in TTES are being developed in three incremental steps.

1. **Basic human movements.** The CCH/N figure will simulate routine human movements such as walking, running, and kneeling.

2. **Individual tactical techniques.** Simulated adversaries will use tactically-correct or specialized movements such as running while maximizing concealment.

3. **Coordinated tactical actions.** Coordinated tactics will be modeled for CCH/N groups, squads, or teams as they move and as adversaries employ weapons in an appropriate tactical fashion.

Human beings are expected to react within a given range of alternatives when faced with certain circumstances. For example, if an individual is shot at, he or she most likely will do one of the following: (a) seek concealment and observe, (b) seek concealment and return fire, (c) go prone and observe, (d) go prone and return fire, (e) stand in place and freeze, (f) drop to the ground and freeze, (g) raise hands in surrender, (h) run away, or (i) begin coordinated tactical movements with others. The probability that an individual will do any one of the above depends on training, mission, intent, and various other characteristics. Most important, the reaction alternatives are independent of the specific threat and are *generically human*.

In any defensive, offensive, or patrol-based engagement, there is an expected set of discrete events. Assigning probabilities of occurrence to the events and to their associated alternative outcomes permits freeplay vignettes to unfold. The likelihood of any given vignette exactly repeating itself will be very small. A replay of the exact circumstances is possible, while ensuing actions can be very different.

Realistic CCH/N activity need only emulate reality, not replicate it. Simulated humans can be categorized into groups, and general group behaviors on the battlefield can be defined and modeled. Computer production of realistic hostiles and neutrals engaged in what appears to be realistic activities is "good enough" to result in appropriate responses of trainees. What is important is that possible targets be presented in a way such that the trainee reacts quickly, decides correctly, and engages a CCH/N appropriately for the given range, weapon, and type of adversary.

2.3 STUDY APPROACH

2.3.1 General Approach

Five types of individuals and groups that might be encountered on the battlefield have been selected for modeling in this study. They are referred to as (1) Standard Elite Troops, (2) Average Irregulars, (3) Isolated Criminals, (4) Frightened Civilians, and (5) Unfriendly Civilians. These categories are defined in Section 5.2.

When modeling CCH/Ns for a training system such as TTES, it is critical that the simulated individuals and groups respond in ways that reflect actual behaviors in the real world. Well-trained Standard Elite Troops will respond using better tactics and coordinated efforts than would Average Irregulars, and civilians are expected to respond in quite different ways than enemy troops. Thus it is fairly easy to set up an ordering system whereby better-trained adversaries respond more professionally, etc.

The question, however, is how *much* more professionally will Standard Elite Troops respond than will Average Irregulars? How *much* better marksmen will Average Irregulars be than Isolated Criminals? And *how* will civilians and enemies react differently on the battlefield (and when civilians sometimes become combatants)? What percent of the time would members of each group be expected to stand firm and what percent to run away?

In addition, no group is totally homogeneous; a range of behaviors always is to be expected. Although most Standard Elite Troops will hold their ground, some proportion will surrender and some will run. In modeling individuals who are representative of this group, what percent of the time is each type of behavior to be expected?

Ideally, definitions of typical human behaviors are obtained through direct observation. Unfortunately, observation is totally impractical for a study such as this. Instead, a survey has been conducted to obtain answers to these (and other) questions from subject matter experts — the same kinds of people who eventually will use TTES for training, and who can draw on their own experiences to tell us how humans behave in combat. "Indirect observations" have been collected from people who have "been there" and can tell us what to expect, using a modified categorical judgment technique. Both military and civilian experts were surveyed to obtain their point estimates on the percentage of time each of several kinds of behavior might be observed, for the

five type of CCH/Ns and for a specific combat vignette typical of those used for training with TTES.

The end product is a "behavioral probability matrix," a set of tables specifying *distributions* of actions and characteristics for each of the five specified populations. That is, for a given group of CCH/Ns and a table of possible actions and characteristics, the matrix documents expected values for the percentage of time each of these actions and characteristics should be observed (ranging from 0% to 100%), considering that the modeled populations are not homogeneous.

The subject matter experts have been selected from several combatant communities and civilian law enforcement agencies. Some have participated in real-world combat, while others have experienced combat only through training exercises. Yet all were able to draw on their experiences to make thoughtful judgments about what they would anticipate to be typical behaviors on the battlefield, as these behaviors differ from group to group.

2.3.2 Selection of Judgment-Collection Procedure

Knowledge acquisition is recognized as one of the most difficult problems in building intelligent computer-controlled forces,[5] in part because the required knowledge is very specific to a given situation. Since it is impractical to collect behavior data during actual combat, the next best thing is to ask those who have been there. Several techniques are commonly used to obtain perceptions, opinions, and judgments from subject matter experts. These techniques generally fall into two categories: personal interviews and questionnaires.

Personal interviews are used to present the situation verbally, then to obtain verbal responses to situations and questions. Such interviews can be *undirected* and open-ended, eliciting those comments that happen to come to mind and that the expert wishes to provide. Interviews also can be *directed* and structured, with the interviewer asking a prepared set of questions and noting the responses. Interviews are useful for obtaining opinions when the possible set of responses is unknown or when respondents are unlikely to take the time to complete a questionnaire. They are expensive because they require a great deal of time on the part of the interviewer, and results may be difficult to analyze.

A third interview technique is referred to as the *verbal protocol* method. The expert actually uses the system being evaluated (or a simulation of it), and verbally provides perceptions and opinions while going through a typical scenario. Like other interview techniques, the verbal protocol method is costly to use and results are hard to analyze. Unlike other interview techniques, this methodology requires that the system be available for use in a form that adequately represents what the final system will be like. The TTES prototype system is in its initial development stage; thus the use of this technique was deemed inappropriate for now.

Questionnaires, unlike interviews, require that the surveyor know in advance what information generally is sought. Questionnaires can be *open-ended*; these are used to obtain opinions when the surveyor does not wish to prejudice the expert by providing a prescribed set of possible responses. Open-ended questionnaires are time-consuming to analyze, but sometimes are the only way to obtain needed opinions.

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[5] D. Keirsey and others. "Case-Based Computer-Generated Forces." *Proceedings of the Fourth Conference on Computer Generated Forces and Behavioral Representation*, Orlando, Fl., May 1994

Structured questionnaires are used for the opposite situation: when the surveyor has prepared a limited set of responses that are to be judged in some manner. The expert then may be asked to select one or more responses, to rank the responses, or to rate them on a scale of importance or likelihood. Such questionnaires must be thoughtfully prepared to avoid biasing the results.[6] Once the questionnaire is prepared, survey administration is cost effective and analysis is straightforward.

One technique that uses both open-ended and structured questionnaires is referred to as the *Delphi* method.[7] Experts first respond to general open-ended questions, within provided guidelines. Summary statistics are generated from the results. These are used to prepare a second questionnaire for submission to experts, for further refining of responses. The conventional *Delphi* method continues iteration of questions and responses until the response distribution converges. However, Sackman has suggested that feeding back "correct" responses to participants biases the results.[8] Thus two iterations usually are considered adequate for most studies.

Cost and time considerations have led to selection of the modified *Delphi* method described above to obtain the judgments needed for this study. Details of the application of the method are provided in Section 5. The survey form used for data collection is reproduced in Appendix A.

2.4 SCOPE AND VALIDITY OF STUDY

2.4.1 Participant Representativeness

The survey discussed in this report makes use of subject matter experts to obtain judgments of anticipated battlefield actions of five groups of hostiles and neutrals as well as characteristics that differ among these groups. Attempts were made to utilize a representative sample of potential TTES users. However, time and funding constraints have bounded the project, and the limited number of experts is a weakness of this study (a second and wider phase of evaluations is planned for July 1996 through July 1997). Thirty-five military and civilian marksmanship trainers were used as the experts in 1995 (see Section 5.3). These individuals primarily were drawn from six agencies and commands. With only 35 experts and only six potential user agencies involved in the survey, the sample may not be representative of the total potential TTES user population and may be biased by the missions of those surveyed.

2.4.2 Participant Variability

As discussed in Section 5.5, point estimate responses were averaged and standard deviations were calculated to obtain a measure of participant variability. Standard deviation values are reported in Appendixes B, C, D, E, and F, along with other summary data. As may be observed,

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[6] D. Meister. *Behavioral Analysis and Measurement Techniques.* New York, John Wiley and Sons, 1985.

[7] N. Dalkey and O. Helmer. "An Experimental Application of the Delphi Method to the Use of Experts." *Management Science*, Vol. 9 (1963).

[8] Rand Corporation. *Delphi-Assessment: Expert Opinion, Forecasting, and Group Processes*, by H. Sackman. Rand, Santa Monica, Ca., 1974. (Report No. R-1283-PR.)

these values are very large (often larger than the averages themselves) and strongly indicate that the averages are very imprecise. This is not especially surprising, since only 35 respondents participated and each was asked to divide 100 points among between 5 and 9 options for each question. Many hundred survey participants would be required for such a distribution to converge toward the expected value. What has been obtained here are *behavioral trends*, for use in modeling, expected to result in simulated actions and responses that generally will be seen as realistic by the individuals who will use TTES for training.

2.4.3 Participant Backgrounds

Survey respondents have been divided into three groups: military personnel who have been in combat, military personnel who have not seen combat, and civilian law enforcement agents. Questionnaire responses were recorded and analyzed separately for each group, to determine whether it was appropriate to combine them. Results were inconclusive. In general, the *order* of option selections remained relatively constant across groups, but expected values for the percentages varied widely.

Results from the 25 combat-experienced respondents probably have the most validity. With only five participants each in the non-combat military and civilian groups, little validity can be implied for these group responses. Average values are provided, but it must be recognized that they do not represent adequate samples of the populations. These results are reported separately in Section 6 for completeness and so differences and similarities can be observed, for those interested. Although the resulting trends may be interesting, great caution should be taken in making any hard inferences from these individual group results.

2.4.4 Participant Responsiveness

Questionnaires used for data collection were carefully designed to be as comprehensive as possible. As a result, they were quite long and required approximately 40 minutes to complete. Most of the respondents were observed while completing the forms, and appeared to take the process seriously and to approach the task thoughtfully. Based on these observations, we feel that the responses are valid for the sample that was surveyed.

3.0 BEHAVIOR REPRESENTATION

3.1 CATEGORIES OF HUMANS ON THE BATTLEFIELD

Behavior representation is a complicated endeavor, ranging from using simple anthropomorphic icons to depict the human figure and human dynamics to the characterization of various kinds of individuals, coordination of movements, and manipulation of objects such as weapons. Since a driving restraint is computer power and capacity, a workable solution is selective representation of typical behaviors, after defining what is "good enough."

We tend to think of a battlefield as a place where soldiers face off in combat. Yet, in the real world of modern hostilities, combat is much more complex; it depends on the scenario and level of conflict. Adult males and females, teenagers, children, and even infants may be encountered. Some of these are overtly hostile, some covertly hostile, some neutral or friendly, some merely curious or confused.

Simply representing a single type of "hostile" and "neutral" behavior in TTES would result in training so unrealistic as to be dangerous. Trainees quickly would learn to separate the "bad guys" to be engaged from the "good guys" to be ignored, without honing the decision-making skills that will be required in actual combat — both for survival and for avoiding mistakes that can result in international incidents.

For example, all *hostiles* are not equally dangerous; they will vary widely in their skills and actions. These individuals can be generally characterized based on the kind of unit or group of which they are a part. *Neutrals* and *friendlies* also come in many "shades" and will behave differently depending on the category that best describes them, their emotions, and the urban or rural setting. Table 1 provides examples of the types of CCH/Ns (and also friendlies) that might be modeled for a training system such as TTES.

Table 1. Examples of Categories that Might Be Modeled for Combat Decision-Making Training.

Hostiles	Neutrals	Friendlies
Super ninja troops	Neutral troops	Friendly troops
Standard elite troops	Neutral police	Friendly police
Highly-trained irregulars	Frightened villagers	Frightened villagers
Moderately-trained irregulars	Frightened city dwellers	Frightened city dwellers
Quality irregulars	Curious villagers	Curious villagers
Highly-trained conscripts	Curious city dwellers	Curious city dwellers
Poorly-trained conscripts	Unfriendly villagers	Uninterested villagers
Marginal irregulars	Unfriendly city dwellers	Uninterested city dwellers
Hostile mobs	Uninterested villagers	Friendly mobs
Random reactionaries	Uninterested city dwellers	Friendly organized group
Hostile gangs	Neutral mobs	Hostages
Organized criminals	Neutral organized group	Prisoners.
Isolated criminals.	Hostages	
Prisoners.	Prisoners.	

Modeling such a variety of people precisely is prohibitively expensive, and is unnecessary as long as a reasonable range of behaviors is characterized. Thus five groups were selected for this study to characterize. The groups are (1) Standard Elite Troops, (2) Average (Moderately-Trained) Irregulars, (3) Isolated Criminals, (4) Frightened Civilians, and (5) Unfriendly Civilians.

3.2 BEHAVIORS AS FUNCTIONS OF THE SCENARIO

Behaviors are closely linked to what is occurring at the time. During low-intensity conflict, a greater density of civilians and irregular troops will be observed that in a high-intensity conflict. Thus a context was needed in which to obtain expert opinions concerning possible actions and responses for the five kinds of CCH/Ns. A simple scenario was developed that can be modeled for TTES. Basically, a CCH/N comes into view and observes the Trainee's presence. The Trainee commands the CCH/N to stop, aims his rifle at the CCH/N, and fires. The CCH/N is wounded and responds in some characteristic manner. This scenario can be modeled as a relatively discrete sequence of events with several possible predictable outcomes (see the flow diagram in Figure 4).

1. A CCH/N comes into Trainee's view, and may not immediately notice that Trainee is present.

2. The CCH/N observes the Trainee and responds in one of two ways:
   a. CCH/N takes an action (seeking cover or going prone) such that the Trainee thinks he is being engaged. Trainee responds with fire, with one of three outcomes:
      (1) Trainee is killed or wounded.
      (2) CCH/N is killed or wounded..
      (3) Either CCH/N or Trainee withdraws from the scene.

   b. CCH/N responds in a way that is not immediately hostile, but that may or may not be considered hostile by Trainee. Trainee responds in one of three ways:
      (1) Trainee decides CCH/N is harmless and simply observes or ignores CCH/N, with one of two outcomes:
         (a) CCH/N actually is neutral and no engagement occurs. CCH/N leaves the scene, walking or running.
         (b) CCH/N actually is hostile and engages, with one of three outcomes:
            (1) Trainee is killed or wounded.
            (2) CCH/N is killed or wounded.
            (3) Either CCH/N or Trainee withdraws from the scene.

      (2) Trainee commands CCH/N to stop. CCH/N responds in one of two ways:
         (a) CCH/N takes an action such that the trainee thinks he is being engaged. Trainee responds with fire, with one of three outcomes:
            (1) Trainee is killed or wounded.
            (2) CCH/N is killed or wounded.
            (3) Either CCH/N or Trainee withdraws from the scene.

         (b) CCH/N takes one of several response options that are not immediately hostile, but that may or may not be considered hostile by Trainee. Trainee responds in one of two ways:
            (1) Trainee decides CCH/N is harmless and simply observes or ignores CCH/N, with one of two outcomes:
               (a) CCH/N actually is neutral and no engagement occurs. CCH/N leaves the scene, walking or running.
               (b) CCH/N actually is hostile and engages, with one of three outcomes:
                  (1) Trainee is killed or wounded.
                  (2) CCH/N is killed or wounded.
                  (3) Either CCH/N or Trainee withdraws from the scene.

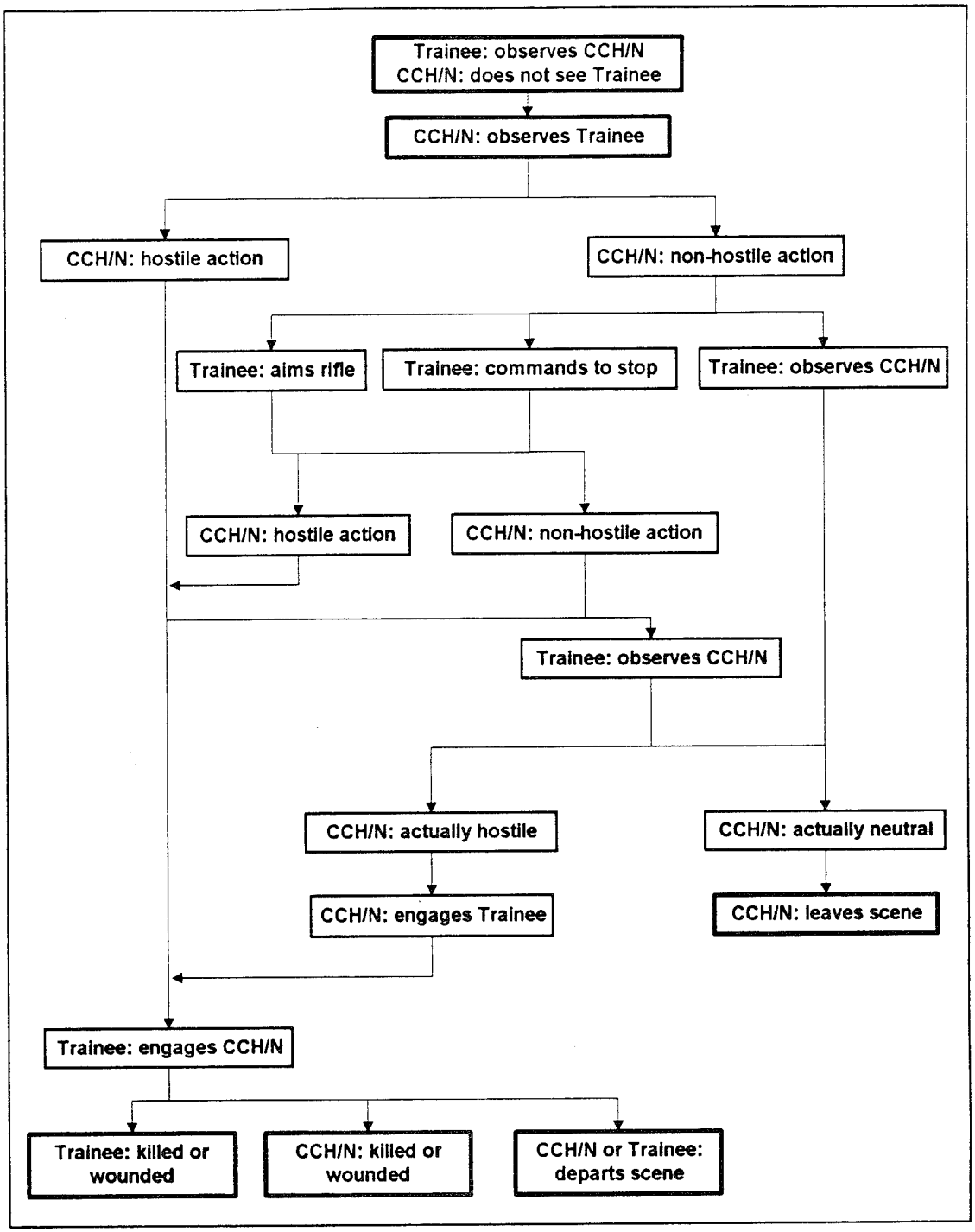

Figure 4. Flow Diagram of a Typical Scenario of an Encounter Between Trainee and a CCH/N.

(2) Trainee engages CCH/N, with one of three outcomes:
  (a) Trainee is killed or wounded.
  (b) CCH/N is killed or wounded.
  (c) Either CCH/N or Trainee withdraws from the scene.

(3) Trainee aims weapon toward CCH/N. CCH/N responds in one of two ways:
  (a) CCH/N takes an action such that the trainee thinks he is being engaged. Trainee responds with fire, with one of three outcomes:
    (1) Trainee is killed or wounded.
    (2) CCH/N is killed or wounded.
    (3) Either CCH/N or Trainee withdraws from the scene.

  (b) CCH/N takes one of several response options that are not immediately hostile, but that may or may not be considered hostile by Trainee. Trainee responds in one of two ways:
    (1) Trainee decides CCH/N is harmless and simply observes or ignores CCH/N, with one of two outcomes:
      (a) CCH/N actually is neutral and no engagement occurs. CCH/N leaves the scene, walking or running.
      (b) CCH/N actually is hostile and engages, with one of three outcomes:
        (1) Trainee is killed or wounded.
        (2) CCH/N is killed or wounded.
        (3) Either CCH/N or Trainee withdraws from the scene.
    (2) Trainee engages CCH/N, with one of three outcomes:
      (a) Trainee is killed or wounded.
      (b) CCH/N is killed or wounded.
      (c) Either CCH/N or Trainee withdraws from the scene.

This simple scenario was used for the survey of subject matter experts, who were asked to provide their estimates of the percentage of time that various listed CCH/N behaviors would be anticipated during each scenario segment. The intent has been to obtain point estimates that can be used to develop distributions for modeling each type of CCH/N response, for the five categories of entities considered here.

3.3 CHARACTERISTIC ACTIONS, TRAITS, AND SKILLS

Behavioral *traits* such as awareness, courage, judgment, resolve, and determination can be used to describe humans and to define how they might differ. Yet such traits cannot be observed directly; they are most easily modeled through observable *postures* and *actions* that may be the result of intellectual or emotional characteristics.

Observable behaviors include static postures and the way the body is held, along with dynamic activities including numerous kinds of whole-body movements. In addition, individual body components can be moved in relation to the body, such as ducking the head or raising an arm. Table 2 provides examples of kinds of postures, actions, and auxiliary behaviors that possibly could be modeled for TTES.

Although Table 2 provides a list of observable behaviors that might be modeled, it is only the first step in defining how to differentiate between hostiles and neutrals. Also needed is a set of *traits* that are characteristic of various groups of people and that can be evidenced via the Table 2 behaviors.

Table 2. Examples of Observable Behaviors To Model, to Illustrate Individual Characteristics.

Basic Static Postures	Basic Dynamic Actions	Auxiliary Behaviors
Standing	Sit down	Raise/lower/duck head
Bent forward at waist	Duck down	Raise head as if looking
Sitting, chair/stool	Squat down	Raise head as if listening
Sitting, ground	Kneel down	Rotate head
Sitting, in vehicle	Crouch down	Rotate body
Ducking	Move to fetal position	Point hand & arm down
Squatting	Lie down on front	Point hand & arm forward
Kneeling	Lie down on back	Point hand & arm to side
Crouched	Hit & roll	Point hand & arm overhead
Fetal position	Roll right & left	Raise both arms overhead
Prone, on front	Fall down on front	Bend one elbow
Prone, on back	Fall down on knees	Bend both elbows
	Fall down on back	Hide/protect face with hands
	Stand up/rise to erect	Protect body with hands
	Turn around to face front	Reach for object
	Turn around to face side	Grasp/grab object
	Turn around to face back	Pick up object
	Walk towards	Cradle object next to body
	Walk laterally	Hold object in one hand
	Walk away	Hold object in both hands
	Duck walk towards	Shift object between hands
	Duck walk laterally	Hold object at arms length
	Duck walk away	Push object away
	Crawl towards	Hide/protect head with object
	Crawl laterally	Protect body with object
	Crawl away	Point object like a gun
	Run towards	Shoot pistol, rifle, shotgun
	Run laterally	Support object on something
	Run away	Set object down
	Back towards	Drop object
	Back laterally	Throw object
	Back away	Strike towards object
	Jump in place	Hit object
	Jump towards	Kick object
	Jump laterally	Communicate, verbally
	Jump away	Communicate, hand signals
	Dive towards	Communicate, eyes
	Dive laterally	Tremble
	Dive away	Shake violently
	Mount vehicle	Cry
	Dismount vehicle	Swagger
	Open/close door	Sneer
	Enter building/bunker	
	Leave building/bunker	
	Enter room	
	Open/close window	
	Leave room	
	Climb stairs	
	Descend stairs	
	Move in front of obstacle	
	Move behind obstacle	
	Climb over obstacle	
	Dive over obstacle	
	Random, meaningful motion	
	Random, senseless motion	

Human traits and trait variability can be categorized in many ways. One commonly-used system is based on five generic types of characteristics or capabilities that vary widely across the human population: sensory, intellectual, physical, emotional, and social characteristics. These general characteristics include various individual traits, such as the ability to detect objects, to make decisions, to carry out physical tasks, and to respond appropriately to a given situation.

Traits themselves are distinguished by trait *components*. *Speed* (sensitivity to the situation, vigilance, latency of starting, completion time) and *accuracy* (response type, strength, and intensity; precision; certainty) of performing various actions perhaps are the most definitive trait components. These generally determine how well a task is carried out or the distinctive manner in which an individual displays his or her traits.

For example, a *Standard Elite Trooper* might immediately recognize a threat (high sensitivity, no latency), go prone (tactical response), aim his rifle (accuracy), and hit his target (precision). A *Frightened Villager* might be slow to recognize a threat (poor sensitivity, long latency), hesitate about what to do (uncertainty), and run away (fear response). Table 3 illustrates how these concepts fit together, for use in modeling CCH/Ns for TTES.

As with the categories of CCH/Ns that might be included in TTES, far too many traits and skills are listed in Table 3 for practical modeling. Seven traits have been selected to define for this study: (1) awareness of surroundings; (2) courage, little fear of danger; (3) judgment of risk; (4) resolve/determination; (5) tactical skills; (6) marksmanship; and (7) determination/aggressiveness. It was felt that these would provide a reasonable set for beginning to characterize the five CCH/N categories selected for modeling.

3.4 MODELING TRAITS AND SKILLS

The seven behavioral traits selected for this study must be demonstrated via physical actions in any simulation. Possible ways to evidence the traits in TTES are proposed in this section. The behaviors listed here can be coupled with results from the survey of subject matter experts to obtain the frequencies with which the various characteristics and levels of traits should be simulated for the five categories of CCH/Ns, as discussed in Section 6.

No attempt has been made here to be totally comprehensive nor to specify CCH/N behaviors explicitly. The actions listed below are merely suggestive. It is left to the programmers who must develop the TTES CCH/Ns to define for the computer the actual body postures and movements that represent terms such as "hesitant," "stooped," "awkward," and "random."

3.4.1 Awareness of Surroundings

Three skills are related to situational awareness, which is largely a sensory or perceptual characteristic: localization, detection, and recognition. The following actions (corresponding to the three skills) and degrees of responses possibly can be used to model several levels of awareness. For the survey, situational awareness was associated with the first scenario segment, before the CCH/N observes the Trainee's presence.

Table 3. Examples of Characteristics, Traits and Trait Components Useful for Modeling.

Trait Categories	Example Traits	Trait Components
Sensory Characteristics: awareness of the situation	Visual detection Visual recognition Auditory detection Auditory recognition Tactile detection Tactile recognition Localizing signals	Latency Completion time Sensitivity Response type Accuracy Precision Certainty Endurance Vigilance/focus/alertness
Intellectual Characteristics: deciding how to respond	Doctrinal decisions Tactical decisions Leadership decisions Judgment of risk Responses to orders Situation assessment Initiative Evaluating alternatives Planning Reasoning	Latency Completion time Sensitivity Response type Accuracy Precision Certainty Endurance
Physical Characteristics: responding to the situation	Physical strength Physical well-being Response to injury Tactical skills Weapons skills: aiming Response to fire Bearing/stance/demeanor Furtiveness/stealth	Latency Completion time Response strength Response type Accuracy Precision Certainty Endurance
Emotional Characteristics: qualities that influence responses	Carefulness/carelessness Selfishness/unselfishness Courage Fear of danger Martyrdom Resolve/determination Perseverance Motivation Enthusiasm Confusion Stress effects/strain Anger/rage Defensiveness/offensiveness Aggressiveness Response to confrontation	Latency Completion time Response intensity Response type Accuracy Precision Certainty Endurance
Social Characteristics: group responses	Leading Following Interactions Instructing Controlling/commanding Group planning Reinforcement	Latency Completion time Response intensity Response type Accuracy Precision Certainty

Localization. Rotates the head and/or body in the direction of the Trainee.

Latency. Time required to start trying to localize the stimulus (the Trainee).

Awareness excellent: begins motion within 0.3 sec.[9]

Awareness poor to very poor: begins motion after 2 sec.

Completion time. Time required to complete the localization of the stimulus.

Awareness excellent: completes motion within 0.6 sec.

Awareness poor to very poor: completes motion in 3 sec.

Precision. Exactness with which the stimulus is localized.

Awareness excellent: moves to face straight-on towards Trainee.

Awareness poor to very poor: faces at least 5 deg off line of direction towards Trainee.

Detection. CCH/N exhibits a slight-to-significant startle reaction upon observing the Trainee's presence, jerking the body and head upright.

Sensitivity. Stimulus strength required for detection.

Awareness excellent: reacts to an off-axis and/or partially concealed Trainee as well as to one in the open.

Awareness poor to very poor: reacts to Trainee only if directly ahead and in the open.

Latency. Time to notice that Trainee is present.

Awareness excellent: begins startle within 0.4 sec.

Awareness poor to very poor: begins startle after 2 sec.

Recognition. Stops present action in preparation for starting response to Trainee presence.

Completion time. Time to complete mental processing required for recognition of Trainee.

Awareness excellent: changes to beginning posture for next action within 0.8 sec.

Awareness poor to very poor: change to beginning posture for next action after 2 sec.

Accuracy. Correctness in recognizing that Trainee is present.

Awareness excellent: moves into a response action that is appropriate for this CCH/N category.

Awareness poor to very poor: does not recognize Trainee; continues as before.

3.4.2 Courage, Little Fear of Danger

Courage and fear of danger are emotional characteristics or traits. They generally are evidenced by posture and dynamic actions, the certainty and intensity of a response, and the person's endurance. This trait was associated with the second scenario segment for the survey, when the CCH/N observes the presence of the Trainee.

Posture. Assumes a basic stance and configuration of body and limbs, after the Trainee is observed.

Courage very high: assumes an upright and "open" posture, with arms held loosely at the sides or holding an object (weapon) in a relaxed but ready manner.

Courage low to very low: assumes a more stooped, huddled, and "closed" posture, arms held tightly against the body, often with elbows bent. Carried object possibly held awkwardly.

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[9] Reaction and response times are based on data from M.S. Sanders and E.J. McCormick, *Human Factors in Engineering and Design*, Sixth Edition, pp. 218-219. New York, McGraw Hill, 1987.

Dynamic actions. Moves the head, whole body, torso, limbs, and carried objects, changing from one posture to another, in response to observing the Trainee.

Courage very high: moves head and arms smoothly and purposefully from one posture to another; walks or runs with a relaxed, constant gait.

Courage low to very low: moves head and arms in a jerky, hesitant manner; varies the size of steps and the direction of movement in random patterns

Certainty. Decisiveness or sureness versus hesitancy of the response.

Courage very high: changes position/location and manipulates objects smoothly and rapidly, without hesitation.

Courage low to very low: changes position/location and manipulates objects hesitantly, including random motions.

Intensity. Strength of the response.

Courage very high: moves limbs with precision and vigor; takes long steps. Manipulates objects forcefully and rapidly.

Courage low to very low: moves limbs limply, more slowly; takes small steps. Manipulates objects slowly and weakly.

Endurance. Time that the response persists or continues.

Courage very high: response lasts until the CCH/N leaves the scene (if neutral) or is killed or kills the Trainee (if hostile).

Courage low to very low: response is extinguished within a few seconds by the presence and/or actions of Trainee.

3.4.3 Judgment of Risk

The ability to judge the risk level of a situation or action is a cognitive or intellectual characteristic, learned through experience and practice. How accurately the CCH/N assesses risk can be shown by posture and dynamic actions, by the speed and certainty with which the response is executed, and by the type of response selected. This trait also was associated with the second scenario segment for the survey, when the CCH/N observes the presence of the Trainee.

Posture. Assumes a basic stance and configuration of body and limbs, after the Trainee is observed.

Judgment very good: assumes a protected offensive/defensive posture from which to observe or engage (if hostile); assumes a non-threatening stance with empty hands in view (if neutral).

Judgment poor to very poor: assumes an offensive/defensive posture from an unprotected position (if hostile); stands/sits with hands hidden so they possibly could be holding a weapon (if neutral).

Dynamic actions. Moves the head, whole body, torso, limbs, and carried objects, changing from one posture to another, in response to observing the Trainee.

Judgment very good: moves directly towards cover or drops to prone position (if hostile); moves away from Trainee or towards an escape route (if neutral).

Judgment poor to very poor: moves head and arms in a jerky, hesitant manner; varies the size of steps and the direction of movement in random patterns.

Latency. Time to determine that risk is present and begin to respond.

Judgment very good: begins response within 0.3 sec.

Judgment poor to very poor: begins response after 4 sec.

Completion time. Time to complete the response to the risk.

Judgment very good: completes response action within 0.5 sec.

Judgment poor to very poor: completes response action after 10 sec.

Certainty. Decisiveness or sureness of the response to the risk, versus hesitancy.

Judgment very good: changes position/location and manipulates objects smoothly and rapidly, without hesitation.

Judgment poor to very poor: changes position/location and manipulates objects hesitantly and awkwardly, including random motions.

Response type.

Judgment very good: seeks cover or goes prone (if hostile); faces Trainee in a non-threatening posture with empty hands in view, or runs/walks away (if neutral).

Judgment poor to very poor: initiates fire from unprotected position (if hostile); approaches Trainee with hands hidden or brandishing an object (if neutral).

3.4.4 Resolve and Determination: Resistency

Resolve and determination are emotional characteristics that determine how well an individual will carry out assigned duties. They generally are demonstrated by an individual's posture and movements; the speed, certainty, and intensity of a response; and the person's endurance. This trait was associated with the third scenario segment for the survey, when the Trainee commands the CCH/N to stop.

Posture. Assumes a basic stance and configuration of body and limbs, after interaction with the Trainee begins.

Resolve very high: leans forward slightly (if standing); holds weapon at the ready (if hostile).

Resolve low to very low: assumes a more stooped posture, leaning back slightly (if standing); weapon not in ready position (if hostile).

Dynamic actions. Moves the head, whole body, torso, limbs, and carried objects, changing from one posture to another, in response to Trainee actions.

Resolve very high: moves head and arms smoothly and purposefully from one posture to another; walks or runs rapidly and in a constant direction.

Resolve low to very low: moves head and arms in a jerky, hesitant manner; varies the size of steps and the direction of movement in random patterns

Latency. Time to begin to respond to Trainee's actions.

Resolve very high: begins response within 0.3 sec.

Resolve low to very low: begins response after 4 sec.

Completion time. Time to complete the response to Trainee's actions.

Resolve very high: completes response action within 0.5 sec.

Resolve low to very low: completes response action after 5 sec.

Certainty. Decisiveness or sureness of the response, versus hesitancy.

Resolve very high: changes position/location and manipulates objects smoothly and rapidly, without hesitation.

Resolve low to very low: changes position/location and manipulates objects hesitantly, including random motions

Intensity. Strength of the response.

Resolve very high: moves limbs with precision and vigor; takes long steps and moves arms forcefully. Manipulates objects forcefully and rapidly.

Resolve low to very low: moves limbs limply, more slowly; takes small steps. Manipulates objects slowly and weakly.

Endurance. Time that the response persists or continues.

Resolve very high: response lasts until the CCH/N leaves the scene (if neutral) or is killed or kills the Trainee (if hostile).

Resolve low to very low: response is extinguished within a few seconds by the presence and/or actions of Trainee.

3.4.5 Tactical Movement Skills

Tactical skills (move, shoot, communicate) combine both cognitive and physical characteristics. These skills were separated into movement skills (considered here) and marksmanship skills (Section 3.4.6) for the survey. Movement skills represent learned responses from both training and experience. For efficient use, these skills must have been practiced long enough to be second nature. Tactical movement skills generally are demonstrated by an individual's posture and movements; the speed, strength, certainty, accuracy, precision, and type of response; and the individual's endurance. While tactical skills technically belong to military personnel, civilians also can demonstrate a form of such skills by acting in thoughtful, logical, self-protective ways in the face of danger. This trait was associated with the fourth scenario segment for the survey, when the Trainee aims the rifle towards the CCH/N.

Posture. Assumes a basic stance and configuration of body and limbs, after interaction with the Trainee begins.

Skills excellent: faces Trainee directly (if not concealed); holds weapon at the ready (if hostile).

Skills poor to very poor: assumes an off-axis posture; weapon not in ready position (if hostile).

Dynamic actions. Moves the head, whole body, torso, limbs, and carried objects, changing from one posture to another, in response to Trainee actions.

Skills excellent: moves head and arms smoothly and purposefully from one posture to another; walks or runs rapidly and in a constant direction; moves weapon smoothly into firing position and manipulates it with confidence (if hostile).

Skills poor to very poor: moves head and arms in a jerky, hesitant manner; varies the size of steps and the direction of movement in random patterns; manipulates weapon jerkily and awkwardly (if hostile).

Latency. Time to begin to respond to Trainee's actions.

Skills excellent: begins response within 0.3 sec.

Skills poor to very poor: begins response after 2 sec.

Completion time. Time to complete the response to Trainee's actions.

Skills excellent: completes response action within 0.5 sec.

Skills poor to very poor: completes response action after 4 sec.

Certainty. Decisiveness or sureness of the response, versus hesitancy.

Skills excellent: changes position/location and manipulates objects smoothly and rapidly, without hesitation.

Skills poor to very poor: changes position/location and manipulates objects hesitantly, including random motions

Strength. Force with which the response is carried out.

Skills excellent: moves limbs with precision and vigor; takes long steps; manipulates objects forcefully and rapidly.

Skills poor to very poor: moves limbs limply, more slowly; takes small steps; manipulates objects slowly and weakly.

Accuracy. Correctness with which the response is carried out.

Skills excellent: uses established proper responses in accordance with doctrine and training.

Skills poor to very poor: makes random, disorganized responses.

Precision. Exactness with which the response is carried out.

Skills excellent: carries out responses "according to the book."

Skills poor to very poor: appears to be making up or modifying established responses on the run.

Endurance. Time that the response persists or continues.

Skills excellent: response lasts until the CCH/N leaves the scene (if neutral) or is killed or kills the Trainee (if hostile).

Skills poor to very poor: response is extinguished within a few seconds by the presence and/or actions of Trainee.

Response type. Option selected from the set of reasonable responses for this portion of the TTES scenario.

Skills excellent: seeks cover or goes prone (if hostile); faces Trainee in a non-threatening posture with empty hands in view, or runs/walks away (if neutral).

Skills poor to very poor: initiates fire from unprotected position (if hostile); approaches Trainee with hands hidden or brandishing an object (if neutral).

3.4.6 Marksmanship

Marksmanship skills, an important component of tactical skills, have both cognitive and physical attributes, with emphasis on the latter. Although basic skills are learned through training, continued practice is critical for good performance. Marksmanship skills can be characterized by the speed, accuracy, and precision of response. This trait was associated with the fifth scenario segment for the survey, when the Trainee fires towards the CCH/N (and the CCH/N may or may not respond with fire). For TTES modeling and training, neutrals generally will not carry weapons (or, if they do, will not fire them at Trainees except in self-defense). Thus it is assumed here that marksmanship skills will be modeled primarily for hostiles.

Latency. Time to begin engaging Trainee after Trainee is observed.

Skills excellent: begins to position rifle for engagement within 0.3 sec after observing Trainee or being engaged.

Skills poor to very poor: begins response at least 2 sec after observing Trainee or being engaged.

Completion time. Time to fire weapon in response to Trainee's presence and/or fire.

Skills excellent: fires first shot within 1 sec.

Skills poor to very poor: fires first shot after 3 sec.

Accuracy. Aims weapon at the correct target, using correct techniques.

Skills excellent: aims weapon at Trainee, using established weapon practices.

Skills poor to very poor: aims weapon generally towards but not exactly at Trainee; uses weapon awkwardly.

Precision. Strikes the desired area of the target exactly and repeatedly.

Skills excellent: simulated rounds hit Trainee in lethal zone, in repeated fire.

Skills poor to very poor: simulated rounds miss Trainee, in repeated fire.

3.4.7 Determination and Aggressiveness: Initiative

Determination/aggressiveness and resolve/determination are very similar emotional characteristics. The former emphasizes an active, heated role a CCH/N may take in desiring to start and win an engagement, while the latter is a more passive, cool response to what is seen as duty. Aggressiveness generally is demonstrated by an individual's posture and movements; the speed, certainty, and intensity of a response; and the person's endurance. This trait was associated with the final scenario segment for the survey, when the CCH/N has been wounded.

Posture. Assumes a basic stance and configuration of body and limbs during interactions with the Trainee.

Aggressiveness very high: leans forward, almost bending at the waist (if standing); holds weapon high and forward, at the ready (if hostile).

Aggressiveness low to very low: leans back slightly (if standing) as if holding back from the fight; weapon held low, but in ready position (if hostile).

Dynamic actions. Moves the head, whole body, torso, limbs, and carried objects, changing from one posture to another, in response to Trainee actions.

Aggressiveness very high: moves head and arms smoothly and purposefully from one posture to another; walks or runs rapidly and in a constant direction.

Aggressiveness low to very low: moves head and arms in a jerky, hesitant manner; limps, walks, or runs relatively slowly; varies the size of steps and the direction of movement in random patterns

Latency. Time to begin to respond to Trainee's actions.

Aggressiveness very high: begins response within 0.3 sec.

Aggressiveness low to very low: begins response after 4 sec.

Completion time. Time to complete the response to Trainee's actions.

Aggressiveness very high: completes response action within 0.5 sec.

Aggressiveness low to very low: completes response action after 5 sec.

Certainty. Decisiveness or sureness of the response, versus hesitancy.

Aggressiveness very high: changes position/location and manipulates objects smoothly and rapidly, without hesitation.

Aggressiveness low to very low: changes position/location and manipulates objects hesitantly, including random motions

Intensity. Strength of the response.

Aggressiveness very high: moves limbs with precision and vigor; takes long steps; moves arms forcefully. Manipulates objects forcefully and rapidly.

Aggressiveness low to very low: moves limbs limply, more slowly; takes small steps. Manipulates objects slowly and weakly.

Endurance. Time that the response persists or continues.

Aggressiveness very high: response lasts until the CCH/N leaves the scene (if neutral) or is killed or kills the Trainee (if hostile).

Aggressiveness low to very low: response is extinguished within a few seconds by the presence and/or actions of Trainee.

Five CCH/N groups of interest selected for this study have been discussed, a simple scenario defined, and characteristics, traits, and trait components representative of the five groups delineated. Postures, actions, and auxiliary capabilities that might be used in TTES to model group traits are listed above. Subject matter experts have provided judgments on the frequencies with which various behaviors and levels of traits should be anticipated for each of the five groups (Sections 5 and 6).

However, modeling in TTES is constrained by numerous factors; there is no point in proposing models that cannot be implemented. Thus it is worthwhile next to review the present TTES modeling process and its capabilities and limitations.

4.0 MODELING BEHAVIOR FOR TTES

Human behavior models for the TTES system are under development by the Institute for Simulation and Training (IST), Orlando, Florida. The *Jack* human simulation model of the University of Pennsylvania Center for Human Modeling and Simulation, Philadelphia, is a major component of the IST behavioral representations.

4.1 IST'S MODELING RESEARCH DIRECTIONS

The general IST human behavior modeling philosophy is well-stated by Fishwick and others in a 1991 paper.[10] Behavioral representation is the problem of generating (1) physically realistic, (2) doctrinally correct, and (3) reasonably intelligent behavior by a computer-generated force (CGF) operating under DIS protocols. Whether modeling a group and its interactions or a single intelligent agent, behavioral representation requires first that the behavior be specified and then that the specification be executed to produce that behavior in the simulation.

The criterion that CGF behavior reflect reasonable intelligence means that the CGF entities must react to a given situation in ways that are similar to those of human counterparts. Even though CGF entities may be limited to battlefield situations, producing intelligent behavior is a formidable task. Nonetheless, the claimed benefits of using CGF in DIS systems are based on the assumption that the CGF can be made to behave in a usefully realistic way.

CGF behavior is divided into two broad types, both of which must be specified: doctrine and mission. *Doctrine* gives general behavior rules applicable to standard, recurring, generic situations. It can be compared with *world knowledge*, for more general situations. *Mission* provides a situation-specific set of instructions for what to do in a single scenario. These instructions are analogous to *procedural* or *situation knowledge*. CGF behavior is determined by both specification types, as is human behavior in general.

Defining CGF behavior requires both subject matter experts and programmers and thus suffers from the familiar difficulties of knowledge engineering. Some military doctrine may be recorded as text in training manuals, while subject matter experts and other sources generally are needed for other doctrinal and mission information. Task description languages are proposed as means to collect and document pertinent knowledge obtained both from experts and from written documents.

4.2 IST CGF TESTBED

Petty provides an overview of IST's CGF Testbed in a 1992 paper.[11] A CGF system will use built-in behavior to cause an entity or agent to react autonomously to the situation or to carry out orders given by its operator. Behavior may be coded as algorithms, production rules, formal

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[10] P.A. Fishwick., M.D. Petty, and D.E. Mullally. "Key Research Directions in Behavioral Representation for Computer Generated Forces," in *Proceedings of the Second Behavioral Representation and Computer Generated Forces Conference*, Orlando, Fl., May 1991.

[11] M.D. Petty. "Computer Generated Forces in Battlefield Simulation," in *Proceedings of the 1992 Southeastern Simulation Conference*, Pensacola, Fl., October 1992.

behavior specifications, or in some other form. The autonomous agent must be realistic, that is, be true to doctrine, physics, and human responses.

The IST CGF Testbed was developed to connect to the well-established Simulation Network (SIMNET), provide a mechanism for testing CGF control algorithms, and demonstrate the feasibility of low-cost CGF systems that run on IBM-compatible personal computers. Essentially any number of CGF entities can be supported, with one computer driving the ANSII C programs (Watcom C++ compiler) and a second computer serving as an operator console. Currently the CGF Testbed can be configured either for SIMNET or DIS protocols.

4.3 FINITE STATE MACHINES

The primary means of behavior specification for the CGF Testbed is a code structuring and encapsulating technique based on *finite state machines* (FSMs). FSMs are programming processes that are adaptable for numerous functions. The executable part of an FSM is normally broken into small pieces called *states* that can be executed one at a time.[12] The primary difference between the CGF Testbed FSMs and classic FSMs is that in the CGF Testbed each state (rather than the state-event pair) determines the next state.[13]

FSMs exist as C structures in the CGF Testbed. Atomic units of behavior are encoded in algorithms as C functions that then become states in an FSM, with each state containing a pointer to the function corresponding to the state. Each state determines the next state to be entered by testing simulation conditions; transitions are triggered by simulation events. Complex behavior is constructed from the bottom up by combining simpler FSMs.

The IST FSM approach was further described by Smith and Petty in 1992.[14] A behavior unit model includes two kinds of processes: physics actions and behavior units. A *physics action* is an action performed to simulate some aspect of real-world physics, such as vehicle dynamics and damage evaluations. These actions are implemented directly in C.

A *behavior unit* is an action that an entity may perform, such as following a route or firing a weapon. A behavior unit may affect or perform a physics action. A *primitive behavior unit* does not build on other behavior units. A primitive behavior unit is implemented as an FSM that is invoked as a whole (that is, no subpart ever is invoked) and that does not itself invoke any subordinate FSMs. A *compound behavior unit* is constructed from one or more other behavior units (either primitive or compound). It is implemented as an FSM that may invoke subordinate FSMs.

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[12] D.A. Reece. "Execution Control for CPU-Sharing Agents," in *Proceedings of the Third Conference on Computer Generated Forces and Behavioral Representation*, Orlando, Fl., March 1993.

[13] C.R. Karr and others. "Integrating Aggregate and Vehicle Level Simulations," in *Proceedings of the Third Conference on Computer Generated Forces and Behavioral Representation*, Orlando, Fl., March 1993.

[14] S.H. Smith and M.D. Petty. "Controlling Autonomous Behavior in Real-Time Simulation," in *Proceedings of the 1992 Southeastern Simulation Conference*, Pensacola, Fl., October 1992.

Each FSM consists of at least two components. First, a dynamically-created *control block* (called an *fsm_record*) is the fundamental data structure that contains all information needed to maintain the FSM's simulation, including its current state. Second, one or more *state functions* (C functions) define and encode the FSM actions and state transitions. What happens within a state function is up to the FSM designer; there are no specific requirements. Typically, a state function would perform some action such as compute a value, test a condition, call another function, or start another FSM. It then tests simulation conditions and selects the next state to be executed.

Each state in a CGF Testbed FSM corresponds to a C function that may or may not invoke another FSM. That is, when an FSM enters a particular state, one of two actions may occur. If the state corresponds to a single function, that function is called. If the state corresponds to a function that invokes another FSM, that FSM is started sometime during execution. Transition conditions associated with each state are used to test conditions in the simulation to determine the next state to be entered. Time delays may be associated with transitions, to produce realistically-timed behavior.

The CGF Testbed was built around an executive that provides non-preemptive task scheduling, thus supporting multiple CGF entities. Multiple independent FSMs can execute synchronously and can control various aspects of a simulation entity. A message queue identifies entity processes waiting to execute, so the executive can give control to the next process in line. An FSM is started by making an executive function call to instantiate the FSM and put an execution message on the queue. This call is made from some place within a state function. The active process, if it is an FSM, executes by calling its current state function. Sometime in the course of executing, this function must reschedule the FSM for execution (via the message queue) if it wants to execute again, and must change the FSM's current state function.

FSMs are created, sequenced, and deleted via a set of utility functions call *FSM services*, implemented in C but (to ease programmer burden) applied via a set of macros that supply parameters. It was assumed that an entity would never need more than one active instance of any particular FSM. Thus an attempt to create an instance of an FSM will always delete any currently active instance for that entity. One result of this implementation is that an entity cannot have more than one missile in the air.

By 1992, 40 different behaviors had been implemented as FSMs. These range from simple one-state event handlers to sophisticated behavior controllers with up to 17 states, many of which involve other FSMs. Partitioning behaviors into states with clearly defined transitions aids both in design and implementation of behavior and aids in organization of the hierarchical construction of complex behaviors.

4.4 IST SAFDI SYSTEM

By the end of 1992, the IST Testbed had been specialized into a Semi-Automated Forces Dismounted Infantry (SAFDI) system, which could generate dismounted infantry fireteams and their associated fighting vehicles in the SIMNET battlefield.[15] The entities developed for SAFDI were fully functional in the SIMNET environment and could interact with other entities on

[15] M.D. Petty, C.R. Karr, and S.H. Smith. "Semi-Automated Forces Dismounted Infantry in the SIMNET Battlefield," in *Proceedings of the 14th Interservice/Industry Training Systems Conference*, San Antonio, Tx., November 1992.

SIMNET. Although the SAFDI project has ended, many of its developments were permanently incorporated into the IST CGF Testbed.

The Testbed simulator developed for SAFDI generated both the fireteam-vehicle entities and their behaviors, using its autonomous behavior modeling mechanisms. Each behavior could consist of several steps and decision points, performed automatically. Both U.S. and opposing force fireteams could be generated, with some information maintained for the team as an aggregate and other information maintained for each individual soldier. One generic SAFDI five- or six-man fireteam might carry a squad automatic weapon, an anti-tank missile, a grenade launcher, and rifles; the numbers, types, and weapons of team members could be modified as desired (e.g., for U.S. Marine four-man fireteams).[16] Fighting vehicles also were generated and controlled.

A SAFDI fireteam had numerous capabilities as an aggregate. These included (1) communicate with headquarters, (2) see and report enemy entities within line of sight, (3) be seen, (4) kill enemy teams and vehicles, (5) be killed, (6) move and change speed, (7) mount and dismount vehicles, and (8) change visual appearance based on posture. A team could be included as a member of another group. That is, SAFDI entities could be grouped into different platoons and the platoons grouped into a company. A single command (such as *change speed*) then would be executed by all group members.

For each individual soldier, data structures included (1) location, (2) posture, (3) whether the soldier is suppressed, (4) whether the soldier is killed, (5) type of missile carried (if any), and (6) type of small arms weapon carried (if any). Thus team members could maintain different postures and be killed as individuals (though there was no simulation of wounding). As soldiers became exhausted from movement, the probability that they would hit their targets was reduced.[17]

A SAFDI entity could be ordered to attach to any simulated entity, which then became its leader. The entity follows its leader when the leader moves, matching speed and direction though not in formation with the leader. This *attach and follow* capability is useful in conjunction with the *fire when* capability that gives an entity permission to fire when a specified entity fires.

Plain text configuration files were used to control SAFDI simulations. Values contained in the files included (1) probability that a fired round will hit an entity, (2) probability of a kill, (3) amount of damage suffered when hit, (4) sighting distances, (5) fireteam mount/dismount time, (6) entity physical specifications such as maximum speed and maximum weapons, (7) missile dynamics, and (8) various parameters for fireteam configurations.

A new sighting model was added to the CGF Testbed for the SAFDI system. It determines whether an entity has unobstructed line of sight to another entity. If so, the visible entity is added to the observing entity's "sighting list" as undetected, detected, recognized, or identified. The

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[16] F.R. Parra and others. "Parametric Fireteam Makeup for Semi-Automated Forces Dismounted Infantry," in *Proceedings of the Fourth Conference on Computer Generated Forces and Behavioral Representation*, Orlando, Fl., May 1994.

[17] R.W. Franceschini and M.D. Petty. "Dismounted Infantry in DIS-Type Scenarios: A SAFDI Project Overview," in *Proceedings of the Fourth Conference on Computer Generated Forces and Behavioral Representation*, Orlando, Fl., May 1994

sighting model uses various factors to determine into which of the four classes the visible (but possibly unnoticed) entity is placed.

SAFDI fireteams selected targets based on predefined vehicle priorities and the existence of nearby friendly fireteams. Losses were suffered incrementally (man by man), resulting in capability decrement. Activity also could be suppressed as a result of fire on the battlefield. As noted, the SAFDI project has ended, but the CGF Testbed retains many of the same capabilities for use in TTES.

4.5 MODELING HUMANS: *JACK*/TTES

A simulated human consists of the geometric representation, visual appearance, articulation, and control regimes that can render a good facsimile of the real thing.[18] The simulated human figures incorporated in TTES scenarios are based on *Jack*, developed at the University of Pennsylvania Center for Human Modeling and Simulation over the last 20 years and used in numerous military and civilian applications.[19]

Jack is a general purpose interactive environment for manipulating articulated geometric figures, with special emphasis on human figures. *Jack* has a rich notation for building articulated figures with revolute and prismatic joints. A general purpose constraint engine is fast enough for interactive use with high-degree-of-freedom joint chains. A behavioral control regime manages the articulation and constraints to define natural primitives for the direct manipulation and goal-directed animation of human figures. These natural primitives include *move arm, bend torso*, and *create foot motion*. Typically, six human figures (each with 73 joints) can be updated by *Jack* at 30 frames per second.

Most applications run *Jack* in conjunction with a graphics window which provides a display of results based on data from an external simulation system. For TTES, however, *Jack* acts like a server for human motion. *Jack* is run off line, non-graphically, simply providing joint angles and figure positions that are stored for use in updating appropriate human geometry in a host rendering system. That is, *Jack* is used for off-line production of motion sequences that are stored in a single linkable library, the *Jack Motion Library* (*JackML*).[20] The stored motion sequences then are put together for real-time playback on a remote image generator.

In TTES, CCH/Ns are controlled via a DIS stream of commands coming from the CGF Testbed simulator. TTES filters and translates the DIS stream into a set of posture tokens that are passed to *JackML*. Library sequences are selected as needed to transition figures from one posture to another. *JackML* passes the sequences of joint angles back to TTES, where simulated humans are animated using articulated soldier figures loaded into an IRIS *Performer* simulation

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[18] J.P. Granieri and N.I. Badler. *Simulating Humans in VR*, presented at the Virtual Reality Applications Conference, British Computer Society, UK, June 1994.

[19] J.P. Granieri. *Jack/TTES: A System for Production and Real-Time Playback of Human Figure Motion in a DIS Environment*. Philadelphia, Pa., U. of Penn, August 1994. (MS-CIS-94-42.)

[20] J.P. Granieri. "Jack," in *Center for Human Modeling and Simulation Quarterly Progress Report No. 54*, Philadelphia, Pa., U. of Penn, February 24, 1995.

application's runtime visual database.[21] Only one set of motions is loaded, then shared among all soldier figures managed by the library.

Frame rate requirements and polygon count restrictions have necessitated use of a lower-resolution *Jack* figure for the TTES runtime system. The normal *Jack* "polybody" soldier (*human-1*) consists of 2,400 polygons and 73 joints, while postures and motions based on a figure with only 500 polygons and 17 joints (*human-2*) are included in the TTES *JackML*. The lower resolution figure generally emulates the polybody except that it has no fingers, no spine, no eyeballs, and the clavicle is a virtual segment; from the waist down, the high- and low-resolution figures are identical. The low-resolution segment geometry was not normalized, so the figure is not scaleable at present; this limitation is being worked on. Currently the figure has the dimensions of a 95th-percentile male.

Possible human states are encoded in *JackML* as *posture graphs*, where nodes represent static postures and directed arcs represent the animated transitions (movements) from posture to posture. Each arc represents a prerecorded motion (referred to as a *channel set*) with a prototypical duration, stored at 30 frames per second for *human-2*. A TTES motion typically uses 10 to 15 primitive *Jack* motions to transition the human and gun from one posture to another. *JackML* includes three posture graph files (and associated channel set motion files) for TTES simulation: one for the static posture transition graph, one for walking and running transitions, and one for crawling transitions.

TTES human entity information is severely limited by what can be stored in the DIS *Entity State* Protocol Data Unit. As part of a DIS network, the human is always in one of only four postures: standing, kneeling, prone, or dead. Posture modifiers such as *weapon deployed* or *weapon firing* are available. The DIS protocol allows up to three weapons per soldier, but only one per soldier is included in TTES and is always modeled with all figures (a TTES entity consists of a camouflaged human and a rifle). Only the AK-47 and M16 weapons have been modeled. Figures have a heading direction and velocity vector. These attributes can be additive: prone + positive velocity = crawling.

When a posture transition is requested, the system samples the prerecorded motion at the frame rate frequency, so it is guaranteed always to play back in real time. In general, the ending posture of a transition is identical to the starting posture of the next transition. Posture graphs are being augmented to accommodate all possible human motions that can be made within the confines of the DIS protocol. Walking, running, and crawling are being extended to jumping, swimming, etc.

When the CCH/N individual moves across the terrain, this is referred to as a *dynamic* or *cyclical* posture transition. Animations are based on a six-stride model for each type of dynamic motion (forward walking, backward walking, running). Strides are left and right starting steps, left and right cyclic steps that repeat normal walking strides as long as motion is needed, and left and right ending steps to return the figure to the base posture. Only straight line locomotion of fixed

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[21] J.P. Granieri, J. Crabtree, and N.I. Badler. "Production and Playback of Human Figure Motion for 3D Virtual Environments," in *Center for Human Modeling and Simulation Quarterly Progress Report No. 54*, Philadelphia, Pa., U. of Penn, February 24, 1995.

stride is modeled at present. Work is underway to extend the system to handle variable stride lengths and curved path locomotion.

TTES controls the global position of each human figure using DIS dead-reckoning algorithms and information about the terrain; *JackML* moves the figure only in its local coordinates. An entity's global coordinate origin is between its feet. Posture transitions are recorded so that the direction of the face and gun are always known; the body then can be globally oriented correctly when the weapon is fired. TTES also performs the ballistics computations to determine if and where adversary human figures are hit.

4.6 IST TTES SYSTEM AND SIMULATION APPROACH

IST's plan for modifying its CGF Testbed for TTES use is described in its 1993 proposal to NAWC-TSD.[22] Since TTES is a fully automatic system, only one personal computer is needed to run the simulator; no operator station is required. The personal computer is connected via ethernet to the infantry training station components of TTES. Network communications use the DIS 2.0 network protocol standard, extended as needed for TTES's special requirements.

The IST task is to provide an automated opposing force of computer-controlled-hostiles (CCHs) within TTES (with neutrals to be included later). CCH soldiers will move and fire in the TTES battlefield, just as trainees do, and will attempt to prevent trainees from accomplishing their scenario objective. The CCH soldiers will extract information from the synthetic environment, select from a wide variety of actions, and execute the selected action. Example capabilities, simulated at a very fine level of realism and detail, include

- Move through urban terrain, using terrain to provide cover and concealment.
- Sight enemy solders and react to those sightings.
- Use weapons in tactically appropriate ways.
- Coordinate actions with fellow CCH soldiers.

Simulations must reflect the physics of the battlefield including movement and weapons effects. Line of sight computations must be very accurate. Realistic models of human movement capabilities and exhaustion are needed. The effects of demolition and destructive weapons must be represented dynamically in the TTES terrain database.

Precise tactical actions of soldiers as individuals and in small groups must be modeled. CGF entities' built-in behavior should react to the simulation situation and perform intelligent actions. CCH tactical behaviors must be doctrinally correct, drawn from a repertoire of subject-matter-expert-defined tactical behaviors appropriate for TTES training. CCH soldiers also must coordinate their behaviors within tactical guidelines. Behaviors must be specified and controlled by encoding them in algorithms written in C.

Training in TTES will take place in simulated terrain, using a database less than 1 kilometer square constructed of polygons approximately 1 meter on a side, and with less than 20 infantrymen in a scenario. The IST SAFDI Testbed has been modified to generate CCH soldiers and neutrals, while retaining the SAFDI system's core architecture, FSM structures, and configuration file

[22] Institute for Simulation and Training. *Development and Implementation of Computer Controlled Hostiles in Support of the Team Target Engagement Simulator*. Orlando, Fl., IST, September 24, 1993.

handling procedures. Physical modeling is being upgraded to enhance the realism of line of sight, detection, and weapons effects. The SAFDI sighting model is being replaced with a more detailed model of individual soldier perception and attention. The route planner is being modified to process smaller polygons and to find routes through doors and windows.

Specific tactical behaviors are being defined for CCH soldiers by military subject matter experts, for implementation in the CCH system. Reasonable and useful default behaviors are being constructed for CCH soldiers and neutrals, for use when none of the expert-defined specific behavior patterns are being executed. These default behaviors should set up the conditions for the expert-defined specific behaviors, when tactically reasonable.

As envisioned by IST, the proposed development will result in demonstration of a variety of CCH capabilities. One to eight trainees will move through the battle area, using the infantry training stations. At the same time, four to 16 CCH soldiers are moving, both on the ground and inside buildings. They are able to conduct line of sight and perception checks correctly, traverse all types of represented terrain, and use small arms. At some point the trainees sight or are sighted by the CCH soldiers. They engage using realistic small arms fire. The CCH soldiers can attack the trainees and are properly vulnerable to small arms fire from trainees.

Specific TTES CCH capabilities now include or eventually will include the following.

- **CCH behavior automation.** Fully-automated simple default behaviors (such as wait, follow a preset patrol route) with conditional triggering of expert-defined tactical behaviors.

- **CCH behavior set.** Route planning, line of sight and perception, weapons usage, individual behaviors from an expert-defined tactics list, and simple default behaviors.

- **CCH soldier perception model.** Unaided-vision, line-of-sight perception model, including field of view, range, and visibility.

- **CCH human physical capabilities model.** Model movements and postures that consider human capabilities, posture, and wound status to determine movement and speed.

- **CCH behavior coordination and communication.** Individual tactical behaviors and simple two-man behaviors.

- **Weapons.** Small arms such as AK-47 or M16 assault rifles.

- **CCH soldiers/neutrals supported.** At least four and up to 16.

IST lists 20 tasks associated with developing the TTES CCH system. Of these, five relate to behavior modeling.

- **Design and implement soldier perception model.** Design a model for soldier perception to be used to determine if a soldier with an unblocked line of sight to a second soldier actually notices the second soldier. The perception model includes field of view, movement, and other considerations.

- **Develop human physical capabilities model**. Design a model for abstractly simulating posture changes and movements. Develop mechanisms to consider factors such as human capabilities, posture, and wound status when simulating actions. Implement those models for the CCH soldiers.

- **Behavior modeling enhancement**. Adapt the existing primitive behaviors (e.g., route planning) to the urban environment and implement the set of expert-defined CCH tactical behaviors.

- **Implement expert-defined tactical behaviors**. Given the specifications for a set of expert-defined specific tactical behaviors which the CCH soldiers must exhibit, implement the execution of those behaviors applicable to single CCH soldiers. Each behavior should be triggered by a certain precondition that is recognized in the simulation by the CCH system or by the operator. Once triggered, the CCH system performs the behavior autonomously as specified.

- **Implement default behaviors**. Design and implement one or more simple default behaviors, which are behaviors the CCH soldiers perform when none of the expert-defined tactical behaviors have been triggered. The implemented default behaviors may be *watch and wait* or *follow preset patrol route*.

Three of the above behavior-related tasks are considered by IST among the most difficult to implement. These are discussed below.

4.6.1 Soldier Perception Model

The original SAFDI system used a perception model intended to represent the *aggregate* perception of a fireteam. It considered only target visibility (size, markings, etc.), movement, observer sensing power, and observer field of view. IST considers that *recognizing* entity types will not be necessary (all are individual men) and *identifying* them may not be necessary (opposing forces may be easy to identify). The original perception model is being improved in several ways.

- Add behavior that represents visual scanning in the correct direction while checking regions for enemy soldiers. This may be implemented by aggregating several seconds of scanning behavior and allowing a CCH soldier to have a wide field of view in one direction for a period of time.

- Require foveal observation of objects at which the CCH soldier fires.

- Add a peripheral vision field, sensitive mostly to motion; soldier movement will be allowed only toward areas at least in peripheral vision. Objects outside peripheral vision will not be visible.

- Provide vertical and horizontal limits to foveal and peripheral fields of view.

- Reduce probabilities of seeing soldiers who are mostly obscured.

- Allow recognition of postures and actions at a distance.

- Include a hearing model (second year) that is sensitive to weapons discharges, soldier movement, and oral communications. Sounds will generate "sound packets" which a CCH soldier may hear. Range and obstructions will be included in a simple attenuation model, and obstructions will modify direction information.

4.6.2 Human Physical Capabilities

The TTES CCH/N system must interface with the *Jack* system to specify actions. Subject matter experts, *Jack* designers, and CCH/N designers must define the states and actions that are possible, what they look like, and how difficult they are. Effects of various states and actions must be defined in a matrix. Matrix entries will indicate whether an action can be performed at all; how long an action should continue; and, for skill actions such as firing, accuracy degradation.

- Physical states may include posture, weapon position, head position, peeking around corners or through apertures, etc.

- Health states may include exhaustion, temporary shock, permanent wound, etc.

- Actions may include walking, running, crawling, jumping, scanning, tracking, aiming, throwing, firing, etc.

4.6.3 Expert-Defined Tactical Behaviors

Expert-defined tactical behaviors (move, shoot, communicate) should be described by the following.

- Preconditions or situations for which the behavior is applicable. Preconditions should be goals that entities try to achieve, mostly through movements. Eventually preconditions will involve movement by multiple CCH/Ns to establish coordinated positions.

- Actions making up the behavior, a combination of sequenced actions and reactions.

- Conditions that end the behavior.

If a given tactical behavior is a normal planned activity, the CCH/N should attempt to put himself in a situation in which the preconditions are satisfied. Recognizing situations requires general situational awareness, such as that buildings have exterior walls with apertures, rooms inside, and stairways, all connected in standard ways. The CCH/N also can know whether these spaces are occupied by friendly or enemy troops; if enemy troops are in nearby rooms, he can start *play dead until back is turned* behavior. Visual sightings, sounds, and oral communications may help a CCH/N maintain his internal world model.

4.7 SUMMARY: THE IST MODEL

4.7.1 General Behavior Exhibited by Simulated Humans

1. Simulated humans will exhibit behavior that is physically realistic, situationally correct, and reasonably intelligent.

2. Simulated human behavior is based both on world knowledge and on situation-specific knowledge (procedural knowledge), both qualitative and quantitative.

3. Behavior is a combination of postures and of sequenced actions and reactions, with beginning and ending conditions.

4. The behavior set (behavior repertoire) of simulated humans includes simple default behaviors, observing objects based on line of sight and perception, route planning, use of terrain for cover and concealment, and situation-specific behaviors.

5. Applicable default and specific behaviors will be modeled for each situation.

6. Default behaviors are carried out whenever conditions are not met for specific behaviors.

7. Default behaviors will be reasonable and useful (*watch and wait, follow preset route, play dead until back is turned*).

8. Preconditions will be modeled for each default and specific behavior; these will trigger that behavior whenever the entity recognizes certain conditions in the simulation.

9. Simulated humans have as goals trying to achieve preconditions (mostly through movement), that is, to set up conditions for triggering specific behaviors.

10. Once triggered, a behavior continues autonomously.

4.7.2 CCH/N Behavior

1. CCH/N entities will exhibit behavior that is physically realistic, doctrinally correct, and reasonably intelligent.

2. CCH/N behaviors are based both on doctrinal rules (world knowledge) and on mission-specific situations (procedural or situation knowledge), both qualitative and quantitative.

3. The behavior set (behavior repertoire) for CCH/N entities includes those of simulated humans in general and also use of weapons in tactically-appropriate ways.

4. CCH/N goals include trying to prevent TTES trainees from accomplishing scenario goals. Entities can attack first and also can react to attacks.

4.7.3 CCH/N Postures

1. Under DIS protocol, CCH/N entities can assume four postures: standing, kneeling, prone, or dead. Posture modifiers, such as *weapon deployed* or *weapon firing*, are available.

2. Postures can be modified to include states such as peeking around corners or through apertures.

3. A DIS stream of commands from the CGF Testbed simulator is filtered by TTES into a set of posture tokens that are sent to *JackML*. *JackML* passes the joint angles and figure positions back to TTES for animating in an IRIS *Performer* run-time articulated database of human geometry.

4. Posture transitions are recorded; the direction of the face and gun are always known so the body can be globally oriented correctly when the weapon is fired.

4.7.4 CCH/N Actions

1. CCH/N entity behaviors may include a sequence of actions (movements) and decision points, performed autonomously.

2. TTES controls CCH/N global positions using DIS dead-reckoning algorithms and terrain information; coordinate origin is between the entity's feet.

3. *JackML* moves the CCH/N figure in its local coordinates only.

4. CCH/N entities have a heading direction and a velocity vector. Movement and speed depend on human capabilities, posture, and wound status.

5. CCH/N actions may include walking, running, crawling, jumping, scanning, tracking, aiming, throwing, and firing.

6. CCH/N posture and action attributes can be additive. Prone + positive velocity = crawling. Standing + positive velocity = walking or running. Jumping and swimming are being implemented in this manner by including heading direction (such as *up*).

7. Walking or running strides have unique left and right starting and ending strides. All intermediate strides are the same (that is, a repeated, cyclical set of motions).

8. A CCH/N action typically uses 10 to 15 primitive *JackML* motions to transition the human and his gun from one posture to another.

9. In general, transition ending postures are identical with next transition starting postures.

4.7.5 CCH/N Individuals

1. A CCH entity consists of a camouflaged human and a rifle (only the AK-47 and M16 at present). Neutrals may be modeled somewhat differently.

2. From the waist up, runtime TTES CCH/N entities are lower resolution than full-capability *Jack* figures. They have no fingers, eyeballs, or spine, and the clavicle is a virtual segment. From the waist down, CCH/N entities are fully-modeled *Jack* figures.

3. All runtime CCH/N entities have the dimensions of 95th percentile males at present. This limitation is being worked on.

4. CCH/N entity physical specifications (sighting distances, mount/dismount time, maximum speed, maximum weapons) are controlled via plain text ASCII configuration files.

5. CCH/N data structures include (a) location, (b) posture, (c) whether the entity is suppressed, (d) whether the entity is killed, (e) type of missile carried (if any), and (f) type of small arms weapon carried (if any).

6. The effects of exhaustion are modeled for CCH/N entities and, to model wounding, TTES performs ballistics computations to determine if and where a CCH/N entity is hit.

7. CCH/N entities sight TTES trainees and other entities and react to sightings using accurate line of sight computations. Probability of observation is reduced for mostly-obscured objects.

8. Unaided vision is modeled for CCH/N entities, including (a) field of view, (b) scanning behavior, (c) observer sensing power (range determination and recognition of postures and actions at a distance), (d) vertical and horizontal limits for foveal and peripheral vision, (e) peripheral vision sensitive to motion, (f) foveal observation of objects fired at, and (g) detection based on conspicuousness (size, markings, movement).

9. If there is clear line of sight between one CCH/N entity and another (or between one entity and a TTES trainee), the sighting model classes the second entity (or trainee) as undetected, detected, recognized, or identified by the first CCH/N entity, as a function of the above factors.

10. Objects outside peripheral vision are not observable; CCH/N entities will move toward objects only if they are in foveal or peripheral vision.

11. A hearing model eventually will model CCH/N sensitivity to weapons discharges, soldier movements, and oral communications; obstructions will modify direction information.

4.7.6 CCH/N Groups

1. At least four CCH/N entities can be modeled concurrently in the CGF Testbed, with plans for modeling as many as 16.

2. CCH/N entities will coordinate actions with fellow CCH/Ns. Simple two-man behaviors will be modeled that include precise and doctrinally-correct tactical actions.

3. A single CCH/N entity can *attach and follow* another CCH/N entity, which becomes its leader. The follower matches movement speed and direction with its leader, and can be told to *fire when* its leader fires.

4. For multiple CCH/N entities, action preconditions include individual and group movements needed to establish coordinated positions.

5. CCH entities can be combined into five- or six-man fireteams that, as an aggregate, can (a) communicate with headquarters, (b) see and report enemy entities within line of sight, (c) be seen, (d) kill enemy CCHs and vehicles, (e) be killed, (f) move and change speed, (g) mount and dismount vehicles, and (h) change visual appearance based on posture.

6. Fireteams can be combined into larger groups (platoons and companies) that, as an aggregate, can carry out the same activities as individual fireteams.

4.7.7 Finite State Machines

1. Allowable postures and actions for CCH and neutral entities will be defined (along with appropriate situations and conditions for each posture and action, difficulty of performance, duration of actions, action accuracy, and accuracy degradation) so this information can be specified as FSMs, states, and FSM preconditions. A matrix will provide a good format for documenting this information.

2. Each FSM and its associated states belongs to a particular entity.

3. Each FSM has a fixed number of discrete states, with an associated set of behaviors in each state.

4. Entity behaviors will be divided into atomic units of behavior that can be specified as sets of discrete states in FSMs.

5. A primitive behavior unit is implemented as an FSM that is invoked as a whole and does not invoke other FSMs. *Route planning* is an example of a primitive behavior.

6. A compound behavior unit is constructed from other behavior units and implemented as an FSM that may invoke subordinate FSMs.

7. FSM states execute one at a time and each state determines the next state to be entered for its entity. That is, entities schedule state executions via a non-preemptive task scheduling executive's message queue. A single state of a single FSM is executed, then the FSM must return to the queue (or identify the next FSM for its entity and send it to the queue) before another state is executed for that entity.

8. An entity can never have two instances of the same FSM active at once.

5.0 METHODOLOGY

5.1 PRELIMINARY SURVEY

As prescribed by the *Delphi* method, a preliminary open-ended survey was conducted in early 1994 to elicit general information on the kinds of humans that should be included in the TTES system. An open-ended questionnaire was completed by a group of 12 subject matter experts who provided unconstrained inputs on behaviors they would expect to observe on the battlefield. Information on sensory, intellectual, and physical characteristics was elicited, along with traits that might characterize various groups of hostiles and neutrals.

5.2 DETAILED STRUCTURED SURVEY

Continuing with the *Delphi* method, results of the preliminary survey and verbal inputs from experts were used to develop a comprehensive 6-page structured questionnaire (included here as Appendix A). The questionnaire was prepared according to the guidelines of the U.S. Army *Questionnaire Construction Manual*.[23] The remainder of this report concerns the results of this second survey.

The structured questionnaire asked respondents to provide their opinions on the kinds of behaviors expected from hostile and neutral individuals, under a specified set of circumstances. Study participants were told that the results will be used to define a *range* of typical actions TTES CCH/Ns might take.

Instructions emphasized the importance of defining behaviors that will *not* lead trainees to make incorrect assumptions about the intelligence or skill or their adversaries. Humans modeled in TTES must behave in ways that are correct (and believable) for the types of individuals being modeled — not be simplistic "cartoons." For satisfactory training, behaviors must represent typical actions of real people in real-world combat situations.

Although simulated humans in TTES eventually may include several kinds of friendlies and neutrals and several levels of hostiles — ranging from "super-ninjas," through trained regulars, untrained conscripts, mobs, and isolated criminals — only five of these possible types were considered in the survey.

1. **Standard Elite Troops**. Well-trained ground troops on a defensive mission, expert in basic combat skills; comparable to U.S. Army Rangers or the French Foreign Legion.

2. **Average Irregulars**. A pick-up army of individuals who have a common goal but little training, equivalent to the troops of Somali warlords, on a defensive mission.

3. **Isolated Criminals**. Individuals acting essentially alone to take advantage of a combat situation, such as a thief and robber; these may be armed and irrational.

4. **Frightened Civilians**. Neutral residents of a village or city, subject to military operations, who are not especially unfriendly and primarily want to escape to safety; these may be armed.

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[23] U.S. Army Research Institute for the Behavioral and Social Sciences. *Questionnaire Construction Manual*, by B.A. Babbitt and C.O. Nystrom. Ft. Hood, Tx., ARI Field Unit, June 1989. (Research Product 89-20.)

5. **Unfriendly Civilians**. Neutral residents of a village or city, subject to military operations, who dislike American troops and may respond with hostility if accosted; these may be armed and irrational.

The situation modeled for the survey was described as follows.

- **Mission**. Urban peacekeeping operation. U.S. Troops are patrolling a partly destroyed village as part of an "Operations other than war" scenario.
- **Location**. Moderate-sized village, damaged by combat operations over several years.
- **Tactical situation**. Armed hostiles are known to be in the area. Shots have been exchanged earlier today. Intermittent weapon fire is heard in the distance.

Expert judgments were based on a simple sequential scenario similar to that discussed in Section 3.2.

1. A CCH/N (may be either hostile or neutral) moves into the view of U.S. ground troops, about 50 to 100 feet away, in an area similar to Quantico Combat Training Village (where the subject matter experts were observing demonstrations of TTES capabilities).
2. The CCH/N observes the troops' presence.
3. Troops tell the CCH/N to stop.
4. Troops aim rifles at the CCH/N.
5. Troops fire rifles at the CCH/N.
6. CCH/N is wounded by rifle fire.

For each of the six segments of the scenario and for each of the five categories of CCH/Ns, respondents were asked to distribute 100 points among between five and nine listed behaviors that might be observed. The instructions were as follows.

- **Kinds of Behaviors or Reactions**: For each type of CCH/N, what percent of the time (from 0% to 100%) can *each* kind of listed behavior, action, or response be expected?
  - For example, **when crossing the street**, 75% of **Frightened Civilians** may *Cross without checking traffic*, while 25% may *Look both ways*. Total must be 100%.

For each of the six segments and for each of the five categories of CCH/Ns, respondents also were asked to distribute 100 points among four listed levels of a trait or skill that might be exhibited for this scenario by a given group. The instructions were as follows.

- **Traits and skills**: For each type of CCH/N, what is the *distribution* of this type of CCH/N for the listed trait or skill?
  - For example, in **Awareness of danger**, 50% of **Average Irregulars** might be *Excellent*, 20% *Good to very good*, 15% *Average*, and 15% *Poor to very poor*. Total must be 100%.

A final question concerned the number of categories of hostiles and neutrals that are needed in TTES for adequate training in making hostile-versus-neutral decisions. Respondents were asked whether the five types discussed here were adequate or inadequate (on a 5-point scale). They also were asked which CCH/N categories (if any) should not be included, and what additional categories should be considered for inclusion in TTES scenarios.

5.3 STUDY PARTICIPANTS

Thirty-five male military and civilian personnel participated in the survey. The following agencies were represented (see Figure 5):

- U.S. Marine Corps Quantico Weapons Training Battalion (WT Bn), Quantico, Virginia: 12
- Marine Corps Security Forces (MCSF) School, Chesapeake, Virginia: 8
- MCSF Battalion Fleet Anti-Terrorist Security Team (FAST), Norfolk, Virginia: 6
- Other individual U.S. Marine Corps and Army personnel: 4
- U.S. Drug Enforcement Agency (DEA), Quantico, Virginia: 2
- San Antonio (Texas) Police Department: 2
- Los Angeles (California) Sheriff's Department: 1

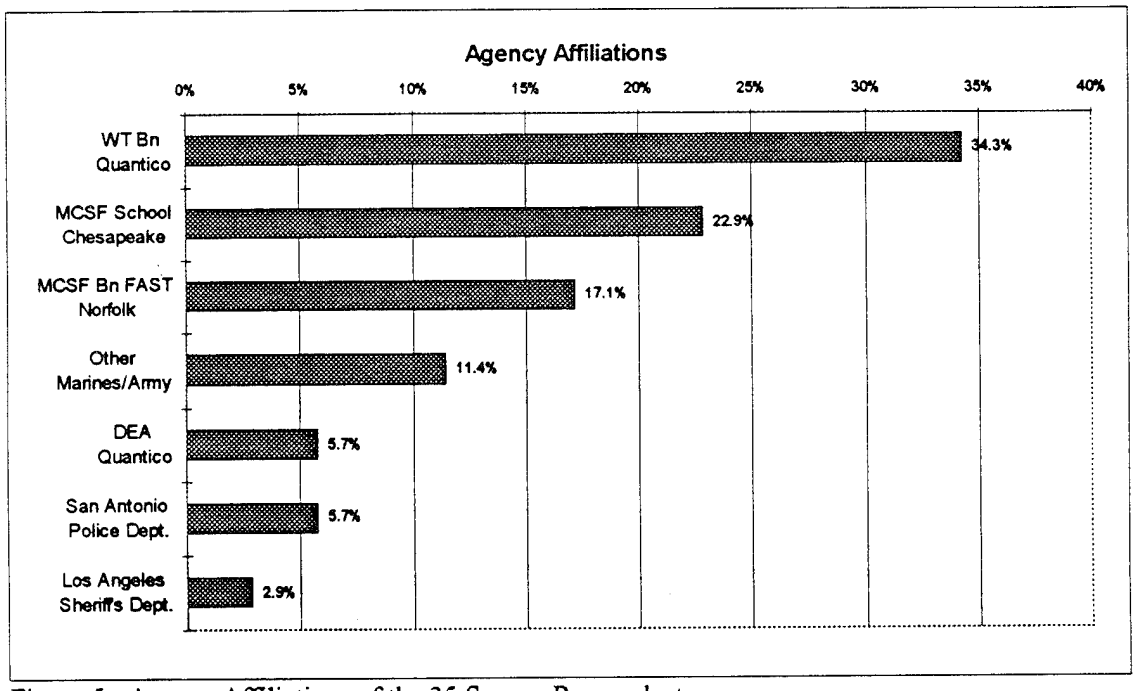

Figure 5. Agency Affiliations of the 35 Survey Respondents.

Scenerio selection was based in part on the individuals available to participate in the survey; the medium-intensity conflict considered here has been fairly common in recent years and respondents were expected to be familiar with it. All military participants had infantry or security backgrounds and were responsible for weapons or tactics training. The Weapons Training Battalion teaches marksmanship. MCSF personnel train Marines who guard state embassies, etc. FAST personnel train those responsible for security and anti-terrorist missions at various vital installations.

Of the participants, 30 (76%) were military and 5 (14%) were civilians; 25 of the military participants (71%) had seen combat: 12 in Southwest Asia, five in Somalia, and one each in Haiti and Liberia; two had served both in Southwest Asia and Panama, while one each had served in Southwest Asia plus Liberia, Lebanon, Somalia, or Cuba. Figure 6 shows the military ranks reported by the experts; of the five who had not been in combat, three were Lance Corporals, one was a Master Sergeant, and one was a Major.

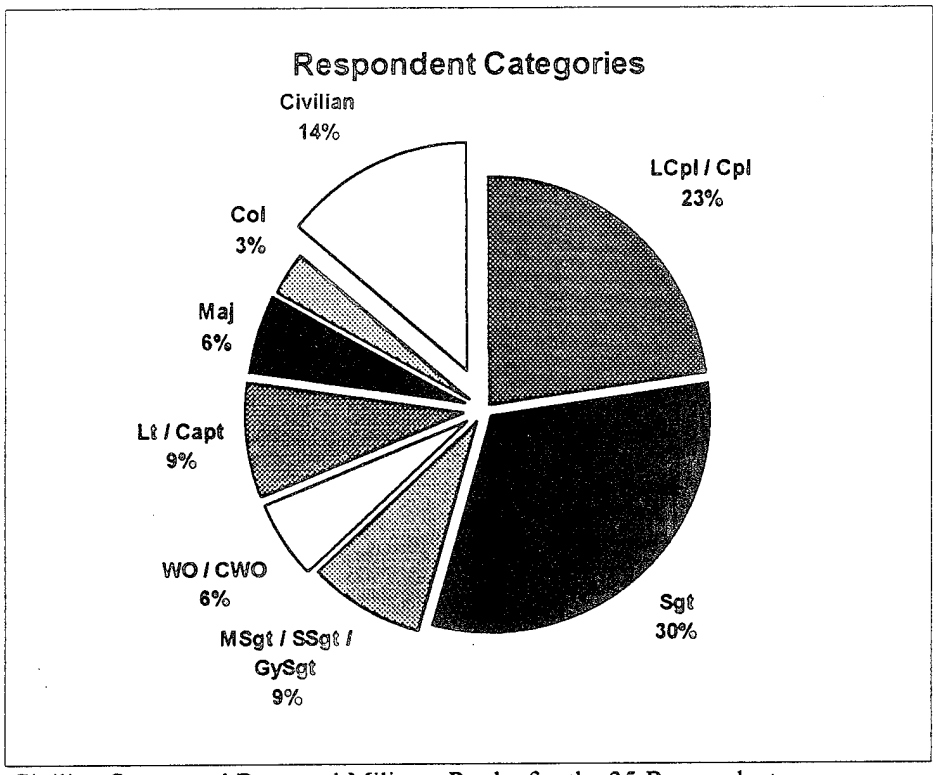

Figure 6. Civilian Status and Reported Military Ranks for the 35 Respondents.

Legend:

LCpl/Cpl	Lance Corporal/Corporal
Sgt	Sergeant
MSgt/SSgt/GySgt	Master Sergeant/Staff Sergeant/Gunnery Sergeant
WO/CWO	Warrant Officer/Chief Warrant Officer
Lt/Capt	Lieutenant/Captain
Maj	Major
Col	Colonel

5.4 SURVEY ADMINISTRATION

The survey for this study was conducted at the Marine Corps MOUT II Quantico Combat Training Village, near Quantico, Virginia, in conjunction with a demonstration of the TTES system. TTES engineers had generated a virtual representation of the MOUT II facility on the training devices. Thus individuals participating in the assessment were able to make tactical observations concerning the TTES MOUT representation and the actual site, along with comparisons between them.

Two one-man TTES systems were set up in a warehouse on the site. Survey participants gathered there for a briefing on the current TTES system and on system capabilities that are

anticipated when the simulator project is completed. The weapon used for the TTES demonstrations and evaluations was a demilitarized but fully functional M16-A2 rifle. Participants controlled the area that was viewed on the display screen via a foot pedal that, when depressed, resulted in apparent movement through the simulated scene. The side-to-side view was controlled by direction of gaze, monitored via a head-tracker contained in a helmet.

Two-man patrol team scenarios were carried out using the two TTES systems. The systems were situated so that the two participants could not see each other in the room. Instead, each observed a simulated trooper on-screen representing the other team member as he would appear when located in a position that would have been visible in the actual MOUT training village. Team members communicated via microphones and headphones included in the helmet. Thus coordinated actions could be carried out as in the real world.

Exercises lasted about 20 minutes and consisted of moving through the terrain and buildings as desired. TTES users were given the opportunity to traverse the virtual village's open areas and roads and to explore the buildings, including a representation of the actual MOUT II hotel building. This three-story building was simulated in detail, including rooms, corridors, stairs, doorways, and windows. Participants were encouraged to move freely throughout the building and to become familiar with its layout.

During the exercises participants encountered computer-controlled hostiles: realistic emulations of uniformed rifle-bearing enemy soldiers who recognized trainee presence and fired weapons as appropriate. Hostiles were engaged as encountered and the participants had the opportunity to try their decision-making and marksmanship skills. Simplistic representations of neutrals also were included: smaller men wearing red shirts and blue trousers, who appeared in the distance, hurried across the scene, and presented no obvious threat.

Not all survey respondents actually used the TTES system, but all observed other participants going through the scenarios. After the exercises, each respondent was given a copy of the survey form, verbally instructed about what was requested, and told that his inputs would be used to guide the continued development of TTES. Respondents were allowed as much time as desired to complete the form, but most completed it in 40 minutes or less.

5.5 DATA ANALYSIS

Survey results consisted of two kinds of data assigned by the respondents.

- **Behaviors or reactions**. For each of six segments of the given scenario, frequency or likelihood ratings were provided for the set of listed actions that might be observed for each group.
- **Traits or skills**. For each of seven listed CCH/N traits, ratings were provided for the frequency with which various trait levels might be expected for each group, ranging from very low or very poor to very high or excellent on a 5-point scale.

Data were complied from the 35 survey forms and entered into the Microsoft Excel spreadsheet program. Averages and standard deviations were calculated across respondents for each option. Results were determined for the group of experts as a whole and also separately for military personnel with combat experience, military personnel without combat experience, and civilians. Summary data and analysis results are provided in Appendixes B, C, D, E, and F.

6.0 RESULTS

Results are reported here generally in the same order and with the same segment headings as on the survey form (Appendix A). A set of actions or behaviors that might be performed by CCH/Ns was listed for each segment; respondents distributed 100 percentage points among the options. Traits that CCH/Ns might exhibit also were included on the questionnaire. Respondents distributed 100 percentage points among four levels of the trait, ranging from very low or very poor to very high or excellent.

The scenario and battlefield conditions used for making the judgments have been discussed in Sections 3.2 and 5.2 and are included in Appendix A. Complete results are provided in Appendixes B, C, D, E, F for (1) the total group, (2) military respondents with combat experience, (3) military respondents with no combat experience, and (4) civilians. Separate averages are given there for each of the five categories of CCH/Ns, along with standard deviations.

Totals in the following tables do not always equal 100 due to round-off errors. Results for the individual subgroups must be used with caution, due to small sample sizes. This and other validity problems have been discussed in Section 2.4.

6.1 BEHAVIORS AND REACTIONS

Subject matter experts were asked to provide judgments on how frequently various kinds of behaviors will be observed on the battlefield, for the given CCH/Ns, scenario, and conditions. A set of possible responses was provided for each of the six scenario segments. Survey respondents were asked to distribute 100 points among the options in each set, giving the most points (highest percentage of time) to the options anticipated most frequently. Results were averaged for the total group of respondents and also individually for the three subgroups.

The resulting percentages are shown below and can be used to model different frequency distributions for the actions taken by the five types of CCH/Ns, for each segment of the typical scenario considered for this study. Only *total group* responses should be used for modeling purposes. Individual subgroup responses are included here for completeness and for making general comparisons. However, the civilian and military-without-combat-experience subgroup sizes were much too small to attribute any significance to numerical results (although the general trends may be useful).

6.1.1 CCH/N Is Observed But Does Not Yet Observe Troops' Presence

Average responses for the total group of 35 respondents are provided in Table 4 for the first segment of the scenario. Note that, even though respondents anticipate that some options will be observed much more frequently than others, all listed stances and movements are expected to occur at least occasionally for each category of battlefield entity.

Overall distributions vary widely for the five categories of CCH/Ns. Standard Elite Troops are rarely expected to be running when they first appear, but instead usually will be moving purposefully and confidently. Average Irregulars differ by moving purposefully less often, about the same proportion of the time as they will move hesitantly or evasively. Frightened Civilians are expected to be running almost half of the time. The distribution for Unfriendly Civilians indicates that the first four options will occur with about equal frequencies. Although none of the groups is expected to be crawling very often, this option received values ranging from 1.6% to 6.4% for the

five CCH/N groups, so probably should be modeled for all of them and be included in the simulations occasionally.

Table 4. **Total Group**: 1. CCH/N can be seen by Troops, but does not yet observe that Troops are present.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Running.	8.3%	10.7%	22.9%	46.2%	24.6%
Moving purposefully and confidently.	50.6%	29.2%	15.5%	6.5%	21.1%
Moving hesitantly and fearfully.	4.4%	24.5%	30.0%	35.1%	21.5%
Looking around and moving evasively.	30.4%	29.5%	29.4%	8.7%	27.4%
Crawling.	6.2%	6.4%	1.6%	3.9%	5.3%

Figure 7 charts the frequency with which each option was selected by the total group for the five categories of CCH/Ns. It shows more graphically how anticipated behaviors vary among the five categories.

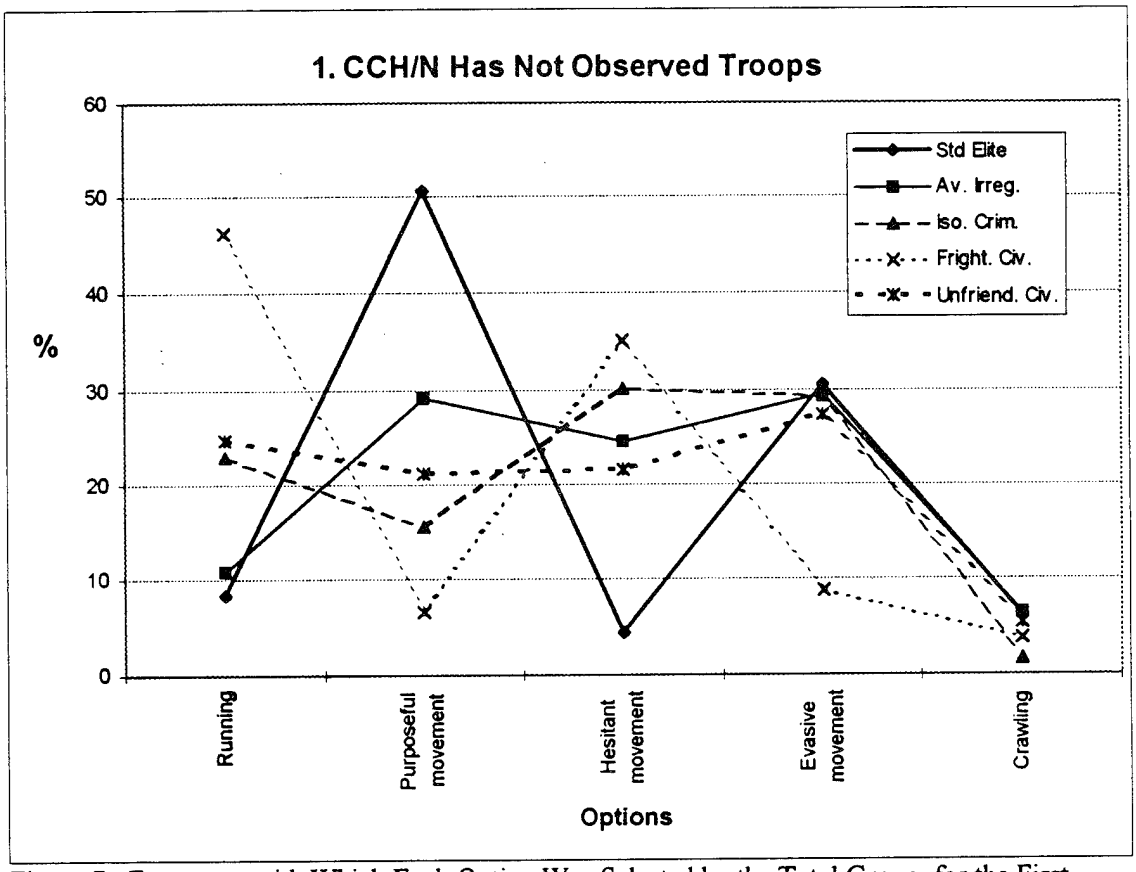

Figure 7. Frequency with Which Each Option Was Selected by the Total Group, for the First Scenario Segment.

Results for the three subgroups of study participants are provided in Tables 5, 6, and 7. Military personnel with combat experience made up the great majority of participates (25 out of 35), so it is not surprising that their individual responses closely mirror those of the total group. Less significance can be given to results for military personnel with no combat experience and for civilians, with only five respondents each.

Military with combat experience and civilians both appear to have higher opinions of the confidence with which both Standard Elite Troops and Average Irregulars will be moving than do those who have not seen combat. This may indicate that combat experience results in greater respect for the adversary's capabilities. Such respect is critical to survival, and is something that TTES must be programmed to provide.

Military respondents expect that Isolated Criminals often will be running, while civilians expect hesitant and fearful movement — probably based on U.S. urban experiences. Military with combat experience expect Frightened Civilians to be running and Unfriendly Civilians to move evasively, while those with no combat experience generally expect both groups of civilians to be running. Civilian respondents expect Frightened Civilians to move hesitantly, while Unfriendly Civilians will move purposefully, again probably based on observations made in U.S. cities.

Table 5. **Military with Combat**: 1. CCH/N can be seen by Troops, but does not yet observe that Troops are present.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Running.	6.4%	10.4%	22.1%	45.5%	22.1%
Moving purposefully and confidently.	49.6%	31.5%	16.8%	6.7%	19.9%
Moving hesitantly and fearfully.	5.4%	23.2%	27.5%	33.2%	22.0%
Looking around and moving evasively.	32.2%	27.8%	31.4%	10.6%	29.4%
Crawling.	6.4%	7.4%	1.4%	4.4%	6.7%

Table 6. **Military with No Combat**: 1. CCH/N can be seen by Troops, but does not yet observe that Troops are present.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Running.	23.0%	17.0%	36.0%	61.0%	53.0%
Moving purposefully and confidently.	28.0%	15.0%	3.0%	7.0%	5.0%
Moving hesitantly and fearfully.	2.0%	20.0%	32.0%	28.0%	19.0%
Looking around and moving evasively.	38.0%	43.0%	26.0%	2.0%	21.0%
Crawling.	9.0%	5.0%	3.0%	3.0%	2.0%

Table 7. **Civilians**: 1. CCH/N can be seen by Troops, but does not yet observe that Troops are present.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Running.	0.0%	3.3%	14.0%	35.0%	9.0%
Moving purposefully and confidently.	96.7%	33.3%	21.0%	5.0%	43.0%
Moving hesitantly and fearfully.	0.0%	43.3%	41.0%	52.0%	22.0%
Looking around and moving evasively.	3.3%	20.0%	22.6%	6.0%	24.0%
Crawling.	0.0%	0.0%	1.4%	2.0%	2.0%

6.1.2 CCH/N Observes Troops

Table 8 provides responses of the total group for the scenario's second segment when the CCH/N first observes the presence of U.S. troops (TTES trainees). Figure 8 charts the frequency with which each option was selected by the total group for the five categories of CCH/Ns. Tables 9, 10, and 11 provide average responses for the three subgroups of participants.

Table 8. **Total Group**: 2. CCH/N observes Troops' presence.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	5.2%	6.5%	8.5%	8.0%	21.6%
Seeks cover/concealment & observes.	21.2%	16.9%	17.2%	5.4%	16.3%
Seeks cover/concealment & initiates fire.	24.1%	25.0%	7.0%	0.9%	4.0%
Goes prone & observes.	9.9%	10.0%	5.2%	2.5%	5.5%
Goes prone & fires.	17.7%	16.8%	5.9%	1.3%	3.0%
Stands in place & freezes.	7.1%	8.3%	11.3%	17.0%	13.1%
Drops to ground & freezes.	5.9%	7.1%	7.7%	4.2%	4.7%
Raises hands in surrender.	3.2%	3.5%	10.8%	18.6%	7.7%
Runs away.	5.2%	5.0%	26.1%	41.9%	23.5%

As can be observed in Figure 8, the total group expects almost identical distributions of the options for the Standard Elite Troops and Average Irregulars. For this scenario segment, both groups possibly could be modeled to respond in the same manner. Isolated Criminals and Unfriendly Civilians also respond similarly, except that Unfriendly Civilians are more likely to ignore the U.S. troops and continue as before. Frightened Civilians are not expected to make any sort of hostile response, but instead will run away or move into a surrender posture. Dropping to the ground and freezing is seen as an unlikely response for any of the five groups, but still might be observed between 4.2 and 7.7% of the time.

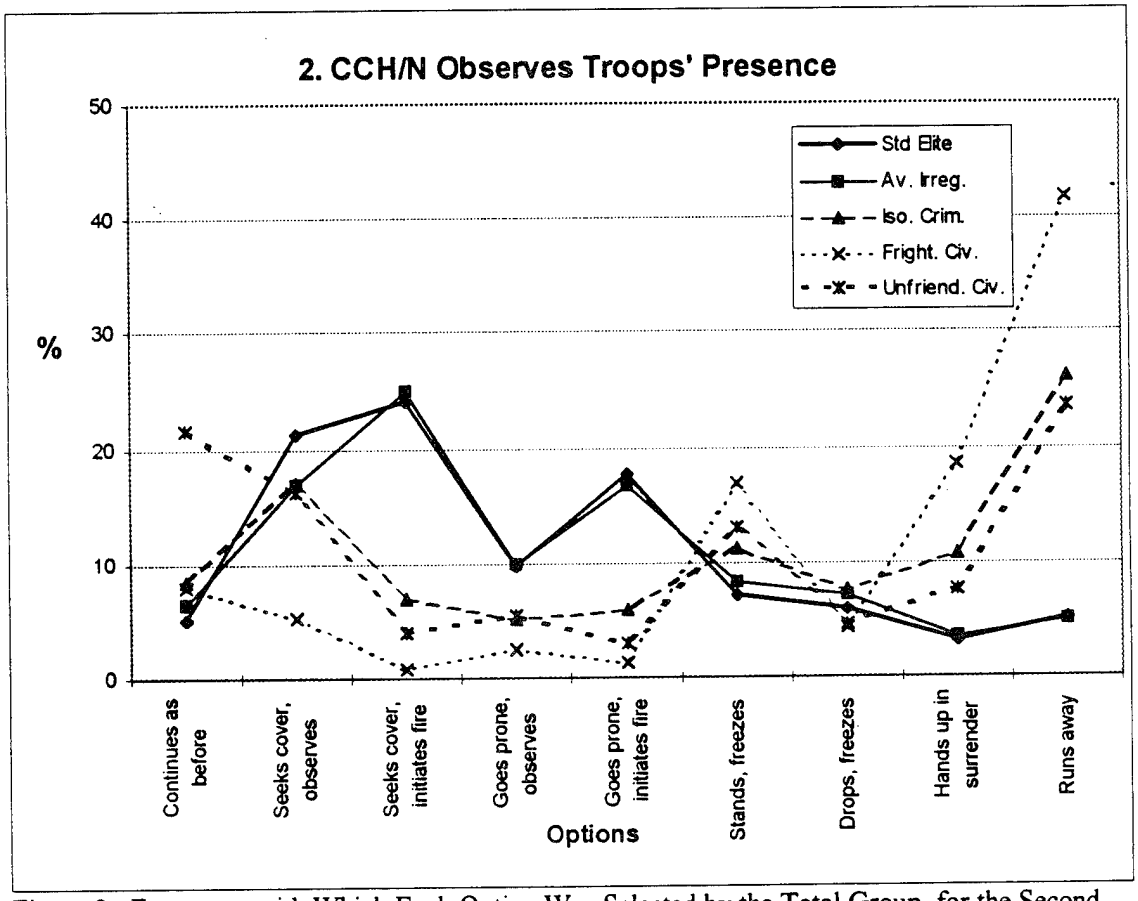

Figure 8. Frequency with Which Each Option Was Selected by the Total Group, for the Second Scenario Segment.

Looking at the individual groups of respondents, military participants both with and without combat experience expect Standard Elite Troops and Average Irregulars to respond about the same when they observe the U.S. presence. However, those who have seen combat expect an immediate hostile response, while those who have not been in combat expect that these adversaries will seek cover and observe. It appears that real-world combat experience results in increased respect for the immediate danger presented by hostiles. It is hoped that realistic TTES modeling will provide training that adequately can prepare combat novices for their first real-world engagements.

Civilian respondents expect quite different behavior for the two levels of trained adversaries, with the better disciplined Standard Elite Troops seeking cover and observing, while Average Irregulars immediately drop and fire. Civilians expect Isolated Criminals either to freeze or to run away, military with combat experience generally expect them to run, and those without combat experience expect them to hide and observe.

With respect to civilians on the battlefield, military with combat experience expect them generally to run away at this point in the scenario. Without combat experience, military respondents expect Frightened Civilians to run away and Unfriendly Civilians to hide and observe. Civilians expect Frightened Civilians to freeze and Unfriendly Civilians generally to continue on their way.

Table 9. **Military with Combat**: 2. CCH/N observes Troops' presence.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	4.9%	6.5%	10.2%	9.2%	18.9%
Seeks cover/concealment & observes.	29.0%	16.9%	17.6%	5.1%	14.5%
Seeks cover/concealment & initiates fire.	32.4%	25.0%	7.5%	0.5%	4.6%
Goes prone & observes.	9.5%	10.0%	5.9%	2.9%	5.6%
Goes prone & fires.	17.9%	16.8%	6.0%	0.6%	2.1%
Stands in place & freezes.	1.9%	8.3%	9.0%	12.8%	15.9%
Drops to ground & freezes.	2.8%	7.1%	7.9%	2.9%	4.1%
Raises hands in surrender.	0.6%	3.5%	10.2%	19.7%	7.7%
Runs away.	0.9%	5.0%	25.2%	46.4%	25.6%

Table 10. **Military with No Combat**: 2. CCH/N observes Troops' presence.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	0.7%	1.5%	7.1%	4.7%	15.1%
Seeks cover/concealment & observes.	32.7%	39.8%	18.4%	10.2%	27.7%
Seeks cover/concealment & initiates fire.	23.7%	16.3%	8.7%	3.8%	4.2%
Goes prone & observes.	12.7%	13.4%	5.6%	1.1%	9.0%
Goes prone & fires.	24.3%	12.6%	10.4%	6.6%	5.2%
Stands in place & freezes.	3.3%	3.5%	6.3%	16.3%	9.9%
Drops to ground & freezes.	1.3%	2.0%	6.0%	7.3%	4.2%
Raises hands in surrender.	0.1%	2.7%	8.5%	13.9%	5.9%
Runs away.	1.3%	8.3%	28.9%	36.1%	18.7%

Table 11. **Civilians**: 2. CCH/N observes Troops' presence.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	3.3%	1.7%	1.4%	5.2%	41.0%
Seeks cover/concealment & observes.	43.3%	25.0%	14.0%	2.2%	14.0%
Seeks cover/concealment & initiates fire.	36.7%	30.0%	2.6%	0.0%	0.8%
Goes prone & observes.	6.7%	3.3%	1.2%	2.2%	1.6%
Goes prone & fires.	6.7%	33.3%	1.2%	0.0%	5.4%
Stands in place & freezes.	0.3%	3.3%	28.0%	39.0%	2.2%
Drops to ground & freezes.	3.0%	3.3%	8.0%	8.0%	8.0%
Raises hands in surrender.	0.0%	1.7%	16.0%	17.8%	9.0%
Runs away.	0.0%	1.7%	27.6%	25.6%	18.0%

6.1.3 CCH/N Commanded to Stop

Table 12 provides responses of the total group for the scenario's third segment when the troops (TTES trainees) command the CCH/N to stop. Figure 9 charts the frequency with which each option was selected by the total group for the five categories of CCH/Ns. Tables 13, 14, and 15 provide average responses for the three subgroups of participants.

Table 12. **Total Group**: 3. Troops command CCH/N to stop.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	5.3%	5.7%	6.6%	6.2%	11.6%
Seeks cover/concealment & observes.	15.7%	9.9%	8.4%	3.0%	7.0%
Seeks cover/concealment & initiates fire.	42.8%	30.9%	14.5%	0.7%	9.1%
Goes prone & observes.	6.9%	8.5%	3.1%	3.8%	6.3%
Goes prone & fires.	16.0%	20.3%	5.7%	1.1%	4.7%
Stands in place & freezes.	3.3%	8.7%	13.6%	27.4%	14.3%
Drops to ground & freezes.	2.0%	3.6&	5.0%	6.7%	6.9%
Raises hands in surrender.	2.0%	6.0%	17.0%	34.1%	14.8%
Runs away.	5.6%	6.3%	26.3%	17.3%	25.3%

The total group again anticipates that the responses of both of the hostile military groups will be similar, but expects a higher proportion of Standard Elite Troops to seek cover and initiate fire while more Average Irregulars go prone and fire. Isolated Criminals and Unfriendly Civilians again are expected to behave similarly, taking all options some of the time, but being most likely to run away. Frightened Civilians at this point generally are expected to freeze or to surrender.

Both of the military respondent groups now expect both Standard Elite Troops and Average Irregulars generally to seek cover and fire. Those who have not seen combat also expect Isolated Criminals to display this same behavior. Those who have seen combat expect Isolated Criminals to run away, while the civilian respondents expect them to surrender or, next most likely, to run away.

With respect to Frightened Civilians, all military respondents expect them generally to freeze or surrender, while civilians expect that more than half of the time they will raise their hands in surrender. Military respondents with combat experience expect Unfriendly Civilians to run away most frequently, while those who have not seen combat expect them to freeze or to run away with about equal frequency. Civilians expect Unfriendly Civilians either to surrender or to run away.

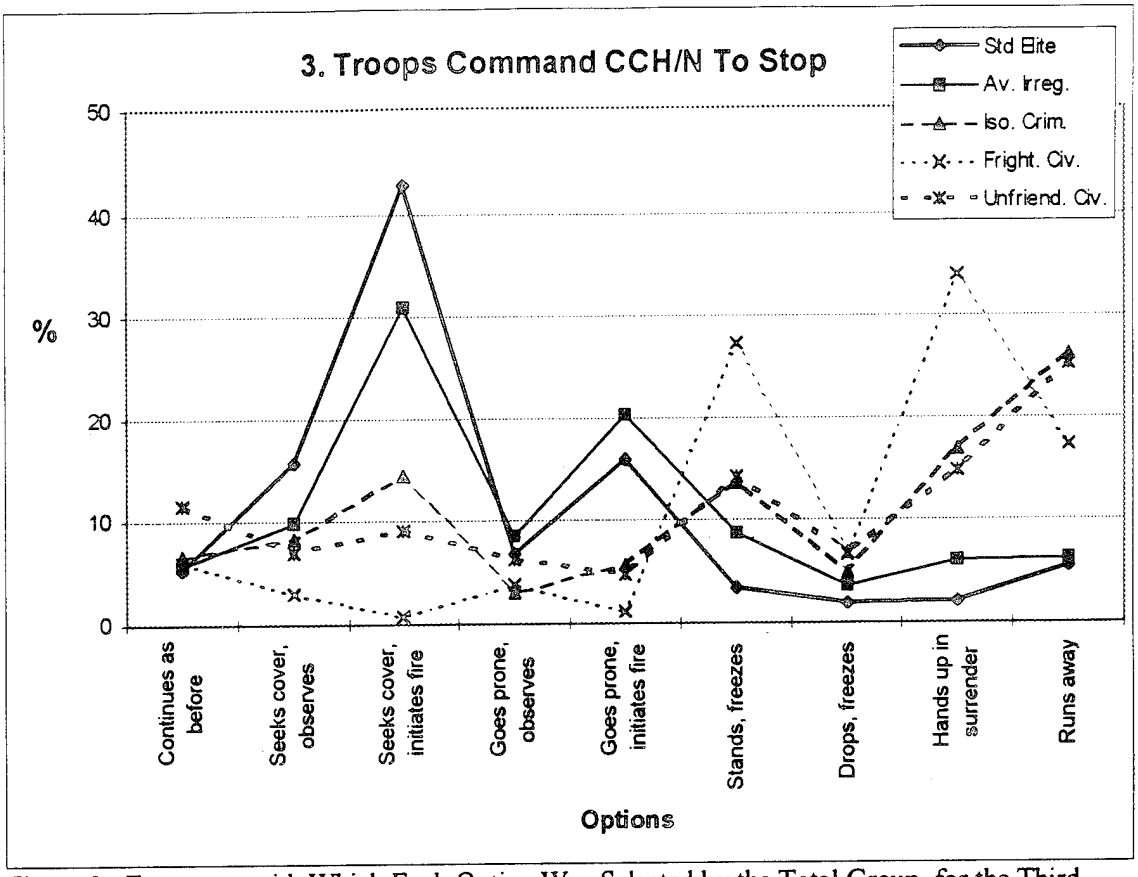

Figure 9. Frequency with Which Each Option Was Selected by the Total Group, for the Third Scenario Segment.

Table 13. **Military with Combat**: 3. Troops command CCH/N to stop.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	5.2%	6.3%	5.2%	5.3%	10.9%
Seeks cover/concealment & observes.	15.0%	10.1%	9.1%	3.0%	7.2%
Seeks cover/concealment & initiates fire.	42.1%	29.0%	13.3%	0.8%	10.9%
Goes prone & observes.	6.6%	9.2%	2.5%	3.6%	8.0%
Goes prone & fires.	15.8%	18.8%	4.6%	1.4%	5.1%
Stands in place & freezes.	4.1%	10.1%	15.5%	29.6%	15.6%
Drops to ground & freezes.	2.0%	3.6%	6.2%	6.6%	7.9%
Raises hands in surrender.	2.3%	5.4%	16.0%	30.9%	10.4%
Runs away.	6.5%	7.4%	27.8%	19.2%	24.0%

Table 14. **Military with No Combat**: 3. Troops command CCH/N to stop.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	6.9%	5.9%	8.9%	9.7%	13.0%
Seeks cover/concealment & observes.	15.8%	12.8%	9.3%	1.9%	5.8%
Seeks cover/concealment & initiates fire.	40.1%	41.0%	31.3%	1.0%	8.0%
Goes prone & observes.	8.3%	6.6%	5.6%	1.0%	2.8%
Goes prone & fires.	22.5%	16.2%	15.4%	0.6%	5.0%
Stands in place & freezes.	0.4%	5.1%	5.3%	28.9%	20.8%
Drops to ground & freezes.	1.3%	1.7%	2.9%	11.7%	7.4%
Raises hands in surrender.	2.1%	7.5%	1.7%	32.3%	15.5%
Runs away.	2.1%	3.2%	19.6%	12.9%	21.6%

Table 15. **Civilians**: 3. Troops command CCH/N to stop.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	3.3%	0.0%	11.0%	7.0%	14.0%
Seeks cover/concealment & observes.	21.7%	3.3%	4.0%	4.0%	7.0%
Seeks cover/concealment & initiates fire.	53.3%	30.0%	4.0%	0.0%	1.2%
Goes prone & observes.	6.7%	6.7%	3.0%	8.0%	1.2%
Goes prone & fires.	6.7%	40.0%	1.0%	0.0%	2.2%
Stands in place & freezes.	1.7%	3.3%	13.0%	15.0%	1.4%
Drops to ground & freezes.	3.3%	6.7%	1.0%	2.0%	1.4%
Raises hands in surrender.	0.0%	8.3%	37.0%	52.0%	36.6%
Runs away.	3.3%	1.7%	26.0%	12.0%	35.0%

6.1.4 Rifles Aimed at CCH/N

Table 16 provides responses of the total group for the scenario's fourth segment when the troops (TTES trainees) aim their rifles in the direction of the CCH/N. Figure 10 charts the frequency with which each option was selected by the total group for the five categories of CCH/Ns. Tables 17, 18, and 19 provide average responses for the three subgroups of participants.

Table 16. **Total Group**: 4. Troops aim rifles in direction of CCH/N.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	3.5%	3.1%	4.0%	5.1%	6.7%
Seeks cover/concealment & observes.	14.6%	10.6%	6.1%	2.9%	6.6%
Seeks cover/concealment & initiates fire.	47.6%	35.0%	14.9%	1.2%	11.5%
Goes prone & observes.	4.9%	9.3%	5.1%	1.8%	3.4%
Goes prone & fires.	20.6%	23.7%	8.8%	1.4%	6.5%
Stands in place & freezes.	2.4%	5.2%	13.3%	19.5%	16.5%
Drops to ground & freezes.	1.2%	2.2%	7.6%	8.3%	4.4%
Raises hands in surrender.	2.0%	4.9%	21.9%	40.7%	20.2%
Runs away.	3.4%	6.7%	18.0%	19.3%	24.2%

Total group responses for this fourth scenario segment are very similar to those for the third segment, as can be observed by comparing Figures 9 and 10. If they have not done so already, the two military adversaries are expected generally to seek concealment and fire, Isolated Criminals and Unfriendly Civilians will surrender or run away, and Frightened Civilians will surrender. Percentages do vary somewhat from segment three, however, so somewhat more precise option modeling may be worthwhile.

All three respondent groups expect that the most likely response for Standard Elite Troops at this point is to seek cover and fire. Both military groups expect that same behavior for Average Irregulars, while civilians expect this CCH/N group to go prone and fire. Both military respondents with combat experience and civilians expect Isolated Criminals usually to raise their hands in surrender, while military without combat experience expect these individuals either to seek concealment and fire or to run away. All three groups of respondents expect Frightened Civilians to raise their hands in surrender at this point, with civilians selecting this option especially strongly. Civilians expect this same behavior from Unfriendly Civilians, while respondents with combat experience expect Unfriendly Civilians to run away and those without combat experience expect them either to surrender or to run away, with about equal frequency.

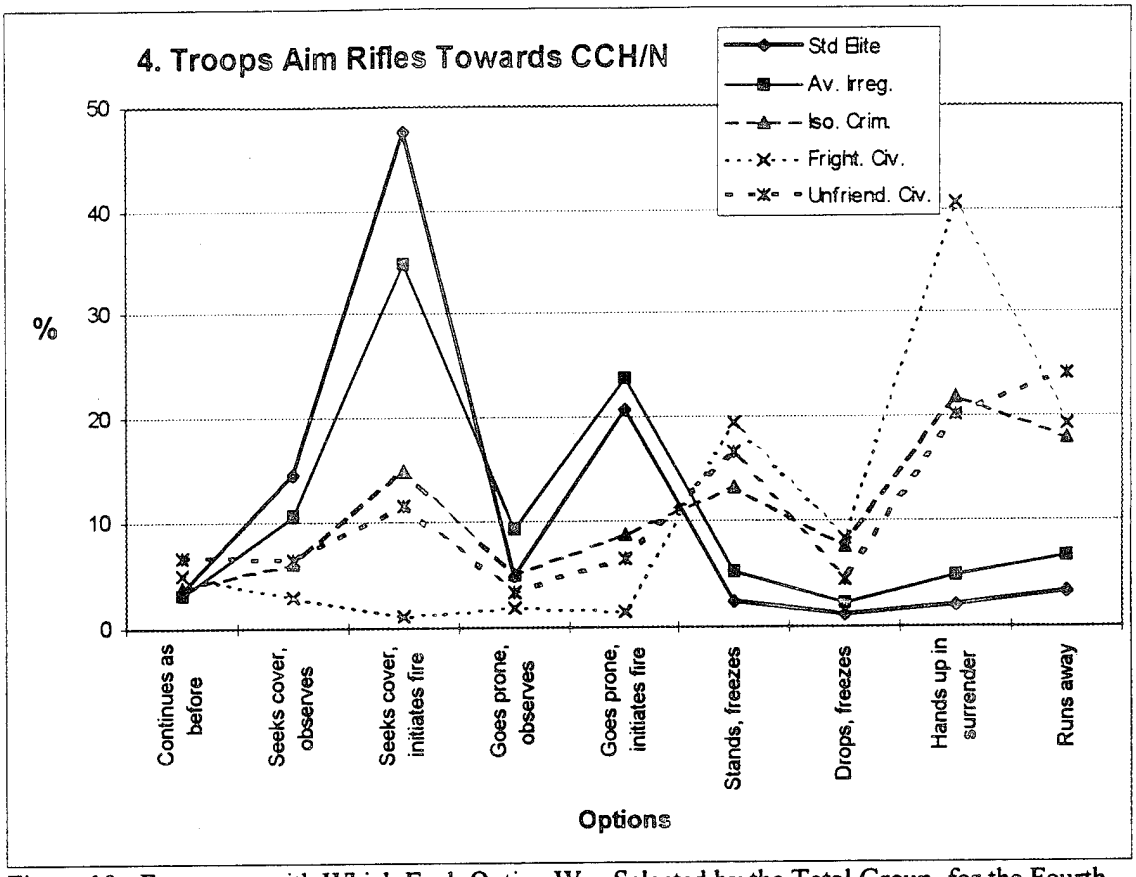

Figure 10. Frequency with Which Each Option Was Selected by the Total Group, for the Fourth Scenario Segment.

Table 17. **Military with Combat**: 4. Troops aim rifles in direction of CCH/N.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	1.2%	1.5%	3.6%	2.2%	5.3%
Seeks cover/concealment & observes.	14.0%	11.3%	5.6%	3.5%	6.0%
Seeks cover/concealment & initiates fire.	47.9%	37.0%	15.0%	1.4%	14.1%
Goes prone & observes.	4.9%	7.7%	5.2%	1.8%	3.5%
Goes prone & fires.	21.4%	22.9%	9.3%	1.7%	6.7%
Stands in place & freezes.	3.1%	5.6%	15.3%	20.2%	17.8%
Drops to ground & freezes.	1.4%	2.5%	9.2%	8.4%	4.8%
Raises hands in surrender.	2.1%	5.6%	19.7%	38.2%	15.6%
Runs away.	4.0%	6.6%	16.5%	22.8%	26.2%

Table 18. **Military with No Combat**: 4. Troops aim rifles in direction of CCH/N.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	17.0%	13.0%	9.0%	17.5%	14.2%
Seeks cover/concealment & observes.	24.6%	12.4%	8.2%	0.2%	5.3%
Seeks cover/concealment & initiates fire.	28.6%	32.9%	24.3%	0.2%	8.2%
Goes prone & observes.	7.6%	5.7%	3.5%	0.2%	3.5%
Goes prone & fires.	17.0%	19.1%	10.3%	0.2%	9.2%
Stands in place & freezes.	0.2%	6.2%	7.0%	17.3%	16.5%
Drops to ground & freezes.	0.6%	1.7%	2.7%	10.7%	2.8%
Raises hands in surrender.	2.8%	4.2%	11.3%	42.7%	18.2%
Runs away.	2.6%	5.2%	23.8%	10.9%	22.1%

Table 19. **Civilians**: 4. Troops aim rifles in direction of CCH/N.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues movement as before.	0.0%	0.0%	0.8%	7.5%	6.0%
Seeks cover/concealment & observes.	3.3%	1.7%	6.8%	2.5%	11.0%
Seeks cover/concealment & initiates fire.	76.7%	21.7%	4.8%	1.3%	2.0%
Goes prone & observes.	0.0%	28.3%	5.8%	3.8%	3.0%
Goes prone & fires.	20.0%	38.3%	4.8%	1.3%	3.0%
Stands in place & freezes.	0.0%	0.0%	10.0%	17.5%	10.0%
Drops to ground & freezes.	0.0%	0.0%	4.2%	5.0%	4.0%
Raises hands in surrender.	0.0%	0.0%	43.2%	53.8%	45.0%
Runs away.	0.0%	10.0%	19.6%	7.5%	16.0%

6.1.5 Rifles Fired at CCH/N

Table 20 provides responses of the total group for the scenario's fifth segment when the troops (TTES trainees) fire their rifles in the direction of the CCH/N. Figure 11 charts the frequency with which each option was selected by the total group for the five categories of CCH/Ns. Tables 21, 22, and 23 provide average responses for the three subgroups of participants.

Table 20. **Total Group**: 5. Troops fire towards CCH/N.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Seeks cover/concealment & observes.	6.4%	6.5%	4.2%	6.3%	4.7%
Seeks cover/concealment & returns fire.	66.7%	48.7%	20.0%	1.2%	12.4%
Goes prone & observes.	2.5%	3.3%	1.9%	2.0%	3.4%
Goes prone & returns fire.	20.0%	28.2%	12.9%	1.6%	11.8%
Stands in place & freezes.	1.1%	2.2%	5.1%	10.5%	7.2%
Drops to ground & freezes.	1.5%	2.3%	7.2%	20.7%	10.9%
Raises hands in surrender.	0.4%	3.6%	18.8%	23.8%	21.0%
Runs away.	1.7%	5.2%	30.3%	34.5%	28.6%

The total group expects that a high proportion of the time trained troops, whether Standard Elite Troops or Average Irregulars, will return fire when fired on. On the other hand, Isolated Criminals and both groups of civilians are expected to run away as their most frequent response.

Looking at the individual respondent groups, all three agree that returning fire is the most likely response from the Standard Elite Troops and Average Irregulars, with civilians most emphatic on this. There is total disagreement on the response of an Isolated Criminal when fired on: military with combat experience expect the CCH/N to run away, military without combat experience expect him to seek cover and fire, and civilians expect him to surrender as the most likely option. As to CCH/N civilians, military who have seen combat expect them to run away, while those without combat experience and civilian respondents expect them to surrender.

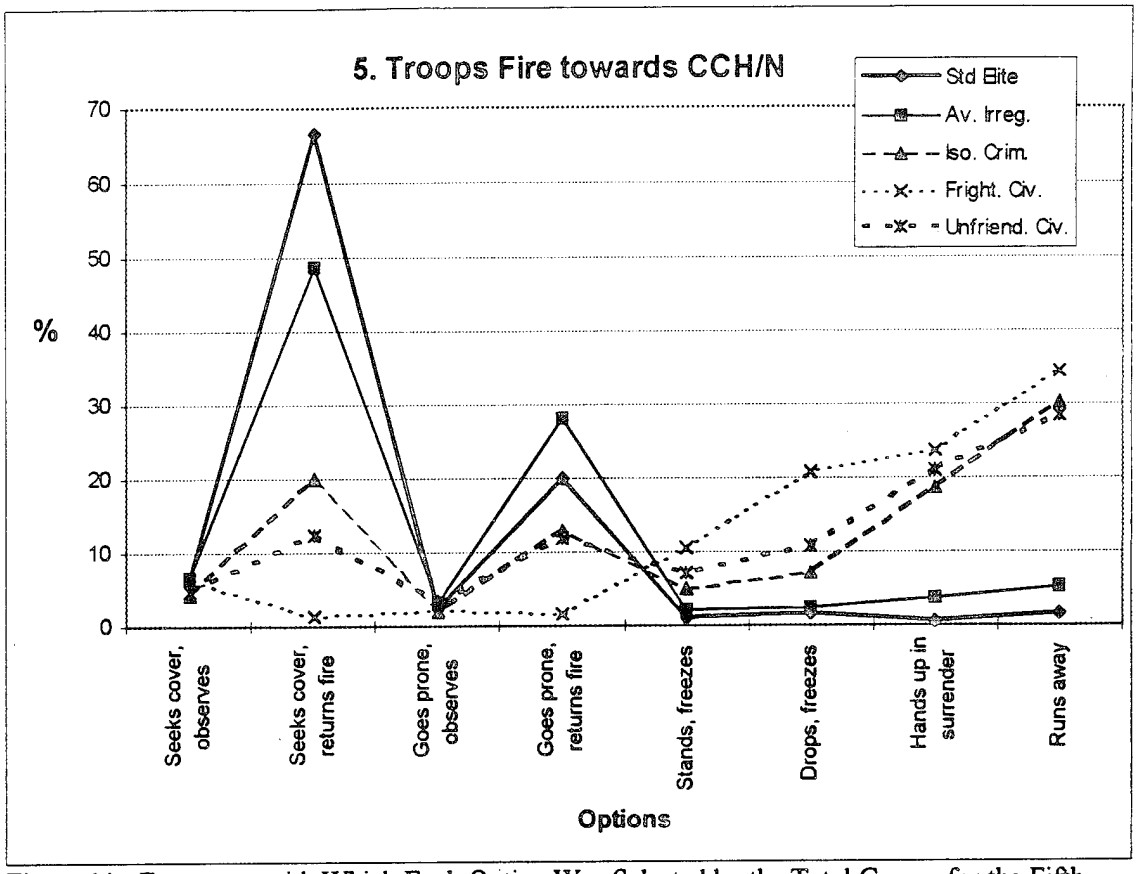

Figure 11. Frequency with Which Each Option Was Selected by the Total Group, for the Fifth Scenario Segment.

Table 21. **Military with Combat**: 5. Troops fire towards CCH/N.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Seeks cover/concealment & observes.	3.7%	5.0%	2.7%	5.3%	3.0%
Seeks cover/concealment & returns fire.	67.9%	47.4%	16.5%	1.2%	12.9%
Goes prone & observes.	2.3%	3.1%	1.8%	1.7%	3.0%
Goes prone & returns fire.	20.7%	29.2%	14.0%	1.3%	14.1%
Stands in place & freezes.	1.4%	2.6%	3.9%	8.1%	7.8%
Drops to ground & freezes.	1.5%	2.4%	7.8%	23.9%	13.2%
Raises hands in surrender.	0.5%	4.2%	15.9%	20.5%	15.4%
Runs away.	2.1%	6.2%	37.6%	38.1%	30.6%

Table 22. **Military with No Combat**: 5. Troops fire towards CCH/N.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Seeks cover/concealment & observes.	23.8%	16.6%	10.5%	2.0%	7.5%
Seeks cover/concealment & returns fire.	50.8%	40.9%	34.3%	2.0%	8.3%
Goes prone & observes.	4.9%	4.9%	3.1%	3.0%	5.1%
Goes prone & returns fire.	18.4%	26.0%	12.2%	4.0%	6.4%
Stands in place & freezes.	0.4%	1.5%	5.1%	17.0%	7.1%
Drops to ground & freezes.	2.4%	3.5%	6.4%	14.0%	8.4%
Raises hands in surrender.	0.4%	2.8%	19.0%	34.0%	32.3%
Runs away.	0.4%	3.5%	9.9%	24.0%	24.9%

Table 23. **Civilians**: 5. Troops fire towards CCH/N.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Seeks cover/concealment & observes.	0.0%	1.7%	5.0%	17.5%	10.0%
Seeks cover/concealment & returns fire.	83.3%	73.3%	23.0%	0.0%	14.0%
Goes prone & observes.	0.0%	1.7%	1.0%	2.5%	4.0%
Goes prone & returns fire.	16.7%	23.3%	8.0%	0.0%	6.0%
Stands in place & freezes.	0.0%	0.0%	11.0%	17.5%	4.0%
Drops to ground & freezes.	0.0%	0.0%	5.0%	8.8%	2.0%
Raises hands in surrender.	0.0%	0.0%	33.0%	31.3%	38.0%
Runs away.	0.0%	0.0%	14.0%	25.0%	22.0%

6.1.6 CCH/N Wounded

Table 24 provides responses of the total group for the scenario's fourth segment when the troops (TTES trainees) fire their rifles in the direction of the CCH/N. Figure 12 charts the frequency with which each option was selected by the total group for the five categories of CCH/Ns. Tables 25, 26, and 27 provide average responses for the three subgroups of participants.

Table 24. **Total Group**: 6. CCH/N responds to being wounded by rifle fire.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues effective fire.	41.1%	22.1%	7.1%	1.2%	4.5%
Tries to return fire.	35.9%	32.4%	18.4%	1.7%	16.0%
Drops to ground & freezes.	7.7%	17.9%	16.7%	25.9%	18.8%
Raises hands in surrender.	3.5%	9.8%	29.7%	46.1%	30.3%
Tries to run/crawl away.	11.8%	17.6%	28.1%	25.1%	30.1%

When wounded, Standard Elite Troops are seen as capable of continuing effective fire, while Average Irregulars will try to return fire but will not be as effective. Isolated Criminals and Unfriendly Civilians either will surrender or will try to escape. Frightened Civilians are expected usually to surrender at this point (if they have not done so previously).

While both the military-with-combat-experience and civilian groups agree that Standard Elite Troops most often will continue effective fire even when wounded, respondents without combat experience downgrade their abilities to only Tries to return fire. This is similar to responses to the first two segments, where military personnel who have not experienced combat may be underestimating the capabilities and determination of their adversaries. TTES modeling of CCH/Ns must not reinforce in any way the minimization of danger presented by hostiles.

Civilian respondents strongly expect Isolated Criminals to surrender when wounded; military without combat experience also expect this outcome, but less strongly. Those who have seen combat expect Isolated Criminals to try to escape at this point. Frightened and Unfriendly Civilians are expected by all groups generally to surrender when wounded, though combat-experienced military personnel say that, for Unfriendly Civilians, trying to escape is a little more likely and military respondents who have not seen combat suggest that Frightened Civilians also may drop to the ground and freeze.

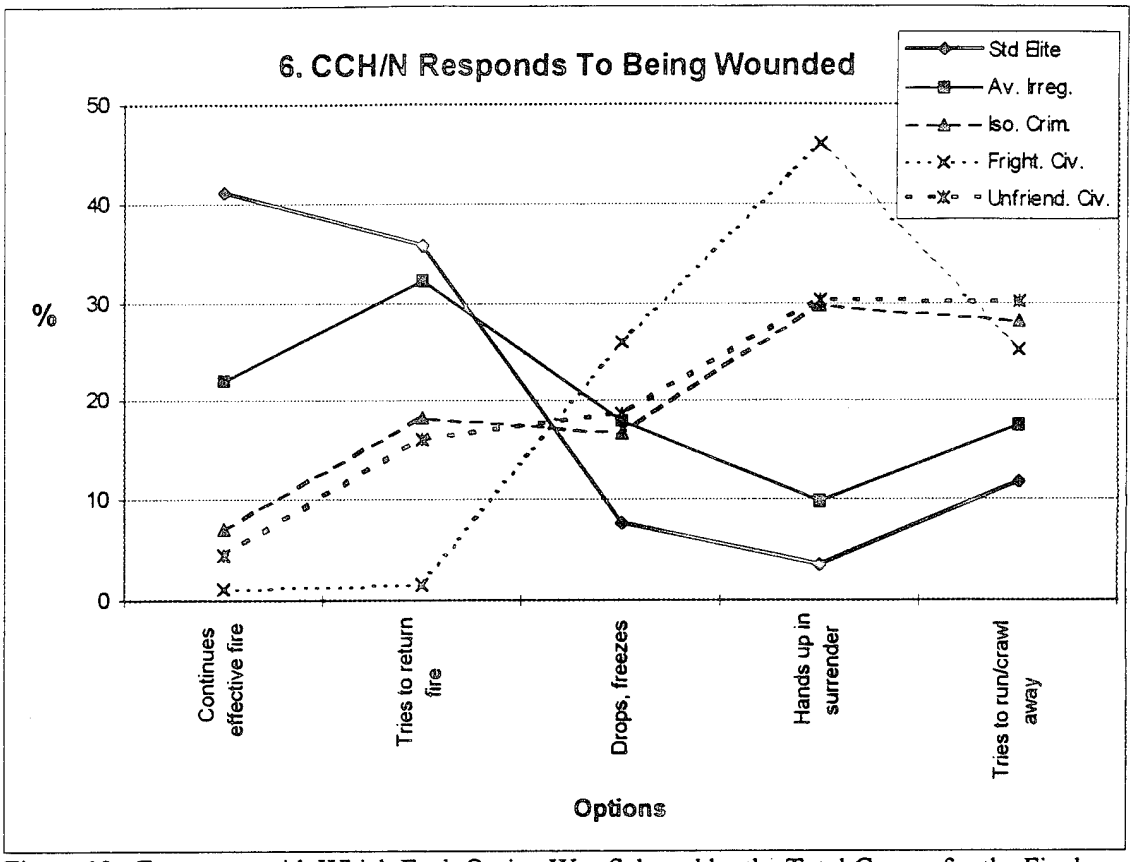

Figure 12. Frequency with Which Each Option Was Selected by the Total Group, for the Final Scenario Segment.

Table 25. **Military with Combat**: 6. CCH/N responds to being wounded by rifle fire.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues effective fire.	42.0%	24.2%	7.8%	1.5%	4.7%
Tries to return fire.	34.8%	30.1%	17.6%	1.5%	17.7%
Drops to ground & freezes.	7.2%	18.7%	18.8%	22.4%	17.4%
Raises hands in surrender.	3.9%	9.6%	26.2%	45.8%	26.6%
Tries to run/crawl away.	12.1%	17.4%	29.6%	28.9%	33.2%

Table 26. **Military with No Combat**: 6. CCH/N responds to being wounded by rifle fire.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues effective fire.	26.2%	12.5%	5.4%	1.0%	2.0%
Tries to return fire.	54.8%	38.9%	28.9%	4.0%	13.7%
Drops to ground & freezes.	9.0%	16.5%	10.4%	38.3%	22.5%
Raises hands in surrender.	1.0%	11.6%	33.1%	39.3%	33.9%
Tries to run/crawl away.	9.0%	20.4%	23.3%	17.5%	27.8%

Table 27. **Civilians**: 6. CCH/N responds to being wounded by rifle fire.

Stance and Movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Continues effective fire.	58.3%	20.0%	5.0%	0.0%	6.3%
Tries to return fire.	13.3%	40.0%	10.0%	0.0%	8.8%
Drops to ground & freezes.	10.0%	13.3%	11.3%	32.5%	22.5%
Raises hands in surrender.	5.0%	8.3%	47.5%	56.3%	48.8%
Tries to run/crawl away.	13.3%	15.0%	25.0%	11.3%	13.8%

6.2 TRAITS AND SKILLS

In addition to specifying the frequency with which various *behaviors* might be exhibited during the six scenario segments, respondents were asked to specify a distribution of levels at which various human *traits* and *skills* might be expected, for each of the five CCH/N groups. For example, how aware of their surroundings are Standard Elite Troops expected to be, ranging from excellent to very poor? Such awareness will determine how rapidly and appropriately the CCH/Ns respond to the TTES trainee's presence and actions. Suggestions for how the results of this portion of the survey might be used for modeling TTES CCH/Ns are included in Section 3.4.

Survey respondents distributed 100 points among four listed levels for each of seven traits or skills. Results are provided below for the total group and for each of the three subgroups. As noted earlier, no numerical significance should be attributed to results from the civilian and military-without-combat-experience subgroups due to small sample sizes, although trends may be useful. Complete summary results are provided in Appendixes B through F.

6.2.1 Awareness of Surroundings

In conjunction with the first segment of the scenario, respondents were asked to provide a distribution of frequencies for how aware of their surroundings members of each type of CCH/N group are likely to be. In this context, it was expected that the respondents would be considering how long it might be before the CCH/N noticed the TTES trainee's presence — useful for modeling speed, sensitivity, accuracy, and precision of CCH/N responses to the surroundings. Total group responses are provided in Table 28 and Figure 13. Responses of the three subgroups are shown in Tables 29, 30, and 31.

Table 28. **Total Group**: Awareness of surroundings.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	74.3%	43.1%	36.9%	17.7%	25.3%
Good to very good	20.3%	28.0%	25.6%	21.2%	25.2%
Average	4.6%	21.4%	21.8%	24.5%	31.8%
Poor to very poor	0.8%	7.3%	15.4%	36.2%	17.4%

Table 29. **Military with Combat**: Awareness of surroundings.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	71.6%	43.7%	32.7%	22.4%	26.1%
Good to very good	22.3%	26.4%	31.8%	22.6%	26.5%
Average	5.4%	21.2%	21.5%	23.5%	30.7%
Poor to very poor	0.8%	8.3%	13.7%	31.5%	16.3%

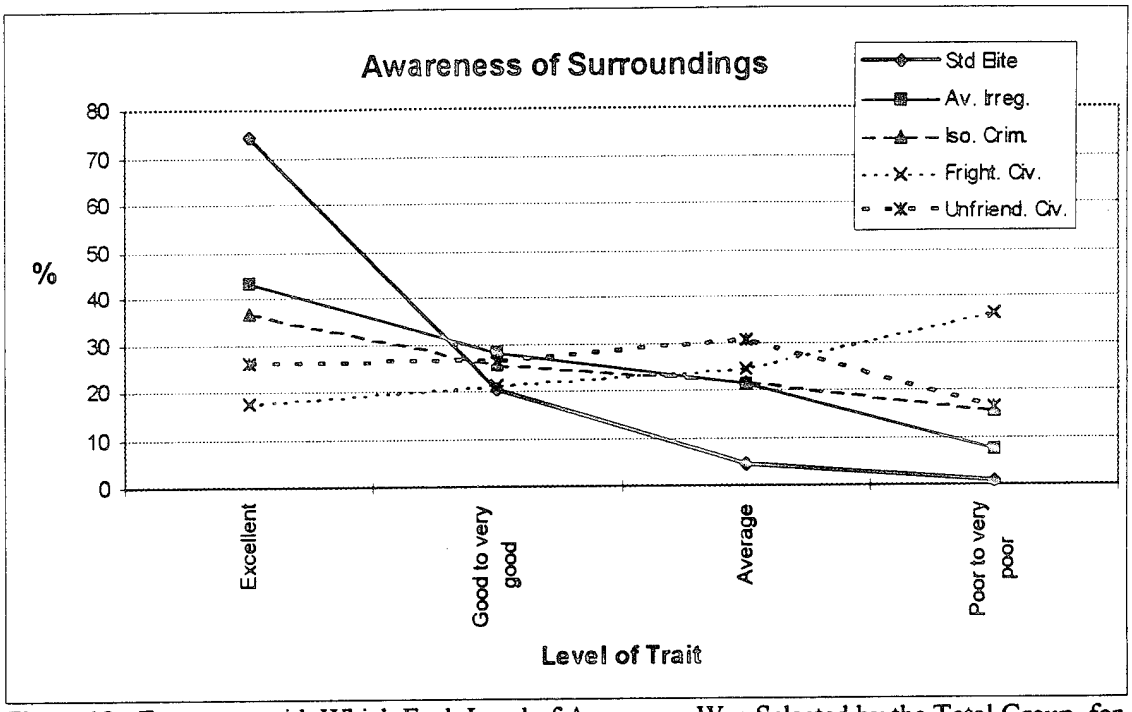

Figure 13. Frequency with Which Each Level of Awareness Was Selected by the Total Group, for Each CCH/N Category.

Table 30. **Military with No Combat**: Awareness of surroundings.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	76.0%	48.0%	50.0%	13.0%	15.0%
Good to very good	18.8%	18.0%	20.0%	8.0%	11.0%
Average	3.6%	27.0%	15.0%	26.0%	51.0%
Poor to very poor	1.6%	7.0%	15.0%	53.0%	23.0%

Table 31. **Civilians**: Awareness of surroundings.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	93.3%	30.0%	43.0%	1.0%	32.0%
Good to very good	6.7%	56.7%	3.0%	28.0%	33.0%
Average	0.0%	13.3%	30.0%	28.0%	18.0%
Poor to very poor	0.0%	0.0%	24.0%	41.0%	17.0%

6.2.2 Courage

In the second segment of the scenario, the CCH/N observes the Troops' presence. Respondents were asked to provide a distribution of frequencies for how courageous or fearless members of each type of CCH/N group are likely to be. In this context, it was expected that the respondents would consider a CCH/N's response certainty, intensity, and endurance. A courageous CCH/N should react decisively and strongly, with exceptional endurance. A fearful one is expected to be indecisive, weak, and give up more easily. Total group responses are provided in Table 32 and Figure 14, and responses of the three subgroups are shown in Tables 33, 34, and 35.

Table 32. **Total Group**: Courage, little fear of danger.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	55.0%	35.6%	26.3%	6.5%	13.5%
High	26.7%	33.8%	19.8%	4.6%	22.2%
Average	14.9%	19.9%	31.8%	24.2%	38.3%
Low to very low	3.4%	10.6%	22.0%	64.8%	25.7%

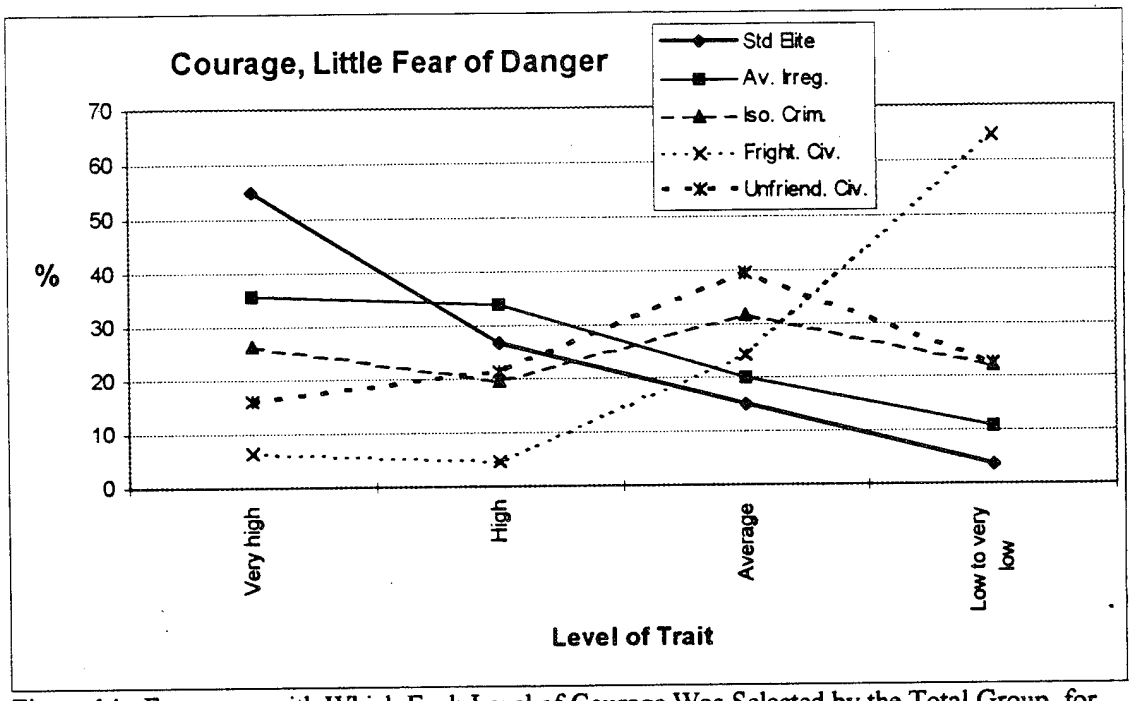

Figure 14. Frequency with Which Each Level of Courage Was Selected by the Total Group, for Each CCH/N Category.

Table 33. **Military with Combat**: Courage, little fear of danger.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	61.0%	41.2%	29.2%	8.6%	16.0%
High	21.9%	31.6%	21.2%	5.6%	21.4%
Average	15.1%	17.8%	33.0%	25.8%	39.6%
Low to very low	2.0%	9.4%	17.0%	60.0%	22.6%

Table 34. **Military with No Combat**: Courage, little fear of danger.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	24.7%	19.2%	16.4%	1.2%	5.3%
High	42.9%	34.3%	27.7%	2.4%	10.6%
Average	20.0%	27.4%	25.8%	18.1%	44.5%
Low to very low	12.4%	19.1%	28.1%	78.3%	39.7%

Table 35. **Civilians**: Courage, little fear of danger.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	55.0%	16.7%	22.0%	1.0%	9.0%
High	40.0%	51.7%	5.0%	2.0%	38.0%
Average	5.0%	25.0%	32.0%	22.0%	26.0%
Low to very low	0.0%	6.7%	41.0%	75.0%	27.0%

6.2.3 Judgment of Risk

This trait also is related to the second segment of the scenario, when the CCH/N observes the Troops' presence. Respondents were asked to provide a distribution of frequencies for how good at judging risk each type of CCH/N is likely to be. In this context, it was expected that the respondents would consider the CCH/N's speed and certainty of response, and how appropriate the response will be for this situation, based on the level of risk involved. Total group responses are provided in Table 36 and Figure 15, and responses of the three subgroups are shown in Tables 37, 38, and 39.

Table 36. **Total Group**: Judgment of risk.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very good	65.4%	38.5%	38.9%	16.5%	18.8%
Good	24.1%	30.0%	23.6%	13.0%	20.5%
Average	8.6%	22.7%	20.6%	26.4%	34.0%
Poor to very poor	2.5%	8.2%	16.9%	44.2%	26.6%

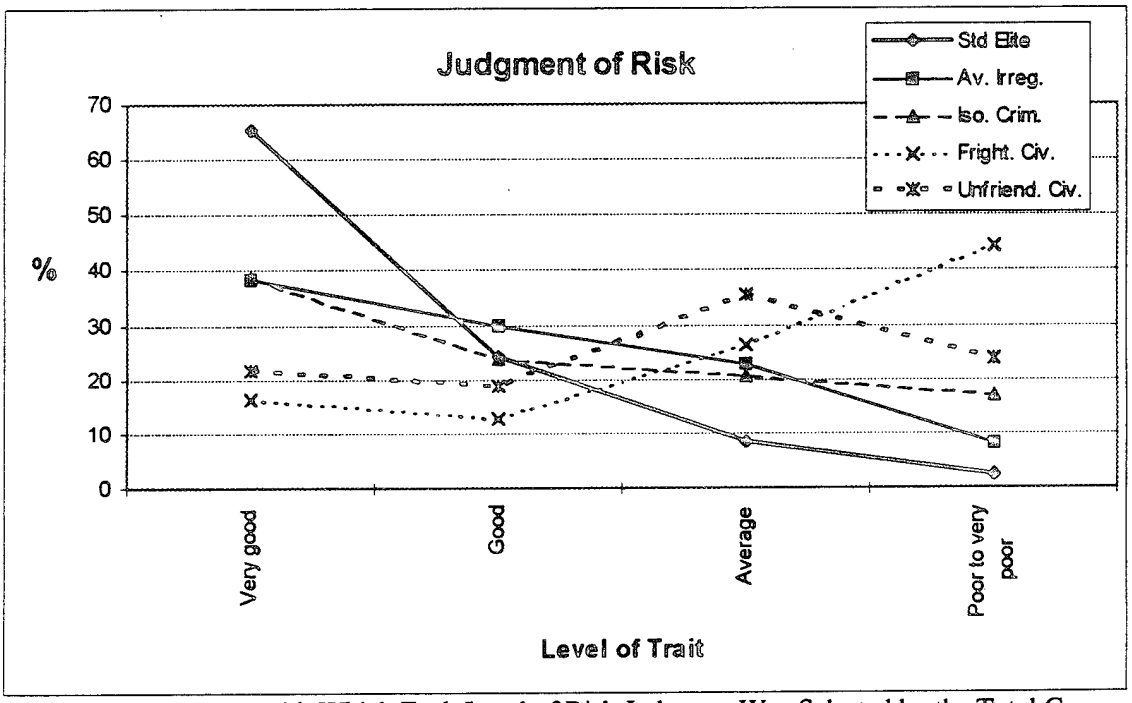

Figure 15. Frequency with Which Each Level of Risk Judgment Was Selected by the Total Group, for Each CCH/N Category.

Table 37. **Military with Combat**: Judgment of risk.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very good	68.7%	40.9%	36.8%	18.0%	21.6%
Good	21.8%	31.5%	25.6%	16.2%	19.0%
Average	7.3%	19.5%	23.6%	26.2%	35.4%
Poor to very poor	2.2%	7.3%	14.0%	39.8%	23.8%

Table 38. **Military with No Combat**: Judgment of risk..

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very good	51.9%	33.8%	25.1%	4.3%	4.3%
Good	32.0%	28.2%	27.5%	7.7%	14.8%
Average	14.4%	26.4%	22.2%	36.3%	43.7%
Poor to very poor	5.7%	11.7%	25.2%	51.7%	37.2%

Table 39. **Civilians**: Judgment of risk.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very good	60.0%	26.7%	63.0%	21.0%	19.0%
Good	30.0%	20.0%	10.0%	2.0%	34.0%
Average	10.0%	43.3%	4.0%	18.0%	17.0%
Poor to very poor	0.0%	10.0%	23.0%	59.0%	30.0%

6.2.4 Resolve and Determination

In the third segment of the scenario, the Troops command the CCH/N to stop. Respondents were asked to provide a distribution of frequencies for how determined the members of each type of CCH/N group are likely to be. Response speed, certainty, intensity, and endurance possibly can be used to characterize resolve. Total group responses are provided in Table 40 and Figure 16, and responses of the three subgroups are shown in Tables 41, 42, and 43.

Table 40. **Total Group**: Resolve/determination.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	75.5%	38.2%	33.9%	10.8%	18.1%
High	15.8%	35.2%	19.8%	8.9%	24.8%
Average	6.6%	19.5%	24.4%	31.4%	26.9%
Low to very low	2.1%	6.8%	22.5%	49.1%	30.5%

Table 41. **Military with Combat**: Resolve/determination.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	75.0%	38.0%	30.2%	12.5%	19.1%
High	15.7%	34.3%	22.3%	9.1%	23.8%
Average	7.0%	19.1%	30.7%	33.2%	28.2%
Low to very low	2.5%	8.2%	17.3%	45.5%	29.3%

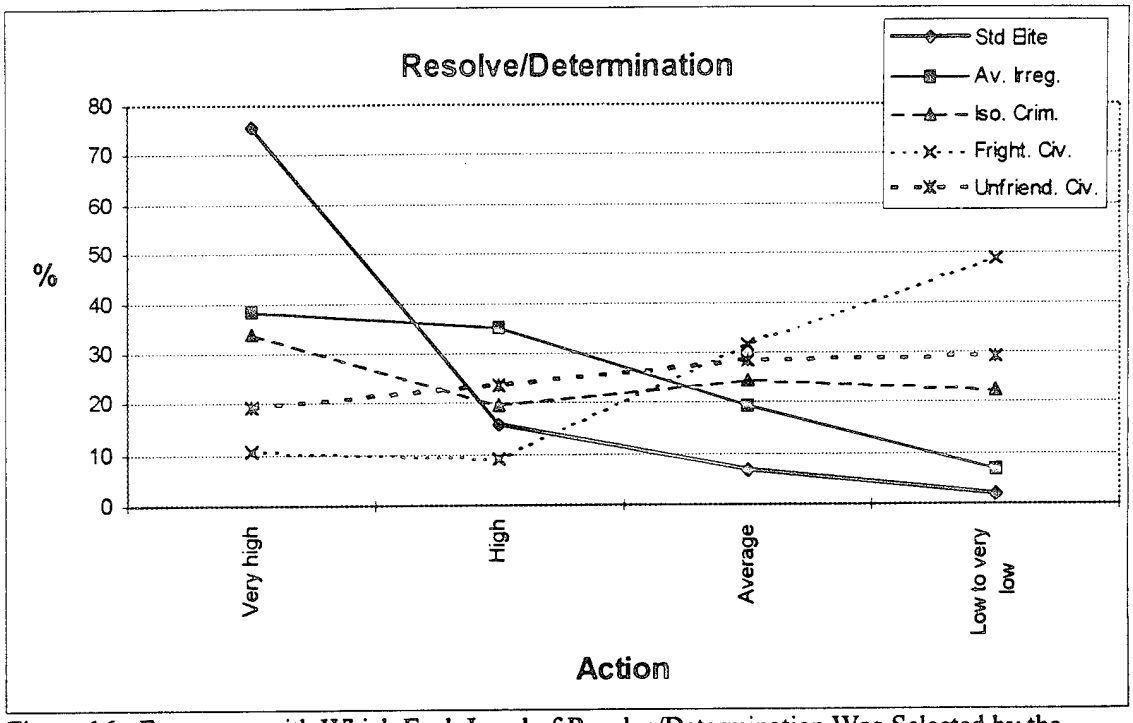

Figure 16. Frequency with Which Each Level of Resolve/Determination Was Selected by the Total Group, for Each CCH/N Category.

Table 42. **Military with No Combat**: Resolve/determination.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	74.0%	40.0%	48.0%	12.0%	14.0%
High	17.0%	40.0%	19.0%	15.0%	25.0%
Average	7.0%	15.0%	13.0%	29.0%	30.0%
Low to very low	2.0%	5.0%	22.0%	44.0%	31.0%

Table 43. **Civilians**: Resolve/determination.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	81.7%	36.7%	36.0%	2.0%	17.5%
High	15.0%	33.3%	10.0%	2.0%	30.0%
Average	3.3%	30.0%	8.0%	26.0%	16.3%
Low to very low	0.0%	0.0%	46.0%	70.0%	36.3%

6.2.5 Tactical Skills

In the fourth segment of the scenario, the Troops aim their rifles in the direction of the CCH/N. Respondents were asked to provide a distribution of frequencies for tactical skill levels for members of each type of CCH/N group. Level of tactical skill probably can be inferred from the CCH/N's response speed, certainty, strength, accuracy, precision, and endurance, along with the type of response made. Total group responses are provided in Table 44 and Figure 17, and responses of the three subgroups are shown in Tables 45, 46, and 47.

Table 44. **Total Group**: Tactical skills.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	73.8%	39.8%	18.6%	2.7%	8.5%
Good to very good	20.5%	23.6%	21.0%	4.6%	13.2%
Average	4.3%	25.6%	36.4%	17.0%	25.4%
Poor to very poor	1.2%	11.2%	23.9%	76.0%	53.3%

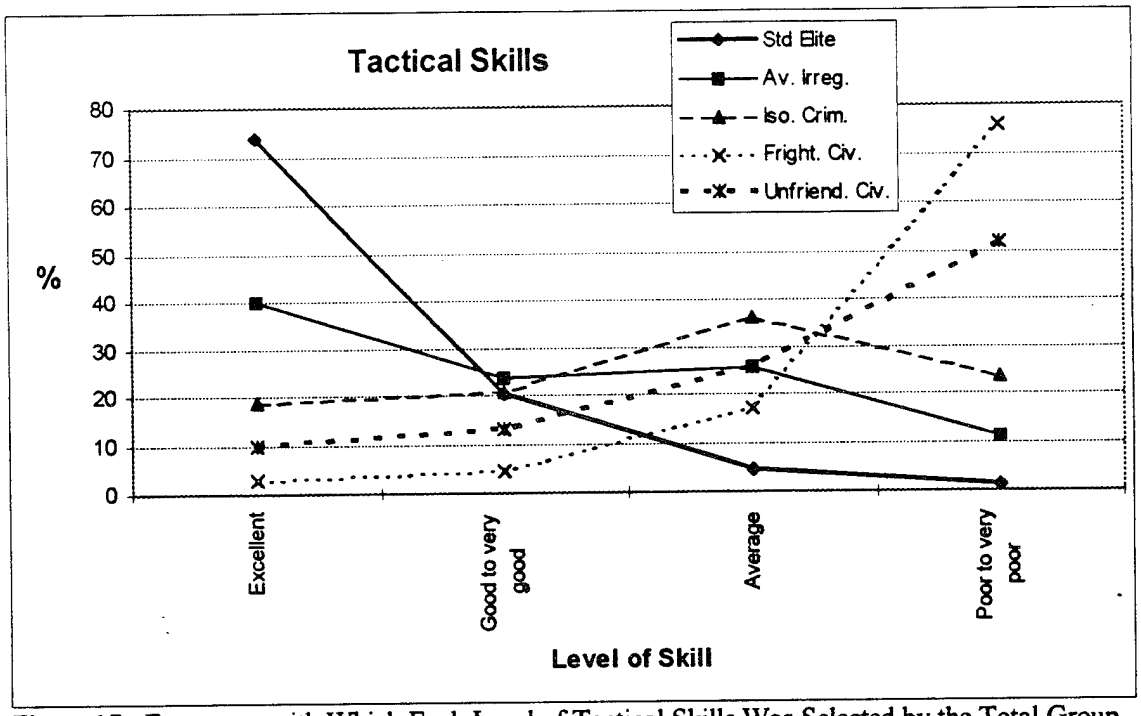

Figure 17. Frequency with Which Each Level of Tactical Skills Was Selected by the Total Group, for Each CCH/N Category.

Table 45. **Military with Combat**: Tactical skills.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	76.8%	42.4%	18.2%	1.8%	10.0%
Good to very good	17.7%	24.0%	23.8%	4.3%	12.9%
Average	3.9%	25.0%	35.4%	18.5%	25.7%
Poor to very poor	1.4%	9.0%	22.4%	75.8%	51.8%

Table 46. **Military with No Combat**: Tactical skills.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	49.0%	33.0%	24.0%	8.0%	9.0%
Good to very good	43.0%	28.0%	21.0%	8.0%	13.0%
Average	7.0%	31.0%	40.0%	19.0%	30.0%
Poor to very poor	1.0%	8.0%	15.0%	65.0%	49.0%

Table 47. **Civilians**: Tactical skills.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	90.0%	30.0%	15.0%	1.3%	1.0%
Good to very good	6.7%	13.3%	7.0%	2.5%	15.0%
Average	3.3%	21.7%	38.0%	5.0%	19.0%
Poor to very poor	0.0%	35.0%	40.0%	91.3%	65.0%

6.2.6 Marksmanship

In the fifth segment of the scenario, the Troops fire their rifles towards the CCH/N. Respondents were asked to provide a distribution of frequencies for how good CCH/N marksmanship skills are expected to be (speed, accuracy, and precision) for members of each type of CCH/N group, if and when the CCH/N returns fire. Although results were collected for all five CCH/N groups, marksmanship skills probably need be modeled only for hostiles, since neutrals are unlikely to have guns (though they might throw rocks or other objects if attacked or angry enough). Total group responses are provided in Table 48 and Figure 18, and responses of the three subgroups are shown in Tables 49, 50, and 51.

Table 48. **Total Group**: Marksmanship.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	67.3%	36.1%	16.8%	3.7%	10.0%
Good to very good	24.3%	23.6%	19.7%	9.0%	14.6%
Average	7.1%	28.6%	33.8%	23.1%	28.5%
Poor to very poor	1.4%	12.0%	29.9%	64.3%	47.2%

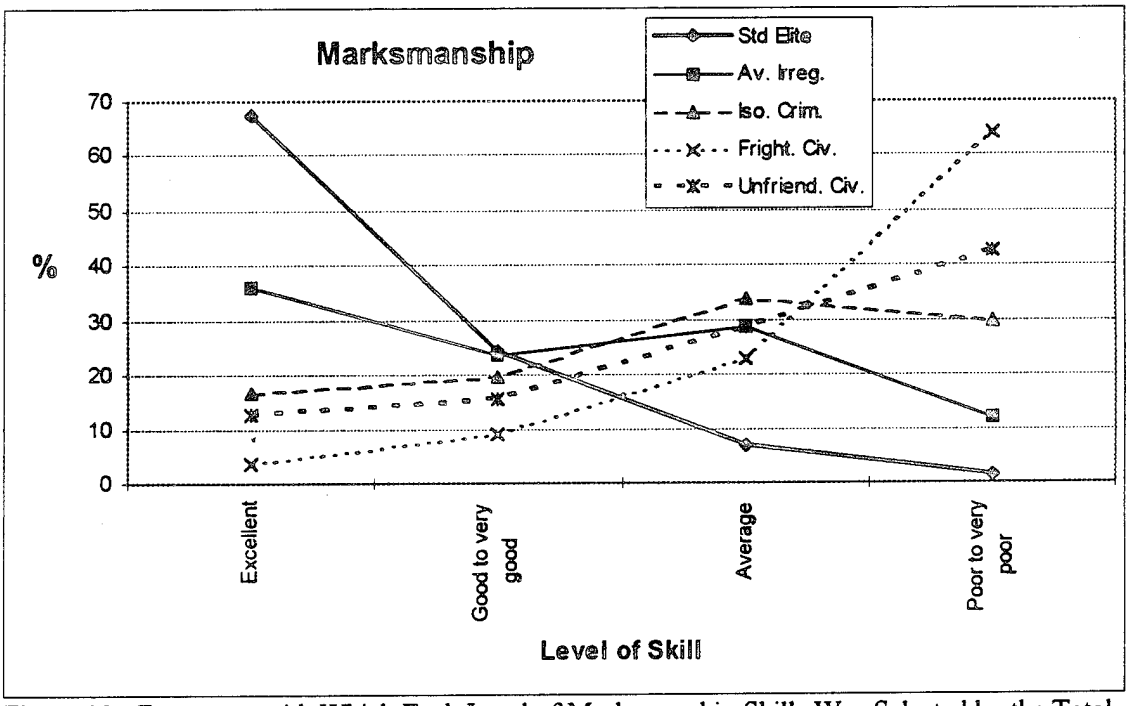

Figure 18. Frequency with Which Each Level of Marksmanship Skills Was Selected by the Total Group, for Each CCH/N Category.

Table 49. **Military with Combat**: Marksmanship.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	70.1%	38.4%	17.4%	4.8%	12.8%
Good to very good	19.9%	23.2%	17.9%	11.1%	15.6%
Average	8.3%	29.2%	35.4%	24.5%	28.8%
Poor to very poor	1.7%	9.6%	30.1%	59.8%	42.8%

Table 50. **Military with No Combat**: Marksmanship.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	54.4%	31.0%	15.0%	0.4%	2.0%
Good to very good	39.7%	31.0%	32.0%	5.0%	12.0%
Average	5.3%	28.0%	29.0%	23.0%	39.0%
Poor to very poor	0.8%	10.0%	22.0%	71.6%	49.0%

Table 51. **Civilians**: Marksmanship.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Excellent	65.0%	25.0%	16.0%	1.3%	2.5%
Good to very good	35.0%	15.0%	16.0%	1.3%	11.3%
Average	0.0%	25.0%	31.0%	15.0%	13.8%
Poor to very poor	0.0%	35.0%	37.0%	82.5%	72.5%

6.2.7 Determination and Aggressiveness

In the final segment of the scenario, the CCH/N has been wounded by the Troops' rifle fire. Respondents were asked to provide a distribution of frequencies for how determined or aggressive a member of each type of CCH/N group is likely to be. Will he continue to try to fight, or will he give up? If he fights, will he fight fiercely? A wounded but highly-determined CCH/N should continue to respond relatively rapidly and with certainty and intensity, while a less aggressive one will be slower and give up easier. Total group responses are provided in Table 52 and Figure 19, and responses of the three subgroups are shown in Tables 53, 54, and 55.

Table 52. **Total Group**: Determination/aggressiveness.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	72.4%	40.0%	25.5%	4.1%	15.0%
High	19.4%	27.8%	21.6%	8.0%	19.1%
Average	6.7%	22.6%	27.0%	23.0%	31.1%
Low to very low	1.5%	9.0%	25.5%	64.6%	34.8%

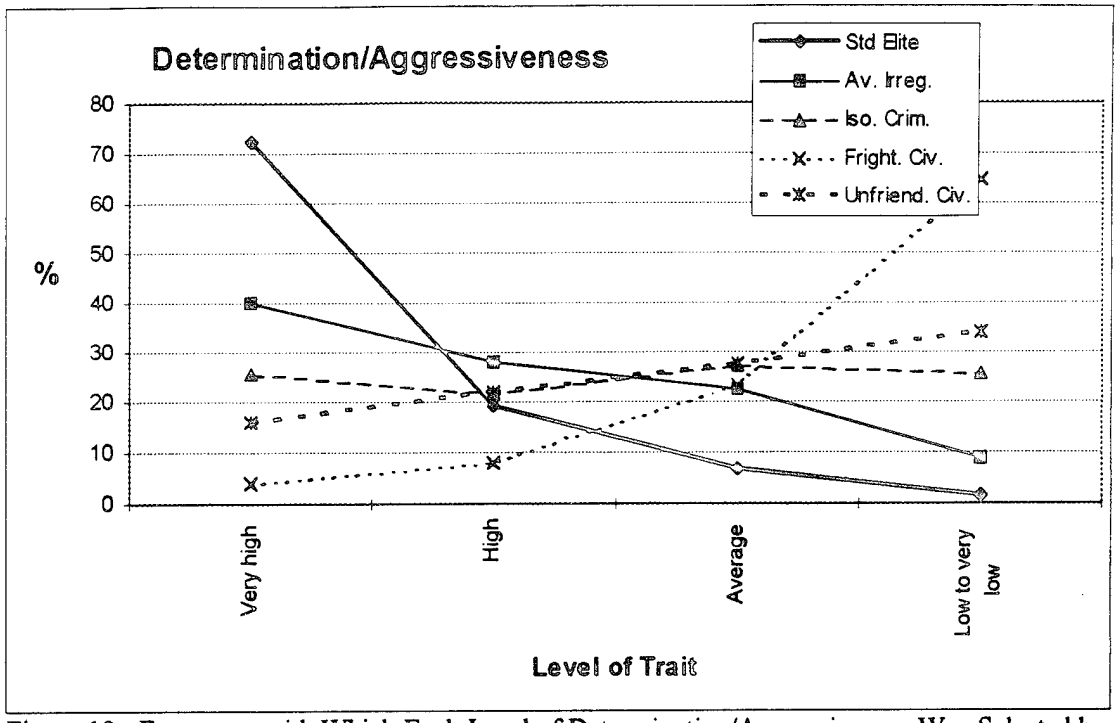

Figure 19. Frequency with Which Each Level of Determination/Aggressiveness Was Selected by the Total Group, for Each CCH/N Category.

Table 53. **Military with Combat**: Determination/aggressiveness.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	75.3%	42.9%	26.0%	4.8%	16.2%
High	17.5%	26.0%	20.8%	8.5%	22.1%
Average	5.8%	20.5%	27.6%	19.4%	27.6%
Low to very low	1.3%	9.7%	25.0%	67.0%	34.1%

Table 54. **Military with No Combat**: Determination/aggressiveness.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	48.0%	30.0%	28.0%	2.0%	6.0%
High	34.0%	34.0%	36.0%	8.0%	13.0%
Average	15.0%	26.0%	26.0%	23.0%	57.0%
Low to very low	3.0%	10.0%	10.0%	67.0%	24.0%

Table 55. **Civilians**: Determination/aggressiveness.

Level of Trait or Skill	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilians	Unfriendly Civilians
Very high	90.0%	33.3%	18.8%	2.5%	18.8%
High	10.0%	31.7%	8.8%	5.0%	8.8%
Average	0.0%	33.3%	25.0%	45.0%	20.0%
Low to very low	0.0%	1.7%	47.5%	47.5%	52.5%

6.3 QUANTITY OF CCH/N CATEGORIES

How many categories of CCH/Ns must be modeled in TTES for satisfactory decision-making training? How good is "good enough"? Currently, TTES models one type of hostile and one type of neutral. The range of individuals and groups encountered in combat suggests that two is far too few for training military and civilian personnel in when to engage and when not, and in the appropriate type and level of response.

Some 14 types of hostiles have been proposed in Section 3.1 as modeling candidates, another 14 for neutrals, and 12 for friendlies who might be encountered on the battlefield. Individually characterizing and modeling 40 types of CCH/Ns would be prohibitively expensive.

An arbitrary compromise was made for this study, based primarily on how long a questionnaire can be before survey respondents are unwilling to complete it. Three levels of hostiles and two of neutrals were selected simply out of consideration for the participants. The survey participants then were asked the question, "Do these five categories provide enough types of CCH/Ns to include in TTES, for adequate training in making hostile-versus-neutral decisions?" Respondents had already observed the present versions of TTES hostiles and neutrals, and had given much consideration to the five CCH/N categories while completing the questionnaire, so were considered logical candidates to ask.

As may be observed in Figure 20, more than half of the respondents feel that the five CCH/N categories included in the questionnaire are totally adequate. Nearly 20% each suggested that the five categories were either "Barely adequate" or "More than adequate." Only 3% said that the list is "Somewhat inadequate" and no one voted for "Totally inadequate."

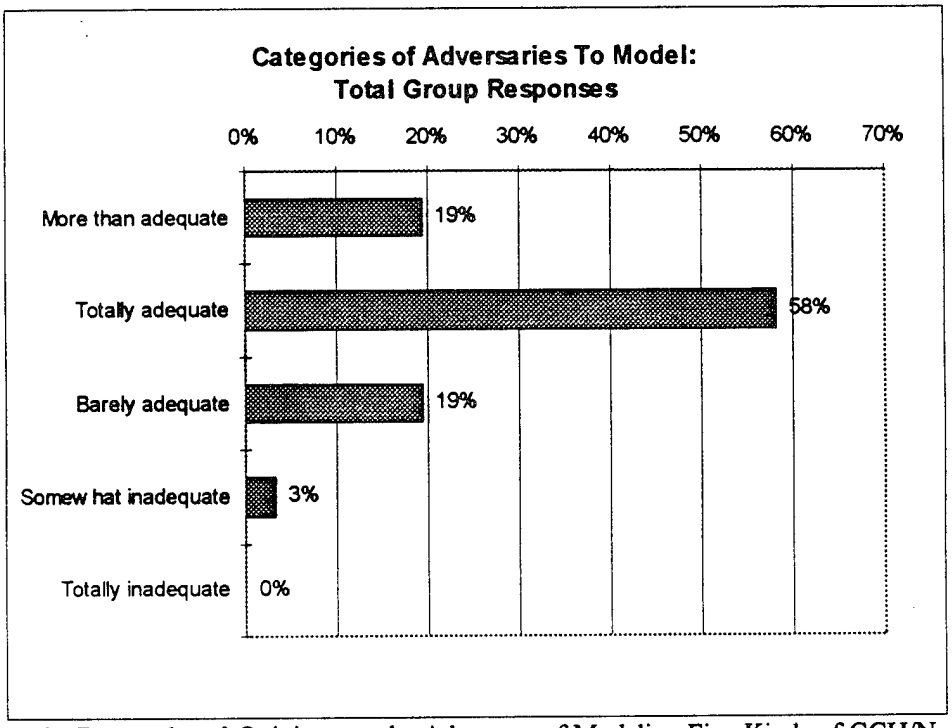

Figure. 20. Respondents' Opinions on the Adequacy of Modeling Five Kinds of CCH/Ns for TTES Training.

If any of these five categories must be omitted, which should it be? Five respondents suggested that Frightened Civilians might be dropped and three suggested Isolated Criminals. However, generally all five types were considered valuable to include in TTES. What additional categories are needed? Respondents proposed the following, if any are added; the first four in the left column each received two votes; the rest were mentioned once. The *Combat, No Combat,* or *Civilian* designation indicates the group or groups of survey respondents who suggested the new category.

- Religious radicals/zealots: *Combat*
- Militia: *Combat, Civilian*
- Gangs: *Combat*
- Terrorists: *Combat*
- Drug/weapon dealers in a raid: *Civilian*
- Group of criminals: *No Combat*
- Armed looters: *No Combat*
- Machine gun teams: *Combat*
- Snipers: *Combat*
- Multiple targets (patrols): *Combat*
- Civilians *pretending* to be friendly: *Combat*
- Neutrals that look like threats: *Combat*
- Mob: *Combat*
- Angry civilians: *Combat*

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS AND RECOMMENDATIONS FOR THE IST/*JACK* MODEL

The goal of the survey described here is to assist IST and NAWC-TSD in modeling the behavior of CCH/Ns, both individuals and groups, on the battlefield. Our emphasis at present is on modeling behavioral *differences* between hostiles and neutrals — differences that are important for the TTES discretionary decision-making training function. There are constraints on the kinds of behaviors that can be selected to aid trainees in differentiating between hostiles and neutrals, since entities must be modeled in the CGF Testbed using *Jack* capabilities. With the above goal, emphasis, and constraints in mind, the following conclusions can be drawn and recommendations made, based on the IST model summary presented in Section 4.

7.1.1 Modeling Simulated Humans

- The kinds of realistic behaviors exhibited on the battlefield by hostiles and neutrals must be extracted from subject matter experts for modeling in TTES, because actual behaviors cannot be observed directly. Elicitation of expert knowledge is difficult at best. Unless great care is taken, experts' responses may be biased by the knowledge collection process, so that "expected" responses are obtained rather than the objective information that was desired. Care was taken during the present study to minimize biases as much as possible.

- CCH/N behaviors must be divided into atomic units of behavior that can be specified as set of discrete states in FSMs. Each FSM and its associated states will belong to a specific entity. Only one instance of an FSM is active at a time, for a given entity.

- CCH/N behaviors can combine postures and sequenced actions and reactions, but predefined beginning and ending conditions must be specified for each behavior.

- Behaviors can include situation-specific postures and actions, but must naturally transition into simple default behaviors when the ending conditions are met.

- Once triggered, default behaviors will continue until preconditions are met for a situation-specific behavior.

- TTES eventually is expected to model smoke, dust, and fog as well as clear meteorological conditions. The TTES sighting model must take into account the effects of such obscurants on human abilities to detect and identify objects — both for Trainees and for CCH/Ns. Several excellent military target acquisition models are available for this purpose.

- Non-preemptive task scheduling, while useful in supporting multiple CGF entities, should not prevent an individual CCH/N from stopping mid-action to carry out a higher-priority activity (e.g., to respond to a new, higher threat).

- Only DIS-limited postures (standing, kneeling, prone, and dead) can be included in the behavior set, though this basic set may be extended by addition of velocity vectors and headings.

- IST's plans to incorporate sounds into the TTES environment are critical for realistic training. In addition to verbal communications, sounds provide key indications of the kinds of weapons faced and tactical movement skills of adversaries.

- The low-resolution *JackML* figures required for runtime TTES will limit the ability to model fine details of human posture, such as finger movements and direction of gaze.

7.1.2 Differentiating Between Neutrals and Hostiles

- Since training in discretionary decision making is a primary function of TTES, it is critical that realistic computer-controlled neutrals, as well as hostiles, be present on the battlefield.

- Since an entity consists of a camouflaged human and his rifle, a technique is needed to generate a fully-functional neutral figure that is not carrying what obviously is a gun.

- Modeling of only the AK-47 and M16 weapons in TTES severely limits the kinds of scenarios that can be practiced. Irregular troops, world-wide, use numerous kinds of old (often outdated) weapons; practice in best responses to such weapons is critical for low- and medium-intensity conflicts in Third World countries.

- The inability to model facial expressions and to carry non-military objects in TTES will seriously limit the ways in which neutrals and hostiles can be differentiated.

- In general, the overall "human" behavior set for neutrals is the same as that for hostiles, except that neutrals usually will not fire weapons.

- Neutrals must be differentiated from hostiles primarily by selecting behaviors from the common set that are physically possible but less likely for hostiles, such as running away, falling to the ground, or raising arms in a surrender position.

7.1.3 Modeling Groups

- Modeling of small groups of neutrals can be done in a manner similar to modeling of SAFDI fireteams, except that possibly no weapons will be carried.

- The *attach and follow* capability will be useful in modeling two neutrals as well as two hostiles, one of which is the leader.

7.2 CONCLUSIONS AND RECOMMENDATIONS FROM THE SURVEY

The survey of 35 subject matter experts described in Section 6 has resulted in much data that should be useful in modeling CCH/Ns for TTES. The study participants provide a reasonable cross section of military and civilian individuals who potentially will use TTES systems to train others. Thus their opinions and judgments should be respected and used, insofar as possible, during continued efforts at representing behavior on the battlefield. Several conclusions can be drawn and recommendations made, based on the survey results. These are noted below.

7.2.1 Validity of Study Results

- Experts who participated in the study appeared to take the process seriously and to approach the task thoughtfully, even though the questionnaire was long and difficult to complete. We feel the resulting judgments are valid for the sample that was surveyed.

- Only 35 military and civilian experts participated in this study, representing six agencies. Results should not be construed to represent the opinions of the total population of potential TTES users.

- The questionnaire was based on a specific medium-intensity conflict, and results may not be applicable to low- or high-intensity situations.

- Participant variability resulted in very large standard deviations when summary statistics were computed. Resulting average percentages obviously are very imprecise, and generally indicate *trends* in the data rather than statistically-significant differences in behaviors and traits.

- For completeness, results have been provided in Section 6 for the three individual groups (military personnel with and without combat experience and civilian law enforcement officers), along with total group results. Results from the non-combat military group and the civilian group have no statistical significance, due to the small sample sizes, and should not be used for modeling CCH/Ns.

- In general, results for the total group mirror those for military respondents who have seen combat since the preponderance of participants came from that group. This combat-experienced group also has the most credibility, since they have "been there."

7.2.2 CCH/N Behaviors and Reactions

- Although a very simple scenario was used for the survey (Sections 3.2 and 5.2), the sequence of events and listed options included in that scenario are typical for encounters observed during TTES demonstrations. It should provide a good starting point for defining and modeling behaviors that CCH/Ns can exhibit throughout more complex scenarios.

- The distributions of time the various CCH/N behaviors and reactions are anticipated, as provided by the total group of subject matter experts in Section 6.1, can serve at least as useful rules of thumb for how often to model each type of CCH/N response, for the situations included and the five CCH/N categories considered here.

- Lacking other sources of similar data, the total group percentages included in the Section 6.1 tables could be used directly for CCH/N modeling. Since these values were obtained from a reasonable sample of the kinds of individuals who will use TTES for training, they generally represent what will be considered realistic actions by users — even though a statistician may consider the data somewhat suspect due to the large standard deviations.

- Results included in Section 6.1 for the civilian subgroup of experts indicate that at least the five law enforcement agents who participated view the battlefield and events that occur there somewhat differently than do military personnel. However, results are so inconclusive that no attempt should be made to model different CCH/Ns for civilian use at this time — although this might be considered in the future if a much larger civilian sample can be surveyed.

- Results for the subgroup of military personnel who never have been in combat indicate that at least the five who were surveyed may underestimate the responses of hostiles on the battlefield (Section 6.1). While combat veterans generally indicated that they expect to face skilled adversaries relatively often (whether Standard Elite Troops or Average Irregulars), those without combat experience generally selected poorer tactical responses for these same adversaries. It is critical that TTES model adversaries in ways that will prepare trainees for real-world encounters on the battlefield. Impressions of stupid or unskilled adversaries obtained during training would be very difficult to unlearn and could result in unnecessary casualties in combat.

7.2.3 CCH/N Traits and Skills

- The distributions of skill levels for the various CCH/N characteristics or traits, as provided by the total group of subject matter experts (Section 6.2), will at least provide useful rules of thumb for how often to model each level for CCH/Ns, for the five categories of entities considered here.

- Unless other sources of data are located that indicate otherwise, the distributions of trait and skill levels included in the Section 6.2 tables could be used directly for CCH/N modeling. As noted above, these values were obtained from potential TTES users and should represent the expectations of these users. However, only results from the total survey group should be used for this purpose.

- Modeling perceptual, intellectual, and emotional characteristics is difficult, since these are made overt only through physical actions and the TTES *Jack* entity is very limited in subtle responses. Several suggestions for how characteristics and traits might be modeled have been included in Section 2.4. Used in conjunction with the frequencies provided by subject matter experts (Section 6.2), they may provide a starting point for TTES programmers.

7.2.4 CCH/N Categories

- According to those surveyed, the three types of hostiles and two types of neutrals defined for this study will provide enough varieties of CCH/Ns to model for TTES at present, for satisfactory decision-making training.

- If other CCH/N categories are added later, the list of suggested types included in Section 6.3 should be considered strong candidates for inclusion in TTES scenarios.

Appendix A,
SURVEY FORM: MODELING HOSTILES AND NEUTRALS FOR TTES

Questionnaire

Team Tactical Engagement Simulator:

Modeling Hostiles and Neutrals for TTES

Background

The Team Tactical Engagement Simulator (TTES) is a U.S. Marine Corps trainer that will teach tactical decision-making and close combat marksmanship skills. The system includes (a) a dynamic representation of a combat area's physical environment and (b) physical and behavioral representation of friendlies, hostiles, and neutrals in that environment. The refinement of discretionary and tactical decision skills will be the most significant TTES payoff. Other payoffs include maintenance of perishable skills such as marksmanship, realistic training in expeditionary situations such as during prolonged shipboard deployments, and weapon virtual prototyping.

TTES is intended as a supplement and complement to live-fire and field training, not as a substitute. The software developed in the effort can be applied as a modular upgrade to compatible small arms training systems for infantry, security forces, and special operations units. The envisioned TTES product is projected for fielding in the 2002 to 2006 time frame.

In its final version, TTES trainees will train in a realistic simulated combat environment where they will encounter computer-controlled hostiles/neutrals (CCH/Ns), that is, simulated civilians and military forces whose high-fidelity simulated combat behavior will closely emulate that of actual hostile and neutral units and individuals. CCH/Ns will *not* be simplistic "cartoons," but rather will be modeled to represent typical actions of real people in real-world combat situations.

The following situations and events are being used to obtain opinions from subject matter experts on the kinds of behaviors expected from hostile and neutral individuals, under the specified circumstances. Results will be used to define a *range* of typical actions TTES CCH/Ns might take. The TTES trainee's job will be to decide *whether* to engage a simulated individual, prior to opening fire. That is, based on the CCH/N's behavior and actions, is he *hostile* or *neutral*? Thus, modeled behaviors must be believable and representative of hostiles and neutrals. **It is critical that these behaviors not lead trainees to make incorrect assumptions about the intelligence or skill of their adversaries.**

Thank you for your assistance!

Your written and verbal comments will be welcome!

Return survey forms to: MAJ Frank Wysocki (703) 640-2220 or 4788
Amphibious Warfare Technology Directorate
US Marine Corps Systems Command
Quantico, VA 22134

Questionnaire: Modeling Hostiles and Neutrals for TTES

Respondent Information

Name:

Agency and Mailing Address:

Phone Number:

Served in Combat (circle):	Haiti	Lebanon	Liberia	Panama	Somalia
	Southwest Asia	Other:_____			

TTES Computer-Controlled Hostiles/Neutrals (CCH/Ns) To Be Modeled

- Humans modeled in TTES must *behave* in ways that are correct (and believable) for the types of individuals being modeled — *not* be simplistic "cartoons." Behaviors *must* represent typical actions of real people in real-world combat situations, for satisfactory training.

- Simulated humans in TTES include **friendlies, frightened neutrals, unfriendly neutrals**, and several levels of **hostiles** — ranging from "super-Ninjas," through trained regulars, untrained conscripts, mobs, and isolated criminals.

- **Only five of these types are considered here:**

1. **Standard elite.** Well-trained ground troops, equivalent to U.S. Marines and Rangers or the French Foreign Legion, on a defensive mission.

2. **Average irregulars**: A pick-up army of individuals who have a common goal but little training, equivalent to the troops of Somali warlords, on a defensive mission.

3. **Isolated criminal**: Individual acting essentially alone to take advantage of a combat situation, such as a thief and robber; he may be armed and irrational.

4. **Frightened civilian**: Neutral resident of a village or city, subject to military operations, who is not especially unfriendly and primarily wants to escape to safety; he may be armed.

5. **Unfriendly civilian**: Neutral resident of a village or city, subject to military operations, who dislikes American troops and may respond with hostility if accosted; he may be armed and irrational.

TTES Situation Modeled for this Survey

- **Mission**: Urban peacekeeping operation. U.S. Troops are patrolling a partly destroyed village as part of an "Operations other than war" scenario.

- **Location**: Moderate-sized village, damaged by combat operations over several years.

- **Tactical situation**: Armed hostiles are known to be in the area. Shots have been exchanged earlier today. Gunfire is heard in the distance occasionally.

Questionnaire: Modeling Hostiles and Neutrals for TTES

TTES Scenario and Events for this Survey: Summary

1. A CCH/N (may be either hostile or neutral) moves into the view of U.S. ground troops, about 50 - 100 feet away, in an area similar to Quantico Combat Training Village.
2. The CCH/N observes the troops' presence.
3. Troops tell the CCH/N to stop.
4. Troops aim rifles at the CCH/N.
5. Troops fire rifles at the CCH/N.
6. CCH/N is wounded by rifle fire.

Instructions

- **Kinds of Behaviors or Reactions: For each type of CCH/N, what percent of the time (from 0% to 100%) can *each* kind of listed behavior, action, or response be expected?**

[For example, when crossing the street, 75% of Frightened Civilians may *Cross without checking traffic*, while 25% may *Look both ways*. Total must be 100%.]

- **Traits and skills: For each type of CCH/N, what is the *distribution* of this type of CCH/N for the listed trait or skill?**

[For example, in Awareness of danger, 50% of Average Irregulars might be *Excellent*, 20% *Good to very good*, 15% *Average*, and 15% *Poor to very poor*. Total must be 100%.]

***Fictitious example*: CCH/N is crossing street.**

Behavior	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilian	Unfriendly Civilian
Crosses without checking traffic.	90 %	80 %	100 %	75 %	35 %
Looks both ways before crossing.	10 %	20 %	%	25 %	65 %
Total:	**100%**	**100%**	**100%**	**100%**	**100%**
Awareness of danger					
Excellent:	90 %	50 %	10 %	%	5 %
Good to very good:	10 %	20 %	20 %	10 %	15 %
Average:	%	15 %	60 %	60 %	60 %
Poor to very poor:	%	15 %	10 %	30 %	20 %
Total:	**100%**	**100%**	**100%**	**100%**	**100%**

Questionnaire: Modeling Hostiles and Neutrals for TTES

1. CCH/N can be seen by Troops, but does not yet observe Troops are present.

Stance and movement	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilian	Unfriendly Civilian
Running	%	%	%	%	%
Moving purposefully & confidently.	%	%	%	%	%
Moving hesitantly & fearfully.	%	%	%	%	%
Looking around & moving evasively.	%	%	%	%	%
Crawling.	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**
Awareness of surroundings					
Excellent:	%	%	%	%	%
Good to very good:	%	%	%	%	%
Average:	%	%	%	%	%
Poor to very poor:	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**

2. CCH/N observes Troops' presence.

Reaction	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilian	Unfriendly Civilian
Continues movement as before.	%	%	%	%	%
Seeks cover/concealment & observes.	%	%	%	%	%
Seeks cover/concealment & initiates fire.	%	%	%	%	%
Goes prone & observes.	%	%	%	%	%
Goes prone & fires.	%	%	%	%	%
Stands in place & freezes.	%	%	%	%	%
Drops to ground & freezes.	%	%	%	%	%
Raises hands in surrender.	%	%	%	%	%
Runs away.	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**
Courage, little fear of danger					
Very high:	%	%	%	%	%
High:	%	%	%	%	%
Average:	%	%	%	%	%
Low to very low:	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**
Judgment of risk					
Very good:	%	%	%	%	%
Good:	%	%	%	%	%
Average:	%	%	%	%	%
Poor to very poor:	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**

3. Troops command CCH/N to stop.

Reaction	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilian	Unfriendly Civilian
Continues movement as before.	%	%	%	%	%
Seeks cover/concealment & observes.	%	%	%	%	%
Seeks cover/concealment & initiates fire.	%	%	%	%	%
Goes prone & observes.	%	%	%	%	%
Goes prone & fires.	%	%	%	%	%
Stands in place & freezes.	%	%	%	%	%
Drops to ground & freezes.	%	%	%	%	%
Raises hands in surrender.	%	%	%	%	%
Runs away.	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**
Resolve/determination					
Very high:	%	%	%	%	%
High:	%	%	%	%	%
Average:	%	%	%	%	%
Low to very low:	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**

4. Troops aim rifles in direction of CCH/N.

Reaction	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilian	Unfriendly Civilian
Continues movement as before.	%	%	%	%	%
Seeks cover/concealment & observes.	%	%	%	%	%
Seeks cover/concealment & initiates fire.	%	%	%	%	%
Goes prone & observes.	%	%	%	%	%
Goes prone & initiates fire.	%	%	%	%	%
Stands in place & freezes.	%	%	%	%	%
Drops to ground & freezes.	%	%	%	%	%
Raises hands in surrender.	%	%	%	%	%
Runs away.	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**
Tactical skills					
Excellent:	%	%	%	%	%
Good to very good:	%	%	%	%	%
Average:	%	%	%	%	%
Poor to very poor:	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**

5. Troops fire towards CCH/N.

Reaction	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilian	Unfriendly Civilian
Seeks cover/concealment & observes.	%	%	%	%	%
Seeks cover/concealment & returns fire.	%	%	%	%	%
Goes prone & observes.	%	%	%	%	%
Goes prone & returns fire.	%	%	%	%	%
Stands in place & freezes.	%	%	%	%	%
Drops to ground & freezes.	%	%	%	%	%
Raises hands in surrender.	%	%	%	%	%
Runs away.	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**
Marksmanship					
Excellent:	%	%	%	%	%
Good to very good:	%	%	%	%	%
Average:	%	%	%	%	%
Poor to very poor:	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**

6. CCH/N responds to being wounded by rifle fire.

Reaction	Standard Elite	Average Irregulars	Isolated Criminal	Frightened Civilian	Unfriendly Civilian
Continues effective fire.	%	%	%	%	%
Tries to return fire.	%	%	%	%	%
Drops to ground & freezes.	%	%	%	%	%
Raises hands in surrender.	%	%	%	%	%
Tries to run/crawl away.	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**
Determination/aggressiveness					
Very high:	%	%	%	%	%
High:	%	%	%	%	%
Average:	%	%	%	%	%
Low to very low:	%	%	%	%	%
Total:	**100%**	**100%**	**100%**	**100%**	**100%**

Five categories of CCH/Ns have been defined for this survey: (1) Standard Elite, (2) Average Irregulars, (3) Isolated Criminals, (4) Frightened Civilians, (5) Unfriendly Civilians.

1. Do these five categories provide *enough types* of CCH/Ns to include in TTES, for adequate training in making *hostile-versus-neutral* decisions? **How good is "good enough"?** Select one:

More than adequate Totally adequate Barely adequate Somewhat inadequate Totally inadequate

2. Which of these five CCH/N categories (if any) should *not* be included?

3. What *additional* CCH/N categories *should* be included, for training to be "good enough"?

Appendix B,
MODELING HOSTILES AND NEUTRALS: STANDARD ELITE TROOPS

Modeling Hostiles and Neutrals: Standard Elite Troops

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
CCH/N Behaviors												
1. CCH/N can be seen by Troops, but does not yet observe Troops are present.												
Running	33	8.3	17.2	25	6.4	11.3	5	23.0	35.5	3	0.0	0.0
Purposeful movement	33	50.6	32.6	25	49.6	31.0	5	28.0	22.0	3	96.7	5.8
Hesitant movement	33	4.4	6.3	25	5.4	6.9	5	2.0	2.7	3	0.0	0.0
Evasive movement	33	30.4	30.1	25	32.2	29.1	5	38.0	39.0	3	3.3	5.8
Crawling	33	6.2	10.2	25	6.4	10.7	5	9.0	10.2	3	0.0	0.0
2. CCH/N observes Troops' presence.												
Continues as before	33	4.1	14.1	25	4.9	16.1	5	0.7	0.9	3	3.3	5.8
Seeks cover, observes	33	30.9	24.7	25	29.0	22.5	5	32.7	29.5	3	43.3	40.4
Seeks cover, initiates fire	33	31.5	24.4	25	32.4	23.8	5	23.7	21.6	3	36.7	40.4
Goes prone, observes	33	9.7	10.8	25	9.5	11.5	5	12.7	7.2	3	6.7	11.5
Goes prone, initiates fire	33	17.9	18.1	25	17.9	19.1	5	24.3	14.8	3	6.7	11.5
Stands, freezes	33	2.0	3.7	25	1.9	3.8	5	3.3	4.1	3	0.3	0.6
Drops, freezes	33	2.6	4.5	25	2.8	4.8	5	1.3	2.2	3	3.0	5.2
Hands up in surrender	33	0.5	1.2	25	0.6	1.4	5	0.1	0.3	3	0.0	0.0
Runs away	33	0.9	2.0	25	0.9	1.9	5	1.3	3.0	3	0.0	0.0
3. Troops command CCH/N to stop.												
Continues as before	33	5.3	15.0	25	5.2	16.8	5	6.9	9.1	3	3.3	5.8
Seeks cover, observes	33	15.7	20.0	25	15.0	20.2	5	15.8	20.1	3	21.7	25.7
Seeks cover, initiates fire	33	42.8	28.9	25	42.1	29.8	5	40.1	27.4	3	53.3	32.1
Goes prone, observes	33	6.9	11.3	25	6.6	11.4	5	8.3	13.2	3	6.7	11.5
Goes prone, initiates fire	33	16.0	18.1	25	15.8	17.9	5	22.5	22.8	3	6.7	11.5
Stands, freezes	33	3.3	7.5	25	4.1	8.4	5	0.4	0.9	3	1.7	2.9
Drops, freezes	33	2.0	4.3	25	2.0	4.5	5	1.3	2.7	3	3.3	5.8
Hands up in surrender	33	2.0	4.9	25	2.3	5.4	5	2.1	4.4	3	0.0	0.0
Runs away	33	5.6	11.4	25	6.5	12.8	5	2.1	4.4	3	3.3	5.8
4. Troops aim rifles in direction of CCH/N.												
Continues as before	33	3.5	12.5	25	1.2	3.5	5	17.0	29.9	3	0.0	0.0
Seeks cover, observes	33	14.6	21.7	25	14.0	20.3	5	24.6	32.3	3	3.3	5.8
Seeks cover, initiates fire	33	47.6	28.3	25	47.9	26.5	5	28.6	28.8	3	76.7	23.1
Goes prone, observes	33	4.9	7.2	25	4.9	7.1	5	7.6	9.3	3	0.0	0.0
Goes prone, initiates fire	33	20.6	19.7	25	21.4	20.2	5	17.0	17.2	3	20.0	26.5
Stands, freezes	33	2.4	6.1	25	3.1	6.9	5	0.2	0.4	3	0.0	0.0
Drops, freezes	33	1.2	2.8	25	1.4	3.1	5	0.6	1.3	3	0.0	0.0
Hands up in surrender	33	2.0	7.1	25	2.1	8.0	5	2.8	4.4	3	0.0	0.0
Runs away	33	3.4	7.7	25	4.0	8.6	5	2.6	4.3	3	0.0	0.0
5. Troops fire towards CCH/N.												
Seeks cover, observes	33	6.4	12.9	25	3.7	7.8	5	23.8	22.5	3	0.0	0.0
Seeks cover, returns fire	33	66.7	26.5	25	67.9	25.9	5	50.8	25.6	3	83.3	28.9
Goes prone, observes	33	2.5	5.3	25	2.3	4.9	5	4.9	8.5	3	0.0	0.0
Goes prone, returns fire	33	20.0	17.9	25	20.7	16.8	5	18.4	21.0	3	16.7	28.9
Stands, freezes	33	1.1	2.6	25	1.4	2.9	5	0.4	0.9	3	0.0	0.0
Drops, freezes	33	1.5	3.1	25	1.5	3.0	5	2.4	4.3	3	0.0	0.0
Hands up in surrender	33	0.4	1.2	25	0.5	1.3	5	0.4	0.9	3	0.0	0.0
Runs away	33	1.7	4.6	25	2.1	5.2	5	0.4	0.9	3	0.0	0.0

Modeling Hostiles and Neutrals: Standard Elite Troops

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
6. CCH/N responds to being wounded by rifle fire.												
Continues effective fire	33	41.1	28.3	25	42.0	29.2	5	26.2	16.6	3	58.3	32.5
Tries to return fire	33	35.9	23.3	25	34.8	23.4	5	54.8	15.0	3	13.3	5.8
Drops, freezes	33	7.7	10.0	25	7.2	9.9	5	9.0	7.4	3	10.0	17.3
Hands up in surrender	33	3.5	6.3	25	3.9	6.9	5	1.0	2.2	3	5.0	5.0
Tries to run/crawl away	33	11.8	13.1	25	12.1	13.8	5	9.0	10.2	3	13.3	15.3
CCH/N Characteristics												
Awareness of surroundings												
Excellent	32	74.3	27.7	24	71.6	29.0	5	76.0	27.9	3	93.3	5.8
Good to very good	32	20.3	24.9	24	22.3	26.5	5	18.8	24.2	3	6.7	5.8
Average	32	4.6	7.8	24	5.4	8.7	5	3.6	4.2	3	0.0	0.0
Poor to very poor	32	0.8	1.8	24	0.8	1.7	5	1.6	2.3	3	0.0	0.0
Courage, little fear of danger												
Very high	33	55.0	32.7	25	61.0	29.0	5	24.7	31.1	3	55.0	48.2
High	33	26.7	24.5	25	21.9	20.3	5	42.9	27.8	3	40.0	43.6
Average	33	14.9	21.9	25	15.1	24.2	5	20.0	14.2	3	5.0	5.0
Low to very low	33	3.4	8.9	25	2.0	3.5	5	12.4	21.0	3	0.0	0.0
Judgment of risk												
Very good	33	65.4	29.0	25	68.7	25.1	5	51.9	35.0	3	60.0	52.9
Good	33	24.1	22.9	25	21.8	22.4	5	32.0	19.2	3	30.0	36.1
Average	33	8.6	8.5	25	7.3	6.8	5	14.4	9.3	3	10.0	17.3
Poor to very poor	33	2.6	4.5	25	2.2	3.5	5	5.7	8.3	3	0.0	0.0
Resolve/determination												
Very high	30	75.5	17.9	22	75.0	18.2	5	74.0	20.7	3	81.7	16.1
High	30	15.8	10.8	22	15.7	10.4	5	17.0	14.0	3	15.0	13.2
Average	30	6.6	7.9	22	7.0	8.3	5	7.0	8.4	3	3.3	5.8
Low to very low	30	2.1	3.6	22	2.5	3.6	5	2.0	4.5	3	0.0	0.0
Tactical skills												
Excellent	33	73.8	26.1	25	76.8	23.1	5	49.0	34.4	3	90.0	10.0
Good to very good	33	20.5	22.9	25	17.7	19.9	5	43.0	31.5	3	6.7	5.8
Average	33	4.3	6.2	25	3.9	6.6	5	7.0	4.5	3	3.3	5.8
Poor to very poor	33	1.2	2.7	25	1.4	3.0	5	1.0	2.2	3	0.0	0.0
Marksmanship												
Excellent	33	67.3	26.4	25	70.1	20.5	5	54.4	40.9	3	65.0	47.7
Good to very good	33	24.3	22.9	25	19.9	14.1	5	39.7	37.0	3	35.0	47.7
Average	33	7.1	10.0	25	8.3	11.0	5	5.3	4.6	3	0.0	0.0
Poor to very poor	33	1.4	2.8	25	1.7	3.1	5	0.8	1.3	3	0.0	0.0
Determination/aggressiveness												
Very high	32	72.4	24.1	24	75.3	20.2	5	48.0	32.7	3	90.0	10.0
High	32	19.4	17.1	24	17.5	14.3	5	34.0	26.3	3	10.0	10.0
Average	32	6.7	10.4	24	5.8	7.4	5	15.0	20.0	3	0.0	0.0
Low to very low	32	1.5	3.6	24	1.3	3.0	5	3.0	6.7	3	0.0	0.0

Appendix C,
MODELING HOSTILES AND NEUTRALS: AVERAGE IRREGULARS

Modeling Hostiles and Neutrals: Average Irregular Troops

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
CCH/N Behaviors												
1. CCH/N can be seen by Troops, but does not yet observe Troops are present.												
Running	33	10.7	12.5	25	10.4	11.2	5	17.0	19.9	3	3.3	5.8
Purposeful movement	33	29.2	27.9	25	31.5	27.8	5	15.0	10.0	3	33.3	49.3
Hesitant movement	33	24.5	23.1	25	23.2	21.7	5	20.0	11.7	3	43.3	45.1
Evasive movement	33	29.5	22.2	25	27.9	19.9	5	43.0	33.3	3	20.0	17.3
Crawling	33	6.4	11.0	25	7.4	12.3	5	5.0	5.0	3	0.0	0.0
2. CCH/N observes Troops' presence.												
Continues as before	32	5.2	9.8	24	6.5	11.1	5	1.5	2.2	3	1.7	2.9
Seeks cover, observes	32	21.2	21.6	24	16.9	14.1	5	39.8	37.6	3	25.0	31.2
Seeks cover, initiates fire	32	24.1	14.4	24	25.0	14.5	5	16.3	15.7	3	30.0	8.7
Goes prone, observes	32	9.9	10.5	24	10.0	11.2	5	13.4	8.8	3	3.3	5.8
Goes prone, initiates fire	32	17.7	15.3	24	16.8	11.4	5	12.6	10.3	3	33.3	38.2
Stands, freezes	32	7.1	9.0	24	8.3	10.0	5	3.5	2.8	3	3.3	5.8
Drops, freezes	32	5.9	7.5	24	7.1	8.1	5	2.0	2.7	3	3.3	5.8
Hands up in surrender	32	3.2	4.7	24	3.5	5.0	5	2.7	4.1	3	1.7	2.9
Runs away	32	5.2	6.4	24	5.0	6.6	5	8.3	6.1	3	1.7	2.9
3. Troops command CCH/N to stop.												
Continues as before	33	5.7	12.0	25	6.3	13.2	5	5.9	8.9	3	0.0	0.0
Seeks cover, observes	33	9.9	9.5	25	10.1	10.0	5	12.8	8.1	3	3.3	5.8
Seeks cover, initiates fire	33	30.9	21.4	25	29.0	18.5	5	41.0	28.3	3	30.0	36.1
Goes prone, observes	33	8.5	10.3	25	9.2	11.1	5	6.6	6.5	3	6.7	11.5
Goes prone, initiates fire	33	20.3	18.9	25	18.8	15.6	5	16.2	10.1	3	40.0	43.6
Stands, freezes	33	8.7	11.2	25	10.1	12.2	5	5.1	5.9	3	3.3	5.8
Drops, freezes	33	3.6	5.5	25	3.6	5.9	5	1.7	2.1	3	6.7	5.8
Hands up in surrender	33	6.0	7.6	25	5.4	7.0	5	7.5	10.3	3	8.3	10.4
Runs away	33	6.3	11.4	25	7.4	12.8	5	3.2	4.3	3	1.7	2.9
4. Troops aim rifles in direction of CCH/N.												
Continues as before	33	3.1	9.1	25	1.5	3.6	5	13.0	21.1	3	0.0	0.0
Seeks cover, observes	33	10.6	10.7	25	11.3	11.4	5	12.4	7.9	3	1.7	2.9
Seeks cover, initiates fire	33	35.0	24.6	25	37.0	26.4	5	32.9	15.7	3	21.7	22.5
Goes prone, observes	33	9.3	16.3	25	7.7	11.4	5	5.7	6.3	3	28.3	44.8
Goes prone, initiates fire	33	23.7	18.8	25	22.9	19.3	5	19.1	9.0	3	38.3	25.7
Stands, freezes	33	5.2	7.9	25	5.6	8.3	5	6.2	8.0	3	0.0	0.0
Drops, freezes	33	2.2	3.7	25	2.5	4.1	5	1.7	2.0	3	0.0	0.0
Hands up in surrender	33	4.9	9.5	25	5.6	10.7	5	4.2	4.0	3	0.0	0.0
Runs away	33	6.7	10.1	25	6.6	11.1	5	5.2	3.7	3	10.0	10.0
5. Troops fire towards CCH/N.												
Seeks cover, observes	33	6.5	9.3	25	5.0	7.8	5	16.6	12.6	3	1.7	2.9
Seeks cover, returns fire	33	48.7	25.0	25	47.4	25.1	5	40.9	18.9	3	73.3	24.7
Goes prone, observes	33	3.3	4.8	25	3.1	4.7	5	4.9	6.1	3	1.7	2.9
Goes prone, returns fire	33	28.2	18.3	25	29.2	19.3	5	26.0	14.7	3	23.3	18.9
Stands, freezes	33	2.2	3.7	25	2.6	4.1	5	1.5	2.1	3	0.0	0.0
Drops, freezes	33	2.3	3.5	25	2.4	3.5	5	3.5	4.1	3	0.0	0.0
Hands up in surrender	33	3.6	5.6	25	4.2	6.2	5	2.8	2.3	3	0.0	0.0
Runs away	33	5.2	7.5	25	6.2	8.3	5	3.5	2.8	3	0.0	0.0

Modeling Hostiles and Neutrals: Average Irregular Troops

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
6. CCH/N responds to being wounded by rifle fire.												
Continues effective fire	33	22.1	21.9	25	24.2	23.9	5	12.5	7.0	3	20.0	20.0
Tries to return fire	33	32.4	20.7	25	30.1	19.5	5	38.9	18.9	3	40.0	36.1
Drops, freezes	33	17.9	18.6	25	18.7	20.7	5	16.5	8.9	3	13.3	15.3
Hands up in surrender	33	9.8	8.1	25	9.6	8.9	5	11.6	6.8	3	8.3	2.9
Tries to run/crawl away	33	17.6	14.2	25	17.4	15.6	5	20.4	8.2	3	15.0	13.2
CCH/N Characteristics												
Awareness of surroundings												
Excellent	31	43.1	28.3	23	43.7	25.9	5	48.0	34.9	3	30.0	43.6
Good to very good	31	28.0	23.7	23	26.4	21.6	5	18.0	8.4	3	56.7	40.4
Average	31	21.4	22.2	23	21.2	22.9	5	27.0	26.8	3	13.3	5.8
Poor to very poor	31	7.3	10.0	23	8.3	10.7	5	7.0	8.4	3	0.0	0.0
Courage, little fear of danger												
Very high	33	35.6	26.8	25	41.2	26.2	5	19.2	20.5	3	16.7	28.9
High	33	33.8	25.3	25	31.6	24.9	5	34.3	26.6	3	51.7	28.4
Average	33	19.9	12.7	25	17.8	11.3	5	27.4	20.0	3	25.0	5.0
Low to very low	33	10.6	12.0	25	9.4	9.4	5	19.1	22.3	3	6.7	5.8
Judgment of risk												
Very good	33	38.5	27.7	25	40.9	26.4	5	33.8	27.1	3	26.7	46.2
Good	33	30.0	19.1	25	31.5	19.4	5	28.2	19.3	3	20.0	20.0
Average	33	22.7	20.0	25	19.5	16.3	5	26.4	19.8	3	43.3	40.4
Poor to very poor	33	8.2	8.0	25	7.3	8.1	5	11.7	7.5	3	10.0	10.0
Resolve/determination												
Very high	30	38.2	26.8	22	38.0	25.9	5	40.0	23.5	3	36.7	47.3
High	30	35.2	22.8	22	34.3	23.8	5	40.0	23.5	3	33.3	20.8
Average	30	19.5	18.7	22	19.1	18.6	5	15.0	15.8	3	30.0	26.5
Low to very low	30	6.8	11.3	22	8.2	12.8	5	5.0	5.0	3	0.0	0.0
Tactical skills												
Excellent	33	39.8	29.5	25	42.4	27.9	5	33.0	34.2	3	30.0	43.6
Good to very good	33	23.6	20.9	25	24.0	22.8	5	28.0	13.0	3	13.3	15.3
Average	33	25.6	21.2	25	25.0	22.0	5	31.0	23.0	3	21.7	16.1
Poor to very poor	33	11.2	18.5	25	9.0	14.0	5	8.0	10.4	3	35.0	44.4
Marksmanship												
Excellent	33	36.1	28.3	25	38.4	27.8	5	31.0	29.2	3	25.0	39.1
Good to very good	33	23.6	15.3	25	23.2	14.6	5	31.0	19.5	3	15.0	13.2
Average	33	28.6	19.5	25	29.2	20.3	5	28.0	17.9	3	25.0	21.8
Poor to very poor	33	12.0	17.2	25	9.6	11.5	5	10.0	12.2	3	35.0	44.4
Determination/aggressiveness												
Very high	32	40.0	28.6	24	42.9	26.9	5	30.0	27.4	3	33.3	49.3
High	32	27.8	21.4	24	26.0	19.3	5	34.0	20.7	3	31.7	41.9
Average	32	22.6	18.5	24	20.5	13.2	5	26.0	18.2	3	33.3	49.1
Low to very low	32	9.0	12.9	24	9.7	14.4	5	10.0	7.1	3	1.7	2.9

Appendix D,
MODELING HOSTILES AND NEUTRALS: ISOLATED CRIMINALS

Modeling Hostiles and Neutrals: Isolated Criminals

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
CCH/N Behaviors												
1. CCH/N can be seen by Troops, but does not yet observe Troops are present.												
Running	35	22.9	25.0	25	22.1	23.1	5	36.0	31.3	5	14.0	28.6
Purposeful movement	35	15.5	21.2	25	16.8	18.6	5	3.0	4.5	5	21.0	38.8
Hesitant movement	35	30.0	24.0	25	27.5	21.2	5	32.0	19.6	5	41.0	40.4
Evasive movement	35	29.4	24.3	25	31.4	24.9	5	26.0	17.1	5	22.6	30.1
Crawling	35	1.6	3.1	25	1.4	3.1	5	3.0	4.5	5	1.4	2.2
2. CCH/N observes Troops' presence.												
Continues as before	35	8.5	10.4	25	10.2	11.3	5	7.1	7.6	5	1.4	2.2
Seeks cover, observes	35	17.2	18.5	25	17.6	16.4	5	18.4	29.1	5	14.0	20.7
Seeks cover, initiates fire	35	7.0	12.1	25	7.5	13.5	5	8.7	10.2	5	2.6	4.3
Goes prone, observes	35	5.2	9.3	25	5.9	10.8	5	5.6	4.1	5	1.2	2.2
Goes prone, initiates fire	35	5.9	8.5	25	6.0	8.6	5	10.4	10.6	5	1.2	2.2
Stands, freezes	35	11.3	18.0	25	9.0	12.9	5	6.3	4.1	5	28.0	36.5
Drops, freezes	35	7.7	12.5	25	7.9	14.2	5	6.0	7.0	5	8.0	8.4
Hands up in surrender	35	10.8	12.8	25	10.2	14.0	5	8.5	7.6	5	16.0	10.8
Runs away	35	26.1	21.0	25	25.2	18.2	5	28.9	26.4	5	27.6	32.1
3. Troops command CCH/N to stop.												
Continues as before	34	6.6	10.6	24	5.2	8.0	5	8.9	6.3	5	11.0	21.9
Seeks cover, observes	34	8.4	11.3	24	9.1	12.8	5	9.3	5.7	5	4.0	6.5
Seeks cover, initiates fire	34	14.5	25.4	24	13.3	25.1	5	31.3	34.3	5	4.0	4.2
Goes prone, observes	34	3.1	5.8	24	2.5	5.8	5	5.6	7.3	5	3.0	4.5
Goes prone, initiates fire	34	5.7	9.1	24	4.6	8.5	5	15.4	10.8	5	1.0	2.2
Stands, freezes	34	13.6	16.3	24	15.5	17.0	5	5.3	4.6	5	13.0	19.9
Drops, freezes	34	5.0	8.1	24	6.2	9.3	5	2.9	3.1	5	1.0	2.2
Hands up in surrender	34	17.0	23.5	24	16.0	17.8	5	1.7	2.0	5	37.0	44.0
Runs away	34	26.3	29.2	24	27.8	28.9	5	19.6	28.7	5	26.0	36.3
4. Troops aim rifles in direction of CCH/N.												
Continues as before	35	4.0	6.8	25	3.6	6.5	5	9.0	9.6	5	0.8	1.8
Seeks cover, observes	35	6.1	9.3	25	5.6	9.1	5	8.2	8.1	5	6.8	13.1
Seeks cover, initiates fire	35	14.9	20.4	25	15.0	20.6	5	24.3	27.0	5	4.8	5.0
Goes prone, observes	35	5.1	12.9	25	5.2	14.6	5	3.5	4.2	5	5.8	10.9
Goes prone, initiates fire	35	8.8	12.6	25	9.3	14.1	5	10.3	10.4	5	4.8	5.0
Stands, freezes	35	13.3	15.7	25	15.3	16.5	5	7.0	7.6	5	10.0	17.3
Drops, freezes	35	7.6	9.6	25	9.2	10.6	5	2.7	2.5	5	4.2	6.9
Hands up in surrender	35	21.9	24.7	25	19.7	20.3	5	11.3	12.1	5	43.2	42.8
Runs away	35	18.0	18.4	25	16.5	16.8	5	23.8	17.8	5	19.6	28.3
5. Troops fire towards CCH/N.												
Seeks cover, observes	35	4.2	7.3	25	2.7	4.4	5	10.5	14.2	5	5.0	8.7
Seeks cover, returns fire	35	20.0	24.8	25	16.5	23.1	5	34.3	30.2	5	23.0	27.7
Goes prone, observes	35	1.9	3.4	25	1.8	3.8	5	3.1	2.8	5	1.0	2.2
Goes prone, returns fire	35	12.9	17.7	25	14.0	20.5	5	12.2	5.8	5	8.0	7.6
Stands, freezes	35	5.1	9.1	25	3.9	7.4	5	5.1	5.2	5	11.0	17.5
Drops, freezes	35	7.2	11.8	25	7.8	13.2	5	6.4	6.7	5	5.0	8.7
Hands up in surrender	35	18.8	21.2	25	15.9	15.5	5	19.0	34.3	5	33.0	29.9
Runs away	35	30.3	29.0	25	37.6	31.1	5	9.9	9.4	5	14.0	8.2

Modeling Hostiles and Neutrals: Isolated Criminals

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
6. CCH/N responds to being wounded by rifle fire.												
Continues effective fire	34	7.1	11.2	25	7.8	12.6	5	6.4	6.8	4	5.0	4.1
Tries to return fire	34	18.4	17.5	25	17.6	16.7	5	28.9	24.1	4	10.0	9.1
Drops, freezes	34	16.7	16.8	25	18.8	17.8	5	10.4	10.6	4	11.3	16.0
Hands up in surrender	34	29.7	22.0	25	26.2	19.2	5	33.1	27.8	4	47.5	27.8
Tries to run/crawl away	34	28.1	21.1	25	29.6	23.2	5	23.3	13.2	4	25.0	16.8
CCH/N Characteristics												
Awareness of surroundings												
Excellent	33	36.9	33.2	23	32.7	29.2	5	50.0	32.2	5	43.0	52.4
Good to very good	33	25.6	22.7	23	31.8	23.4	5	20.0	12.7	5	3.0	6.7
Average	33	21.8	18.0	23	21.5	16.5	5	15.0	12.2	5	30.0	28.3
Poor to very poor	33	15.4	18.8	23	13.7	15.0	5	15.0	30.8	5	24.0	23.0
Courage, little fear of danger												
Very high	35	26.3	24.8	25	29.2	20.5	5	16.4	24.6	5	22.0	43.8
High	35	19.8	15.7	25	21.2	13.3	5	27.7	25.3	5	5.0	7.1
Average	35	31.8	21.4	25	33.0	21.0	5	25.8	15.5	5	32.0	30.5
Low to very low	35	22.0	22.8	25	17.0	14.7	5	28.1	30.5	5	41.0	39.3
Judgment of risk												
Very good	35	38.9	30.7	25	36.8	28.1	5	25.1	29.2	5	63.0	37.7
Good	35	23.6	17.8	25	25.6	18.3	5	27.5	17.7	5	10.0	10.0
Average	35	20.6	18.5	25	23.6	19.6	5	22.2	13.2	5	4.0	5.5
Poor to very poor	35	16.9	22.8	25	14.0	16.5	5	25.2	34.1	5	23.0	38.0
Resolve/determination												
Very high	32	33.9	30.4	22	30.2	29.1	5	48.0	31.1	5	36.0	37.8
High	32	19.8	13.8	22	22.3	14.6	5	19.0	12.4	5	10.0	7.1
Average	32	24.4	22.6	22	30.7	24.3	5	13.0	8.4	5	8.0	8.4
Low to very low	32	22.5	26.9	22	17.3	19.1	5	22.0	32.9	5	46.0	42.2
Tactical skills												
Excellent	35	18.6	22.6	25	18.2	20.5	5	24.0	28.8	5	15.0	30.8
Good to very good	35	21.0	20.8	25	23.8	21.6	5	21.0	23.6	5	7.0	6.7
Average	35	36.4	27.4	25	35.4	23.9	5	40.0	31.6	5	38.0	43.8
Poor to very poor	35	23.9	25.2	25	22.4	22.7	5	15.0	17.3	5	40.0	39.4
Marksmanship												
Excellent	35	16.8	21.4	25	17.4	21.0	5	15.0	17.3	5	16.0	30.5
Good to very good	35	19.7	18.3	25	17.9	17.3	5	32.0	20.2	5	16.0	20.7
Average	35	33.8	24.1	25	35.4	22.8	5	29.0	7.4	5	31.0	41.6
Poor to very poor	35	29.9	26.6	25	30.1	23.6	5	22.0	26.6	5	37.0	42.7
Determination/aggressiveness												
Very high	33	25.5	22.9	24	26.0	22.7	5	28.0	23.9	4	18.8	27.8
High	33	21.6	16.2	24	20.8	12.3	5	36.0	27.0	4	8.8	8.5
Average	33	27.0	18.7	24	27.6	15.3	5	26.0	20.7	4	25.0	36.7
Low to very low	33	25.5	26.4	24	25.0	21.9	5	10.0	14.1	4	47.5	49.4

Appendix E,
ING HOSTILES AND NEUTRALS: FRIGHTENED CIVILIANS

Modeling Hostiles and Neutrals: Frightened Civilians

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
CCH/N Behaviors												
1. CCH/N can be seen by Troops, but does not yet observe Troops are present.												
Running	35	46.2	31.8	25	45.5	32.6	5	61.0	22.5	5	35.0	36.1
Purposeful movement	35	6.5	8.2	25	6.7	8.4	5	7.0	8.4	5	5.0	8.7
Hesitant movement	35	35.1	26.5	25	33.2	23.8	5	28.0	32.1	5	52.0	32.7
Evasive movement	35	8.7	10.5	25	10.6	11.7	5	2.0	2.7	5	6.0	5.5
Crawling	35	3.9	9.0	25	4.4	10.3	5	3.0	4.5	5	2.0	4.5
2. CCH/N observes Troops' presence.												
Continues as before	35	8.0	13.2	25	9.2	14.7	5	4.7	4.6	5	5.2	11.1
Seeks cover, observes	35	5.4	9.2	25	5.1	9.8	5	10.2	9.4	5	2.2	4.4
Seeks cover, initiates fire	35	0.9	2.9	25	0.5	1.4	5	3.8	6.8	5	0.0	0.0
Goes prone, observes	35	2.5	5.9	25	2.9	6.7	5	1.1	1.7	5	2.2	4.4
Goes prone, initiates fire	35	1.3	4.3	25	0.6	1.5	5	6.6	10.3	5	0.0	0.0
Stands, freezes	35	17.0	21.0	25	12.8	16.9	5	16.3	11.6	5	39.0	34.4
Drops, freezes	35	4.2	7.6	25	2.9	6.6	5	7.3	8.6	5	8.0	11.0
Hands up in surrender	35	18.6	19.6	25	19.7	17.6	5	13.9	12.5	5	17.8	34.8
Runs away	35	41.9	28.4	25	46.4	27.9	5	36.1	25.2	5	25.6	32.2
3. Troops command CCH/N to stop.												
Continues as before	35	6.2	10.6	25	5.3	10.7	5	9.7	8.9	5	7.0	13.0
Seeks cover, observes	35	3.0	5.3	25	3.0	5.7	5	1.9	3.6	5	4.0	5.5
Seeks cover, initiates fire	35	0.7	2.1	25	0.8	2.2	5	1.0	2.3	5	0.0	0.0
Goes prone, observes	35	3.8	11.6	25	3.6	12.1	5	1.0	2.3	5	8.0	15.2
Goes prone, initiates fire	35	1.1	5.1	25	1.4	6.0	5	0.6	1.4	5	0.0	0.0
Stands, freezes	35	27.4	29.1	25	29.6	32.1	5	28.9	24.2	5	15.0	14.1
Drops, freezes	35	6.7	9.4	25	6.6	9.6	5	11.7	11.2	5	2.0	4.5
Hands up in surrender	35	34.1	28.1	25	30.9	24.0	5	32.3	27.5	5	52.0	45.1
Runs away	35	17.3	15.6	25	19.2	17.2	5	12.9	6.7	5	12.0	12.5
4. Troops aim rifles in direction of CCH/N.												
Continues as before	34	5.1	13.1	25	2.2	5.4	5	17.5	30.3	4	7.5	9.6
Seeks cover, observes	34	2.9	8.8	25	3.5	10.1	5	0.2	0.4	4	2.5	2.9
Seeks cover, initiates fire	34	1.2	3.7	25	1.4	4.2	5	0.2	0.4	4	1.3	2.5
Goes prone, observes	34	1.8	3.7	25	1.8	3.8	5	0.2	0.4	4	3.8	4.8
Goes prone, initiates fire	34	1.4	3.9	25	1.7	4.5	5	0.2	0.4	4	1.3	2.5
Stands, freezes	34	19.5	19.7	25	20.2	21.8	5	17.3	11.3	4	17.5	17.1
Drops, freezes	34	8.3	12.3	25	8.4	12.9	5	10.7	14.1	4	5.0	5.8
Hands up in surrender	34	40.7	27.5	25	38.2	25.6	5	42.7	32.6	4	53.8	36.8
Runs away	34	19.3	22.5	25	22.8	25.2	5	10.9	8.8	4	7.5	2.9
5. Troops fire towards CCH/N.												
Seeks cover, observes	34	6.3	15.3	25	5.3	11.8	5	2.0	4.5	4	17.5	35.0
Seeks cover, returns fire	34	1.2	3.9	25	1.2	4.1	5	2.0	4.5	4	0.0	0.0
Goes prone, observes	34	2.0	3.5	25	1.7	3.1	5	3.0	4.5	4	2.5	5.0
Goes prone, returns fire	34	1.6	5.0	25	1.3	4.4	5	4.0	8.9	4	0.0	0.0
Stands, freezes	34	10.5	14.2	25	8.1	11.3	5	17.0	12.0	4	17.5	28.4
Drops, freezes	34	20.7	25.8	25	23.9	28.7	5	14.0	11.4	4	8.8	14.4
Hands up in surrender	34	23.8	26.5	25	20.5	24.3	5	34.0	20.4	4	31.3	45.9
Runs away	34	34.5	29.3	25	38.1	29.2	5	24.0	16.4	4	25.0	43.6

Modeling Hostiles and Neutrals: Frightened Civilians

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
6. CCH/N responds to being wounded by rifle fire.												
Continues effective fire	34	1.2	3.9	25	1.5	4.5	5	1.0	2.2	4	0.0	0.0
Tries to return fire	34	1.7	3.8	25	1.5	3.6	5	4.0	5.5	4	0.0	0.0
Drops, freezes	34	25.9	25.4	25	22.4	25.6	5	38.3	25.6	4	32.5	23.6
Hands up in surrender	34	46.1	27.0	25	45.8	29.3	5	39.3	14.2	4	56.3	26.3
Tries to run/crawl away	34	25.1	20.4	25	28.9	21.6	5	17.5	12.5	4	11.3	13.1
CCH/N Characteristics												
Awareness of surroundings												
Excellent	33	17.7	24.8	23	22.4	26.0	5	13.0	26.4	5	1.0	2.2
Good to very good	33	21.2	19.3	23	22.6	15.8	5	8.0	7.6	5	28.0	35.6
Average	33	24.5	19.2	23	23.5	17.9	5	26.0	21.9	5	28.0	25.9
Poor to very poor	33	36.2	35.3	23	31.5	34.1	5	53.0	30.7	5	41.0	46.4
Courage, little fear of danger												
Very high	35	6.5	17.7	25	8.6	20.6	5	1.2	2.7	5	1.0	2.2
High	35	4.6	7.7	25	5.6	8.5	5	2.4	5.4	5	2.0	4.5
Average	35	24.2	24.3	25	25.8	25.3	5	18.1	11.0	5	22.0	31.3
Low to very low	35	64.8	31.4	25	60.0	33.0	5	78.3	17.3	5	75.0	32.4
Judgment of risk												
Very good	35	16.5	28.1	25	18.0	27.2	5	4.3	9.6	5	21.0	44.2
Good	35	13.0	14.4	25	16.2	14.9	5	7.7	12.4	5	2.0	4.5
Average	35	26.4	22.1	25	26.2	21.0	5	36.3	24.0	5	18.0	26.8
Poor to very poor	35	44.2	35.3	25	39.8	34.7	5	51.7	33.1	5	59.0	42.5
Resolve/determination												
Very high	32	10.8	17.5	22	12.5	19.1	5	12.0	17.9	5	2.0	4.5
High	32	8.9	9.8	22	9.1	8.7	5	15.0	15.0	5	2.0	4.5
Average	32	31.4	28.7	22	33.2	28.8	5	29.0	13.4	5	26.0	42.2
Low to very low	32	49.1	35.1	22	45.5	34.5	5	44.0	29.5	5	70.0	42.4
Tactical skills												
Excellent	34	2.7	7.4	25	1.8	3.8	5	8.0	17.9	4	1.3	2.5
Good to very good	34	4.6	7.6	25	4.3	6.8	5	8.0	13.0	4	2.5	2.9
Average	34	17.0	17.7	25	18.5	18.5	5	19.0	18.8	4	5.0	4.1
Poor to very poor	34	76.0	24.6	25	75.8	23.4	5	65.0	36.1	4	91.3	6.3
Marksmanship												
Excellent	33	3.7	9.3	24	4.8	10.7	5	0.4	0.9	4	1.3	2.5
Good to very good	33	9.0	12.9	24	11.1	14.2	5	5.0	8.7	4	1.3	2.5
Average	33	23.1	20.1	24	24.5	19.9	5	23.0	21.7	4	15.0	23.5
Poor to very poor	33	64.3	30.4	24	59.8	31.4	5	71.6	29.2	4	82.5	22.5
Determination/aggressiveness												
Very high	33	4.1	9.3	24	4.8	10.6	5	2.0	4.5	4	2.5	5.0
High	33	8.0	14.0	24	8.5	15.7	5	8.0	11.0	4	5.0	5.8
Average	33	23.0	24.5	24	19.4	18.6	5	23.0	22.8	4	45.0	48.0
Low to very low	33	64.6	32.7	24	67.0	30.8	5	67.0	34.6	4	47.5	45.7

Appendix F,
MODELING HOSTILES AND NEUTRALS: UNFRIENDLY CIVILIANS

Modeling Hostiles and Neutrals: Unfriendly Civilians

	Total Group			Military: Saw Comba			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
CCH/N Behaviors												
1. CCH/N can be seen by Troops, but does not yet observe Troops are present.												
Running	35	24.6	25.7	25	22.1	22.5	5	53.0	32.3	5	9.0	13.4
Purposeful movement	35	21.1	23.9	25	19.9	21.4	5	5.0	6.1	5	43.0	33.8
Hesitant movement	35	21.5	23.4	25	22.0	20.7	5	19.0	24.1	5	22.0	38.5
Evasive movement	35	27.4	21.2	25	29.4	21.0	5	21.0	28.4	5	24.0	16.7
Crawling	35	5.3	9.6	25	6.7	10.9	5	2.0	2.7	5	2.0	4.5
2. CCH/N observes Troops' presence.												
Continues as before	35	21.6	24.8	25	18.9	22.4	5	15.1	15.7	5	41.0	37.5
Seeks cover, observes	35	16.3	22.6	25	14.5	22.8	5	27.7	27.0	5	14.0	17.8
Seeks cover, initiates fire	35	4.0	6.5	25	4.6	7.2	5	4.2	5.8	5	0.8	1.1
Goes prone, observes	35	5.5	11.1	25	5.6	11.9	5	9.0	12.3	5	1.6	3.6
Goes prone, initiates fire	35	3.0	5.6	25	2.1	3.2	5	5.2	8.3	5	5.4	11.0
Stands, freezes	35	13.1	19.4	25	15.9	22.1	5	9.9	6.8	5	2.2	3.5
Drops, freezes	35	4.7	8.5	25	4.1	8.5	5	4.2	6.2	5	8.0	11.5
Hands up in surrender	35	7.7	11.5	25	7.7	12.4	5	5.9	8.3	5	9.0	10.8
Runs away	35	23.5	19.7	25	25.6	22.5	5	18.7	5.3	5	18.0	12.5
3. Troops command CCH/N to stop.												
Continues as before	35	11.6	14.3	25	10.9	14.7	5	13.0	4.1	5	14.0	20.4
Seeks cover, observes	35	7.0	11.6	25	7.2	13.2	5	5.8	4.9	5	7.0	8.4
Seeks cover, initiates fire	35	9.1	13.9	25	10.9	15.6	5	8.0	8.0	5	1.2	2.2
Goes prone, observes	35	6.3	12.4	25	8.0	14.3	5	2.8	3.0	5	1.2	2.2
Goes prone, initiates fire	35	4.7	7.6	25	5.1	8.5	5	5.0	6.2	5	2.2	2.6
Stands, freezes	35	14.3	17.3	25	15.6	17.0	5	20.8	22.8	5	1.4	2.2
Drops, freezes	35	6.9	10.5	25	7.9	11.8	5	7.4	7.7	5	1.4	2.2
Hands up in surrender	35	14.8	21.1	25	10.4	10.9	5	15.5	19.8	5	36.6	44.5
Runs away	35	25.3	22.8	25	24.0	23.6	5	21.6	11.0	5	35.0	28.3
4. Troops aim rifles in direction of CCH/N.												
Continues as before	35	6.7	10.3	25	5.3	7.6	5	14.2	21.1	5	6.0	5.5
Seeks cover, observes	35	6.6	10.2	25	6.0	10.4	5	5.3	4.7	5	11.0	13.4
Seeks cover, initiates fire	35	11.5	17.0	25	14.1	19.2	5	8.2	9.3	5	2.0	2.7
Goes prone, observes	35	3.4	5.9	25	3.5	6.6	5	3.5	4.2	5	3.0	4.5
Goes prone, initiates fire	35	6.5	9.2	25	6.7	10.0	5	9.2	9.1	5	3.0	2.7
Stands, freezes	35	16.5	17.2	25	17.8	18.4	5	16.5	11.1	5	10.0	17.3
Drops, freezes	35	4.4	6.2	25	4.8	6.8	5	2.8	2.6	5	4.0	5.5
Hands up in surrender	35	20.2	24.3	25	15.6	18.3	5	18.2	13.5	5	45.0	43.6
Runs away	35	24.2	21.4	25	26.2	22.1	5	22.1	21.9	5	16.0	19.2
5. Troops fire towards CCH/N.												
Seeks cover, observes	35	4.7	10.2	25	3.0	5.9	5	7.5	10.6	5	10.0	22.4
Seeks cover, returns fire	35	12.4	16.5	25	12.9	16.0	5	8.3	9.6	5	14.0	25.8
Goes prone, observes	35	3.4	4.7	25	3.0	4.2	5	5.1	7.0	5	4.0	5.5
Goes prone, returns fire	35	11.8	15.7	25	14.1	17.6	5	6.4	6.9	5	6.0	8.2
Stands, freezes	35	7.2	8.8	25	7.8	10.0	5	7.1	4.4	5	4.0	5.5
Drops, freezes	35	10.9	12.6	25	13.2	13.9	5	8.4	4.8	5	2.0	4.5
Hands up in surrender	35	21.0	24.2	25	15.4	16.7	5	32.3	26.7	5	38.0	43.5
Runs away	35	28.6	22.4	25	30.6	22.5	5	24.9	6.1	5	22.0	32.7

Modeling Hostiles and Neutrals: Unfriendly Civilians

	Total Group			Military: Saw Combat			Military: No Combat			Civilians		
	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev	No.	Av, %	Std Dev
6. CCH/N responds to being wounded by rifle fire.												
Continues effective fire	34	4.5	8.1	25	4.7	8.7	5	2.0	2.7	4	6.3	9.5
Tries to return fire	34	16.0	15.8	25	17.7	16.4	5	13.7	14.1	4	8.8	14.4
Drops, freezes	34	18.8	17.2	25	17.4	17.6	5	22.5	9.7	4	22.5	24.0
Hands up in surrender	34	30.3	22.0	25	26.6	20.9	5	33.9	15.6	4	48.8	30.9
Tries to run/crawl away	34	30.1	20.2	25	33.2	22.1	5	27.8	7.5	4	13.8	7.5
CCH/N Characteristics												
Awareness of surroundings												
Excellent	33	25.3	28.1	23	26.1	26.9	5	15.0	25.5	5	32.0	38.3
Good to very good	33	25.2	20.3	23	26.5	15.8	5	11.0	5.5	5	33.0	39.3
Average	33	31.8	24.5	23	30.7	24.1	5	51.0	21.3	5	18.0	20.8
Poor to very poor	33	17.4	20.1	23	16.3	19.2	5	23.0	9.7	5	17.0	32.7
Courage, little fear of danger												
Very high	35	13.5	18.8	25	16.0	19.9	5	5.3	8.7	5	9.0	20.1
High	35	22.2	23.5	25	21.4	19.7	5	10.6	12.3	5	38.0	41.5
Average	35	38.3	26.7	25	39.6	27.9	5	44.5	23.8	5	26.0	24.3
Low to very low	35	25.7	25.9	25	22.6	24.5	5	39.7	25.3	5	27.0	33.7
Judgment of risk												
Very good	35	18.8	25.8	25	21.6	26.2	5	4.3	6.0	5	19.0	34.4
Good	35	20.5	20.9	25	19.0	16.1	5	14.8	12.0	5	34.0	41.6
Average	35	34.0	24.2	25	35.4	25.2	5	43.7	22.0	5	17.0	13.0
Poor to very poor	35	26.6	25.0	25	23.8	21.3	5	37.2	30.6	5	30.0	38.2
Resolve/determination												
Very high	31	18.1	19.5	22	19.1	19.4	5	14.0	15.2	4	17.5	28.7
High	31	24.8	20.3	22	23.8	20.0	5	25.0	18.0	4	30.0	29.4
Average	31	26.9	19.3	22	28.2	21.0	5	30.0	10.0	4	16.3	18.0
Low to very low	31	30.5	29.2	22	29.3	28.8	5	31.0	25.1	4	36.3	42.7
Tactical skills												
Excellent	35	8.5	13.4	25	10.0	13.2	5	9.0	20.1	5	1.0	2.2
Good to very good	35	13.2	14.7	25	12.9	13.1	5	13.0	12.0	5	15.0	25.5
Average	35	25.4	22.6	25	25.7	22.9	5	30.0	15.8	5	19.0	29.7
Poor to very poor	35	53.3	30.7	25	51.8	31.4	5	49.0	27.5	5	65.0	33.5
Marksmanship												
Excellent	34	10.0	15.4	25	12.8	17.0	5	2.0	2.7	4	2.5	5.0
Good to very good	34	14.6	11.5	25	15.6	11.6	5	12.0	11.5	4	11.3	13.1
Average	34	28.5	17.9	25	28.8	17.4	5	39.0	19.5	4	13.8	11.1
Poor to very poor	34	47.2	27.5	25	42.8	26.1	5	49.0	31.3	4	72.5	23.6
Determination/aggressiveness												
Very high	33	15.0	16.8	24	16.2	16.1	5	6.0	8.2	4	18.8	27.8
High	33	19.1	16.2	24	22.1	17.2	5	13.0	12.0	4	8.8	8.5
Average	33	31.1	21.7	24	27.6	17.4	5	57.0	25.9	4	20.0	20.4
Low to very low	33	34.8	29.5	24	34.1	28.6	5	24.0	26.8	4	52.5	38.4

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