Development of Scenario-Based Pre-deployment Counter-IED Training

Benjamin Bell, Ph.D.
CHI Systems, Inc.
Fort Washington, PA USA
bbell@chisystems.com

Jerzy Jarmasz, Ph.D.
Defence Research and Development
Toronto, ON CANADA
jerzy.jarmasz@drdc-rddc.gc.ca

Inez Nelson
CHI Systems, Inc.
Fort Washington, PA
inelson@chisystems.com

ABSTRACT

Improvised Explosive Device (IED) incidents account for the majority of combat deaths among Canadian Forces (CF) in Afghanistan. The problem of training for safe and early IED detection in-theatre is exacerbated by insurgent forces that observe counter-IED efforts and quickly adapt to them. Further, the average Afghan tour of duty for Canadian Forces is much less than a year in duration, severely limiting institutional memory in the combat unit. Recently-arrived troops are much less likely to identify an IED threat in time to prevent an event than are those with several months in-country. This paper reports on the front-end analysis, design, development and evaluation of a game-based training application that distills the experiences and lessons learned of just-returned CF troops to present immersive, scenario-based training. The Counter-IED Immersive Training Environment (CIITE) employs VBS2, intelligent agents and speech interaction. We summarize the design principles and technical implementation, and present empirical findings from a pilot evaluation, to include measures of operational relevance, usability, and perceived training potential. For operational relevance, Canadian troops recently returned from Afghanistan participated in shaping the scenarios. We also worked with CF Land Forces Directorate Training Services (LFDTS) group to develop survey instruments aimed at shaping the training to meet the expectations and background of the CF target audience. For usability and attitudes toward training value, ten soldiers with at least one tour of duty in Afghanistan each completed two scenarios and provided survey data to assess attitudes toward the fidelity of the information contained in the scenarios and the perceived benefit to soldiers about to be deployed. We present findings from this pilot study and discuss what these preliminary results suggest about the training approach employed in this program.

ABOUT THE AUTHORS

Benjamin Bell is the President and CEO of CHI Systems, Inc. Dr. Bell has over twenty years of experience in intelligent tutoring, cognitive science, and artificial intelligence and holds a Master's Degree in Human Factors from Embry Riddle and a Ph.D. in Computer Science from Northwestern University. Prior to CHI Systems, he served on the faculty of Teachers College, Columbia University and held positions with Lockheed Martin and the Technical University of Denmark.

Jerzy Jarmasz is a research scientist at Defence R&D Canada, the science and technology agency of the Canadian Department of National Defence. His work focuses on simulation-based training in a number of areas, including distributed mission training, IED detection and awareness, and decision making in complex, dynamic environments. Dr. Jarmasz' areas of expertise include basic cognitive processes, team communications and cognition, and the use of dynamic systems theory for understanding cognition and command-and-control.

Inez Nelson is a software engineer with over 5 years of experience in interface development and game design. She has designed and implemented client-server architectures for incorporating speech dialogue into training simulation applications, as well serving as the lead developer for CHI Systems' Counter-IED Immersive Training Environment. She specializes in animation, modeling, and graphical simulation design and development. Ms. Nelson holds a Master of Science and Engineering degree in Computer Graphics and Game Technology from the University of Pennsylvania.

Development of Scenario-Based Pre-deployment Counter-IED Training

Benjamin Bell, Ph.D.
CHI Systems, Inc.
Fort Washington, PA USA
bbell@chisystems.com

Jerzy Jarmasz, Ph.D.
Defence Research and Development
Toronto, ON CANADA
jerzy.jarmasz@drdc-rddc.gc.ca

Inez Nelson
CHI Systems, Inc.
Fort Washington, PA
inelson@chisystems.com

INTRODUCTION

Improvised Explosive Devices (IEDs) present one of the greatest threats to Canadian and allied forces operating in Afghanistan and are rapidly spreading to other conflict regions. The challenges for IED training are critical and complex. IEDs have transformed the battle zone by putting all personnel on the front line at any time. The character of the IED threat is perpetually changing – the adversary is always improvising to defeat our counter-IED activities. Thus, flexible, changeable tactics, techniques, and procedures (TTPs) are needed to counter the IED threat, and capabilities for adapting and updating training in this area present a corresponding need.

This type of training should not be restricted to TTPs nor to specific knowledge, but must include basic IED threat awareness and procedural skills. To address this training need, we created a prototype learning tool called the Counter-IED Immersive Training Environment (CIITE). CIITE demonstrates an approach to providing a cognitive skills practice environment based on scenario-based guided practice principles. The overarching objective of this program was the development and evaluation of a prototype game-based immersive training tool for recognition and mitigation of IED threats. Scenarios were drawn from lessons learned in-theater and employ simulation, interactive speech, intelligent agents, and automated performance assessment.

CIITE employs scenario-driven counter-IED training scenarios that immerse users in a simulated environment featuring typical local terrain, variable pedestrian behaviors, access to simulated equipment and interaction with other entities. A central feature of the CIITE architecture is coupling a commercial off-the-shelf (COTS) game engine (in this case, VBS2 from Bohemia Interactive) with an intelligent agent framework, in this case, the Advanced Speech Interactive Synthetic Teammates Authoring Toolkit (ASIST-AT)®, a toolkit developed by the lead author and colleagues. These agents enrich the training by providing interactive behaviors for select entities in each scenario. The use of this agent framework also demonstrates the ability to collect diagnostic measures of proficiency that can be presented immediately following the mission. Finally, segmenting training content from any specific COTS gaming tool provides flexibility for future implementations. One design principle we therefore employed for CIITE is to avoid as much as possible embedding training content in the VBS2 product and instead relying on the lightweight, open architecture of ASIST-AT for representing and executing learning objectives, tutoring help, performance measurements, and select entity behaviors.

TRAINING REQUIREMENTS ANALYSIS

The training requirements for CIITE reflect the subtle and constantly changing realities faced by warfighters in Afghanistan. IED attacks are, by their very nature, highly adaptable and opportunistic. Subject-matter experts reported that standard training has been less than effective because it underemphasizes this variance. Enemy forces in Afghanistan have exhibited continuous adaptability in the placement, concealment and detonation of IEDs. "They learn from us because they watch us," says an officer recently returned from Afghanistan.

This battlespace fluidity requires a dynamic set of desired competencies and learning objectives. Rather than mastering a set of procedures or skills, the Canadian soldier must learn to anticipate and counteract the ever-changing responses of the enemy to Canadian Forces' procedures. The essential competencies to be deconstructed into objectives must stress both agility of thought and field-level formation and execution of strategy.

Subject-Matter Expert Interviews and Cognitive Task Analysis

The principal focus of CIITE training is cognitive skills, such as how to identify, understand, and prioritize potential IED threats and what immediate actions to take according to the procedures appropriate in each case. The specific target skills were derived through close and frequent interaction with subject

matter experts (SMEs) facilitated by our Canadian Forces (CF) collaborators. Interaction with these operational personnel helped to identify relevant aspects of this complex training requirement and informed the design and implementation of the program of instruction. A Cognitive Task Analysis approach (Zachary, Ryder, & Hicinbothom, 1998) defined specific training requirements through documentation analysis, unstructured interviews with experts, a visit to a regimental installation, and multiple site visits to a CF simulation training facility, Land Forces Doctrine and Training System (LFDTS) Directorate of Army Training (DAT), CFB Kingston.

We interviewed members of Princess Patricia's Canadian Light Infantry (PPCLI) Charlie Company, at Canadian Forces Base Edmonton. Eight volunteer participants were chosen based on their time in service, deployments and exposure to IED events. Highlights from the interviews include a universal belief in the power of enemy forces to adapt quickly to published observed changes in CF procedures. Interviewees also cautioned against absorbing too much training material from US forces, as American combatants' experiences were shaped by operations in Iraq and the lessons learned do not translate well into an Afghan context. Finally, the soldiers stressed deliberate, planful adherence to established procedures even in crisis situations. The cognitive-task analysis process we employed yielded one primary training objective and nine secondary objectives, each with corresponding enabling objectives, described below.

Training Objectives

We express the CIITE training objectives using Mission Essential Competencies (MECs), a framework to describe "high-order individual, team, and inter-team competencies" needed "for successful mission completion under adverse conditions and in a non-permissive environment" (Colegrove & Alliger, 2002). MECs are composed of supporting competencies. For CIITE we identified one top-level MEC: *identify and successfully neutralize IED threats while minimizing the opposing force's ability to mount such threats*; as well as nine supporting competencies (Table 1) and thirty-eight knowledge and skills objectives. These objectives center on Vulnerable Point Search (VPS) and standoff, finding and confirming the presence of an IED and securing the area while awaiting the arrival of explosive-ordinance-disposal (EOD) personnel. These objectives echo and expand upon the "five Cs" currently taught to Canadian Forces in basic and pre-deployment training. These measures — Confirm, Clear, Call, Cordon, Control — form the basis of recognized counter-IED procedures.

Table 1. Supporting Competencies

1	Perform VPS or standoff in response to environmental changes
2	Perform VPS or standoff in the presence of chokepoints and traffic changes
3	Choose VPS activities and methods that will prevent enemy forces from learning standard operating procedures or predicting the responses of Canadian Forces (CF) to threats.
4	Undertake preventive countermeasures in the presence of life activities that signal the possible presence of an IED.
5	Perform VPS, enforce standoff and practice avoidance consistently even during an IED event.
6	Perform VPS activities in the presence of regionally specific architectural and environmental constructs.
7	Apply appropriate operational limits to available technology while exploiting it fully.
8	Disregard common misperceptions and maintain vigilance in situations offering a false sense of security.
9	Use preventive strategies where possible.

Training Approach

The format of the program of instruction in CIITE is a scenario-centered, immersive game-based application based on the construct of Goal-Based Scenarios (Schank, Fano, Bell & Jona, 1994; Bell, 1999). This generalizable methodology enables highly context-specific training that links performance assessment to training objectives, thus addressing the requirement, discussed earlier, of a program of instruction that can be rapidly adapted in response to changing TTP in the counter-IED domain.

We defined four scenarios, two of which were implemented as part of the demonstration and evaluation reported here. The scenarios differ according to the underlying objectives and non-player character (NPC) actions and reactions. Each CIITE scenario incorporates the following:

1. A *mission pre-brief* to describe the mission and the surroundings, including a map and overlay orders;
2. *Randomization*: Scenarios feature probabilistic threat locations and IED detonations;
3. *Real-time Feedback*: CIITE incorporates virtual instructor hints with feedback and mentoring for specific actions and decisions within a scenario;
4. *Debrief*: CIITE provides a debrief capability that presents basic performance metrics.

Scenario Synopses
Scenario 1 focuses on transporting a high-value person through a crowded marketplace. The emphasis in Scenario 2 is interaction between the forward operating base (FOB) and an adjacent village. An outline of each scenario is provided below.

Scenario 1 – Urban Transport
In this scenario the user is in command of a section of soldiers and an armored personnel carrier (LAV III, a variant of the Stryker). The mission is to escort a Canadian civilian development official to a meeting within a typical Afghanistan urban setting. Early in the scenario the user will encounter canalized (narrow, high walls) ground and be forced to dismount his section from the LAV III and perform appropriate actions to ensure the area is free from IEDs. Figure 1 shows the section embarked in the LAV III.

Figure 1. Section embarked in the LAV III.

The principal training points covered in this scenario are as follows:
- the use of appropriate formations for VPS
- travel in canalized areas
- check the tops of walled and patched areas for evidence of IEDs
- check walls and the base of trees or other environmental features that could conceal and IED
- perform VPS when encountering bottlenecks or canalized ground
- perform VPS when encountering debris piles
- look out for suspicious followers
- look out for suspicious vehicles such as:
  - vehicles with single occupants
  - vehicles following too closely
  - cars with tires much newer than the vehicle
- watch for fleeing children
- watch for deserted areas that should not be
- on IED detection perform the 5 C's (Confirm, Clear, Call, Cordon, Control)

Mission: Transport a high-value person (HVP) through a populated neighborhood to a meeting point.

Event Summary:
- LAV III leaves facility.
- Vehicle traverses a crowded marketplace
- Vehicle traverses a walled neighborhood with high rooftops
- Dismounted patrol traverses canalized area, intersections.
- Dismounted patrol delivers HVP to destination

Scenario 2 – Village Patrol
This scenario takes place in the vicinity of a FOB. The user is the lead section commander in a platoon that is maneuvering to a nearby village to meet with a village elder. The platoon consists of three LAV IIIs with the user controlling the lead LAV III. Shortly after leaving the FOB, the platoon will encounter a location that shows signs of a possible IED attack. The lead section will then be ordered to dismount and perform the appropriate VPS alongside a Wadi. Figure 2 illustrates a first-person view shortly after dismounting the LAV.

Figure 2. Disembarked from the LAV III.

The principal training points covered are:
- check recently disturbed ground for buried IEDs
- check culverts, sides of wadis and other features that could conceal an IED
- perform VPS when encountering features that could conceal an IED
- use caution when approaching suspicious events such as an accident or awkward placement of a barrier
- look out for suspicious followers
- look out for suspicious vehicles such as:
  - vehicles with single occupants
  - vehicles following too closely
  - cars with tires much newer than the vehicle

- maintain vigilance and spacing even in sight of CF or AF compounds
- maintain 360-degree awareness even when investigating a possible IED.
- avoid roads that may be IED-rich. Drive cross-country when there is no human cost (*e.g.*, farmer's field) and the road is likely to be planted with IEDs.
- on IED detection perform the 5 C's (Confirm, Clear, Call, Cordon, Control)

Mission: To visit the village elder to discuss village members who have been observed placing IEDs

Event Summary:

- Vehicle convoy leaves FOB
- Vehicle moves through rudimentary roads
- Vehicles encounter traffic accident, damaged vehicles in road
- Dismounted patrol investigates
- Dismounted patrol will traverse
  - Culvert
  - Wadi system
  - High feature (walls/berms)
- Patrol proceeds to elder's residence.

DESIGN OF THE CIITE TRAINING SYSTEM

CIITE runs in VBS2 and employs ASIST-AT to provide behaviors for select entities beyond the scripting capability in VBS2. ASIST-AT agents collect performance measures and provide a framework for organizing and presenting tutorial information. Figure 3 shows the architecture integrating these elements.

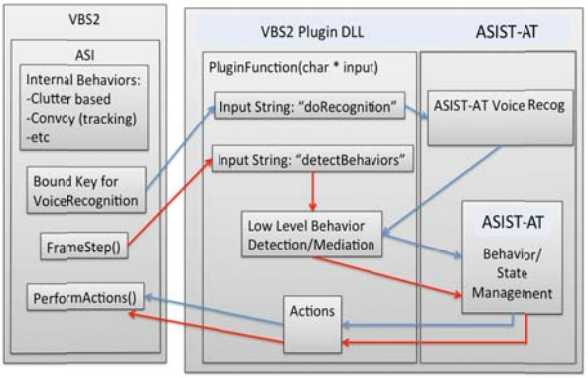

Figure 3. CIITE architecture. Red arrows depict behavioral or cognitive data; Blue arrows depict dialogue data.

We also employed the Unified Learning Platform (ULP), a lightweight learning management system (LMS) developed by the lead author and colleagues, to organize training objectives, manage user login and scenario selection, and present performance measures in an after-action review (Figure 4).

VBS2 supplies the simulated environment, models, art assets, terrain, NPCs, game mechanics, view (camera) controls and movement commands. The elements described below were added to provide counter-IED training beyond the capabilities native to VBS2.

Counter-IED menu

Training objectives in CIITE focus on doctrinal procedures to promote force protection and mission effectiveness. We encapsulated the most common ones

Training Objectives

Training Objective	Result	Severity	Feedback
Decide to Dismount Vehicle in a timely manner to perform Vital Point Search in canalized area	Success	High	You made the correct decision to dismount the vehicle allowing you to perform Vital Point in canalized area and you dismounted the vehicle in time
Decide what type of formation to use for vital point searches (VPS)	Success	High	You correctly used the V-formation which you should always use for vital point searches
Demonstrate completion of the appropriate Counter IED procedures in the correct order	Failure	High	You did not perform the 5C's in the correct order
Demonstrate creating the correct size cordon around suspected IED	Failure	High	You created a cordon of the incorrect size. The correct size is 100m – 300m
Demonstrate how to confirm all IED sightings to chain of command	Success	High	You were able to contact the chain of command and correctly confirm IED sightings
Demonstrate how to respond for support and decide who to call on	Success	High	You made the correct decision to call the Explosive Ordinance Disposal Team and you correctly completed the call
Recognize Trash Pile 1 as a possible IED threat	Success	High	By properly checking Trash Pile 1, you correctly identified Trash Pile 1 as a possible IED threat

Figure 4. Mission Debrief as presented in the ULP.

to help the user make choices during missions that conform to these procedures. These actions are available to the user via the CIITE menu in which options are context-sensitive to assure the actions are tactically relevant. Figure 5 shows a sample menu.

Figure 5. Sample CIITE menu.

Tutoring Hints

A dynamic, context-sensitive window displays pop-up hints as the user navigates through a mission. These mission-relevant hints are generated by the agent. There are two general categories of hints: those related to the VBS2 game mechanics (*e.g.*, "To mount the vehicle press the U key and click the green arrow on the passenger side"), and those related to performing the mission (*e.g.*, "Be aware of canalized movement. Check the tops and surfaces of walls for repairs and placed wires"). We segmented the tutoring support into these categories to support future implementation of CIITE training in other synthetic environments.

IED Detection

Visual detection of IEDs in CIITE is accomplished while dismounted using binoculars with which the user is equipped. The user selects the binoculars and scans an area of possible IED placement (*e.g.*, a debris pile). Upon spotting a possible IED, the user can employ the counter-IED menu to follow the prescribed procedures. Figure 6 shows a sample visual detection of an IED.

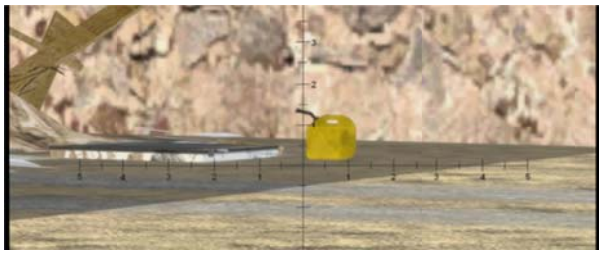

Figure 6. Visual detection of a possible IED threat.

Intelligent Non-Player Characters

A key research emphasis in this program was the potential training benefits of introducing intelligent NPCs into an immersive simulation environment. We employed two frameworks for representing these behaviors. For lower-level actions (path-finding, walking to a waypoint, gesturing) we used the scripting language built into VBS2. For higher-level functions (choosing a course of action, engaging in discourse) we used the ASIST-AT agent framework which emphasizes utility and functionality over deep computational modeling of human performance. This framework has the ability to control multiple NPCs within a simulation and share data constructs among those NPCs, and offers the ability to perform dialog interactions with both a user and other NPCs.

User interaction with the synthetic team members is accomplished via actions in VBS2. For instance, the user can command the team to effect a desired cordon size once an IED has been discovered via a drop-down menu. For performing a VPS sweep, the user can order the section to move faster or slower and can specify one of several formations.

Additional NPCs (Afghan civilians) are used to replicate crowd conditions and responses. For generic local nationals we employed VBS scripting. In crowd conditions, these NPCs have a modest level of artificial intelligence. For example, civilians fleeing from the LAV III as it approaches can be used as an indicator of a pending IED attack. Richer behaviors were implemented in ASIST-AT. Specifically, scenarios included a villager who might follow the patrol (presenting a risk that the user should mitigate by detaining the individual) and another local national who breaches the cordon established by the user (also a risk that the user should mitigate).

Spoken Dialogue for Counter-IED Reporting

Although the explosive ordnance disposal (EOD) is not within the training scope of this project, command and control with the EOD team is a training objective. Users report a suspected or detonated IED through a menu command or by verbal discourse with the agent to accomplish a standard "ten-liner". The spoken ten-liner is implemented with the agent playing the role of the FOB with whom the user establishes communication and conducts the ten-liner reporting. For this project we used the Microsoft Speech Application Programming Interface (SAPI). However, because of the need to provide Canadian Forces with flexibility in determining the most suitable speech recognition product, we implemented a speech recognition architecture that enables the incorporation of any speech recognizer that complies with the

Worldwide Web Consortium (W3C) Speech Recognition Grammar Specification (SRGS) standard. We created an abstraction layer (speech engine template) to implement plug-and-play modularity. This template defines the generic base functionality that a speech recognizer must implement in order to communicate with the system. Each engine uses its corresponding API to implement the template's protocols. Grammar reusability is facilitated by compliance with the SRGS. This creates a "multiple engine/one grammar" architecture in which a speech recognition grammar need be defined only once to specify recognizable phrases for any compliant speech engine. Figure 7 illustrates this modular architecture.

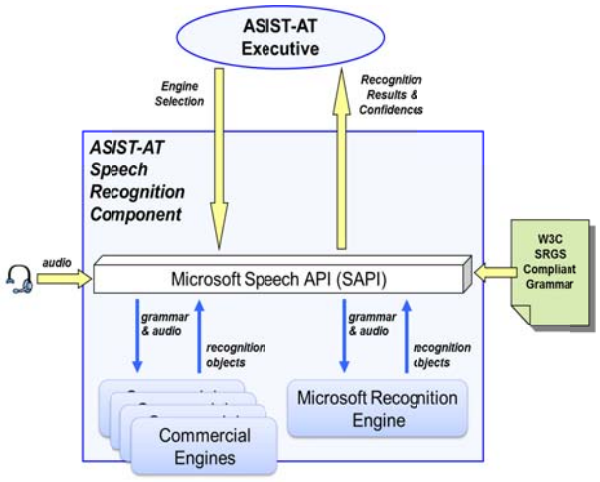

Figure 7. CIITE Speech Interaction Architecture.

USER EVALUATION STUDY

As we were not in a position to conduct a controlled experimental study to assess the training effectiveness of CIITE, due to participant and resource constraints, we conducted a pilot study designed to assess participants' experiences with, and impressions of, the CIITE software. We conducted this study at Defence Research and Development (DRDC) Toronto to gather user feedback on the CIITE software and measure subjects' perceptions of the potential benefits of this approach for counter-IED training.

Methodology

The CIITE software was installed on two laptop computers. Two CIITE scenarios were used during the testing with one scenario being installed on each computer. Test subjects were selected from the local Toronto Reserve Brigade. Ten subjects completed the testing. All subjects had recent experience in Afghanistan. Rank levels of the subjects were Corporal, Master Corporal, Sergeant and Captain with between 5 and 20 years of reserve force experience. Two-hour time blocks were allocated for each test period, during which the subject completed the test in a private office, observed by one or two members of the research team. Subjects were first given an overall briefing on the CIITE project and its objectives. The first CIITE scenario was then demonstrated by the research team and then subjects were requested to complete each of the two scenarios in turn. The scenarios employed were the Urban Transport and Village Patrol scenarios described earlier.

During the scenario runs, observations were gathered regarding software usability, performance and the validity of the learning objectives. The subjects were given the opportunity to provide qualitative feedback during the scenario runs and on completion of each scenario. After completing both scenarios, subjects were asked to complete a survey related to potential training benefits of this training capability. The questionnaire was comprised of two parts: on one side of the page, a quantitative section which asked participants to rate a set of items on a 5-point scale (Likert-type items); and on the reverse side, a section that included free-response questions.

User feedback and observational data

User feedback regarding design characteristics and recommendations for future implementation was collected through observational data and free-response items on the survey. A rubric provided categories for capturing observational data. Table 2 summarizes these data by category.

Table 2. Summary of Observational Data.

Category	Comments
Control of Game Elements	Game controls were considered awkward by most subjects at the outset. However with familiarization and brief practice most subjects were able to adapt to the controls. Those with previous VBS2 experience or regular gamers adapted more quickly.
Organization / Heuristics	Most subjects were able to find and use the main functions after the initial demonstration and explanation were provided. The speech recognition system was not intuitive as it had to be activated outside the main application.
Hints	Use of the hints varied. Many subjects either forgot to use them or disregarded the hints.
Feedback	Mechanisms for accessing the ULP were awkward, but subjects liked the idea of being able to get instant review and feedback.

Analysis of the observational data yielded three categories of suggestions and comments: tactical, technical, and recommendations, summarized below.

Tactical: observations on inaccuracies or improvements in the C-IED tactics that should be incorporated into CIITE before it can be released for general use.

1. IED search should use the rifle scope rather than the binoculars, which are not generally carried; the rifle scope is better for observing trash piles or other suspected IED locations;
2. On approaching a suspicious area, the crew would generally observe from a distance using the LAV gunner's sights prior to dismount. The user should be able to perform this drill in the game;
3. The first drill carried out (before the 5 C's) is the 5's and 20's check, in which the soldier scans for threats 5 meters ahead prior to dismounting, and 20 meters ahead after dismounting. This needs to be included in the game drills and the learning objectives;
4. The user needs more options for VPS search formations. The "V" formation is not always the most appropriate;
5. If an IED is hit, the scenario should not end. The user needs to have the ability to call in a "nine-liner" MEDEVAC request;
6. In the Urban Transport scenario the mounting area should be moved outside of the built up area;
7. The choice of cordon size needs to be re-evaluated as a learning objective as different users had different opinions on the correct size of the cordon;
8. The term "high value person" should be changed to "escort" as high value persons or VIPs would actually be escorted by Special Forces soldiers rather than infantry. Infantry would be more appropriately used to transport more routine passengers (below BGen, or civilian reporters, etc);
9. When EOD arrives they should do a "link up" with the player prior to proceeding to the IED;
10. Once EOD has arrived, a bypass route is required to complete the mission rather than proceeding close to the IED;
11. In the Village Patrol scenario, EOD arrives from the opposite direction. They should arrive from the same direction as the player;
12. The LAV gunner should remain mounted for over-watch during the VPS;
13. In the Village Patrol scenario the player needs the ability to re-mount the LAV to complete the mission; and
14. The player's section members need to be able to revert to formation once EOD controls the cordon.

Technical: usability considerations and observations on inaccuracies or improvements in the game play that should be incorporated into CIITE:

1. The path-following script needs to be changed to ensure that soldiers don't move close to the IED when occupying cordon positions;
2. The voice recognition system needs to be separated from Windows so it does not override game play; It should be activated from within the game rather than pausing the game;
3. Scenarios need to be tweaked to ensure that the situation actually requires dismounting; not all players would dismount at the dismount sites;
4. The actual IEDs are very difficult to identify in CIITE. Higher fidelity IED models or more clues (wires, etc) need to be shown in the game;
5. In order to transmit a 10-liner, an actual IED must be confirmed. A user should have the option to call in a 10-liner for a suspected IED from any suspected location.
6. The second of the 5 C's (Clear) needs to be explicitly put into the IED menu and tracked as a training objective;
7. The voice recognition should accept "I say again" and "niner"; not only "say again" and "nine";
8. In the Urban Transport scenario civilians sometimes migrate back inside the cordon. This should not happen;
9. Once the vehicle is stopped it cannot be re-started so the only way to complete the mission is to dismount and continue on foot. The ability to re-start the LAV must be provided;
10. The ability for a negative IED confirmation is required (i.e., to confirm that there is no IED in a suspicious looking location); and
11. The ULP should be able to be accessed from within the game. It is awkward to access on completion of a scenario at the moment.

Recommendations: observations, comments and suggestions that could be included in future versions of CIITE to improve the overall simulation.

1. Enable vehicles to be used in a cordon;
2. Allow more control over subordinates;
3. Enable network play, i.e. multiple players acting as section members;
4. Include use of Passive Countermeasures/Electronic Countermeasures (PCM/ECM) in scenarios;
5. Incorporate use of EOD specialist vehicles and equipment into scenarios (i.e. mine detectors, EROC vehicles);

6. Allow user to drive or command the vehicle rather than have it scripted;
7. Allow the hints to be turned on or off for more experienced users; and
8. Enrich the overlay orders to include previous significant incidents.

Survey Data

The qualitative section consisted of seventeen Likert-type items, where statements were to be endorsed on a 5-point scale, with 1 representing strong disagreement, 3 representing neither agreement not disagreement, and 5 representing strong agreement. The seventeen items assessed six categories of information: one category about participants' experience with simulations and games, and five categories about experiences with CIITE, namely, quality of the game controls (including voice), feedback by the game on player's actions, quality of the in-game guidance (hints and tips), realism of the task and scenario presented by the game, and CIITE's potential as a training tool for C-IED operations for CF soldiers. Note that the number of items in each category ranged between two and four items, depending on the category.

The questionnaire also asked participants questions about their military experience, experience on tour in Afghanistan (number of tours, dates of last tour, experience with IED events), their level of IED knowledge, and some additional information about their experiences with CIITE. The additional questions about CIITE included open-ended questions about what they liked and disliked about CIITE, and whether they would recommend CIITE to other soldiers (yes/no answer). All ten participants completed the first, quantitative part of the questionnaire. A tabulation of the quantitative results appears in Table 3.

Mean scores for each participant were computed for each of the 6 categories in the Likert-scale part of the questionnaire. Single-sample t-tests (with a significance level of $\alpha = .05$) were computed on the sample's means for each category, to determine whether they differed significantly from the baseline score of 3 (neutral rating). This analysis assumed that any deviations from a neutral rating would indicate that participants' experiences with CIITE had an effect (positive or negative) on their perception of the system.

Table 3. Summary of User Evaluation Responses to Likert-Scale Survey Items.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	% Agree or Strongly Agree
1. CIITE was easy to use	0	0	3	7	0	3.7	70%
2. I had sufficient access to the appropriate controls in CIITE.	0	0	2	8	0	3.8	80%
3. The simulation showed appropriate responses to my actions / decisions	0	2	4	4	0	3.2	40%
4. I used the on-screen learning objective hints in CIITE.	0	0	1	7	2	4.1	90%
5. I used the on-screen game controls help tools in CIITE.	0	0	1	8	1	4	90%
6. The voice recognition system recognized my inputs.	1	3	0	4	2	3.3	60%
7. The voice recognition system responded appropriately to my inputs.	1	0	1	4	4	4	80%
8. I received meaningful information from the after-action feedback report in CIITE.	1	1	3	4	1	3.3	50%
9. The CIITE scenario was realistic.	0	0	6	4	0	3.4	40%
10. CIITE effectively presented situations that are encountered in-theatre	0	1	0	8	1	3.9	90%
11. CIITE could help improve awareness of basic IED threats and procedures	0	0	1	6	3	4.2	90%
12. CIITE could better prepare CF personnel to effectively communicate IED threats	0	0	1	6	3	4.2	90%
13. CIITE could be an effective use of soldiers' training time	0	0	2	5	3	4.1	80%
14. Soldiers could feel more prepared to respond to potential IED threats because of CIITE.	0	0	2	8	0	3.8	80%
15. I am an experienced user of computer simulation for military training purposes.	1	2	2	5	0	3.1	50%
16. I am an experienced user of computer simulations/games	0	0	3	5	2	3.9	70%
17. I have previous experience with VBS2.	5	1	1	2	1	2.3	30%

The results of this analysis are shown in Table 4. Of the six categories, four (game control, hints, realism and training potential) were rated significantly higher than 3 (neutral), while 2 (feedback and game experience) did not statistically differ from the neutral rating. On average, none of the categories was rated as lower than neutral by the participants, indicating overall positive impressions of CIITE.

Table 4. Means and t-tests by Category

Category	Mean (Standard Deviation)	*t* value (degrees of freedom)
Experience with Simulations and Simulation-based Training	3.1 (0.72)	0.44 (9)
Quality of Game Controls	3.7 (0.73)*	3.0 (9)
Feedback from CIITE	3.3 (0.68)	1.2 (9)
Quality of In-game Guidance	4.1 (0.28)*	11.7 (9)
Realism	3.7 (0.53)*	3.9 (9)
CIITE's Potential for Training	4.1 (0.53)*	6.4 (9)

*means that significantly differed from 3 ($\alpha = .05$)

Five of the categories in the quantitative part of the questionnaire (Quality of Controls, Feedback, In-game Guidance, Realism and Training Potential) were also correlated with the Experience with simulations category for each participant. This was done to determine whether the results were influenced by participants' familiarity with simulation. This analysis found that only one category, Realism, had a significant correlation with participants' experience levels. The correlations are reported in Table 5.

Participants were asked in the second part of the questionnaire whether they would recommend CIITE to fellow soldiers. All participants who completed the second section of the questionnaire (7 out of 10) endorsed this statement. Thus, no analyses were conducted on this rating.

Table 5. Correlations between Experience category and other Likert item questionnaire categories

Category	Correlation *r* value
Quality of game controls	0.23
Feedback from CIITE	-0.06
Quality of in-game guidance	0.33
Realism	0.64*
CIITE's potential for training	-0.22

*correlations that were significant at the $\alpha = .05$ level.

The core issues of interest to this study were operational relevance and potential training benefit. Responses to these items were highly favorable. For questions 10-12, 90% reported Agree or Strongly Agree, and for questions 13-14, 80% reported either Agree or Strongly Agree.

Discussion

Observational and free-response data signal the need for improvements in the CIITE prototype. Many of the technical/usability observations are directly attributable to the use of VBS2 as the underlying game engine and may be addressed as future versions of the VBS2 software are released. Many of the tactical observations can likely be readily addressed through scenario modifications that would not require significant re-engineering. And the design approach of segmenting much of the CIITE Counter-IED training content and capabilities from VBS2 provides Canadian Forces with additional options for future implementation using alternative simulation platforms.

The user survey data is preliminary and derived from a small sample size (N=10). However the results of the quantitative portion of our questionnaire indicate that participants uniformly saw CIITE as being easy to use and as a potentially useful training tool that they would recommend to other soldiers. Among the questions asking about CIITE's training value and mission impact, *agree* or *strongly agree* responses were noted in either 80% or 90% of the surveys. All seven subjects who responded to whether they would recommend CIITE to other soldiers answered in the affirmative, and no category was rated as lower than neutral. Attitudinal data is thus trending highly positive from the pilot study data.

In addition to positively rating the Training Potential category, they also indicated that it presented the training scenarios in a realistic manner, and that the system provided good in-game guidance *(i.e.*, the intelligent tutor aspects of the system were helpful). As can be seen in Table 4, the only category for which participants did not collectively give a positive rating was the Feedback category, suggesting that this aspect of the system requires some fine-tuning.

Note also that while all participants had operational experience in Afghanistan and had received extensive counter-IED and explosive threat hazard training prior to their deployments, they varied widely in their experience with simulations, video games, and simulation-based training (hence the overall 'neutral' rating for this category).

Of the ratings categories related to various aspects of CIITE, only Realism correlated with participants' levels of experience with simulation, suggesting that the other positive impressions of CIITE were not related to how experienced participants were with simulation for training or other purposes. The Realism category captured participants' impressions of both the perceived realism of the environment and the pertinence of the scenarios to actual operations. Thus, while it is understandable that this measure would be influenced by participants' familiarity with simulation, the fact that it was highly rated overall still indicates that experienced soldiers perceive the CIITE scenarios as having good face validity.

CONCLUSION

CIITE demonstrates the use of COTS gaming technologies coupled with sophisticated training techniques and technologies. The VBS2 game environment, in use throughout CF training, was augmented with a learning objectives-driven, scenario-based approach to training that employs intelligent agents, performance measures, spoken dialogue, and debriefing. Results from a pilot study show preliminary but highly favorable and consistent indicators that soldiers regard CIITE as a potentially useful tool that can improve readiness and mission success.

This program was a technology demonstration, conducted in a relatively condensed time period in order to inform and accelerate development of a near-term solution for the C-IED training problem. The issues raised during the evaluation should be factored into development of more mature training solutions intended for the fielding of C-IED training.

The use of intelligent agents, automated performance measures, and speech interaction provide an enhanced C-IED training experience for which subjects expressed nearly unanimous support. This technology could prove useful for training across military environments (Army, Navy, Air Force, Marine Corps, Special Forces) as well as across simulation domains, whenever individual users require practice in mastering team-oriented training objectives.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the program leadership provided by Mr. Mark Espenant of DRDC who supported the research team through a host of challenges with exceeding professionalism, and who facilitated access to Canadian soldiers for the CIITE evaluation studies. Throughout the program we have had access to CF personnel whose expertise and generosity of time contributed immeasurably to the operational relevance of the CIITE demonstration program. We are particularly grateful to the PPCLI, DAT, Directorate Land Synthetic Environment (DLSE), and 32 Combat Brigade Group personnel who made themselves available to our team throughout the project.

REFERENCES

Bell, B.L. (1999). "Supporting Educational Software Design with Knowledge-Rich Tools". *The International Journal of Artificial Intelligence and Education, 10* (1), 46–74.

Colegrove, C. M. & Alliger, G. M. (2002, April). Mission Essential Competencies: Defining Combat Mission Readiness in a Novel Way. Paper presented at the NATO RTO Studies, Analysis and Simulation Panel (SAS) Symposium. Brussels, Belgium.

Schank, R.C., Fano, A., Bell, B.L., and M.K. Jona (1994). "The Design of Goal Based Scenarios." *The Journal of the Learning Sciences, 3*(4), 305-345.

Zachary, W., & Ryder, J., & Hicinbothom, J. (1998). Cognitive task analysis and modeling of decision making in complex environments. In J. Cannon-Bowers & E. Salas (Eds.), Decision making under stress: Implications for training and simulation (pp. 315-344). Washington, DC: American Psychological Association.