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The Development Of A Dismounted Infantry Embedded Trainer With An Intelligent Tutor System

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THE DEVELOPMENT OF A DISMOUNTED INFANTRY EMBEDDED TRAINER WITH AN INTELLIGENT TUTOR SYSTEM

by

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ABSTRACT

The dismounted infantryman has been neglected in the fielding of simulation systems by the United States Army. The gains in technology made in the Land Warrior System, and the Future Combat Systems (FCS) development have increased the desire to have an embedded simulation system for each soldier. The Simulation and Training Technology Center (STTC) of the U.S. Army Research, Development and Engineering Command (RDECOM) is currently exploring the embedded training concept. The project is titled the Embedded Combined Arms Training and Mission Rehearsal Science and Technology Objective (ECATT-MR) (STO). The purpose of this project is to provide collective training and on-demand mission rehearsal for current and future Unit of Action (UA) forces. The product will result in a proof of concept for field capable interoperable mounted/dismounted embedded training.

The dismounted infantry system is a man wearable system with intelligent tutoring tool used to assess training. The tasks used to assess training for the intelligent tutoring were: (1) move as a member of a fireteam, (2) enter and clear a room, and (3) report battlefield information. The soldier wearing the simulation system acts as a member of a fireteam to conduct a virtual mission. The soldier's teammates are computer generated entities to conduct the mission.

Soldiers were surveyed on the tasks assessed as well as the features of the system. Soldiers were also surveyed on tasks they felt needed to be added to the tutoring functions of the system.

The intelligent tutor system and training in virtual reality was generally accepted by the participants. The general consensus was the technology needed additional

refinement to provide a better training environment. Most felt that working with Semi-Automated Forces (SAF) entities made the scenario more difficult to execute. The parameters established for successful completion of the movement and reporting tasks were too strict and hindered the experience for the participant. Locomotion is another aspect that deserves further research. Moving the locomotion controls to the feet would free the soldier from having to accomplish multiple tasks with only two hands. Future research should concentrate on locomotion methods and controls, as well as only using human participants for all unit members.

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LIST OF ACRONYMS/ABBREVIATIONS

AAR	After Action Review
AIS	Advanced Interactive Systems
COE	Contemporary Operating Environment
CTC	Combat Training Center
DBBL	Dismounted Battlespace Battle Lab
ECATT-MR	Embedded Combined Arms Training and Mission Rehearsal
ET	Embedded Training
FCS	Future Combat Systems
FOV	Field of View
GOMS	Goal Operator Method Selection
HMD	Head Mounted Display
IPB	Intelligence Preparation of the Battlefield
ITS	Intelligent Tutor System
LW	Land Warrior
MOUT	Military Operations in Urban Terrain
OLED	Organic Light-Emitting Diode
SAF	Semi-Automated Forces
SCUI	Soldier Control Unit
SSE	Squad Synthetic Environment
STO	Science and Technology Objective
SVS	Soldier Visualization System

TTP	Tactics, Techniques and Procedures
VW	Virtual Warrior
WUI	Weapon Interface

CHAPTER ONE: INTRODUCTION

The United States Army is in the process of transformation. The goal of the transformation process is to change the Army to a highly mobile, rapidly deployable, infantry centric, and more situationally aware than previous Army formations fielded for battle. The development of the Future Combat Systems (FCS) is the path for the Army to reach the transformation goals. The FCS program is centered on a number of common platforms that are linked together through a wireless network. The information shared on the network allows for a unified process of gathering intelligence, sharing intelligence, and aggressive battlefield decision making. (DA, 2003)

1.1 Embedded Training

Embedded Training (ET) is a cornerstone of the FCS program. ET is defined as a function hosted in hardware and/or software, integrated into the overall equipment configuration. ET will support training the leader and soldier in the following categories: new equipment training, unit sustainment training, and mission essential collective and individual tasks. (DA, 2003)

New equipment training is training that is focused on an individual or unit learning to implement the system on the battlefield. The training is initiated due to new equipment fielding or assignment of personnel inexperienced in the employment of the system. Unit sustainment training is defined as training evolutions conducted in order to allow a unit to remain proficient in collective tasks over an extended period of time. Mission essential tasks are those tasks the unit must remain proficient in order to accomplish their wartime mission. The individual tasks are the subtasks of the collective tasks. Without individual proficiency within the collective task, the task will be unsuccessful.

Embedded training for the individual infantryman brings unique challenges to the design and implementation of the system. Not until the fielding of the Land Warrior (LW) system is accomplished can the infantryman be considered for embedded training. The LW system brings the computer to the soldier as part of the fighting equipment. With the computer as part of the equipment, additional equipment can be added to accomplish the embedded training goals. The design of such a system must require little modification to the current fighting system worn by the Soldier. The attachments must be robust to survive daily abuse and use in all climates. The controls must be easy to learn and simple to use. Controls must be modular to tailor the controls to the user's preferences.

1.2 Intelligent Tutoring Systems

An Intelligent Tutoring System uses artificially intelligent software to replace an instructor, and establish a one-on-one tutoring experience for the student. Some ITS systems use simulations to achieve training objectives by automating the process of monitoring student actions and providing feedback, either in real-time or in an After Action Review (AAR).

The components of an ITS include: a cognitive model, expert model, student model, an overlay diagnosis or model tracing capability, a database of curriculum, training scenarios and instructional strategies. The expert model is the method used by an expert to achieve a goal. The student model is the method that the student or trainee is currently using to achieve the goal. In model tracing, the ITS overlays the expert model on the student model to identify deviation from the norm (Sanders, 2005).

In a scenario based ITS system, the model tracing component serves as the basis for the automated evaluation of student actions in a scenario. The ideal student model would consist of the knowledge and skills required to successfully perform required tasks within each training scenario and are based on the Tactics, Techniques and Procedures (TTPs) identified to complete the exercise to standard. These models in some cases are based upon a Goals, Operators, Methods, and Selection Rules (GOMS) task analysis. GOMS consists of four parts: the goal to be achieved, the operators or actions applied to achieve the goal, the method or sequencing of these operators, and selection rules for applying a method if more than one method exists to accomplish a goal. Model tracing enables an ITS to determine when students incorrectly select or apply GOMS and serves as the basis for feedback. (Sanders, 2005)

1.3 Research Question

It is this context that the following research questions emerge. Do the standards for the tasks represented reflect an accurate representation of the teaching points needed to train infantryman? What modifications to this system are needed to enhance the experience of the individual soldier?

1.4 Research Purpose

The purpose of this research is to provide proof of concept for embedded training with intelligent tutoring for the individual infantry soldier. This information can be applied to future versions of fielded systems, and help shape training doctrine as the U.S Army transforms to the Future Force.

CHAPTER TWO: BACKGROUND

2.1 Virtual Infantry Training

Use of virtual reality systems for the individual infantry soldier has progressed quickly over the last ten years. The U.S. Army has fielded specific simulators that allow the infantryman to train in virtual reality. Prior to the fielding of these systems, the infantryman was largely ignored mainly due to the lack of available technology. These systems are housed in dedicated simulation centers in which units visit to train in their mission essential tasks. This system is named the Squad Synthetic Environment (SSE). (Chisholm, 2003)

This virtual infantry training system is located in the Dismounted Battlespace Battle Lab (DBBL) at Fort Benning, Georgia. The DBBL is located in a warehouse type building and is the first system that has attempted to provide a fully immersive environment for the infantry soldier. (Rodriguez, 2003)

The Squad Synthetic Environment is based on the Soldier Visualization System^{TM} (SVS). Advanced Interactive Systems (AIS) manufactures SVS. The Squad Synthetic Environment (SSE) is used in two forms: a fully immersive system that uses a cave and a desktop version. The cave systems are rather large. Each one is approximately 15 feet by 30 feet by 10 feet in dimension. (Miller, 2002) The cave has sensors to determine the soldier's location and posture. The helmet and weapon also have sensors to help with determine the soldiers viewpoint, and location of any simulated rounds that he may fire. (Gately, 2005) The other form is simply a desktop version. The desktop versions have the same capabilities as the cave systems in terms of weapon selection and communications. (Miller, 2002) Using the desktop version is an experience similar to any first person shooter games that are marketed to gamers.

The SSE has allowed the U.S Army to explore virtual training for the dismounted infantry soldier. The most glaring limitation of this system is the availability of the systems. Fort Benning, Georgia is responsible for training all infantry soldiers from the ranks of Private to Captain. The post also is the home of two infantry battalions and a ranger battalion. That is roughly three thousand soldiers available for training each day. The DBBL can only provide eighty stand up modules for training. (Gately, 2005) This is not nearly enough systems to provide a huge training benefit to the commanders and trainers that are responsible for training soldiers. Desktop trainers can supplement the cave systems. The British Army has conducted a study on the effectiveness of desktop trainers for urban operations. Naturally, most soldiers surveyed indicated that they prefer to train in a live environment. Most soldiers also felt that the desktop trainer would be a useful tool for the leaders to sharpen their decision making and command and control skills. Slight improvement has also been seen in a section that received only virtual training before performing the collective task in the live environment. No instances of negative training were noted from those surveyed training in the virtual environment. (Pennel, 2003)

Cave Type System Desktop Version

Figure 1: SSE System

2.2 Deficiencies in Current Training

Observations from the Combat Training Centers (CTC's) have tracked trends in tasks where soldiers habitually failed to accomplish to the published standard. Soldiers are not executing battle drills to standard. Basic individual tasks that support the collective task are a contributing factor. Lack of leader training and home station training at squad/team level hampers effectiveness. Leaders are unable to synchronize the drill/fight in a dynamic environment. Units are not prepared to execute on unfamiliar terrain because they tailor all their rehearsals toward the specific terrain/enemy they expect to encounter rather than training a battle drill to standard. This results in leaders unable to set the conditions for the fight, poor battle drill reaction times, and hesitancy to engage targets for fear of fratricide in a dynamic environment. Inaccurate reports result in an inaccurate picture of the battlefield, which then results in poor condition settings for battle drills and desynchronizes the fight on the objective.

Rehearsals should be structured for desired effects rather than “cookie cutter” actions taken at a particular point on the ground. Soldiers should expect a dynamic battlefield and rehearse contingencies. Soldiers must be trained on “how to think” vs. “what to think.” This involves everyone understanding the mission, task/purpose, and the commander’s intent as well as how it all fits into the big picture. Platoon orders should not be a regurgitation of the company order with a few things deleted, and squad orders should not be a regurgitation of the platoon order. Junior leaders need to conduct a refined Intelligence Preparation of the Battlefield (IPB) down to their level. This should be based on their course of action development for their level along with the appropriate control measures and triggers. (CALL, 2003)

2.3 Feedback

AARs are a method of providing feedback after individual and collective training by involving individuals in the training process to increase and reinforce learning. AARs are proctored by individuals knowledgeable in the tasks trained during the exercise. An instructor/operator provides AAR’s for individual and crew training. An observer controller provides AAR’s for collective training. (DA, 2003) The purpose of the AAR leader is to guide participants in identifying errors and to develop solutions to correct these errors. The AAR is arranged to answer three questions: what happened; why it happened; and how to fix it. AAR leaders use open-ended questions to promote discussion and lead participants through a problem-solving process to allow participants to discover for themselves the answers to these three questions (DA, 1990).

2.4 Man Wearable Systems

An unwelcome byproduct of training an individual soldier in virtual reality with a man wearable system is difficulty with locomotion. The most convenient method to accomplish the task is with a joystick type control. Any large apparatus would defeat the goal of having a system that could be used at any location where a soldier could be deployed. A drawback of using a joystick from personal experience is the increased cognitive load placed on the individual using the joystick. Joystick movements are less precise, and it is common for a trainee to inadvertently select the wrong button.

Additional controllers (e.g., the omni-directional treadmill, Uniport) have been developed that attempt to replicate human movement. These devices provide a way for the human legs to represent their normal function virtually. This device allows the user to move in all directions but has suffered some issues with replicating the intended results. Body control on the omni directional treadmill can be unsteady, and leave the participant in a perceived state of unbalance. (Darken, 1997) The device has also suffered from false starts, noise generation, and being difficult to sidestep or turn in place. The Uniport was developed to replicate the physiological effort needed to negotiate the virtual world. The device was similar to a unicycle without the wheel. The individual pedaled the uniport for locomotion. While successful at accomplishing the effort needed to move, the uniport did not convey sense of walking or running to the user. (Kneer, 2005) Walking platforms have also been developed. These devices are simply platforms that track the footsteps of the participant through the use of sensors. (Witmer, 2000) The drawback to the above devices is their inability to be easily transportable and a large operational infrastructure.

As previously stated, most locomotion devices do not generally meet the needs of embedded virtual training. The joystick is popular due to its simplicity of design, and most soldiers today attach a vertical foregrip to their weapon. While the joystick meets the intent for embedded training, soldiers have ranked the ability to move indoors very poor in virtual training studies. (Kneer, 2002) There are a few items that show promise for virtual training. These devices are the cyber shoe, pressure mat, and ankle trackers. These items are small and easily transportable but they will need to be hardened to increase their durability. Ankle sensors monitor the foot movement of a person walking in place in order to generate virtual motion. (Parsons, 2005) A pressure mat is a rubber mat with sensors which can interpret foot placement and pressure to generate locomotion. The cybershoe is an insole that has sensors embedded in it. The insole is wireless and generates locomotion through foot movement. (Reese, 2002)

The Head Mounted Devices (HMD) used in the man wearable systems have a dramatically narrower (FOV) field of view (28 degrees) than a human (200 degrees). A study of human performance using HMD's on subjects performing a walk and a search task found that the wider field of view provided improvements in performance. The study compared various HMD's from 176 degree FOV to an HMD with a 48 degree FOV. The 48 degree FOV HMD saw performance degrade 31% for walking and 24% than the search tasks performed with the 176 degree FOV HMD. (Arthur, 2000) Soldiers that underwent testing on wearable virtual simulators also disliked the narrow FOV provided by the HMD's, but liked the ability to quickly scan the virtual battlefield. (Knerr, 2004)

Battery life is an issue that is degrading from the system. Most early versions of wearable systems suffered from this problem. (Knerr, 2004) Updated prototypes have shown improved battery life. The system, fully charged, has operated for up to six hours.

The computer system is a challenge to fielding a virtual reality embedded trainer. The current Land Warrior Computer can barely support the operational mission. Two computers may need to be fielded; a computer for live training/operations, and one computer for virtual training. (Marshall, 2004) Previous prototypes have had durability issues with various sensors and connectors. (Knerr, 2004) Designers have attempted to solve some of these problems by using existing cables and connectors from the Land Warrior system.

Rendering of combatant behaviors has been improved. The added ability to place satchel charges, employment of distractionary, explosive, and screening devices has received high marks in previous experiments on existing systems. (Knerr, 2003) Ballistic, mechanical, and human breaching behaviors need to be implemented in the Virtual Warrior. Ballistic breaching is usually accomplished by using a shotgun to defeat the door hinges or door knobs. Mechanical breaching involves the use of tools to defeat a door. Human breaching is simply using the human body to breach. Developers could leverage gaming technology to adapt these behaviors for virtual training.

CHAPTER THREE: METHODOLOGY

This research was based on the creation of a scenario to demonstrate mounted/dismounted integration in support of the Embedded Combined Arms Training and Mission Rehearsal Science and Technology Objective (ECATT-MR) (STO). No intelligent tutoring models had been made for the dismounted soldier. The scenario created is based on relevant activities encountered in the Contemporary Operating Environment (COE).

Standards for the tasks were derived from the appropriate doctrinal documents. These documents led to the creation of pictorial descriptions of each task to create the intelligent tutoring architecture. The scenario was then executed by soldiers to determine if the tasks tutored were an accurate representation of the task, what additional tasks could be included, comments concerning operating in the virtual environment, and information on the inputs to the virtual world.

3.1 Tasks

The tasks to be tutored are for the most part individual tasks the soldier must accomplish for the collective task to be successful. The dismounted intelligent tutoring system will be able to evaluate three individual tasks. They must be able to; move as a member of a fire team, send a report, perform movement techniques during MOUT, and can provide tutoring for the collective task Enter and Clear a Room. For the collective task, the tutor will prompt the player unit on his individual actions within the task. The standards for the Move as a Member of the Fireteam include the evaluated individual observing the proper sector of fire during movement, position in the formation, dispersion in the formation, and maintaining contact with the fire team leader. All of these sub-tasks are critical components to successful completion of the larger task. Figure 2 is a pictorial representation of the fire team wedge formation. The arrows represent the sector of fire the soldier should maintain during movement.

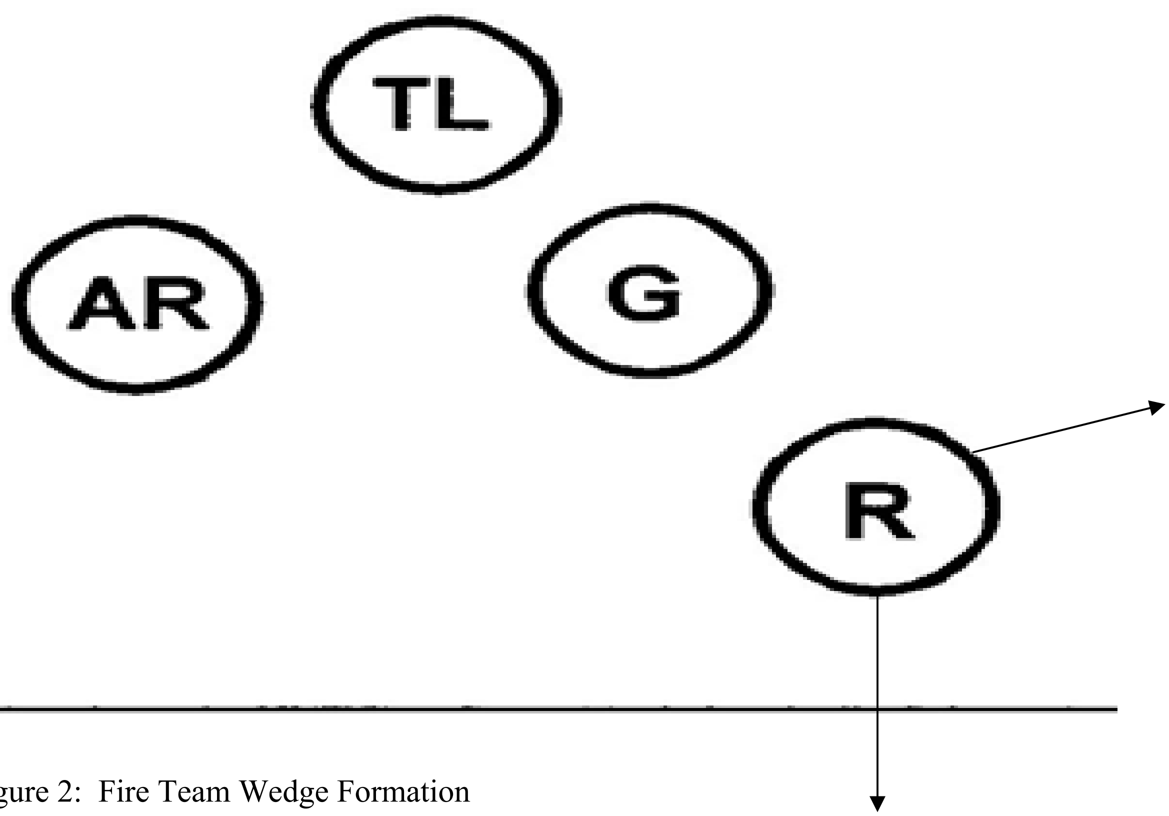


Figure 2: Fire Team Wedge Formation

If the soldier fails to maintain the sector of fire during movement, a message will displayed to notify the soldier of his error, or maintain dispersion in the formation a message will be displayed to the soldier.

Figure 3: ITS message for sector of fire during movement

Figure 4: ITS message for formation dispersion

Tutoring is provided for the soldier during the process of clearing a room. The activities initiate with stacking. Stacking is the line-up of team members outside the room. . During the stacking process, the evaluations concern the location of the soldier and the sector of fire of the soldier. During the actual room entry the soldier must accomplish the following subtasks: clear the point of entry, engage the immediate threat, move to a point of domination, clear sector of fire, and collapse sectors of fire.

Clear the Point of Entry or Breach Point, the first action to be taken by the soldier upon entry into a room, is to clear the fatal funnel. The area, which surrounds the door threshold, is known as the fatal funnel and this is the focal point of attention for anyone in the room. The assault team members must move quickly to reduce the risk of being hit by hostile fire directed at the doorway.

The soldiers next step is to engage any immediate threat encountered. The following criterion defines an immediate threat: any threat that blocks the movement of the soldier to his point of domination. Any hostile target that is too close to be ignored is an immediate threat. Although this factor is vague, the decision of what is too close is, in the final analysis, the decision of the individual soldier. A general guideline of too close is whatever is within arm's reach; however, a soldier must never turn completely around to engage a target. Once he has passed a target, he must move on and not change his mind. During the soldiers move to the point of domination he must move to the corners. The corners are the points of domination in any room.

The assault teams next action is to clear the corners and occupy them as points of domination. The No. 1 man and the No. 2 man are initially responsible for the corners. If the No. 1 man and the No. 2 man are unable to clear the corners, the No. 3 man and the No. 4 man must assume this critical responsibility. Each soldier has a primary and secondary sector of fire. Every man has a primary and secondary sector of fire enroute to his point of domination. Once each soldier reached the point of domination he scans his sectors of fire from that. The last step is to collapse sectors of fire. Once each man on the team has reached his points of domination, he ensures he has interlocking sectors of fire. The Reporting Tactical Information process will be evaluated on the digital reports sent by the soldier. If the tutor does not receive the report a prompt will be sent to the soldier.

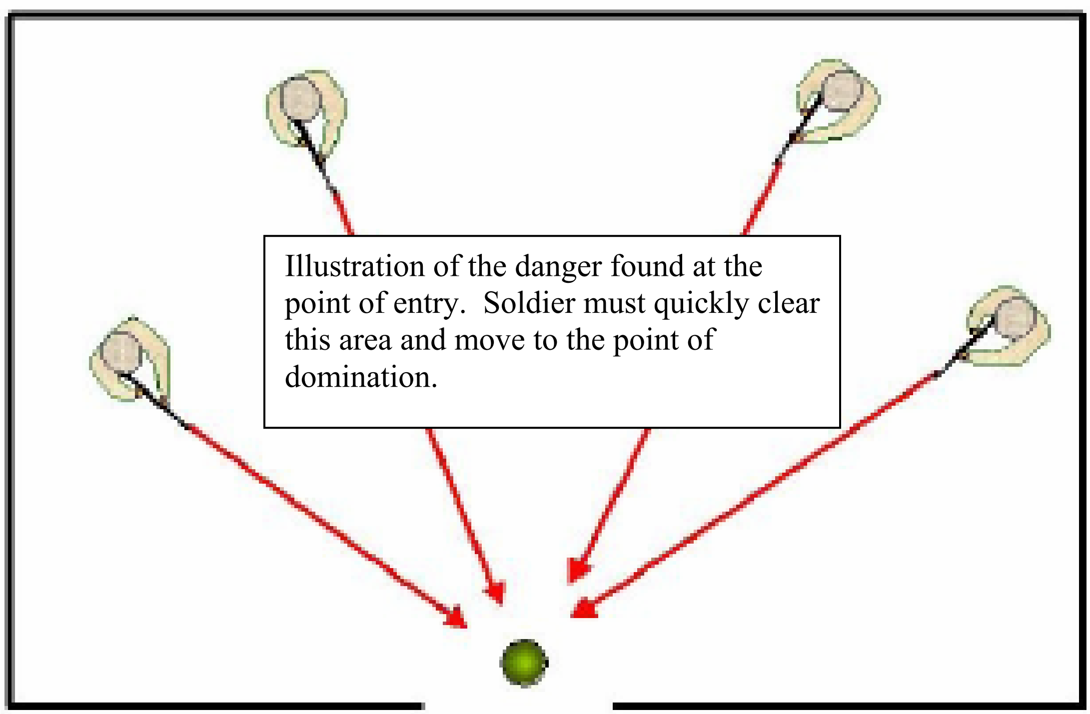


Figure 5: Clearing the Point of Entry

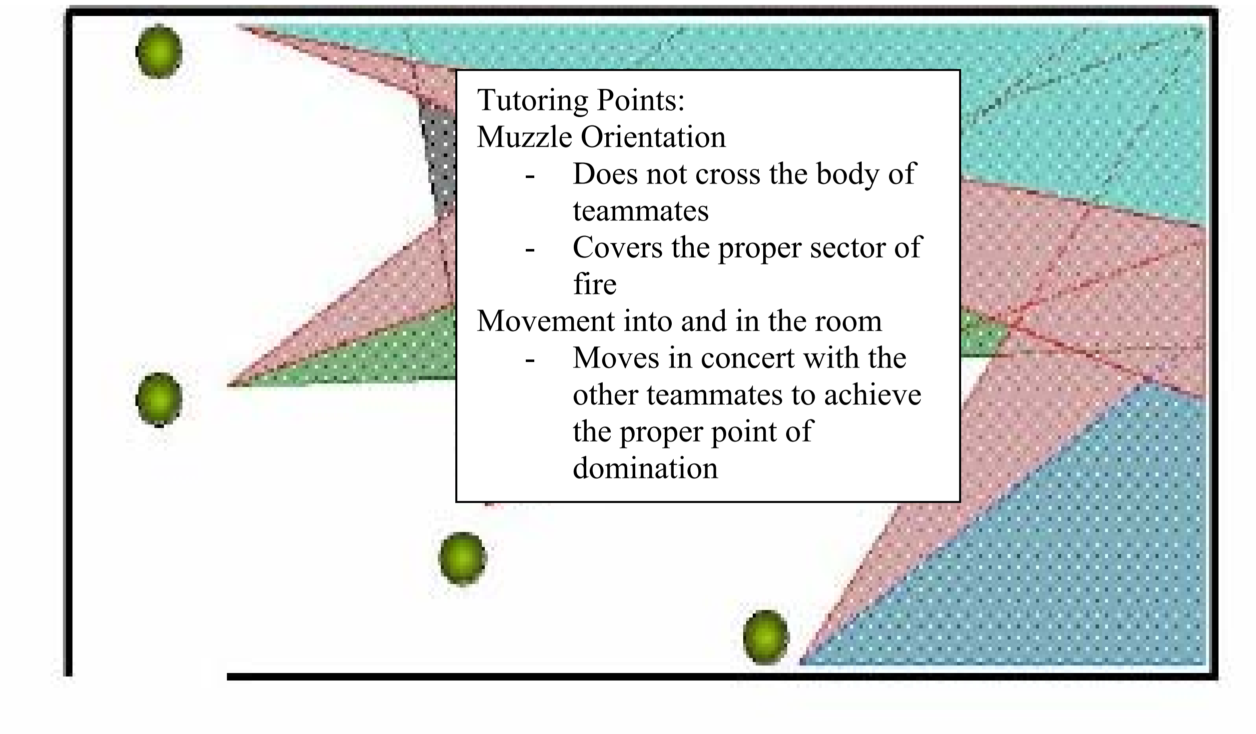


Figure 6: Final positions of the room clearing team

Figure 7: Tutor message for incorrect sector of fire in room clearing

Figure 8: Tutor message for reporting tactical information

3.2 Subjects

100% of the subjects tested came from an infantry occupational specialty. 60% of the subjects tested were officers, 20% were non-commissioned officers, and 20% were enlisted. 40% of the subjects tested had combat experience, and 40% had combat experience accomplished the tasks involved in the scenario. 100% of the subjects have been trained in the tasks involved in the scenario. 80% of those tested had more than ten years experience in the military, and 20% had less than four years experience.

3.3 Materials

General Dynamics has developed a prototype embedded trainer for the Land Warrior system. This system is named the Virtual Warrior (VW). This system replicates the Land Warrior system in appearance, and uses much of the same hardware.

Virtual Warrior Inputs

Body Tracking

The Virtual Warrior system incorporates the six degrees of freedom tracking system. These sensors independently track the head, leg, torso, and weapon. These sensors are integrated into the hardware and software interfaces.

Figure 9: Head Sensor

Physical Controls

There are two physical controllers used with the VW; the Weapon User Interface or WUI, and the Soldier Control Unit Interface or SCUI. The WUI is essentially a joystick that allows the user to move forward, backwards, left, right, and toggle through certain tasks such as boresighting and marking cleared rooms.

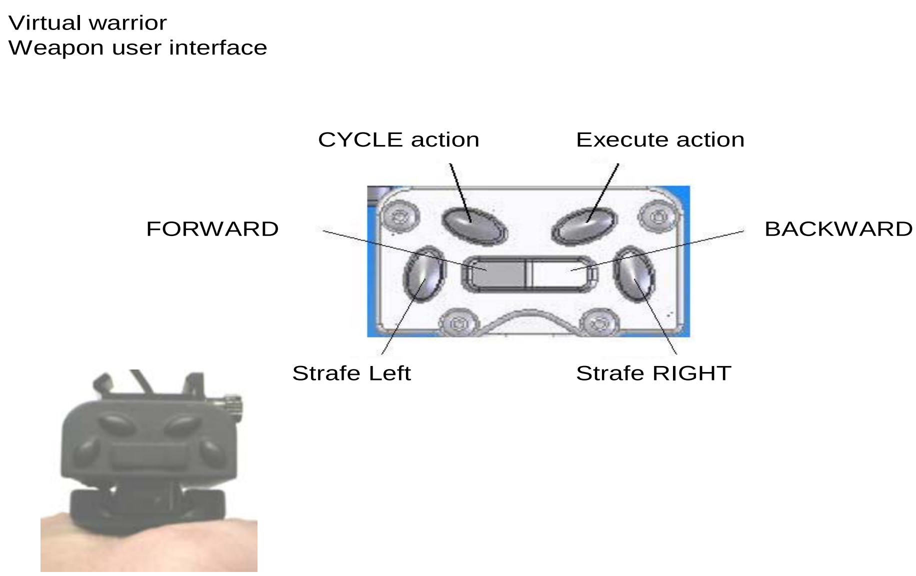


Figure 10: Weapon Interface

The SCUI allows the user to view the situational awareness screen, send digital messages, use mouse controls, change posture, and reset the system. The WUI and SCUI are both items that have been adapted from the Land Warrior components to operate in the virtual world.

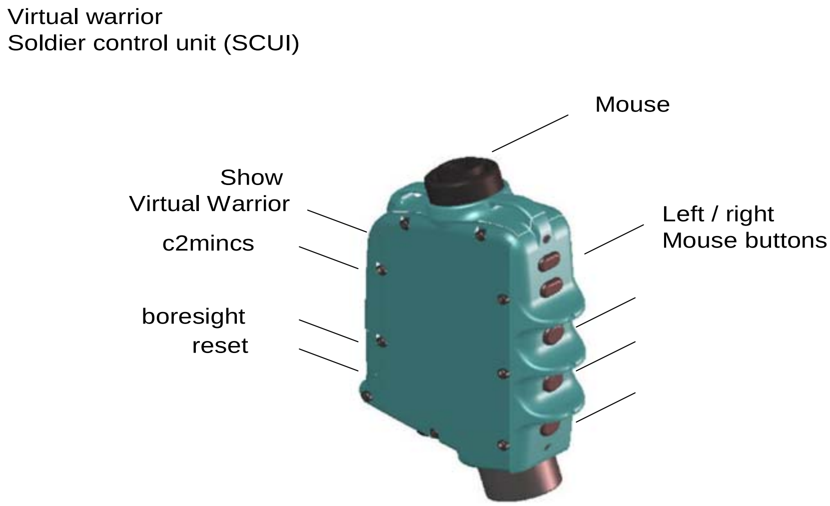


Figure 11: Soldier Control Unit

Virtual Warrior Outputs

Visual Display

The visual display used in the Virtual Warrior is an organic light-emitting diode (OLED) head mounted display (HMD). The HMD has been adapted to attach to the soldiers helmet using the existing bracket used for the night vision goggles. The HMD's provide an 800x600 resolution and a 28 degree field of view.

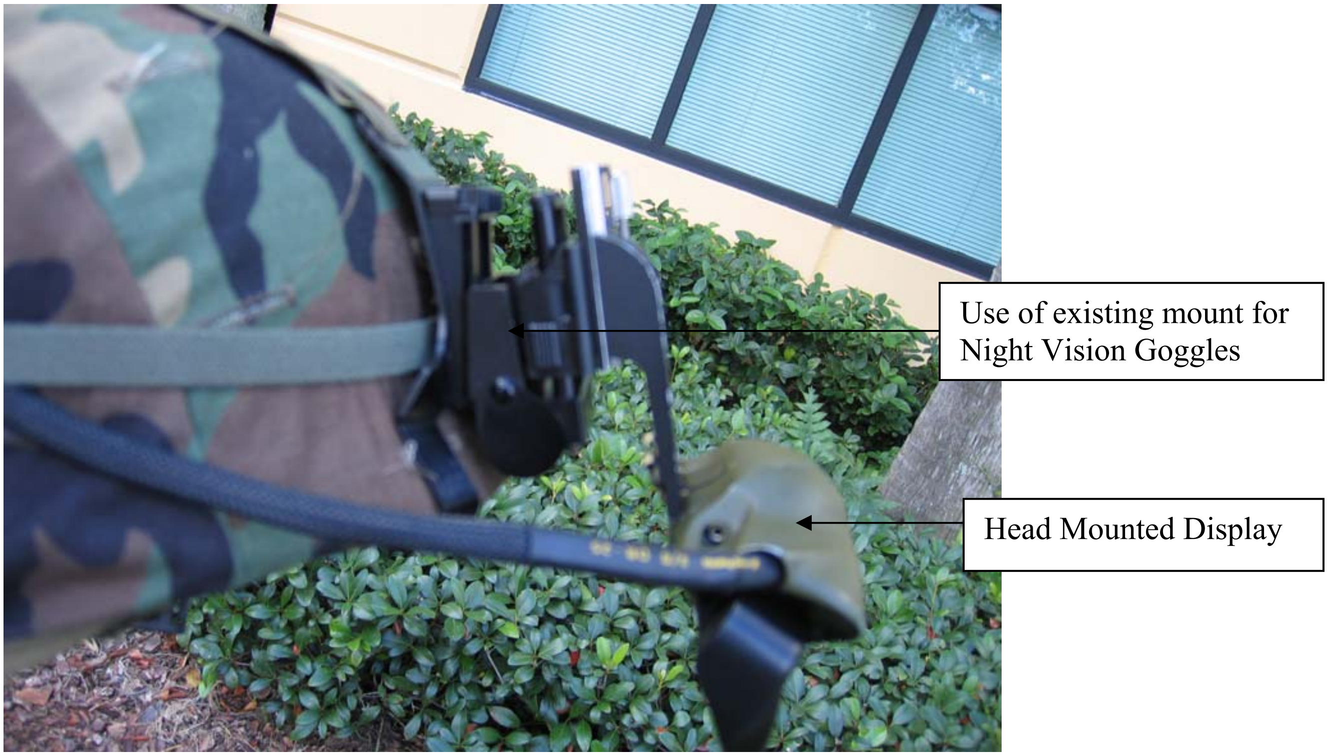


Figure 12: Head Mounted Display

Aural Display

Full Stereo sound is provided in the system. The current system has sound routed through speakers that have been adapted to the helmet. The aural display will need to be integrated into the HMD in order to meet true embedded systems goals.

Figure 13: Speakers

Rendering System

The Virtual Warrior uses the APEX advanced game rendering engine. This engine is interoperable with DIS protocols, HLA protocols, and Open Flight database.

3.4 Procedures

Test subjects received a block of instruction on the use of the dismounted infantry system. They were given time to wear the system and acclimatize themselves to the display, weapons mounted controls, and vest mounted controls. The subjects were also allowed to move about the virtual world to further increase their comfort level. Immediately following the preparatory training period, the subjects were given a standard mission brief using the mission planning tool with the software. After the mission brief the subject executes in the virtual world for 30 minutes. The subject completed as many iterations of the scenario as possible within the 30 minutes. Upon completion of the iterations, the subjects then answered the required survey.

A survey was developed to meet the goals of the research. This survey is divided into five sections. Section one contained general questions pertaining rank, service, combat experience, and familiarity of the tasks conducted in the scenario. Section two consisted of questions pertaining to the tutor evaluations. The subject was asked to complete each evaluation based on their perception of the effectiveness of the tutor as a training tool. Section three contained questions pertaining to their evaluation of the system and whether is allowed them to accomplish the required tasks virtually. Section three also consisted of questions concerning realism. Subjects were asked a variety of questions concerning training value, weapons effects, and the ability of tutoring to focus the attention of the subject. Section four consisted of the subject ranking a list of developments in additional tutoring tasks and modifications to the design of the system. Section five of the survey contained a set of questions concerning the individual's response to operating in the virtual world.

CHAPTER FOUR: FINDINGS

The data gathered during this experiment was very broad in its scope. The following categories of the dismounted infantry simulator with intelligent tutoring were explored: assessment of the tutoring messages, evaluation of the usability of the system, future modifications to the system, additional soldier tasks for tutoring, and individual response to the system. The results of these findings provide a starting point for development of future versions of this tool.

4.1 Assessment of Tutoring Messages

The intent of the assessment of the tutoring messages is to determine if the translation of the standard for the task from the appropriate doctrinal material to the software program is a realistic interpretation of the published standard. The data gathered from the subjects provide their assessment of the instructional aid to evaluate the performance of the task. A seven point Likert scale was used for each question taken from five experiment participants. Statistical analyses used include: a One Sample Wilcoxon (Table 1), descriptive statistics (Table 2), and a Chi Square (Tables 3 and 4).

The Wilcoxon test measure was based on a cutting point of a median ≥ 4.0 versus a median < 4.0. Seven out the eleven tasks were greater than or equal to 4.0. The tasks listed in bold are the main tasks. The italicized tasks are subtasks of the main task. Although the trend is for acceptance (rating greater than or equal to 4.0), none of the responses are statistically significant.

Table 1: Wilcoxon test on assessment of tutoring messages

Task	N	N for test	Wilcoxon Statistic	P	Estimated Median
Enter and Clear a Room	5	4	2.0	0.361	3.500
Location and spacing in the stack formation	5	3	6.0	0.181	4.500
Location in the room	5	4	10.0	0.100	5.000
Maintaining sector of fire in the room	5	4	10.0	0.100	5.000
Marking the room cleared	5	4	5.0	1.000	4.000
Maintain muzzle awareness	5	3	6.0	0.181	5.000
Move as a member of a fireteam	5	4	0.0	0.100	3.000
Maintain dist in formation	5	2	0.0	0.371	3.500
Maintain sector of fire in mvt	5	2	3.0	0.371	4.500
Monitor TL during mvt	5	4	1.5	0.273	3.000
Report Tactical Information	5	4	5.0	1.000	4.000

Table 2: Descriptive statistics of tasks monitored by intelligent tutoring

Question	Mean	Median	Std Dev	Min	Max
Location in the room in relation to your perceived location in the room based on your number in the clearing team	5.2	5	0.8366	4	6
Maintaining muzzle awareness	5	5	1	4	6
Maintaining sector of fire in the room	4.8	5	0.4472	4	5
Location an spacing in the Stack Formation	4.6	5	0.5477	4	5
Maintaining sector of fire during movement	4.4	4	0.5477	4	5
Marking the room cleared	4	4	1.5811	2	6
Report tactical information	4	4	1	3	5

Maintaining dispersion in the formation	3.6	4	0.5477	3	4
Enter and Clear a Room	3.4	3	1.1401	2	5
Fireteam tactical movement	3.2	3	0.4471	3	4
Monitor team leader during movement	3.2	3	1.3038	2	5

The results of the descriptive statistics were ranked numerically by mean. The tasks or subtasks that were rated the most favorably were subtasks of *Enter and Clear a Room*. These subtasks were *Maintaining Sector of Fire in the Room* and *Maintaining Muzzle Awareness*. These subtasks were rated much higher than the parent task of *Enter and Clear a Room*.

The lowest rated tasks were *Enter and Clear a Room* and *Move as a Member of a Fireteam*. All of the tasks with a mean score lower than four require the subject to operate in conjunction with SAF entities to meet the required standard. The SAF forces can be difficult to work with, and the majority of the soldiers voiced their displeasure with trying to accomplish their mission with the SAF entities. Representative comments of the difficulty of working with the SAF follow: "The SAF move too fast in the scenario. I have little time to report before I get left behind.", "There is no way for me to communicate with the SAF", "The SAF behavior is erratic, they are not consistent from iteration to iteration" and, "The SAF do not follow a logical movement pattern to the target building".

The differences in the ratings of the parent tasks from the subtasks merit further analysis. A Chi Square test was used to analyze the difference in ratings from the main tasks (*Enter and Clear a Room* and *Move as a Member of a Fireteam*) as compared to each subtask. All ratings of three and below were considered negative, and all ratings of four and above were considered positive.

Table 3: Chi Square Analysis of Enter and Clear a Room and Subtasks

	Tasks	**Positive Ratings**	**Negative Ratings**
Main Task	Enter and Clear a Room	2	3
Subtask	Location and Spacing in the Stack Formation	5	0
	Chi Square	**DF**	**P**
	4.286	1	0.038
	Tasks	**Positive Ratings**	**Negative Ratings**
Main Task	Enter and Clear a Room	2	3
Subtask	Location in the room	5	0
	Chi Square	**DF**	**P**
	4.286	1	0.038
	Tasks	**Positive Ratings**	**Negative Ratings**
Main Task	Enter and Clear a Room	2	3
Subtask	Maintain Sector of Fire in the room	5	0
	Chi Square	**DF**	**P**
	4.286	1	0.038
	Tasks	**Positive Ratings**	**Negative Ratings**
Main Task	Enter and Clear a Room	2	3
Subtask	Maintain muzzle awareness	5	0
	Chi Square	**DF**	**P**
	4.286	1	0.038
	Tasks	**Positive Ratings**	**Negative Ratings**
Main Task	Enter and Clear a Room	2	3
Subtask	Mark the room cleared	3	2
	Chi Square	**DF**	**P**
	0.400	1	0.527

Table 3 demonstrates that the main task of *Enter and Clear a Room* was rated much more negatively than the subtasks. The only comparison that did not have a significant statistical rating was the comparison between *Enter and Clear a Room* and the subtask *Mark the Room Cleared*.

Table 4: Chi Square Analysis of Move as a Member of a Fireteam and Subtasks

	Tasks	**Positive Ratings**	**Negative Ratings**
Main Task	Move as a Member of a Fireteam	1	4
Subtask	Maintain distance in the formation	3	2
	Chi Square	**DF**	**P**
	1.667	1	0.197
	Tasks	**Positive Ratings**	**Negative Ratings**
Main Task	Move as a Member of a Fireteam	1	4
Subtask	Maintain sector of fire during movement	5	0
	Chi Square	**DF**	**P**
	6.667	1	0.010
	Tasks	**Positive Ratings**	**Negative Ratings**
Main Task	Move as a Member of a Fireteam	1	4
Subtask	Monitor team leader during movement	2	3
	Chi Square	**DF**	**P**
	0.476	1	0.490

Table 4 indicates the main task *Move as a Member of a Fireteam* and its subtasks ratings are not statistically significant except when comparing *Move as a Member of a Fireteam* to the subtask *Maintain Sector of Fire During Movement*. A possible source of this rating is the use of the C2Mincs system at the start of the mission. The subject was instructed to report to the higher unit headquarters when the mission began. The sending of the report often caused the subject to lag behind the unit, and cause difficulty in their conduct of the *Move as a Member of a Fireteam task*.

Since all participants verbalized a problem with the SAF. A Chi Square Test was also administered (Table 5) on SAF compliance versus the presence versus theoretical absence of complaint. The results of this analysis demonstrate a statistically significant distribution pattern between the number of complaints versus the absence of complaint as a function of whether the task was, or was not, SAF compliant.

Table 5: Chi Square analysis of SAF complaint versus absence of complaints

	Complaint	
SAF Compliant	**No**	**Yes**
Yes	0	5
No	5	0
Chi Square	**DF**	**P**
10.000	1	0.002

It is clear from the distribution that SAF compliance resulted in far more complaints than did tasks which were not SAF compliant.

4.2 System Evaluation

Evaluation of the system overall was derived from the survey data. The intent of this section is to provide information on the ability of the system to allow participants to negotiate the virtual world. This section covers a wide variety of topics, but all are important for the user to have a positive experience. If any of these categories are lacking in realism, ease of use, or visual quality the experience will suffer. A seven point Likert scale was used for each question. A One Sample Wilcoxon (Table 6) and descriptive statistics (Table 7) were used to analyze the data.

Table 6: Wilcoxon test for System Evaluation

Task	**N**	**N for test**	**Wilcoxon Statistic**	**P**	**Estimatated Median**
Layout of the joystick	5	3	6.0	0.181	5.000
Scan for targets	5	2	3.0	0.371	4.500
Quality of image display	5	3	4.5	0.593	4.500
MVT to front, right, left, rear, and obliques	5	1	1.0	1.000	4.000
ID of friend and enemy	5	3	4.0	0.789	4.000
Engage targets	5	4	6.0	0.855	4.000
Depth perception within the buildings	5	3	4.0	0.789	4.000
Frequency of Pop-up messages	5	4	6.0	0.855	4.000
Move within buildings	5	4	2.0	0.361	3.500
Use of mouse and joystick simultaneously	5	3	0.0	0.181	3.000
Use of C2Mincs	5	3	0.0	0.181	3.000
Location of Pop-up messages	5	3	0.0	0.181	3.000

The Wilcoxon test measure was based on a cutting point of a median ≥ 4.0 versus a median < 4.0. Eight of the twelve tasks were greater than or equal to 4.0. The tasks listed in bold are the main tasks. The italicized tasks are subtasks of the main task. Although the trend is for acceptance (rating greater than or equal to 4.0), none of the responses are statistically significant.

The results of the descriptive statistics were ranked numerically by mean. The majority of the system was rated favorably. The lowest rated evaluations were ability to move within buildings, location of pop-up messages, use of joystick and mouse simultaneously, and use of the C2Mincs for reporting tactical messages. The move within buildings was more of a fidelity issue. Certain buildings within the database had glitches that made it almost impossible to identify corridors for movement. This problem generally presented itself in stairwells or narrow hallways.

The use of joystick and the mouse simultaneously could be an issue of workload for the participants. It also required the soldier to violate sound tactical judgment. In order to use the mouse, the soldier must remove his firing hand from the weapon due to the non- firing hand controlling locomotion. This is unnatural activity and generally caused difficulty for the participants. This is also a departure from the usual procedure required to operate the actual Land Warrior system.

Difficulty with use of the C2Mincs could be an issue of workload. This was identified in the development stage of this program, and several modifications were made to make sending reports easier. The issue is once the C2Mincs system is employed the focus is on sending the required report, and not moving with the unit. By the time the soldier has sent the report he is being bombarded with messages admonishing him for failing to meet the standards for the movement tasks.

Table 7: Descriptive statistics for System evaluation

Question	Mean	Median	Std Dev	Min	Max
Layout of control buttons for ease of use	5	5	1	4	6
Scan for targets	4.4	4	0.5477	4	5
Quality of image display	4.4	4	1.1401	3	6
Movement to the front, left, right, rear, and obliques	4.2	4	0.4472	4	5
Identification of friendly and enemy forces	4.2	4	0.8366	3	5
Engage Targets	4.2	4	1.083	3	6
Depth perception within buildings	4.2	4	0.8366	3	5
Frequency of pop-up messages	4.2	4	1.3038	3	6
Ability to move within buildings	3.4	3	1.1401	2	5

Location of pop-up messages	3	3	0.4472	2	4
Use of joystick and mouse simultaneously	2.8	3	1.3083	1	4
Use of C2Mincs for reporting tactical information	2.8	3	1.3083	1	4

4.3 System Modifications

Subjects were given a list of five items for possible modification in future updated versions of the system. These items were locomotion, head mounted display, joystick, mouse, and the format of digital reports. The subjects were asked to rank these items numerically in the order of their need to be modified. The system modifications results were based on subjects ranking their changes to the system from the choices listed.

A Mann Whitney Test (Table 8), descriptive statistics (Table 9), and a Chi Square (Table 10) were used to analyze the data. The Mann Whitney test compared the modifications in the order of their rankings. This test determined if there was statistical significance between the ratings. Significance is shown between Locomotion Control versus Joystick and HMD versus Mouse. Joystick versus HMD and Mouse versus Report Formats had little statistical difference.

Table 8: Mann Whitney Test for possible System Modifications

Comparisons	**P Value** at ∞ = .05
Locomotion vs Joystick	0.0379
Joystick vs HMD	0.3008
HMD vs Mouse	0.0184
Mouse vs Report Formats	0.1235

Locomotion was the highest rated in the need for modification. This modification would be the most difficult issue to implement, and still meet the needs assessment of an embedded training system. Any device used for locomotion must be small and require minimal accessories to use. The Army has a vision for embedded devices to be used as a mission planning/rehearsal tool for combat operations. If the devices associated with the dismounted systems interfere with unit's ability to carry the required tools for combat, those devices will not be deployed with the unit.

The joystick was the second rated device recommended for modification. The main issue with the joystick or WUI (Weapon Interface) is the size of the buttons, and the location of accessories around the joystick. In attempt to use as much of the Land Warrior equipment as possible, the designers used the gun camera controls for locomotion, menu commands, as well as the original purpose associated with the gun camera. The size of the buttons, which are small, leads to inaccurate locomotion inputs by the user. The placement of the gun camera also stymied right-handed shooters. The gun camera is mounted in the 9 o'clock position on the modular rail fore end of the weapon. In this location, the camera impedes the thumb of the operator as the buttons are manipulated. The mounting location of camera is not an issue on the actual Land Warrior system because the buttons are only accessed to operate the camera.

Table 9: Descriptive Statistics for possible System Modifications

Question	Mean	Median	Std Dev	Min	Max
Locomotion	1.2	1	0.4472	1	2
Joystick	2.4	2	0.5477	2	3
HMD	2.8	3	1.3083	1	4
Mouse	4	4	1	3	5
Report Formats	4.8	5	0.4472	4	5

A Chi Square analysis was performed on the following items listed for modification. The joystick ratings would more than likely increase if locomotion controls were not on the joystick. In fact, if the locomotion input was not supplied by the joystick, the joystick inputs would similar to those found on the Land Warrior. The main deficiency with the mouse is the inability to configure it quickly between left and right hand use. Most of the subjects found the mouse acceptable if the mapping for the pointer could be configured by the user. Moving locomotion controls away from the joystick would also eliminate most of the difficulty of using the mouse and joystick simultaneously (A low rating of the system evaluation).

Table 10: Chi Square analysis of system modifications

Modifications	**Positive Ratings**	**Negative Ratings**
Locomotion	0	5
Joystick	1	4
Mouse	4	1
Chi Square	**DF**	**P**
10.516	2	0.005

The significant Chi Square that ratings for locomotion were very much related to the joystick, but not to the mouse.

4.4 Additional Tutoring Evaluations

Subjects were given a list of four additional tutoring evaluations for possible inclusion in future updated versions of the system. These evaluations were soldier exposure, shot placement, hallway movement, and selector switch location. The subjects were asked to rank these items numerically in the order of the most important to include. The additional tutoring evaluations results were based on subjects ranking their changes to the system from the choices listed.

A Mann Whitney Test (Table 11) and descriptive statistics (Table 12) were used to analyze the data. The Mann Whitney test compared the additional tutoring evaluations in the order of their rankings. This test determined if there was statistical significance between the ratings.

Significance was shown between "Shot Placement" versus "Hallway Movement" and "Hallway Movement versus Selector Switch Location". "Exposure" versus "Shot Placement" was not statistically different.

Table 11: Mann Whitney test for additional tutoring tasks

Comparisons	**P Value** at ∞ = .05
Exposure vs Shot Placement	0.4584
Shot Placement vs Hallway MVT	0.0141
Hallway MVT vs Selector Switch Location	0.0184

The additional tutoring subjects wanted most dealt with exposure. In an urban fight, it is extremely easy for a soldier to expose themselves to the enemy. In the process of clearing a room, soldiers become fixated on the threat and often disregard windows and doors to adjacent rooms.

Shot placement was the second most selected item for tutoring. This would allow soldiers to receive feedback instantly on their shot placement. This rating for shot placement may be an aberration due to the lack of feedback from the SAF enemy entities. They were able to absorb at least 10 rounds to the body before becoming neutralized. The only way to achieve instant incapacitation with the SAF enemy entities was to score a head shot.

Table 12: System Modifications Additional Tutoring

Question	**Mean**	**Median**	**Std Dev**	**Min**	**Max**
Exposure	1.6	1	0.8955	1	3
Shot Placement	1.6	2	0.5477	1	2
Hallway MVT	2.8	3	0.4472	2	3
Selector Switch	4	4	0	4	4

4.5 Scenario Realism

The scenario realism questions were used to determine if the participants viewed the virtual training as a realistic method for training. Questions in this section primarily ask the participant to rate the scenario to prepare them to accomplish the tasks in a live environment. A seven point Likert scale was used for each question. A One Sample Wilcoxon (Table 13) and descriptive statistics (Table 14) were used to analyze the data.

Table 13: Wilcoxon Test for Scenario Realism

Question Context	**Task**	**N**	**N for test**	**Wilcoxon Statistic**	**P**	**Estimatated Median**
Negative	Exercises like this do not prepare me for combat	5	3	6.0	0.181	5.500
Negative	There are better ways to train than using this system	5	4	10.0	0.100	5.500
Positive	Tutoring messages helped focus my attention	5	3	2.0	0.789	4.000
Positive	The exercise was realistic	5	4	0.0	0.100	3.000
Positive	Weapons effects were accurate	5	3	0.0	0.181	3.000

The Wilcoxon test measure was based on a cutting point of a median ≥ 4.0 versus a median < 4.0. The only positive response concerned the tutoring messages. Although the trend is to not accept the scenario as realistic, none of the responses are statistically significant.

The results of the descriptive statistics were ranked numerically by mean. None of the ratings for this scenario were very favorable. The majority of the subjects did not approve of the force structure used in the mission. During the scenario development stage, the initial force structure for the mission followed the doctrinal template required for such a mission. Much of the force structure had to be chopped due to erratic behavior of the SAF entities. To achieve a smooth level of interaction between SAF entities and live players some realism was compromised.

Most of the subjects were wary of using the technology of the system to accomplish their training goals versus using the tried and true live training methods. Most stated that the technology needed to grow, and they would like to have interacted with live players in their team. Weapons effects are also an area that needed improvement. The sounds from rifles and carbines lacked a realistic sound, and as stated earlier SAF entities (dismounted infantry) could absorb an inordinate amount of bullets without much effect.

Table 14: Descriptive Statistics for Scenario Realism

Question Context	**Question**	**Mean**	**Median**	**Std Dev**	**Min**	**Max**
Negative	Exercises like this do not prepare you for combat	5.4	5	0.6728	4	7
Negative	There are better ways to train these tasks than using this system	5.4	5	1.1401	4	7
Positive	The tutoring messages helped focus my attention during the exercise	3.8	4	0.8366	3	5
Positive	The exercise was realistic	2.8	3	0.8366	2	4
Positive	Weapons effects were an accurate representation of live training	2.8	3	1.3083	1	4

4.6 Individual Response to System Use

The final section of the survey contained questions concerning adverse reactions to the virtual environment or “simulator sickness”. Subjects were asked to complete the following questions contained at the end of Appendix B. All had experienced slight to moderate general discomfort and headache from using the HMD. The participants spent a lot of time adjusting the HMD's through the course of negotiating the scenario. When using the C2Mincs, only one eye would see the image. While this option replicated use of the monocular of the Land Warrior system, it did cause some distress. The amount of sweating indicated by the survey can be attributed to the carriage system and computers. The system is incorporated onto the current ballistic protection platform used today. This system retains body heat, and the computers for the system are located at the user's sides above the beltline further increasing the temperature in that region of the participant.

Table 15: Individual Response to System Use

	None	Slight	Moderate	Severe
General Discomfort		60%	40%	
Fatigue	100%			
Headache	60%	40%		
Difficulty Focusing	100%			
Increased Salivation	100%			
Sweating		40%	60%	

CHAPTER FIVE: CONCLUSION

The dismounted infantry simulator with intelligent tutoring is in the early stages of the program's research and developmental phase. The technology is evolving, and will need many years of development to produce a robust version. The Land Warrior platform, for which this system is a relative, has been in development and testing for over a decade without major unit fielding.

5.1 Tutoring Messages

It is difficult to discern if the tutoring in the scenario was an accurate representation of the tasks. Analysis of tasks accomplished by the individual versus those conducted in conjunction with SAF entities (ONESAF OTB 2.0) is conflicted. The *Move as a Member of a Fireteam* task and its subtasks do not demonstrate the same amount of significance as the *Enter and Clear a Room* task and its subtasks. The initial digital reporting activities required at the mission start may have skewed the results. If the tolerances for success in the tutoring software had been made larger for the reporting and team movement, the results may have been made more favorable. A more accurate assessment would require a team of live players to interact with each other in the scenario, and a reevaluation of the tolerances for successful completion of the evaluation.

5.2 System Evaluation

The system overall was rated favorably. The fidelity of the display is an area that needs improvement. When the user compares this system with a typical first person shooter game on the market, the comparison is not favorable. Most of the issues with moving within the buildings has to do with the correlation between the ONESAF program driving the exercise and the system. The simultaneous use of mouse and joystick will not be solved until there is a breakthrough in locomotion input. Doing these two together (using the mouse and joystick simultaneously) is most difficult task when using the system. Locomotion was also the function most recommended for modification. Task overloading is typical when a subject is asked to move, report, and scan the sector while in the system. I personally experienced this during a demonstration recently. During the clearing of a room, I became so fixated on my target that I forgot to let go of the joystick button. Instead of moving to the required point in the room, I continued to move and found myself out side the building and out of the fight.

5.3 Limitation of Study

The study was limited in two cases: the number of qualified personnel to undergo testing, and the number of systems available to use. The typical operational tempo of units makes it difficult for a unit to conduct a study such as this during training time, which is always limited. The result was a limited supply of qualified individuals to serve as subjects, which led to a small sample. With only one system to conduct a collective task, participants were asked to interact with SAF entities. The SAF entities could not communicate with the individual nor reliably vary their course of action based on enemy influences. The SAF entities have a standard set of responses to battlefield variables, but the results during the study were erratic and disabled. If these variables were not disabled, the scenario would not run smoothly.

5.4 Lessons Learned

The lessons learned during the development process were invaluable. The experience in providing input to designers, and watching the process of task standards become an automated process that provides instant feedback was very rewarding. All of the individuals involved were professional and dedicated to making the best product possible.

The main lesson learned with testing and experimentation would be to include three additional subjects to round out the fireteam in the virtual environment. This would have provided a better test environment and allowed more communication among team members. Michael Woodman, in his dissertation *Cognitive Training Transfer using a Personal Computer-Based Game: A Close Quarters Battle Case Study*, achieved results when he organized his participants to interact with three experts in the experiment. The only change from each experiment run was the subject.

5.5 Future Research

The U.S. Army is an organization that as an institution is very resistant to change. That is not to say the Army is not innovative, or does not embrace technology. Having experienced the digitization of combat platforms through the mid to late 1990's, glitches in systems are readily criticized. This is the same crossroads we are at today with providing the individual infantryman with a virtual training system. Live training is sacred to the infantry soldier. The physical and mental toughening that occurs through exposure to fatigue, hunger, weather, stress, and physical exertion can never be replaced by virtual training systems. The only way to gain acceptance for virtual training is to produce a system that can provide a service to the user that is difficult, expensive, or unsafe to replicate in a live environment. Intelligent tutoring and locomotion are aspects that need continued research.

Intelligent tutoring for this exercise was very specific to the scenario. The subject had to operate in a very specific area for the evaluations to occur. Further development on the authoring tool will increase the value of this program. More tasks need to be developed for the database. The widening of the parameters of the areas the evaluations will occur need to be explored. Future versions will need to allow the trainer to select the area of operation, select the tasks to be evaluated, and then select the personnel to be evaluated. This process needs to be simple and require little additional training if the capability is going to be available at the unit level.

Locomotion is the most complex issue to solve. The constraints of an embedded training do not leave many options for designers. Two possible solutions with locomotion might be considered. Move the locomotion away from the joystick. If the locomotion controls were moved to the feet, the experience would more realistically replicate using the Land Warrior system in a live environment. If that solution is not feasible, it is recommended other methods of manipulating the command and control system without using the other hand be explored. Voice command could be explored, but would widen the gap between the virtual and live experiences of the system.

APPENDIX A: TASK DEVELOPMENT FOR INTELLIGENT TUTORING

TASK DEVELOPMENT

Initial scenario development began with an overview of the military situation. Once the overview was developed, the designers were provided with a table to break the scenario down into manageable portions. Pictorial examples were included to enhance comprehension. The designers then provided their implementation of these tasks to be tutored.

Overview:

Reference: OPORD 04-1-6 SBCT AOR Cougar.

Company Mission: C 1-6 IN conducts a cordon and search of Mckenna Village in AO Charlie NLT 180200MAR05 to seize enemy threat personnel and contraband IOT prevent enemy activity from influencing the SBCT decisive operation in AOR WARRIOR.

Tasks to Maneuver Units:

1. Seize Mckenna APOD
2. 4th in OOM
3. Execute inner and outer cordon, search Mckenna Village and Railyard, capture any Black Listed Personnel
4. Detain any Gray Listed Personnel
5. Conduct negotiations with Mckenna mullahs and clerics: conduct IO operations
6. Destroy any militant resistance and Commando elements encountered
7. Protect key infrastructure to include: McKenna airfield, McKenna railhead, Leyte Heliport, Mckenna Propane Plant and lateral LOC's and rail lines in AOR Charlie.

Overview

Time has passed and C1-6 IN has begun the Area Security mission in the Mckenna AO. Informants have indicated that Muchtada El Sinbad will be meeting with local insurgent leaders to incite riots in Mckenna. Sinbad will meet in the mosque and will be arriving in a vehicle. ICV equipped forces will conduct covert insert of dismounted forces in the target area. ICV's will then conduct a series of rolling checkpoints IOT to distract insurgent forces, confirm that Sinbad's movements are unknown to coalition forces.

Scenario should begin with the squad being dropped off at their target building by ICV. Squad moves to their OP position. Occupies OP and observes the target building. Target is identified and report is sent to the Company Commander. Company Commander gives the unit approval to initiate the raid. Squad must move tactically to the point of entry. Squad conducts raid and seizes the HVT. SQD must egress to the linkup point to be picked up by the ICV's

Mission: 1st PLT, C 1-6 IN conducts raid to secure the terrorist leader NLT (DTG) IOT to prevent destabilization of the McKenna AOR

Maneuver: 1st SQD- Secure left and right flanks vic BLDG's 22/35 IOT to prevent reinforcement against the M/E

2nd SQD- M/E conducts raid to secure Sinbad IOT to prevent destabilization of the Mckenna AOR

3rd SQD- Suppress enemy forces IOT to allow extraction of terrorist leader

Mounted section (ICV): Conduct covert insert of dismounted forces into TGT AO IOT to prevent detection of main effort.

Tasks to Maneuver Units:

1st SQD: Occupy BLDG's 35 and 22

Remain undetected until initiation of the raid

2nd SQD: Occupy BLDG 32

Establish OP to ID HVT

Initiate Raid on confirmation of HVT

3rd SQD: Occupy BLDG 31

Initiate suppression upon exfiltration of 2nd SQD

Mounted Section (ICV): Conduct fake Check Point OPS IOT deceive enemy forces

O/O conduct P/U of HVT

ITS Point of View-

- Be a member of the main effort squad (2nd SQD)
- Be a member that occupies the OP to locate HVT
- Placement during initial stack to enter should be 2,3, or 4 man

Tasks to be tested/taught

Move Tactically

Occupy OP

Send Report

Enter and Clear a Room

Engage Targets

Special Features:

Note on weapon orientation

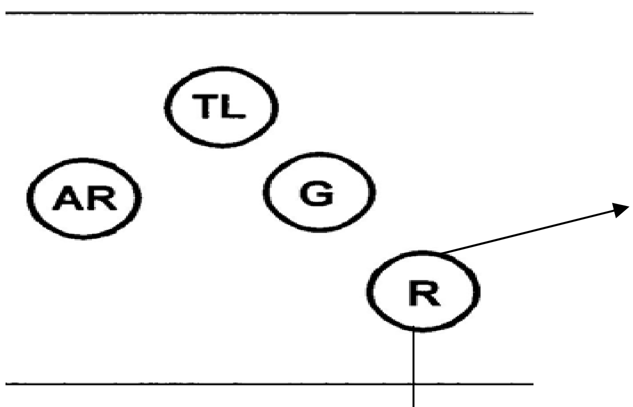
Use of cover/concealment (during movement, during observation of the target area)

E.g. - Not highlighting yourself in the window.

Potential Mistakes

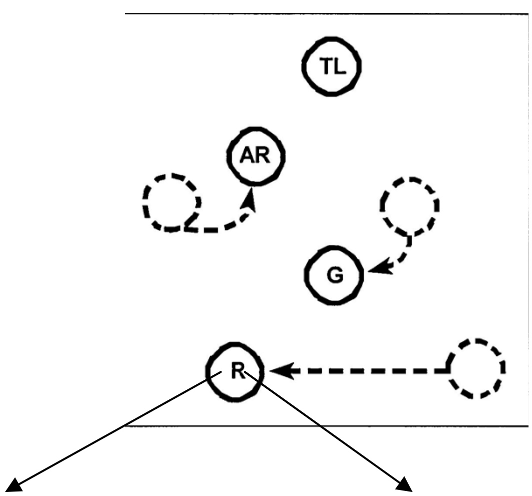
Scenario Steps	Player A	Player B
1. Scenario initiated with one ICV and one dismounted squad to WSW of target area (A) one ICV and one dismounted squad to SW of target area.(B)		
2. - Alpha squad moves out across terrain to East to take position in bldg to prepare for assault, ICV 1 moves out to security position to the W of target area - Bravo squad mounts ICV 2 and moves to position to ESE of target area	MVT Report Wrong location in Fireteam formation Not observing proper sector of fire Not observing team leader	MVT Report

Fire Team Wedge Formation



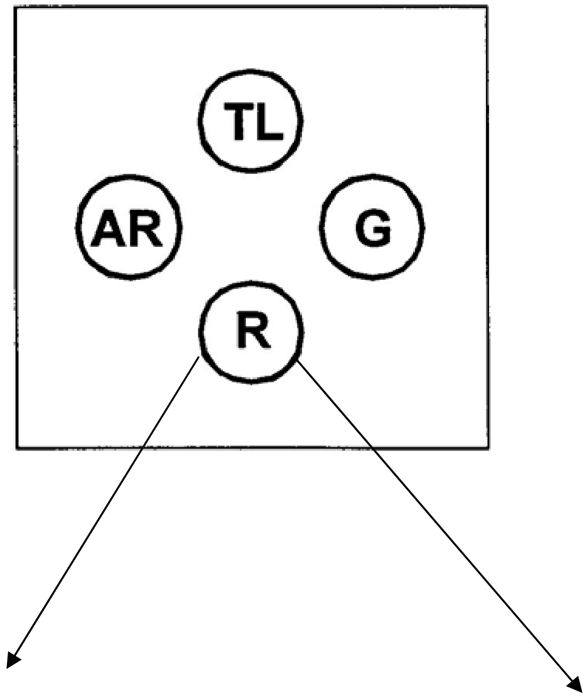
Should primarily be looking in this location with quick looks to the TL. If the player is not looking in this sector for more than 5 sec a warning should be displayed

Modified Fireteam Wedge

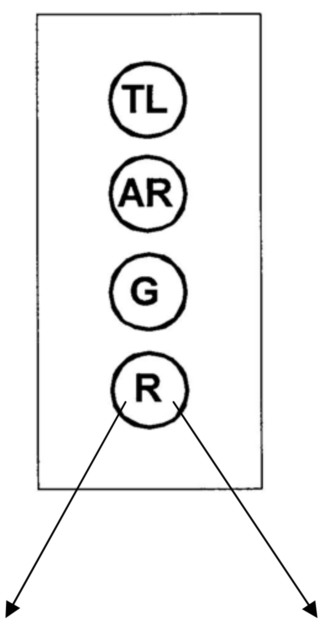


Should primarily be looking in this location with quick looks to the TL. If the player is not looking in this sector for more than 5 sec a warning should be displayed

Fireteam Diamond



Fire Team File

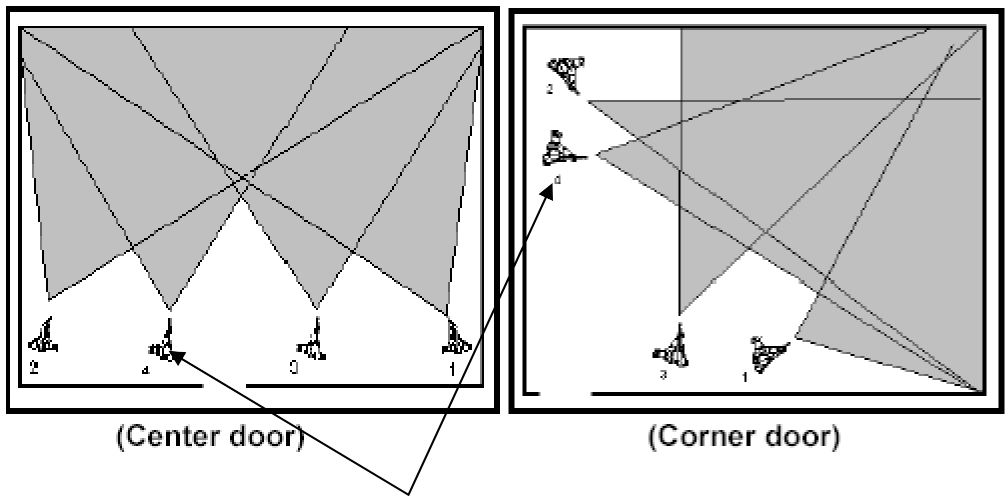


Should primarily be looking in this location with quick looks to the TL. If the player is not looking in this sector for more than 5 sec a warning should be displayed

Potential Mistakes

Scenario Steps	Player A	Player B
3. - Alpha takes position in BLG (West of mosque) - Bravo dismounts and moves to bldg to conduct observation and security for Alpha. - ICV 2 moves (while covering bravo) to NE of target area to conduct security operations - Sinbad and crew begin to move into city in Suburban from NW.	ATM will enter and clear the room Rpt that unit is set Not maintaining position in stack Does not maintain proper location in room Does not maintain proper sector of fire Muzzle sweeps friendly soldiers Head and muzzle move in unison when clearing Soldier moves with the weapon off safe	Report that BTM is moving Wrong location in Fireteam formation Not observing proper sector of fire Not observing team leader

Player will be the last man in the stack. Will cover the rear of the team as they prepare to enter and clear the room



Final positions of team members #4 man based on door location

Some points of interest:

As in all combat situations, the clearing team members must move tactically and safely. Individuals who are part of a clearing team must move in a standard manner, using practiced techniques known to all.

a. When moving, team members maintain muzzle awareness by holding their weapons with the muzzle pointed in the direction of travel. Soldiers keep the butt of the rifle in the pocket of their shoulder, with the muzzle slightly down to allow unobstructed vision. Soldiers keep both eyes open and swing the muzzle as they turn their head so the rifle is always aimed where the soldier is looking. This procedure allows to soldier to see what or who is entering their line of fire.

b. Team members avoid flagging (leading) with the weapon when working around windows, doors, corners, or areas where obstacles must be negotiated. Flagging the weapon gives advance warning to anyone looking in the soldier's direction, making it easier for an enemy to grab the weapon.

c. Team members should keep weapons on safe (selector switch on SAFE and index finger outside of trigger guard) until a hostile target is identified and engaged. After a team member clears his sector of all targets, he returns his weapon to the SAFE position.

Potential Mistakes

Scenario Steps	Player A	Player B
4. Alpha waits for signal to assault - Bravo enters building (across the street from mosque) and clears rooms until arriving at room on second floor to conduct security and observation. - ICV 2 identifies Sinbad vehicle in route and notifies dismounts - ICV 1 and 2 set in positions	Does not acknowledge ICV rpt	BTM will enter and clear the room (See Fig 2) Rpt that unit is set Not maintaining position in stack Does not maintain proper location in room Does not maintain proper sector of fire Muzzle sweeps friendly soldiers Head and muzzle move in unison when clearing Soldier moves with the weapon off safe Does not send report that unit is set Does not acknowledge ICV RPT Player B exposes self from the vantage point
5. - Sinbad vehicle enters the city - Bravo identifies Sinbad vehicles and reports to all elements	Does not acknowledge report	Misses Sinbad Does not send report

Potential Mistakes

Scenario Steps	Player A	Player B
6. Sinbad and crew dismount at mosque parking lot and enter. - Bravo identifies Sinbad and clears alpha for assault - Alpha moves to target building and stacks outside awaiting raid	Players misses both reports Wrong location in Fireteam formation Not observing proper sector of fire (See Fig 1) Not observing team leader (See Fig 1) Not maintaining position in stack Muzzle sweeps friendly soldiers Soldier moves with the weapon off safe	Player does not report
7. - Alpha conducts raid - Sinbad vehicle attempts to escape - Enemy in mosque eliminated. - Bravo identifies escaping vehicle and attempts to engage if possible. - Bravo unable to engage and conducts target handoff to ICV 2 (mounted player)	ATM will enter and clear the room (See Fig 2) Rpt that unit is set Not maintaining position in stack Does not maintain proper location in room Does not maintain proper sector of fire Muzzle sweeps friendly soldiers Head and muzzle move in unison when clearing Soldier moves with the weapon off safe	Does not ID or engage threat vehicle Does not send Target Handoff message
8 - ICV 2 receives target hand-off, identifies suburban, and destroys it. - Alpha and ICVs begin to move to rally point for egress.	Does not maintain position in formation Does not monitor TL Does not maintain sector of fire	Maintains sector of fire to cover ATM
9. ICVs conduct security and covering operations as required - Bravo conducts covering operations as required	Does not maintain position in formation Does not monitor TL Does not maintain sector of fire	Maintains sector of fire to cover ATM

Potential Mistakes

Scenario Steps	Player A	Player B
10. -Alpha and ICV 2 set at rally point - Bravo moves to rally point and links with ICV 1. - Alpha and ICV 2 covers Bravo	Does not send RPT Does not maintain position to cover BTM	Does not maintain position in formation Does not monitor TL Does not maintain sector of fire
11. Squads mount ICVs and conduct egress to the south, scenario terminates.		

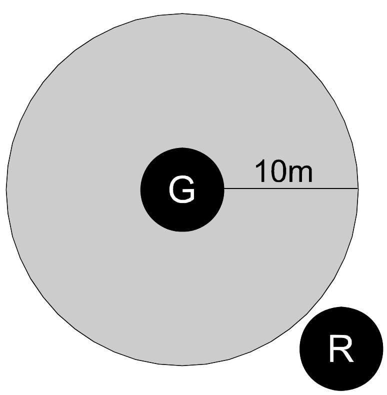
Example of determining formation standards:

Details for formation and sector of fire evals

<u>Wedge formation</u>

1. First implementation

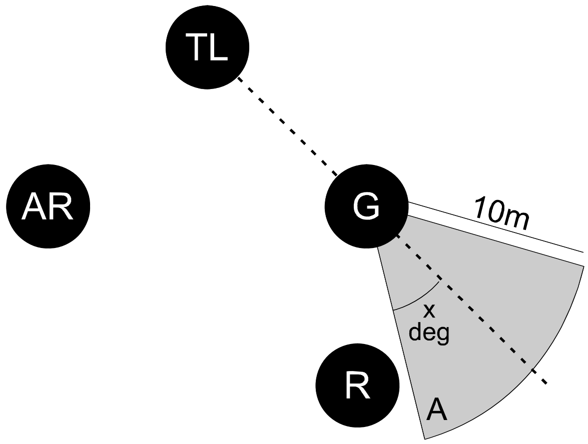
Simple check for relative positions between R and G.



If R is greater than 10m from G, in any direction, then trigger a feedback. In the figure above, R is out of position, being too far from G.

2. Second implementation

Use R and G positions relative to Team Leader position.



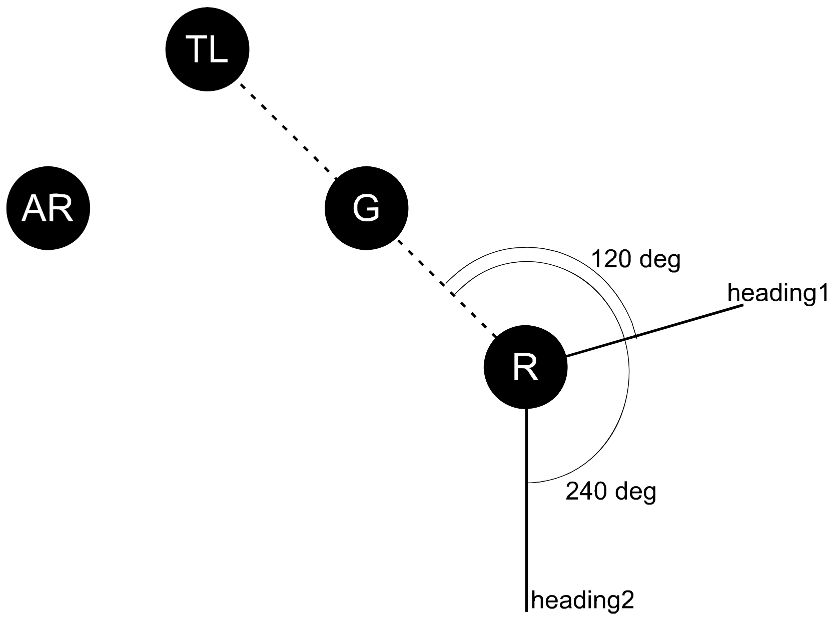
In this case, first we can run the test from the first implementation, which checks if R is within 10m of G, in any direction. If that fails, trigger a feedback. If R is within that radius, then the next step is to check if R is in the proper section of that radius (area A in the fig above).

Area A is defined by taking the heading from G to TL, and calculating the space of a pie wedge created by an offset of x degrees on either side of that heading. In the figure above, the x offset is 30 degrees on either side. In the figure above, R is in a position that would satisfy the first test (position within the 10m radius), but fail the second test (position outside of area A).

This makes an assumption that G is in the proper position relative to TL. If we will need to handle situations where this is not the case, then we will need to define a third implementation that uses more detailed calculation.

Sector of Fire in Wedge Formation

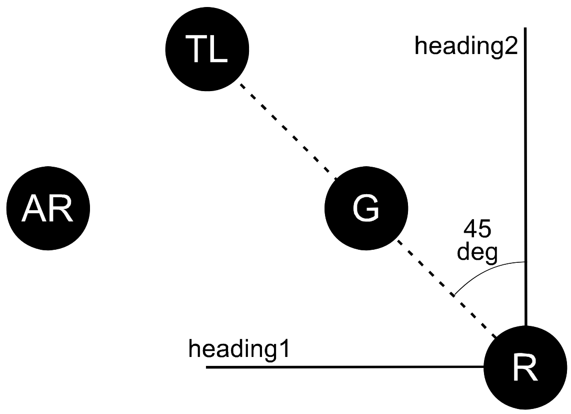
This evaluation is only in effect when R is in the proper position within the formation. If R is out of position, the system will not check for whether R is looking at the proper sector of fire. The sector of fire is calculated strictly from headings, so there are no areas to consider, just relative headings.



The heading analysis is always relative to the heading from R's position to TL's position. The sector of fire is defined as any view heading (determined from head orientation) between two allowable headings, heading1 and heading2 in the figure above. For the wedge formation, heading1 is 120 degrees clockwise from the R-to-TL heading, and heading2 is 240 degrees clockwise from the R-to-TL heading.Feedback is triggered when R's head orientation is not between heading1 and heading2, relative to TL, for any time greater than 5 sec.

Viewing Team Leader in Wedge Formation

This evaluation is similar to the previous one in all respects except for the definition of headings.

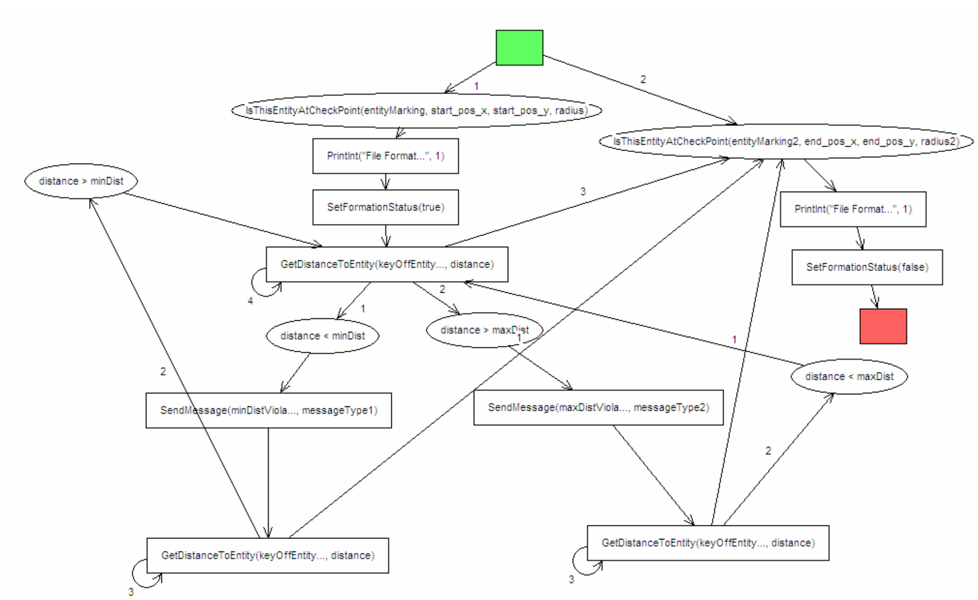


heading1 is 45 degrees counterclockwise from the R-to-TL heading. heading2 is 45 degrees clockwise from the R-to-TL heading.

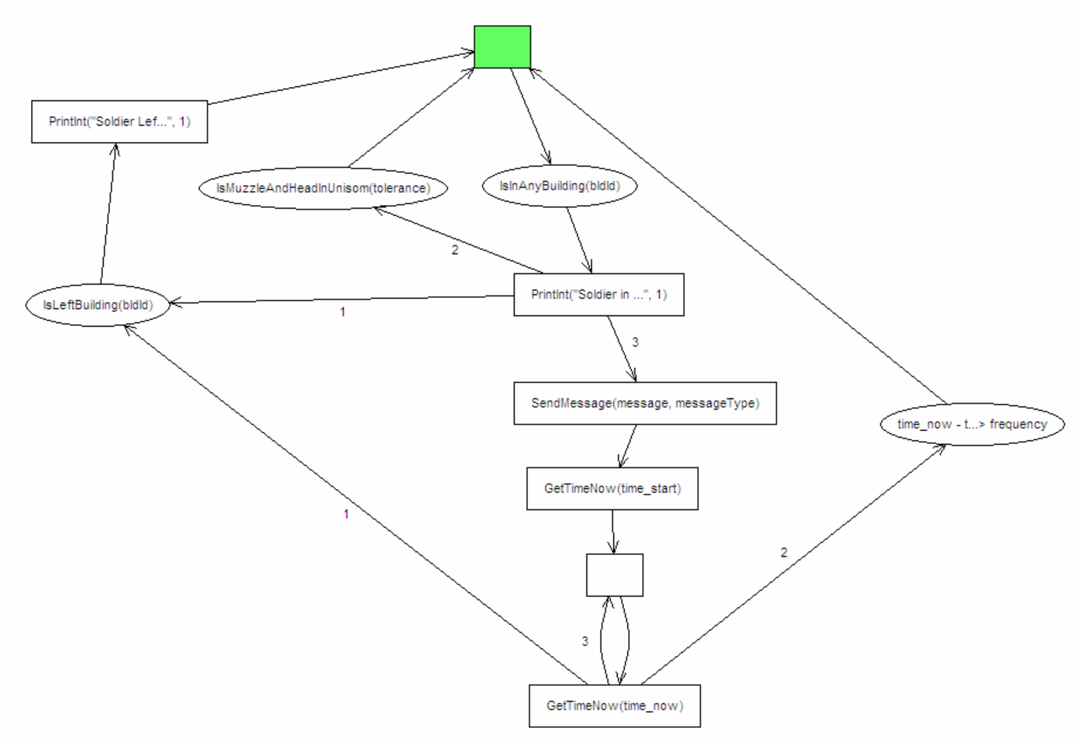
Feedback is triggered when R's head orientation is not between heading1 and heading2, relative to TL, for any time greater than 30 sec.

An example of behavior models:

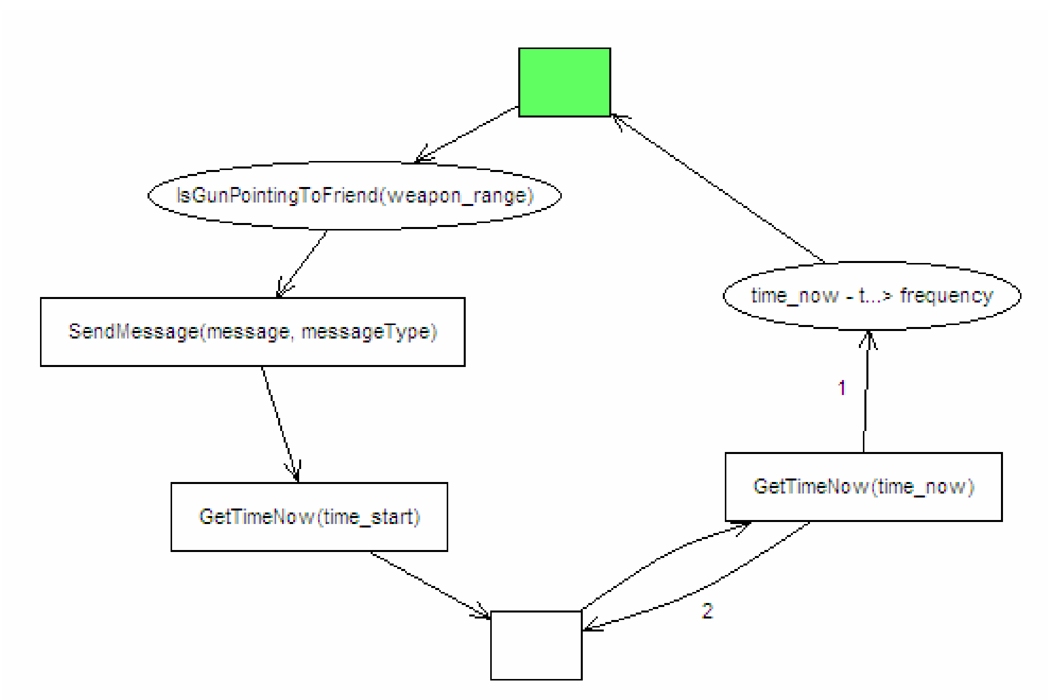
Formation diagram



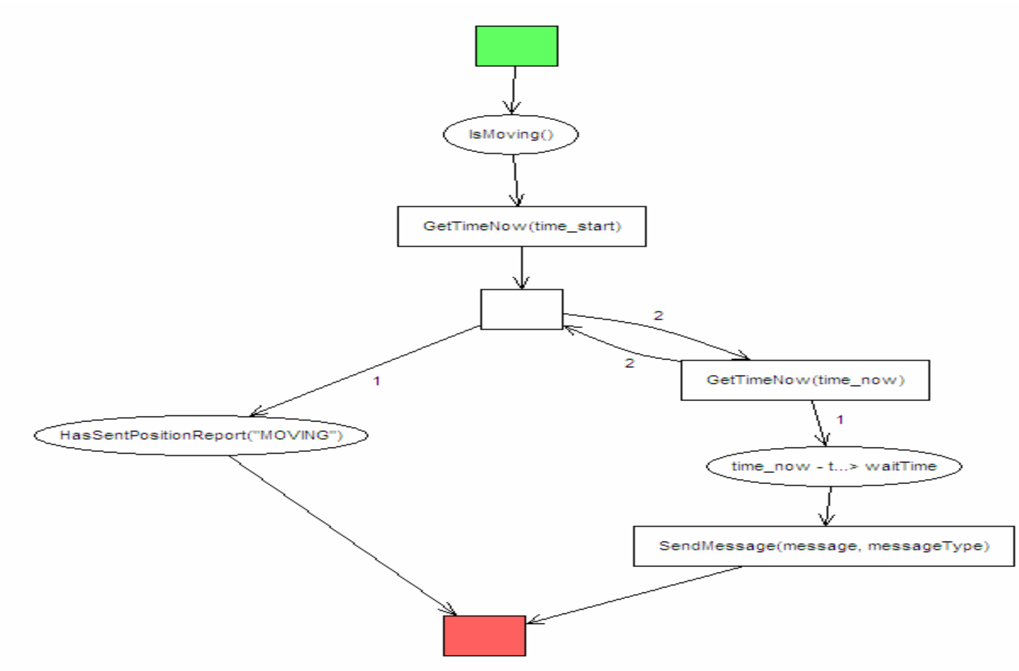
Muzzle and head move in unison



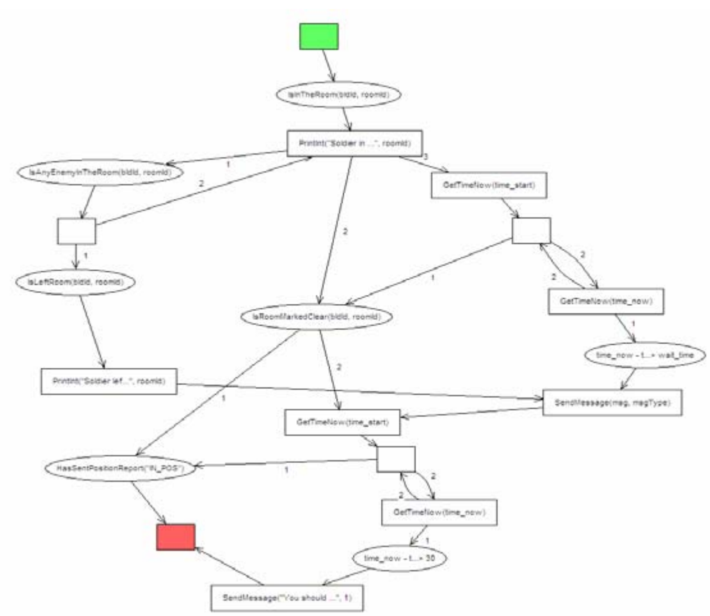
Muzzle sweeps friendly soldier



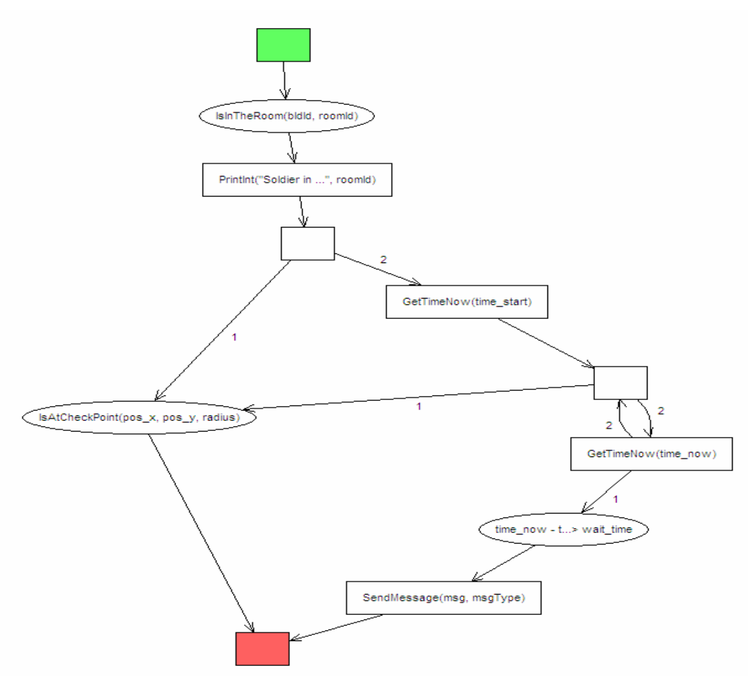
Movement report



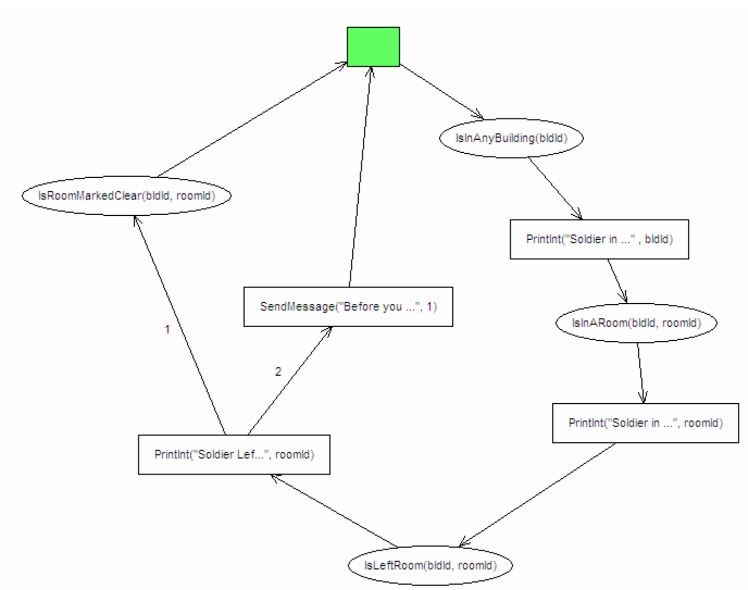
Room Clearing



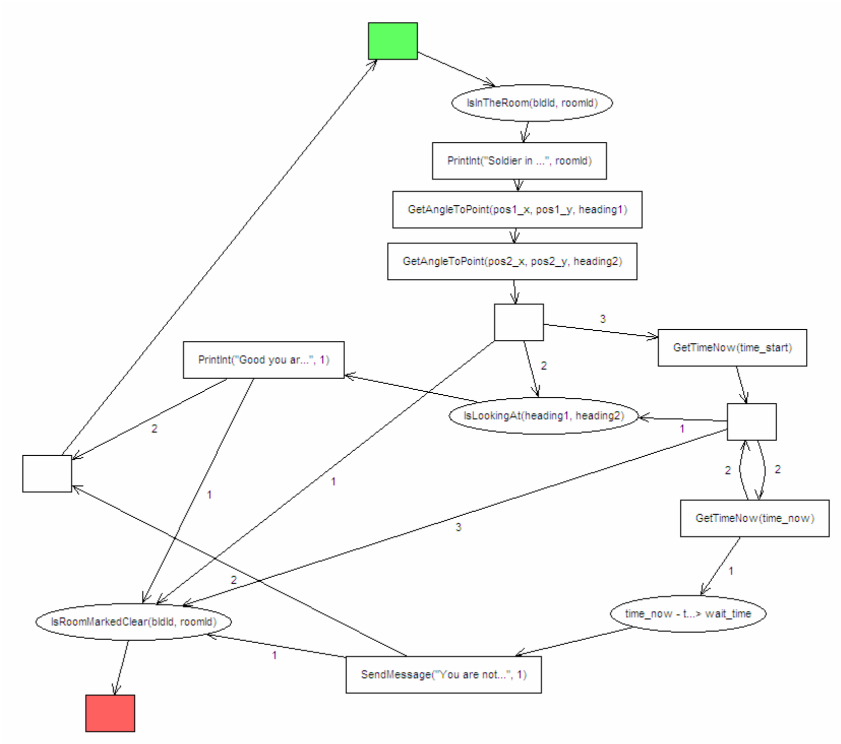
Correct position in the room



Marking the room cleared



Sector of fire in the room



APPENDIX B: SURVEYS

Surveys

SOLDIER SURVEY

What is your rank? _________________

How many years of service do you have? __________________

Do you have combat experience? Y / N

Have you performed any of the following tasks:

	Combat	Training
Enter and Clear a Room?	Y / N	Y / N
Move as a member of a fireteam?	Y / N	Y / N
Report Tactical Information?	Y / N	Y / N

TASKS ASSESSMENT

INSTRUCTIONS: Please circle the number that best represents you answer. 1 is the lowest value you can assign (Not Accurate), and 7 is the highest value (Extremely Accurate). Rate the ability of the intelligent tutoring system to accurately assess the following tasks.

1. Enter and Clear room

   1 2 3 4 5 6 7

2. Location and spacing in the stack formation

   1 2 3 4 5 6 7

3. Location in the room in relation to perceived location based on your number in the clearing team

   1 2 3 4 5 6 7

4. Maintaining sector of fire in the room

   1 2 3 4 5 6 7

Soldier Survey (PG2)

INSTRUCTIONS: Please circle the number that best represents you answer. 1 is the lowest value you can assign (Not Accurate), and 7 is the highest value (Extremely Accurate). Rate the ability of the intelligent tutoring system to accurately assess the following tasks.

5. Maintaining muzzle awareness

   1 2 3 4 5 6 7

6. Marking the room cleared

   1 2 3 4 5 6 7

7. Move as a member of a fireteam

   1 2 3 4 5 6 7

8. Maintaining distance in the formation

   1 2 3 4 5 6 7

9. Maintain sector of fire during movement

   1 2 3 4 5 6 7

10. Monitor Team Leader during movement

   1 2 3 4 5 6 7

11. Report tactical information

   1 2 3 4 5 6 7

Soldier Survey (PG3)

SYSTEM EVALUATION

INSTRUCTIONS: Rate your evaluation of the system's ability to accomplish the following tasks. Please circle the number that best represents you answer. 1 being the lowest (Poor), and 7 is being the highest (Extremely well).

1. Movement to the front, left, right, rear, and obliques

   1 2 3 4 5 6 7

2. Scan for targets

   1 2 3 4 5 6 7

3. Identification of friendly and enemy forces

   1 2 3 4 5 6 7

4. Engage targets

   1 2 3 4 5 6 7

5. Ability to move within buildings

   1 2 3 4 5 6 7

6. Depth perception within the buildings

   1 2 3 4 5 6 7

7. Use of mouse and joy stick simultaneously

   1 2 3 4 5 6 7

8. Use of C2Mincs for reporting tactical information

   1 2 3 4 5 6 7

9. Location of pop-up messages

   1 2 3 4 5 6 7

10. Frequency of pop-up messages

   1 2 3 4 5 6 7

Soldier Survey (PG4)

11. Layout of control buttons on the joystick for ease of use

    1 2 3 4 5 6 7

Scenario Realism

INSTRUCTIONS: Rate your evaluation of the realism of the system. Please circle the number that best represents you answer. 1 is strongly disagree, and 7 is strongly agree.

1. Exercises like this do not prepare you for combat

   1 2 3 4 5 6 7

2. There are better ways to train these tasks than using this system

   1 2 3 4 5 6 7

3. The exercise was realistic

   1 2 3 4 5 6 7

4. The tutoring messages helped focus my attention during the exercise

   1 2 3 4 5 6 7

5. Weapons effects were an accurate representation of live training

   1 2 3 4 5 6 7

6. Quality of image display

   1 2 3 4 5 6 7

Additional Modifications

The following tasks are being considered for development for intelligent tutoring. Rank these tasks in the order of importance you think they should be developed. With one being the most important.

Tasks

Hallway Movement __________________

Exposing yourself through windows, doors, or mouseholes __________________

Shot Placement __________________

Soldier Survey (PG5)

Selector switch location during mission ____________________

System Design

Rank the following features that you think need to be modified to enhance the system. With one being the most important.

Head Mounted Display	____________________
Joystick	____________________
Mouse	____________________
Locomotion	____________________
Formatting of Reports	____________________

Individual Response to System Use

During or after participating in the simulation, did you experience any of the following? Please circle the appropriate response?

General Discomfort:	None	Slight	Moderate	Severe
Fatigue:	None	Slight	Moderate	Severe
Headache:	None	Slight	Moderate	Severe
Difficulty Focusing:	None	Slight	Moderate	Severe
Increased Salivation:	None	Slight	Moderate	Severe
Sweating:	None	Slight	Moderate	Severe

Soldier Survey (PG6)

Would you consider this item to be useful for your unit's training?

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