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EVALUATION OF THE IMPACT OF CIVILIAN ACTIVITY ON THREAT ASSESSMENT IN SIMULATED "ASYMMETRIC THREAT" SCENARIOS

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Abstract

This project was conducted in support of the Defence Research and Development Canada (DRDC) Technology Demonstration Program (TDP) on counter improvised explosive device (CIED) technologies, which aims to deliver useable technologies to front-line users to mitigate the improvised explosive device (IED) threat in current Canadian Forces (CF) operations. This project aims to evaluate the impact of civilian activity as modelled by Civilian Activity Modelling for eXercises and eXperimentation (CAMX) on threat assessment and related actions by CF personnel in a first-person synthetic environment. The goal was to assess the impact of civilian activity in two different tactical scenarios that represent missions where civilians are not the primary focus (i.e., the task does not involve direct interaction with civilians) but where we have reason to believe that the presence of civilian activity may alter a soldier's assessment of the level of threat in the environment and the actions he or she would take as a result. To our knowledge, this exploratory project is the first of its kind, and the results of this study will inform future research in this area and help to answer key research questions. Our exploratory study had participants assess the level of threat in four tactical scenarios, two in which there was high civilian activity and two in which there was low civilian activity. The tactical scenarios were simulated presence patrol missions in Afghanistan developed in Virtual Battlespace 2 (VBS2). Aside from the civilian activity, the scenarios contained a number of IED indicators that would increase the threat level of the scene. After participants watched each video, they were required to complete a questionnaire that collected participant judgments on specific aspects of the scenario (e.g., asking them how threatening particular scenarios were, and asking what made that scenario more or less of a threat). At the end of the four videos, participants were presented with an exit survey asking them about realism, the validity of the scenarios as a training tool, and a demographics questionnaire. Results suggest that CAMX used in conjunction with VBS2 can create virtual environments realistic enough to be able to study and eventually train soldiers' threat assessment in response to civilian activity. Support for this finding was shown when the participants rated low civilian activity present in an area as a higher threat than in an area with high civilian activity. This study informed us about the information soldiers use to make threat assessments in virtual environments and about the utility of virtual environments as training tools in this context. Further research investigating other factors that may affect threat assessment is recommended to support our findings.

Résume

Ce projet a été mené en appui au Programme de démonstration de technologies (PDT) de Recherche et développement pour la défense Canada portant sur les technologies de lutte contre les dispositifs explosifs de circonstance (C-IED). Ce programme vise à fournir des technologies utilisables aux utilisateurs de première ligne afin d'atténuer la menace de C-IED durant les opérations des Forces canadiennes (FC). L'objectif du projet est d'évaluer l'incidence des activités civiles telles que celles créées à l'aide de l'outil de modélisation d'activité civile aux fins d'exercices et d'essais (CAMX) durant l'évaluation de la menace, ainsi que les actions connexes des membres des FC en situation de premier intervenant virtuel. Deux scénarios tactiques différents serviront à examiner les répercussions des activités civiles lors de missions où l'objectif premier n'est pas d'intervenir auprès de civils (p. ex., tâche sans interaction directe avec la foule), mais plutôt lorsque l'on estime que la présence d'une activité civile pourrait modifier l'analyse de la menace réalisée par un soldat et les mesures prises par ce dernier. À notre connaissance, il s'agit d'un projet exploratoire unique en son genre. Les résultats de cette étude orienteront les futures recherches dans le domaine et aideront à répondre à des questions clés liées à la recherche. Durant l'étude préliminaire, les participants ont évalué l'importance de la menace dans quatre scénarios tactiques : deux avec une grande activité civile et deux avec une faible activité civile. Les scénarios simulaient une patrouille de présence en Afghanistan créée dans le jeu Virtual Battlespace 2 (VBS2). Outre l'activité civile, les scénarios comportaient un certain nombre d'indicateurs d'IED élevant le niveau de la menace. Après avoir visionné la vidéo, les participants ont rempli un questionnaire, donnant leur avis sur des aspects spécifiques du scénario (p. ex., le niveau de la menace du scénario, les éléments rendant le scénario plus ou moins menaçant). À la fin des quatre vidéos, les participants ont rempli un questionnaire de fin d'exercice dans lequel ils devaient répondre à des questions sur le réalisme et l'utilité des scénarios comme outil de formation, en plus de remplir un questionnaire démographique. Les résultats indiquent que l'utilisation combinée de CAMX et VBS2 crée un environnement virtuel suffisamment réaliste pour examiner l'évaluation de la menace réalisée par un militaire à l'égard d'une activité civile. Cette conclusion a été appuyée par le fait que les participants ont jugé que la menace était élevée dans la zone où l'activité civile était faible et que la menace était faible dans la zone où l'activité civile était élevée. Cette étude nous a permis de connaître l'information utilisée par les militaires pour évaluer une menace dans un environnement virtuel, de même que la pertinence de tels outils d'entraînement dans ce contexte. Il est recommandé d'effectuer davantage de recherche sur d'autres facteurs pouvant altérer l'évaluation de la menace afin d'appuyer nos conclusions.

Executive Summary

EVALUATION OF THE IMPACT OF CIVILIAN ACTIVITY ON THREAT ASSESSMENT IN SIMULATED "ASYMMETRIC THREAT" SCENARIOS

Lora Bruyn Martin, Erica Elderhorst, Michael Thomson, Cheryl Karthaus, Human*systems*® Incorporated; DRDC Toronto CR2012-044; Defence R&D Canada – Toronto; March 2012.

Mandate: This study was conducted from January until March 2012 on behalf of Defence Research and Development Canada under contract # W7711-088136/011/TOR.

Background: This project was conducted in support of the Defence Research and Development Canada (DRDC) Technology Demonstration Program (TDP) on counter improvised explosive device (CIED) technologies, which aims to deliver useable technologies to front-line users to mitigate the improvised explosive device (IED) threat in current Canadian Forces (CF) operations. Recent CF missions have required CF soldiers to interact extensively with civilians, and there is every reason to believe that the CF will continue to do so in the future. Soldiers interact with civilians on many different levels, including communicating directly with an individual civilian to establish goodwill or to obtain information, to units observing normal civilian activity or an angry crowd, and having to take into account their behaviour in planning the unit's collective actions. Consequently, the CF's training methods need to ensure that soldiers can appropriately prepare for many different types of interactions with civilians in various contexts. Anecdotal evidence from subject matter experts (SMEs) indicates that the presence and behaviour of civilians can have a major impact on situation awareness and decision making, and in particular change the threat level soldiers might assign to individual cues of a possible attack in the environment (Bruyn Martin & Karthaus, 2009; Cazzolato & Levesque, 2010).

In real-life operations, soldiers take many factors into account when they assess the threat of an IED attack. One of these factors, called "pattern of life (POL)", requires that soldiers understand the patterns of civilian behaviour typical of the area being monitored in order to make threat assessments (Bruyn Martin & Karthaus, 2009).

Because simulated environments that model civilian activity are themselves quite new, their role in threat assessment research and how threat assessment is impacted by the presence of civilians is limited. To address this need, DRDC Centre for Operational Research and Analysis (CORA) has developed software, called Civilian Activity Modelling for eXercises and eXperimentation (CAMX), which can generate user-configurable and plausible civilian activity such as pathfinding movements and reactions to danger. The software scenarios are based on reports from CF SMEs with experience in missions involving interactions with civilians (Cazzolato & Levesque 2010).

Purpose: This project aims to evaluate the impact of civilian activity as modelled by CAMX on threat assessment and related actions by CF personnel in a first-person synthetic environment. The goal was to assess the impact of civilian activity in two different tactical scenarios that represent missions where civilians are not the primary focus (i.e., the task does not involve direct interaction with civilians) but where we have reason to believe that the presence of civilian activity may alter a soldier's assessment of the level of threat in the environment and the actions he or she would take as a

result. To our knowledge, this exploratory project is the first of its kind, and the results of this study will inform future research in this area and help to answer key research questions.

Method: This study was a 2x2 repeated measures design in which participants were presented with videos of two tactical scenarios, each with a low civilian activity and high civilian activity condition for a total of four videos. The scenarios were created in Virtual Battlespace 2 (VBS2) in conjunction with CAMX software. They represented presence patrol missions in Afghanistan that had a number of IED indicators in the scene in addition to civilian entities.

Fourteen CF soldiers with operational experience in Afghanistan were asked to watch the four videos described above and were asked to rate the level of threat in the scenarios and state the course of action (COA) they would take in response to the level of threat. They were also asked to indicate what additional information they would need to make a more reliable threat assessment. At the end of the study, participants were asked to indicate how realistic the scenarios were and why, what would make the scenarios more realistic, and to describe any anomalies they observed in the scenarios. They were then asked to list the perceived benefits and drawbacks of using virtual environments for training purposes.

Results: Results showed a significant difference in threat level scores in the stop and cordon scenario between the high and low civilian activity conditions. In line with these results, participants reported that they would use different COAs in the high and low civilian activity conditions of the stop and cordon scenario. In addition there was a main effect of civilian activity on threat level, indicating that overall, the low civilian activity condition was more threatening than the high civilian activity condition regardless of scenario. Participants reported that overall the scenarios were realistic when comparing them to what they have experienced in Afghanistan, but they indicated that the inclusion of audio and the ability to control the simulation would have added to the overall realism of the scenarios.

Significance of Findings: The results of this study suggest that soldiers' threat assessment in response to civilian activity may be effectively studied in a virtual environment using CAMX software in conjunction with VBS2. This, in turn, could have many benefits for the CF. Having the capability to realistically represent civilian activity will allow for more accurate training scenarios to be developed within VBS2. Using such scenarios has the potential to improve training for operational situations that involve civilian activity by increasing the realism of the scenarios and reducing the costs associated with such training (Levesque, Cazzolato, & Martonosi, 2009).**Recommendations**: Future research should aim to confirm the findings of this study as well as rule out the possibility of any other factors contributing to threat assessment and investigate the use of VBS2 and CAMX for training threat assessment.

Sommaire

EXAMEN DE L'INCIDENCE DES FOULES CIVILES SUR L'ÉVALUATION DE LA MENACE DURANT DES SCÉNARIOS DE MENACE ASYMÉTRIQUE SIMULÉS

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Objectif : Cette étude a été effectuée de janvier à mars 2012 au nom de Recherche et développement pour la défense Canada (contrat no W7711-088136/011/TOR).

Contexte : Ce projet a été mené en appui au Programme de démonstration de technologies (PDT) de Recherche et développement pour la défense Canada portant sur les technologies de lutte contre les dispositifs explosifs de circonstance (C-IED). Ce programme vise à fournir des technologies utilisables aux utilisateurs de première ligne afin d'atténuer la menace de C-IED durant les opérations des Forces canadiennes (FC). Lors de missions récentes, des membres des FC ont dû interagir beaucoup avec des civils, et tout porte à croire que cela se reproduira dans le futur. Les militaires interagissent avec les civils à divers niveaux, y compris la communication directe avec un civil afin qu'il coopère ou fournisse de l'information, l'observation d'une activité civile normale ou une foule en colère, et la prise en considération du comportement de la foule lors de la planification des actions collectives des unités. Par conséquent, les méthodes d'entraînement des FC doivent préparer les militaires adéquatement pour qu'ils puissent interagir avec les civils de différentes manières selon le contexte. Des données fournies par des experts en la matière démontrent que la présence et le comportement des civils peuvent avoir une incidence importante sur la connaissance de la situation et la prise de décisions, et surtout, altérer l'évaluation du niveau de menace faite par des soldats lorsqu'il y a des indices d'une éventuelle attaque (Bruyn Martin & Karthaus, 2009; Cazzolato & Levesque, 2010).

Lors de véritables opérations, les soldats doivent tenir compte de divers facteurs en évaluant une menace d'attaque IED; le mode de vie est l'un de ces facteurs. Les militaires doivent comprendre le comportement typique des résidents de la région sous surveillance afin d'évaluer les menaces (Bruyn Martin & Karthaus, 2009).

Comme les environnements de simulation d'activités civiles sont des technologies relativement nouvelles, ils ont un rôle limité dans la recherche sur l'évaluation des menaces et dans l'analyse de la façon dont la présence de civils influence l'évaluation des menaces. Afin de combler ce besoin, le Centre d'analyse et de recherche opérationnelle (CARO) de RDDC a conçu le logiciel CAMX (Outil de modélisation d'activité civile aux fins d'exercices et d'essais), lequel permet de simuler une activité civile plausible et modulable; par exemple, des mouvements d'orientation ou des réactions à un danger. Les scénarios sont construits à partir de rapports de spécialistes des FC qui ont de l'expérience d'interaction avec des civils dans le cadre de missions (Cazzolato et Lévesque 2010).

But : Ce projet vise à évaluer, à l'aide du CAMX, l'incidence de l'activité civile sur l'évaluation des menaces et les actions connexes des militaires dans un environnement synthétique à la première personne. Le but est d'évaluer l'incidence de l'activité civile dans deux scénarios tactiques distincts de missions où l'objectif premier n'est pas d'intervenir auprès de civils (p. ex., une opération sans interaction directe avec la foule), mais dont la présence pourrait influencer l'analyse de la menace

faite par un soldat et les mesures prises par ce dernier. À notre connaissance, ce projet exploratoire est le premier du genre à être réalisé. Les résultats obtenus orienteront les futures recherches dans le domaine et contribueront à trouver des réponses aux grandes questions de recherche.

Méthode : Dans le cadre de cette étude, nous avons opté pour la méthode d'analyse en mesures répétées en double. Nous avons présenté aux participants deux scénarios tactiques sur vidéo. Chaque scénario comportait deux versions différentes : l'une présentant une grande activité civile et l'autre présentant une faible activité civile. Ces scénarios, produits à l'aide du jeu Virtual Battlespace 2 (VBS2) et auxquels des entités du CAMX ont été ajoutées, simulaient des missions de patrouille de présence en Afghanistan. Outre l'activité civile, les scénarios comportaient un certain nombre d'indicateurs d'IED.

Nous avons ensuite fait regarder les vidéos décrites ci-dessus à quatorze membres des FC ayant de l'expérience opérationnelle en Afghanistan auxquels nous avons demandé d'évaluer le niveau de la menace de chacun des scénarios présentés et d'indiquer les mesures qu'ils prendraient dans de telles situations. Nous leur avons aussi demandé d'indiquer tout autre renseignement dont ils auraient besoin afin de produire une analyse aussi fiable que possible. À la fin de l'étude, les participants devaient indiquer quel était le degré de réalisme des scénarios et expliquer pourquoi, suggérer des façons de rendre les scénarios plus réalistes et décrire toutes les anomalies qu'ils ont observées. Ils devaient ensuite énumérer les avantages et les inconvénients, selon eux, d'utiliser les environnements virtuels à des fins de formation.

Résultats : Nous avons noté un écart important entre les deux variantes (forte et faible activité civile) du scénario d'arrêt et de bouclage en ce qui a trait au niveau de la menace. De façon similaire, les participants ont indiqué qu'ils auraient pris des mesures différentes que celles employées dans les scénarios présentés. En outre, nous avons remarqué que l'activité civile produisait un effet majeur sur le niveau de la menace; dans l'ensemble, les participants ont jugé qu'une faible activité civile présentait une menace plus importante qu'une forte activité civile, et ce, peu importe le scénario. Les participants ont aussi mentionné que, en général, les scénarios proposés étaient réalistes en comparaison avec ce qu'ils ont vécu en Afghanistan. Ils ont cependant ajouté que l'expérience aurait semblé encore plus réaliste avec du son et la possibilité de commander la simulation.

Conclusions : Les résultats obtenus dans cette simulation indiquent que le degré d'activité civile a une incidence sur l'analyse de la menace réalisée par les soldats. Les réponses données aux questions qualitatives vont dans ce sens. En général, les résultats de cette étude suggèrent qu'il est possible d'étudier l'influence de l'activité civile sur l'analyse d'une menace dans un environnement virtuel à l'aide du logiciel CAMX et de VBS2.

Recommandations : Le but des prochaines recherches devrait être de chercher à valider les conclusions de cette étude, de vérifier s'il existe d'autres facteurs influençant l'analyse des menaces et d'étudier plus en profondeur l'utilité du CAMX et de VBS2 pour la formation en vue de missions exigeant des interventions auprès de civils.

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List of Acronyms

AAR	**After-action Review**
ANA	**Afghan National Army**
ANOVA	**Analysis of Variance**
CAMX	**Civilian Activity Modelling for eXercises and eXperimentation**
CF	**Canadian Forces**
CIED	**Counter Improvised Explosive Device**
CORA	**Centre for Operational Research and Analysis**
CSA	**Contract Scientific Authority**
DRDC	**Defence Research and Development Canada**
DRDC T	**Defence Research and Development Canada Toronto**
EW	**Electronic Warfare**
FAM	**Fighting Age Male**
FOV	**Field of View**
HSI®	**Human*Systems* Incorporated**
IED	**Improvised Explosive Device**
LN	**Local National**
LAV	**Light Armoured Vehicle**
POL	**Pattern of Life**
SA	**Scientific Authority**
SITREP	**Situation Report**
SME	**Subject Matter Expert**
TDP	**Technology Demonstration Program**
VBS2	**Virtual Battlespace 2**
VPS	**Vulnerable Point Search**

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1. Introduction

This section outlines relevant background information for this study, information about the Civilian Activity Modelling for eXercises and eXperimentation (CAMX) software used in this study, and a general discussion about threat assessment and civilian activity.

1.1 Background

This project was conducted in support of the Defence Research and Development Canada (DRDC) Technology Demonstration Program (TDP) on counter improvised explosive device (CIED) technologies, which aims to deliver useable technologies to front-line users to mitigate the improvised explosive device (IED) threat in current Canadian Forces (CF) operations. Recent CF missions have required CF soldiers to interact extensively with civilians and there is every reason to believe that the CF will continue to do so in the future. Soldiers interact with civilians on many different levels. This can include soldiers communicating directly with an individual civilian to establish goodwill or obtain information, to units observing normal civilian activity or an angry crowd, and having to take into account their behaviour in planning their own collective actions. Consequently, CF's training methods need to ensure that soldiers can appropriately prepare for many different types of interactions with civilians in various contexts.

Virtual environments are increasingly being used for training purposes outside of and within the CF. For CF training these virtual environments need to be sufficiently high fidelity representations of real-world events, for example simulated reconnaissance or patrol missions where the training audience might observe groups of civilians, or interact with specific individuals, but take no action that directly affects the groups of civilians per se. Anecdotal evidence from subject matter experts (SMEs) indicates that even in such scenarios, the presence and behaviour of civilians can have a major impact on situation awareness and decision making, for instance, changing the threat level soldiers might assign to individual cues of a possible attack in the environment (Bruyn Martin & Karthaus, 2009; Cazzolato & Levesque, 2010).

While civilians may play a secondary and seemingly minor role in some training scenarios, their potential impact on decision making indicates that, even in such scenarios, adequately representing them in virtual environments for training purposes is necessary. However, because simulating several hundred entities in a first-person synthetic environment is technically challenging, and civilian activity appears unimportant when the primary task does not directly involve interaction with the civilians, most virtual environment scenarios either do not represent civilian activity, or underrepresent a realistic number of civilians that would typically be present in a real-life situation. The discrepancy between the possible impact of civilian presence on situation awareness and decision-making and on the lack of realistic testing scenarios prompts the question of whether soldiers assess threat in simulated environments the same way that they do in real-world situations.

The first-person synthetic environment most commonly used for tactical-level training in the Canadian Army is Virtual Battlespace 2 (VBS2). In this environment, soldiers can interact with other synthetic human entities from a first-person perspective, either on a one-on-one basis or in groups. With this capability to simulate small-team, tactical-level missions, the need to effectively simulate the different levels of civilian activity described above is becoming more acute. The VBS2 platform is well-suited to small teams (e.g., platoon-sized units) interacting with relatively small numbers (a

few tens) of other entities (either hostile or neutral). However due to limitations in its Artificial Intelligence capabilities and software performance, VBS2 is not designed to simulate many tens or hundreds of neutral civilians performing random (but natural) activities in a given environment. Consequently, the VBS2 platform is inadequate for some CF training, particularly for situations where civilian activity impacts mission objectives.

1.2 CAMX Software

A proposed solution to better represent large numbers of civilians has been developed by DRDC Centre for Operational Research and Analysis (CORA). The software, called CAMX, can generate user-configurable and plausible civilian activity, such as pathfinding movements and reactions to danger, based on reports from CF SMEs with experience in missions involving interactions with civilians (Cazzolato & Levesque 2010). CAMX was created to fill the gap left in civilian activity representation by other games because for military training, it is very important to be able to accurately model not only terrain but human behaviour and civilian traffic. CAMX allows the developer to build models of civilian behaviour in many contexts, using the framework provided within the software. CAMX is a multi-agent simulation, which provides the ability to manage thousands of entities at one time thereby allowing for more realistic simulations and reducing the costs of training. In the past, developers were only able to manage a few civilian entities at a time. This required the use of many developers to manage the number of entities required for a simulation, thus driving up the costs of creating simulations (Levesque, Cazzolato, & Martonosi, 2009).

One of the distinct design specifications of CAMX is that it can control the behaviours of civilian entities that are generated in other simulations, such as VBS2. CAMX allows civilians, animals, and traffic to be added to simulations created using VBS2 software. As long as CAMX is using the same terrain maps as VBS2, entities can be dragged and dropped onto the CAMX version of the map and animated in VBS2. The behaviour of all entities can be set by one developer and can be changed at any time (Levesque, Cazzolato, & Martonosi, 2009).

Developed within the past five years, CAMX is a relatively recent product and its effectiveness in representing realistic civilian activity in a synthetic environment has not been assessed. One specific area that needs to be evaluated is the impact of CAMX-generated civilians on a soldier's judgments of the threat level when presented with specific objects or individuals in an asymmetric threat environment, for instance IED attacks. By determining the impact of CAMX-generated entities on threat judgments, researchers can begin to understand CAMX's utility in simulating missions in "asymmetric" contexts, such as humanitarian operations in a counter-insurgency or IED threat environment.

1.3 Threat assessment and civilian activity

Because simulated environments that model civilian activity are themselves quite new, research in the area of threat assessment and how it is impacted by the presence of civilians is limited. In real-life operations we know that when soldiers assess the threat of an IED attack, there are many factors that are taken into account. One of these factors is called "pattern of life (POL)". Put simply, soldiers need to understand the patterns of civilian behaviour that are typical of the area that they are monitoring. By knowing this information, soldiers can more easily detect when a behaviour pattern has changed, and thus understand if there is a heightened level of threat in the area at that time. A soldier's understanding of the POL in any given area is important when assessing the threat level of a given scenario (Bruyn Martin & Karthaus, 2009). We are interested in learning how soldiers assess their

environment and how threat assessment varies when civilian activity is present or not present along with IED indicators. A model of the relationship we are interested in studying within a simulated environment is shown below in Figure 1.

Figure 1: Model of relationship studied

We hypothesize that when soldiers understand the civilian activity in an area, they are better able to comprehend the level of threat that the situation brings with it. The following project examines the way in which soldiers assess their environment during a mission in a synthetic training environment and the impact of civilian activity on their threat assessment.

1.4 Scope and Objectives

The objective of this project was to evaluate the impact of civilian activity as modelled by CAMX on threat assessment and related actions by CF personnel in a first-person synthetic environment. More specifically, we assessed the impact of civilian activity in two different tactical scenarios that represent missions where civilians are not the primary focus (i.e., the task does not involve direct interaction with civilians) but where we have reason to believe that the presence of civilian activity may alter a soldier's assessment of the level of threat in the environment and the actions he or she would take as a result. To our knowledge, this exploratory project is the first of its kind, and the results of this study will inform future research in this area and help to answer key research questions, namely:

1. Does the presence of civilians in a simulated environment impact threat assessment?
2. Does CAMX provide the nature of civilian activity required to study this?
3. Is a simulation the best way in which to study these effects?
4. Does the combined VBS2 + CAMX software present any unanticipated problems with civilian generation?
5. Are virtual environments such as this one realistic enough that the results will be comparable to what would be seen in a real-world environment?

1.5 Outline of Report

This report describes the methods used to investigate the impact of civilian activity on soldier threat assessment, summarizes the findings, and outlines implications for future training and research.

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2. Methods

This study was conducted in accordance with DRDC Protocol L831 and was approved by the DRDC Human Research Ethics Committee. This section describes the methods used to study the impact of the presence of civilians on a soldier's assessment of threat in their environment and the resulting actions they would take. It highlights the participants that took part in the study; the equipment used in the experimental setup, and explains the experimental procedure in detail. Lastly, data collection methods and data analysis will be discussed.

2.1 Hypothesis

Research suggests that certain indicators can signal a lower or higher level of threat (of an IED attack, in the case of the current study) in the area in which soldiers are operating (Thomson et al., 2009; Bruyn Martin & Karthaus, 2009; Vilhena, Zobarich & Lamoureux, 2007). Indicators that signal a lower likelihood of an attack are referred to as negative indicators. Based on findings from Thomson et al. (2009), we know that the presence of negative indicators such as children in an area indicate that the likelihood of planned IED events for that area is low. Likewise, Thomson et al. (2009) found that when soldiers drove through villages that did not have civilians or vehicles present, the soldiers indicated that those areas were potential IED events, suggesting that barren places with less civilian activity are more likely to be targeted for an IED attack. Based on this we can predict that areas with groups of civilians displaying routine behavioural patterns will be perceived by soldiers as a negative IED indicator, and will be rated as less threatening than areas where no civilians are present. The reasoning behind this is that typically civilians are aware when an IED attack is planned for a specific area, and thus will be less likely to be present at that time. Also civilians show more tolerance and/or goodwill towards foreign troops if the region is not aligned with the Taliban. In other words, their behaviour also provides information on the general threat level in the town, not just a specific location. Our hypothesis is therefore that simulated tactical scenarios with high civilian activity will be assessed as significantly less threatening than those with low civilian activity and participants will indicate an elevated course of action for those higher threat scenarios.

2.2 Participants

Participants in this study were Reservist CF soldiers with experience in Afghanistan (n=14). All participants had completed at least one rotation within the CF's combat mission in Afghanistan prior to participating in the study. The mean length of time served in the military by participants was 13 years. Participants' ages ranged from 23-56 with a mean age of 32.8 years. All participants were male. Participants in this study were recruited and scheduled by the Scientific Authority (SA) and project team members at DRDC Toronto (DRDC T). All participants were provided with a brief background and purpose of the study prior to participating. All participants completed a demographics questionnaire, which included questions about their rank, command, service/trade, number of years served in the military, the tours they had completed, education, relevant training, official first language, age, and sex.

2.3 Equipment

This study was conducted on DRDC T premises and all equipment was thereby provided by DRDC. The testing environment included individual computer workstations that included four main components:

1. 19 inch standard flat-panel monitor
2. Keyboard
3. Mouse
4. Standard computer chair set up in such a way that participants could sit approximately 60 cm in front of the monitor

VBS2 software was used to build simulated tactical scenarios including a number of IED indicators and CAMX software was used to simulate the civilian activity. The workstations were assembled as shown below in Figure 2.

Figure 2: Experimental set-up at DRDC T

2.4 Experimental Design and Procedure

This study's procedure is based on one of the few relevant studies in this area, conducted by Thomson et al. (2009) on behalf of Department of National Defence. Their study looked at soldiers' ability to detect IED indicator clusters and the associated threat levels with these events in a synthetic environment. The results of their study showed that some IED indicators, such as a vehicle carcass, a spotter on the rooftop and a culvert, were more readily identified than other IED indicators. As mentioned above, the effects that civilian activity can have on threat assessment in simulated environments is increasingly important for the CF to understand.

In our study, participants were tasked with assessing the threat level of two tactical scenarios; one in which there was a high level of civilian activity and one in which there was a low level of civilian activity ("high" and "low" will be defined later in this section). Specifically they were presented with two videos of different tactical scenarios and asked to rate their perceived level of threat and indicate actions they would take based on the level of threat.

2.4.1 Design

This study was designed as a 2 x 2 repeated measures design, wherein all fourteen participants took part in each condition of the study. There were a total of four conditions:

1. Afghan village scenario, low civilian activity;
2. Afghan village scenario, high civilian activity;
3. Stop and cordon scenario, low civilian activity;
4. Stop and cordon scenario, high civilian activity.

The conditions were counterbalanced so as to control for possible learning effects. Data collection took place at DRDC T on March 5-6, 2012 in a total of four sessions as described in section 2.4.3.

2.4.2 Scenarios

Four tactical scenarios were developed for the purpose of this study. Two involved a vehicle patrol through an Afghan village. These two scenarios were almost identical to each other except that one had high civilian activity and the other had low civilian activity. The other two scenarios involved a stop and cordon approaching an Afghan town; again one with high civilian activity and one with low civilian activity. The context and content of the scenarios were developed in consultation with the contract scientific authority (CSA). The scenarios were generated by individuals at DRDC T who are skilled at programming in VBS2 with input from the HSI® research team. Two SMEs were on hand to help ensure the face validity of the scenario elements.

Each scenario presented multiple threat indicators including some human indicators such as a spotter on a roof or a vehicle driving too close to the patrol. These entities were fully controlled by VBS2's artificial intelligence. The scenarios included either many (45-55) or no (0) CAMX civilians. For both scenarios participants had the viewpoint of being mounted in a Light Armoured Vehicle (LAV) with a 180 degree field of view (FOV).

All of the scenarios were pre-recorded. Participants were required to simply watch the videos and were not able to control the simulated scenarios in any way. Table 1 provides detailed descriptions of each of the scenarios participants watched.

Table 1: VBS2 Scenarios

Scenario	Location	IED (Threat) Indicators	Number of non-CAMX Civilians Present	Number of CAMX Civilians Present
Afghan Village –low civilian activity	Afghan village	Culvert, spotter on building, vehicle pulling off road slightly later than it should have, man spying from compound near culvert	24	0

Scenario	Location	IED (Threat) Indicators	Number of non-CAMX Civilians Present	Number of CAMX Civilians Present
Afghan village –high civilian activity	Afghan village	Culvert, spotter on building, vehicle pulling off road slightly later than it should have, man spying from compound near culvert	24	53
Stop and cordon –low civilian activity	Stop and cordon in Afghan town	Possible vehicle borne IED/ambush, spotter on building, civilian male approaches CF member in cordon	16	0
Stop and cordon –high civilian activity	Stop and cordon in Afghan town	Possible vehicle borne IED/ambush, spotter on building, civilian male approaches CF member in cordon	16	46

2.4.2.1 Afghan Village Scenario

This scenario was designed to closely represent a typical rural Afghan village in order to maintain a sense of realism for participants who would be familiar with this environment from past deployment. The physical setting depicts a village that has one central road leading through the village and approximately 20 buildings of varying size and function positioned primarily on the left side of the road. The patrol scene through the village includes vehicles visible from the road, and a mosque on the right side of the road. Surrounding the village are fields for crops and animals.

The scenario depicts the CF on a presence patrol that drives through the village on the central road. While driving, the Sentry is able to view the whole town with a 180 degree FOV so that he can observe a number of buildings as well as civilians going about their daily business.

There was a number of specific threat indicators included in this scenario. For example, there is a man on a rooftop on the left hand side of the road who raises a cell phone to his ear as soon as he spots the convoy. Seconds later, a man is visible on the right hand side of the road in a compound in clear view of a culvert located just after the village. Taken together the position and behaviour of these characters is suggestive of that of insurgents planning an attack on the convoy at the culvert. The scenario ends just after the LAV exits the village and just before the culvert. Below are screenshots of the Afghan village scenario both with and without CAMX entities.

Figure 3: Screenshot of Afghan village with low civilian activity (no CAMX entities)

Figure 4: Screenshot of Afghan village with high civilian activity (45-55 CAMX entities)

2.4.2.2 Stop and Cordon Scenario

The stop and cordon scenario was designed to represent the outskirts of a small Afghan town. This setting depicts a realistic desert-like environment with some trees and farmers' fields surrounding the town. Once again, this town has one primary road entering it which was blocked by an abandoned dump truck. Behind the dump truck was the town, which had a variety of buildings.

Once again, the CF are on a presence patrol. Because of the dump truck in the road, they are forced to stop just before the town and observe the situation. The Sentry has a 360 degree FOV and is actively scanning the area. There are children playing soccer to the left of the convoy. A dismounted soldier is

in front of the convoy facing the town. Within the town there are a number of buildings and people going about their daily business. Nearing the end of the scenario, an unidentified man approaches the dismounted soldier at the front of the convoy. As the man approaches the convoy, a spotter appears on top of one of the buildings in the town on the left hand side of the road. The scenario ends shortly after these two individuals appear.

Figure 5: Screenshot of stop and cordon scenario with low civilian activity (no CAMX entities)

Figure 6: Screenshot of stop and cordon scenario with high civilian activity (45-55 CAMX entities)

2.4.3 Procedure

Pre-experimental activities Upon arrival, participants were seated at one of the stations shown in Figure 1. Participants were then verbally briefed on the purpose and background of the study (see Annex) and signed an informed consent form prior to participating (see Annex). Once briefing and consent were complete, participants were shown a brief training video to orient them to the types of things that they would see in the VBS2 environment in the scenarios. The training video was just over a minute long and took participants through a drive in an Afghan village (not the same Afghan village used for one of the experimental scenarios). The village contained buildings, vehicles, people, and threat indicators similar to those that would be seen in the actual experimental scenarios. Participants were told that this video would be similar to the videos that they would see in the experimental task. Below is a screenshot of the training video that participants viewed.

Figure 7: Screenshot of training video

Once participants had observed the training video they had the chance to ask any questions prior to beginning the experimental task. Participants were instructed to observe and assess the scenarios thoroughly, as they would on a real mission. They were asked to look for anything that they as soldiers would look for when making threat assessments in an operational context.

Participants were assigned to one of two conditions: order 1 or order 2 which represents the order in which the four scenarios were presented (see Table 2).

Table 2: Order of Conditions

Presentation Order 1	**Scenario 1:** Afghan Village no CAMX	**Scenario 4:** Stop and Cordon with CAMX	**Scenario 2:** Afghan Village with CAMX	**Scenario 3:** Stop and Cordon no CAMX
Presentation Order 2	**Scenario 4:** Stop and Cordon with CAMX	**Scenario 1:** Afghan Village no CAMX	**Scenario 3:** Stop and Cordon no CAMX	**Scenario 2:** Afghan Village with CAMX

Experimental trials took place on March 5 and 6. There were two time slots each day; 1300-1500h and 1800-2000h. The participant schedule is shown in Table 3.

Table 3: Schedule

Time	**Mar 5**	**Mar 6**
1300-1500h	P1 – Order 1 P2 – Order 2 P3 – Order 1 P4 – Order 2 P5 – Order 1 P6 – Order 2 P7 – Order 1	P10 – Order 2 P11 – Order 1
1800-2000h	P8 – Order 2 P9 – Order 1	P12 – Order 2 P13 – Order 1 P14 – Order 2

Experimental Task Participants were presented with four pre-recorded videos and questionnaires (described in detail below) over approximately one and a half hours. Before the first video began, participants read a mission briefing on their screen (see Annex C: Mission Briefing). This briefing provided participants with some background information about the convoy and the history of threats in the area. The four videos were presented to participants one at a time in one of two orders (described in Table 2). Each video lasted between 1 and 2 minutes. Following each video, participants were asked to complete a questionnaire containing five questions (see Annex D: Questionnaire). Specifically participants were asked to:

1. rate the threat level of the scenario on a 5-point scale;
2. describe the elements in the scenario that supported their threat assessment;
3. indicate the course of action that they would take in response to the specific level of threat;
4. rate (on a 5-point scale) whether or not they felt that enough information was provided to them in the scenario in order to make a reliable threat assessment; and
5. describe other information that they would need in order to make a more reliable threat assessment.

Once participants completed the questionnaire, they began watching the next video.

After participants watched all four videos and completed all four questionnaires, they were presented with an exit survey (see Annex E: Exit Survey) containing questions concerning the realism of the scenarios. They then completed a demographics questionnaire (see Annex F: Demographic Questionnaire).

Post-experimental activities At the end of the study, participants were given a short verbal debrief of the study's purpose and were paid.

2.5 Measures and Data Analysis

This section describes the questionnaires developed for each scenario in this study as well as the methods used to analyse the data.

2.5.1 Questionnaires

The items within the questionnaire were developed in consultation with the CSA and to some extent based on measures used in previous similar studies by Thomson et al. (2009) and Bruyn Martin & Karthaus (2009). The purpose of collecting participant responses to the questions (see section 2.4.3) was to gain insight into the way in which soldiers assess their environment. These answers will provide the basis for a future, more in depth study looking at the effect of civilian activity on threat assessment. The questionnaire was presented to participants following each video for a total of four times.

At the end of the study, participants were presented with one questionnaire (referred to as the exit survey) with questions regarding the realism of the study and the utility of such simulations in future training for the CF. They were asked to rate how realistic the scenarios were on a 5-point scale and asked to explain their response using a free-form response box. In order to gain an understanding of realism in simulations, we also asked participants to answer what would have made the scenarios more realistic. For the purpose of this questionnaire the term realism was used in a very general sense and not specifically defined for participants.

Because this study was exploratory in nature, we also asked participants what are the benefits and drawbacks of using virtual environments such as the one in this study for training purposes. Participants were also asked to list any software anomalies that they observed in the videos that would take away from the realism of the study. This will help to analyse CAMX as a whole and to improve simulations for future studies.

2.5.2 Data Analysis

In this study we collected both quantitative and qualitative data. The following sections describe the methods used to analyse both types of data.

2.5.2.1 Quantitative

All of the quantitative data was collected using rating scales. Participants rated how threatening each scenario was, whether or not they had enough information to make a reliable threat assessment, and the realism of the scenarios, all on 5-point scales. We were primarily interested in the threat assessment ratings that participants provided. Our research questions related to threat assessment included:

- Is there any difference in the threat level between the high civilian activity and low civilian activity scenarios?
- Were the low civilian-activity scenarios equal in terms of participants' threat assessment scores?
- Does the threat assessment in the Afghan village scenario differ significantly from the stop and cordon scenario?

In order to answer these questions, a repeated measures analysis of variance (ANOVA) and post-hoc Fisher's LSD were conducted on the data.

2.5.2.2 Qualitative

The majority of data collected in this study was qualitative in nature. In order to analyse all of the data, categories were created, which allowed the data to be organized into specific themes. Different categories were created for each question in the questionnaire. In creating the categories, two members of the HSI® research team reviewed all of the qualitative data and collectively identified the most common themes which became the categories used for analysis. We created descriptions of each category in order to ensure that all comments were rated in the same manner. Once all of the categories were created, all participant responses were printed and each response was colour coded based on the relevant category. Notable (considering our primary research questions) or common responses for each category were identified and can be seen in the tables shown in section 3.1-3.3. The categories used to analyse the qualitative data for each question can be viewed in the tables below.

Table 4: Threat assessment categories

Category	Description
Physical Attributes of Environment	Absolutely any physical item mentioned (man-made or natural)
Civilian Activity	Anything to do with the activity of the locals
Number of People	Anything that mentions the number of people present in the scenario
Type of People	Anything discussing demographics of the civilians (men, women, children)
Vehicles	Anything discussing vehicles
Individuals of Interest	Any specific individuals mentioned in the scene

Table 5: Course of action (COA) categories

Category	Description
Heightened Vigilance	Ensuring all eyes on Exercising caution
Create Stand-off	Comments related to keeping distance
Force Escalation	Any use of force
Halt	Any stopping
Clear/Cordon	Clearing the area, or dismounting to investigate
Report/Contact Higher	Anything regarding reporting information to a superior
Request Assistance	Requesting assistance from a military source
Vulnerable Point Search/Search Area	Anything regarding physically searching the area
Discuss with Locals	Anything regarding speaking with civilians

Table 6: Information needed categories

Category	Description
History of Area/Previous Attacks	Anything asking for more info on the history of the place, or general info about the place
Auditory Information	Anything asking for audio
Facial Expressions/Mannerisms	Anything requesting to see facial expressions, mannerisms, or gestures
Interaction With the Simulation Software	Requesting to be able to control or alter the way in which they interact with simulation in any way
Civilian Activity	Anything discussing what the locals are doing and why. Including comments regarding speaking with the locals.

Specific questions that we hoped that the qualitative data would answer included:

- Was the reported COA different for scenarios in which there was high civilian activity versus those with low civilian activity?
- What types of indicators were participants perceiving in their environment and how did that impact their threat assessment?
- Were the indicators reported by participants different for scenarios in which there was high civilian activity versus those with low civilian activity?

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3. Results

This section describes the both the quantitative and qualitative data collected in this study and the results of analyses done on this data. Results are outlined according to dependent variable: threat assessment, course of action, information needed to make a reliable threat assessment, and realism.

3.1 Threat Assessment

In each scenario, a number of combat indicators such as culverts, abandoned vehicles, and individuals of interest (i.e. spotters) were present that could signal the threat of an IED attack. As participants viewed each scenario, they were asked to make an overall threat assessment of the scenario on a 5-point scale and indicate via a free response box what information in the environment they used to make their threat assessment. The mean threat assessment scores for each scenario are given below.

Table 7: Mean threat assessment scores for each scenario

Scenario	Mean Threat Level Score
Afghan village with low civilian activity	3.43
Afghan village with high civilian activity	3.43
Stop and cordon with low civilian activity	3.79
Stop and cordon with high civilian activity	2.43

The mean threat assessment scores for both Afghan village scenarios were exactly the same. For the stop and cordon scenario, the mean threat assessment score for the low civilian activity condition was higher than the high civilian activity condition. Based on a 2 (civilian activity: low vs. high) x 2 (scenario: village vs. stop and cordon) repeated measures analysis of variance, we found that there was a significant civilian activity by scenario interaction $F(1,13)=7.76$, $MSE= 0.83$, $p<0.05$ and a main effect of civilian activity (high versus low civilian activity) $F(1,13)= 7.10$, $MSE=0.91$, $p<0.05$ indicating that there was a significant difference between low and high civilian activity threat assessment scores dependent upon scenario. Fisher's LSD post-hoc test revealed a significant difference between scenario 3 (stop and cordon with low civilian activity) ($M= 3.79$) and scenario 4 (stop and cordon with high civilian activity) ($M=2.43$), $p<.05$. Specifically we found that participants rated the threat level of low civilian activity significantly higher than high civilian activity, but only in the stop and cordon scenario. A 2 (civilian activity: low vs. high) x 2 (scenario: village vs. stop and cordon) x 2 (order: 1 vs. 2) mixed model ANOVA showed no effect of order.

The mean threat level ratings for the Afghan village and stop and cordon scenarios with low civilian activity were not significantly different suggesting that the two scenarios were of similar threat level prior to adding the CAMX civilian entities. This shows that the scenarios were associated with a

common baseline level of threat which was important to establish when investigating the impact of civilian activity on the perceived level of threat.

We conducted a qualitative analysis of participant responses for each free-form response in the questionnaire. Table 8 shows common or notable responses that participants gave to support their threat level assessment. Common responses are those that more than one participant made, notable responses were those that we found interesting based on the objectives of the study. Table entries in italics represent responses that differed between the high and low civilian activity conditions. A detailed description of the way in which the data was analysed is provided in section 2.5.2.2.

Table 8: Information participants used to make threat assessment in Afghan village scenario

Scenario	Condition	Category	Common and Notable Responses
Afghan Village	**High Civilian Activity**	**Physical Attributes of Environment**	Object on the culvert; high points; compound on right side; donkey
		Civilian Activity	Man shooing children inside; normal POL
		Number of People	Well populated
		Type of People	Lone male in parked car; *many comments about women and children*
		Vehicles	Vehicle approaching pulls over later than they thought a non-threat would; one vehicle parked on side of road
		Individuals of Interest	Man using cell phone on roof; Man in the compound; *lone male in parked car*[1]
	Low Civilian Activity	**Physical Attributes of Environment**	Donkey, culvert, towers on mosque; high points; compound
		Civilian Activity	Man shooing children inside
		Number of People	Minimal people present
		Type of People	Not many women and children present
		Vehicles	Vehicle pulls off to side of road but the timing is late; lone vehicle on side of road
		Individuals of Interest	Man using cell phone on roof; Man in the compound;

[1] Lone male in parked car was present in both low and high civilian activity conditions but was only noted by participants in the high civilian activity condition

Table 9: Information participants used to make threat assessment in stop and cordon scenario

Scenario	Condition	Category	Common and Notable Responses
Stop and Cordon	**High Civilian Activity**	**Physical Attributes of Environment**	Disturbed earth; bend in the road
		Civilian Activity	Civilians observing patrol; children playing; POL seems normal (everyone is going about their own business)
		Number of People	Populated; people walking along route
		Type of People	Fighting age males (FAM); children coming up to the patrol; children playing
		Vehicles	Orange truck blocking road
		Individuals of Interest	FAM approaches patrol; man using cell phone on roof
	Low Civilian Activity	**Physical Attributes of Environment**	Disturbed earth; bend in the road
		Civilian Activity	Children kicking soccer ball; *no POL near dump truck*; *town clears when man walks up to patrol; POL less than in other scenario*
		Number of People	Only two kids; fewer people; *three men off to the right*
		Type of People	Local Nationals (LN); children; *men only, no women*
		Vehicles	Abandoned truck with nobody around
		Individuals of Interest	LN approaching the dismount; man using cell phone on roof

The participant responses listed in Table 8 and Table 9 show that they perceived and interpreted many potential threats in their environment in all four scenarios. It is also evident that participants detected different indicators in the low compared to the high civilian activity condition. For example, in the low civilian activity condition of the stop and cordon scenario, participant responses suggest that they noted a low POL (i.e. less people which is atypical) near the dump truck and that there were no women present. Consistent with this, in the stop and cordon condition, participants rated the low civilian activity condition as significantly more threatening than the high civilian activity condition.

In the Afghan village scenario, threat level ratings were not significantly different in the low versus high civilian activity conditions. Participant responses indicating what information they used to assess the threat level in both conditions support this in that participants seemed to detect the same indicators in both scenarios and found them to be very similar in threat level. Possible reasons for this are discussed in section 4.1.

The next section describes the participants' reported COAs they would take in response to the particular threat level of each scenario.

3.2 Course of Action

In the questionnaire presented at the end of each of the four videos, participants were asked to indicate what COA they would take in response to the particular threat level of each scenario. Once again, the data were categorized using the methods described in section 2.5.2.2.The only difference in the method used to categorize COA responses was that some categories from the qualitative analysis completed in Thomson et al. (2009) were used. The categories used by Thomson et al. (2009) were found to be relevant to the responses participants gave in this study as COAs tended to be very similar and because of this many of the same categories were used for this study.

Table 10: COA participants would take in the Afghan village scenario

Scenario	Condition	Action Category	Common and Notable Responses
Afghan village	**High Civilian Activity**	**Heightened Vigilance**	Remain vigilant; keep eyes on unusual or out of place details; monitor the two towers; keep eyes on the male on the roof; pay attention to body language; eyes on the man in the compound
		Create Stand-off	Don't let the car approach so quickly or closely; stop the vehicle approaching farther away; bypass the culvert
		Force Escalation	Fire warning shot or pen flare when car approaches; escalate force when dealing with donkey
		Halt	Stop short of culvert
		Clear/Cordon	Cordon the culvert; dismount to investigate; perform 5's and 20s
		Report/Contact Higher	Call it in; call in Situation Report (SITREP); inform chain of command
		Request Assistance	Send engineers to conduct a search of culvert; use interpreter to speak with locals; air sentries and gunners to focus weapons on obvious threat areas; have ECM on
		Vulnerable Point Search/Search Area	Vulnerable point search (VPS) the culvert; search the vehicle that is approaching
		Discuss with Locals	Speak with the man on the roof on the cell phone; question and detain driver if he doesn't pull over; Ask man on roof why he used his cell phone as they passed
	Low Civilian Activity	**Heightened Vigilance**	Keep a keen eye on threats; keep eye on red car; pay attention to compound and man on roof using cell phone; keep eyes on as many people as possible; watch for anything out of the ordinary
		Create Stand-off	Bypass the culvert; wave off first vehicle sooner; bypass the town
		Force Escalation	Engage first vehicle with a warning shot; if cars don't pull off, escalate force; point weapons at vehicle approaching
		Halt	Halt short of culvert; stop on side of road before crossing bridge
		Clear/Cordon	Dismount to investigate; cordon the culvert; perform 5's and 20s
		Report/Contact Higher	Inform chain of command; call it in; SITREP to higher; inform rest of patrol

Scenario	Condition	Action Category	Common and Notable Responses
		Request Assistance	Ensure EW assets are operational; have air sentries watch all high features; RWS systems to watch background
		Vulnerable Point Search/Search Area	VPS culvert; search vehicle before letting it pass; search the compound
		Discuss with Locals	Interrogate man on roof who is using a cell phone

In summary participants indicated they would use similar COAs for both low and high civilian activity conditions. These results are supported by the fact that threat level ratings were not significantly different in both conditions of the Afghan village scenario. As shown in Table 10, participants tended to make the same or similar comments for both conditions.

Table 11 represents the participant responses given for the stop and cordon scenario. Once again, responses in italics represent responses that differed between the high and low civilian activity conditions.

Table 11: COA participants would take in the stop and cordon scenario

		Action Category	Common and Notable Responses
Stop and Cordon	**High Civilian Activity**	**Heightened Vigilance**	Remain vigilant; watch rooftops and dump truck; stay alert; keep eye on disturbed earth; observe any changes with the locals
		Create Stand-off	Create standoff distance between truck and patrol; bypass the village; stop the male that is approaching; push people further away
		Force Escalation	Be ready to return fire
		Clear/Cordon	Continue 5's and 20's; establish a cordon
		Report/Contact Higher	Call in the man on the roof and the dump truck; Inform rest of patrol
		Request Assistance	Call in translator; have air sentries and gunners ready to fire
		Vulnerable Point Search/Search Area	Search the man that is approaching
		Discuss with Locals	Speak with the locals
	Low Civilian Activity	**Heightened Vigilance**	Remain vigilant; eyes on the man on the roof; any movement at this point will be seen as suspicious
		Create Stand-off	Find bypass route; stop man walking towards the convoy earlier; make man stop in the distance; move convoy further from town
		Force Escalation	*Give a warning shot to the man walking towards the patrol; use escalation of force to stop man from approaching; have the gunner target guy on his cell phone*
		Clear/Cordon	Send in dismounts to investigate the situation
		Report/Contact Higher	*Contact higher; call in SITREP*; *call in lack of POL* and disabled truck; inform chain of command about man on roof using cell phone; inform rest of patrol
		Request Assistance	Use EW equipped vehicle for support; call up interpreter; use air assets to find other threats; call up the Afghan National Army (ANA)
		Vulnerable Point Search/Search Area	*VPS; search of village; search disturbed earth; investigate truck, assign arcs;* search man before he approaches
		Discuss with Locals	*Ask LN about enemy activity and the overall situation; speak to man approaching about the truck blocking the road; ask locals why the town is empty; talk to man approaching about how long him and his people have been at the bend in the road*

The participant responses listed in Table 11 show that the COAs they would take in the stop and cordon scenarios differed when there was high versus low civilian activity. In the condition with low civilian activity participants were more likely to make comments regarding the escalation of force, reporting/contacting higher, searching the area, and discussing the situation with the locals.

In the stop and cordon high civilian activity condition, participants commented that they would remain vigilant, keep an eye on anything that changes in the environment and keep a standoff distance from the dump truck. They were also particularly interested in the man on the roof and the man approaching the patrol, much like they were in the low civilian activity condition.

3.3 Information Needed to Make a Threat Assessment

Participants were asked via a free-form response box in the questionnaire to indicate what other information they would have liked to make a more reliable threat assessment. Their most common or particularly notable responses are shown in Table 12. The methods used to develop the categories shown in the table are listed in section 2.5.2.2.

Table 12: Information needed to make threat assessment

Afghan Village		Category	Common and Notable Responses
	High Civilian Activity	**History of Area/Previous Attacks**	Previous attacks that have happened in this location; past IED trends in the area; time of day; frequency of our visits; whether or not they are friends with the village elder; insurgent procedures; village loyalties; are the locals friendly to coalition forces?
		Auditory Information	Need a translator
		Facial Expressions/Mannerisms	N/A
		Interaction With the Simulation Software	*Ability to zoom in with binoculars*
		Civilian Activity	What is the normal POL; how many people are in the car; where are all the women and children; who is the man on the roof speaking with; why is the woman walking into the mosque; would like to speak with local population
	Low Civilian Activity	**History of Area/Previous Attacks**	What is the local economy based on; where do the LN's work; History of previous attacks; how long or often have we held or driven past the area; time of day; day of week; local government; prior successful attacks; population of the village; location of the village in Afghanistan; village loyalties; what type of IEDs are used in the area?
		Auditory Information	Listen to conversation through interpreters
		Facial Expressions/Mannerisms	*Facial expressions of the local population*
		Interaction With the Simulation Software	N/A
		Civilian Activity	Scan the hills for activity; disposition of these people towards us; need more POL info; not many locals walking around; women walking in the streets not typical

The participant responses listed in Table 12, indicate that they generally wanted to know more about the history and characteristics of the scenario location such as past attacks, the local economy, and village loyalties. In addition, participants seemed to be particularly interested in knowing what the locals were saying and understanding the normal POL in the area. The information they wanted did not differ between the high and low civilian activity conditions. Again, any comments that were different between conditions are italicized in Table 12.

Table 13 lists the participant responses related to what information they would have liked in order to make a reliable threat assessment in the stop and cordon scenario.

Table 13: Information needed to make a threat assessment

Scenario	Condition	Category	Common and Notable Responses
Stop and Cordon	**High Civilian Activity**	**History of Area/Previous Attacks**	Type of attacks in the past; is the village friendly; situational intelligence of area; what is the purpose of us being here; do trucks routinely stop in the road; frequency of our visits here; type of IEDs used in past
		Auditory Information	What is the soldier talking about with the village male; Translator to speak with locals
		Facial Expressions/Mannerisms	Attitude of the locals made the situation more comfortable because they continue with their everyday activities
		Interaction With the Simulation	*Ability to zoom in on the spotter on the rooftop*
		Civilian Activity	How often do people stand on roofs here?
	Low Civilian Activity	**History of Area/Previous Attacks**	Past history and method of attacks; time of day; prior and current intelligence of area; background of town; village loyalties; last IED attack; how friendly is the village
		Auditory Information	What are the three males off to the right talking about; translator to talk to LNs
		Facial Expressions/Mannerisms	*Man walking towards patrol should wave or gesture to show his intent; what was the action the locals did when they saw the individual approach the soldier*
		Interaction With the Simulation	N/A
		Civilian Activity	*Lack of POL; why are there only two kids playing; whose orange truck is that; why do 3 males off to the right walk away when individual approaches patrol; why is the male talking to the soldier; who is the male on the roof?*

The participant responses listed in Table 13 suggest that in the low civilian activity condition participants were interested in finding out more information regarding the facial expressions or mannerisms that the civilians displayed. For example, they were interested in seeing the man who was walking towards the patrol gesture to indicate his intent. They were also interested in seeing how the locals were reacting to what was happening around them. They also seem much more interested in the POL and why certain things were happening the way that they were. For example, they indicated that

they would like to know whose truck was in the road, and why the male approached the soldier. In the high civilian activity condition participants appeared to be much more content with the information that was provided to them in the scenario.

3.4 Realism

After participants finished watching all four scenarios and completed all four questionnaires, they were presented with an exit survey addressing the realism of the study. Participants were asked to rate the realism of the simulations in general on a 5-point scale (see Annex E: Exit Survey) and explain their ratings. Although it is likely that the realism of a simulation is multi-dimensional (e.g. behavioural realism of agents, realism of task) was used realism in a very general sense in the questionnaire and did not define it for participants. Participant responses were therefore dependent on their interpretation of the term realism.

Overall, participants' realism ratings ranged from 2-5 with a mean score of 3.93. This suggests that overall participants found the scenarios to be relatively realistic in comparison to what they have experienced in similar operations while deployed in similar areas. A correlation between realism and threat assessment was not significant.

Participants were also asked to explain why they rated realism the way they did. The range of participant responses was broad. On the positive side, participants said that the scenarios were authentic compared to what they had experienced in operations. Similarly they commented that the indicators were ambiguous enough that participants needed to make a judgement as to whether they were threatening, which is much more realistic than if the indicators are very obvious. Participants also stated that the overall entity behaviour was similar to that which would be expected in Afghanistan.

On the negative side, participants stated that they had no basis for POL (they wanted more information about what usually happens in the area since they were not able to gather that information themselves), a lack of information such as history of the locations they were in, and a lack of auditory information. Participants claimed that if they had been able to hear civilians talking and other background noises in the scenarios, they would have felt more immersed in the simulation, thus improving the sense of realism for the participant

In order to make the scenarios more realistic, participants suggested that we improve certain elements of the simulation to make the user experience more realistic, and to modify the related entity behaviour to better mimic the real-life characteristics of local civilians. The two most common suggestions were to include auditory information so that they could get a better sense of the action on the screen, and to provide a way for participants to interact with the simulation by zooming in and out or pausing at a particular point in the scenario.

While the participants noted that the overall entity behaviour in the scenarios was consistent with what they had experienced while on deployment, they noted that certain civilian behaviour was absent. In particular, they suggested that the scenarios include entities that are more curious about the CF soldiers, and to include children that ask for hand-outs. Aside from making the overall scenario more realistic, entities with these behaviours may better test the participants' situation awareness by providing a realistic distraction from other indicators in the overall scene.

4. Discussion

This section summarizes the study findings and discusses their significance in relation to other research in the area and in terms of possible implications for future training in the CF. This section also addresses challenges encountered in conducting this study and potential limitations of the research.

4.1 Summary of Findings

The results of this study suggest that the presence of civilian activity was associated with a lower threat level in the stop and cordon scenario only. This conclusion is based on several findings, namely that participants rated the level of threat significantly lower in the stop and cordon condition with high civilian activity than they did in the stop and cordon condition with low civilian activity. We did not find a significant difference in the soldiers' reported level of threat between the two conditions in the Afghan village scenario. We did, however, find a main effect of civilian activity on threat assessment level, meaning that participants rated the low civilian activity condition overall more threatening than the high civilian activity condition. A significant civilian activity by scenario interaction effect indicates that the main effect of civilian activity was due to the interaction effect (i.e. it is dependent on scenario).

In the Afghan village scenario we found no significant difference in participant threat level ratings in the high versus low civilian activity conditions. Furthermore participants reported using essentially the same IED indicators when assessing the level of threat in both conditions suggesting that they either did not detect a difference in civilian activity or that they did not find the difference in civilian activity threatening. In the stop and cordon scenario, however, participants' responses suggest that they detected a difference in the number, type and activity level of civilians between the two conditions. In the high civilian activity condition participants reported a greater number of civilians, the presence of women and children and "normal" POL (i.e. "people going about their business"), and associated these indicators with a lower level of threat. Participants also stated that their COAs would be different in the stop and cordon scenario if there was high versus low civilian activity. Specifically, they would be more willing to use an escalation of force and search the town when there was less civilian activity.

The results comparing the high civilian activity versus low civilian activity conditions with regards to threat assessment and COAs are interesting. One question that needs to be addressed regarding threat assessment scores is why participants did not feel that low civilian activity in the Afghan village was more threatening than when there was high civilian activity. It may be that, even though there were more CAMX entities in the Afghan village scenario than the stop and cordon scenario, the number of civilians in the Afghan village scenario may not have appeared to be as many as in the stop and cordon condition because the Afghan village scene was bigger than the area in the stop and cordon scenario. In addition, there may have been more information to assimilate in the Afghan village scenario due to its size and by the time participants were asked to rate the threat level they may have forgotten certain elements of the scenario. Another possibility is that it may not have been the mere presence (or lack) of civilians that impacted participant ratings of threat level and that the effect of civilians on threat assessment is much more complex and subtle. For example it may be the case that the behaviour of the civilians in the Afghan village was not friendly (or unfriendly) enough to affect threat perception. Or perhaps the presence of civilians impacts threat perception in different ways depending on the context. Our study results therefore suggest complex interactions between the scenario (context) and the characteristics of the simulated civilian activity that could not be investigated in this study.

Despite the participants' positive response regarding the overall realism of the study, participants reported that a few specific additions to the scenarios would make them more realistic. Specifically, participants suggested that including auditory information such as what people are saying, the tone of their voices and the overall volume level in the environment would make the scenario more realistic. They also expressed that some of the behaviour of entities could have been more realistic, such as children approaching the patrol for hand-outs. Finally, participants indicated that they would like to have the ability to control the simulation themselves might make their interaction with the simulation more realistic. The correlation between realism and threat assessment was not significant however, suggesting that while changes to further enhance realism of the system might improve the overall user experience, it may not impact participants' ability to make a realistic threat assessment.

One of the most interesting findings was that despite our intention to avoid suggesting to participants that the scenarios were linked, participants recognized that there were only two scenarios presented to them, and that one condition in each scenario had more civilians present than the other. Participant qualitative responses suggest that they used the first instance of each scenario presented to them as the basis for establishing the pattern of life against which to compare the second instance of the scenario. For example, if participants saw the stop and cordon scenario with high civilian activity first and then saw the stop and cordon scenario with low civilian activity, they determined that the level of threat must be higher in the second scenario because the civilians had cleared out of town. One participant commented that "the pattern of life of the village was less active than the other scenario" when describing the level of threat in the stop and cordon scenario with low civilian activity (and comparing it to the same scenario with high civilian activity). Although there was no significant effect of order in the quantitative data, the qualitative data suggests that participants did not interpret the two Afghan village and two stop and cordon videos independently but rather used both to "build a story" on which they based their threat assessment ratings.

4.2 Implications

In this section we discuss the implications of the results of this study in relation to past research and what it could mean for future training in the CF.

4.2.1 Threat assessment in a real-world context

One area of research within the DRDC Technology Demonstration Program (TDP) on counter improvised explosive device (CIED) technologies was related to the way individual cues are used in order to make an overall threat assessment in an asymmetric environment such as that encountered in Afghanistan. This research (Bruyn Martin & Karthaus, 2009) found that there are at least nine cognitive tasks that are essential for IED detection and threat assessment. Below is a threat assessment equation that shows how a threat assessment is made.

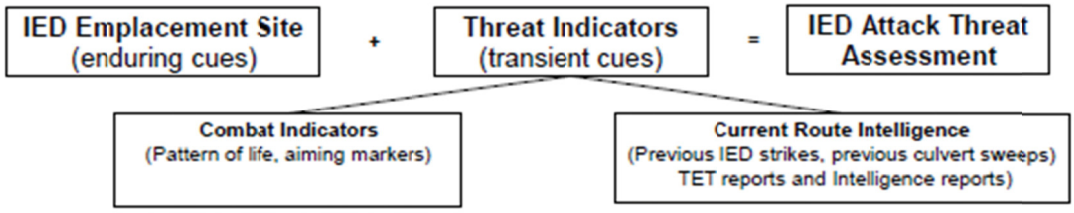

Figure 8: Threat assessment equation (Jarmasz, 2010)

In their study, Bruyn Martin and Karthaus (2009) found that certain IED indicators carry more weight than others when making a threat assessment. This appears to be confirmed by Thomson et al. (2009), whose results showed that IED indicators receive differing responses regarding COAs that soldiers would take. In our study, participant responses to questions about what indicators they used to make their threat assessment and any additional information they would like to have to make a more confident threat assessment, support the additive nature of cue detection and evaluation suggested by the model above. The responses also suggest that participants weigh certain cues as more or less threatening depending on the context. For example, one participant wrote "The greatest threat in the scenario was the man in the brown clothes walking towards the cordon, and none of the locals seem concerned that he is there which seems to signal they know him and he is therefore less likely to hurt them via an IED targeting us." This quotation suggests that while one indicator on its own (i.e. man in brown clothes walking towards the cordon) may be threatening, the presence of other indicators (none of the locals seem concerned) can make a soldier feel less threatened. These are important results, as the purpose of this study was to determine if soldiers respond the same way in a simulated environment as they do in a real-world situation.

In real-life operations, soldiers take many factors into account when they assess the threat of an IED attack. One of these factors, POL, requires soldiers to understand the patterns of civilian behaviour typical of the area being monitored in order to make threat assessments (Bruyn Martin & Karthaus, 2009). Anecdotal evidence from subject matter experts (SMEs) indicates that the presence and behaviour of civilians can have a major impact on situation awareness and decision making, and in particular change the threat level soldiers might assign to individual cues of a possible attack in the environment (Bruyn Martin & Karthaus, 2009; Cazzolato & Levesque, 2010). In terms of the order in which IED indicators are considered when making a threat assessment, Bruyn Martin and Karthaus (2009) indicated that SMEs reported always examining the POL first when making a threat assessment suggesting how important a factor it is. After assessing POL, soldiers will proceed to look for other threats in the environment. This appears to be similar to the approach that the participants in our study used when making a threat assessment. They were very interested in learning more about the pattern of life in the area they were in, and when not given information about POL, they took it upon themselves to link scenarios that were intended to be independent of each other in order to gain a sense of the POL in the area.

4.2.2 Threat assessment in a simulated environment

Similar to our study, Thomson et al. (2009) asked participants to rate the threat level of particular scenarios with IED indicators present, and provide a response indicating what their COA in response to the level of threat would be. In their study, they found that each IED indicator presented to participants received differing responses, but they did not look for a particular association between the reported threat level of a scenario and the COA reported. The main differences we saw in participants' COA responses (i.e. what actions they would take in response to the perceived level of threat) were in relation to the stop and cordon scenario. For example, cases where participants stated that they would escalate force occurred more often in the low civilian activity condition. This response supports the link between threat assessment and COA, since the threat assessment scores in the stop and cordon scenario were significantly different in the high and low civilian activity conditions.

In this study we observed differences in participants' responses based on the level of threat in the scenario. We found that in the stop and cordon scenario participants perceived a higher level of threat when no CAMX civilians were present. In line with their threat assessment score, participants reported being more likely to escalate force. Specifically, participants in this condition were much

more likely to say that they would give a warning shot or use an escalation of force to keep an unknown individual from approaching as opposed to taking other actions such as remaining more vigilant or reporting the situation.

Overall, the results of our study suggest that that it may be possible to replicate in a simulated environment the real-world relationship between IED indicators, particularly the presence of civilian activity, and the associated threat level. However, because the synthetic environment we used has not been independently validated, we cannot use it as a reliable indicator of what cues soldiers *use* in real missions, but the results of this study do tell us what cues soldiers *look for* in real missions.

4.2.3 Implications for future training in the CF

In the exit survey, participants were asked about the benefits and drawbacks of using virtual environments such as this one for training. These questions were intended to provide information to help us determine the utility of virtual environments such as this one as training tools. Participants reported that virtual environments are valuable for pre-deployment training, especially for soldiers who have never been deployed. In addition, they are a low cost tool and are great for after-action review (AAR). One of the main complaints that participants reported was that they were not able to experience the sounds, smells, anxiety, etc. associated with being on a real patrol.

In order for us to gain more insight into how virtual environments compare with real-world situations, participants were asked to provide feedback about the realism of the scenarios Although this study was not specifically designed to test the realism of virtual environments in general, we were able to gain insight into the opinions of soldiers who would be most affected by the use of these training tools. Soldiers stated that tools such as this one are great for pre-deployment training and are also great for after-action review to discuss what happened in a safe environment. Since the virtual environment in this study has not been validated in terms of realism, future research should include designing a validated virtual environment.

Thomson et al. (2009) found that after using a virtual environment in a similar manner to our study at more than one time period, the virtual training environment allowed trainees the ability to detect IEDs and respond in the same manner that SMEs would in the virtual environment. Although we cannot say this definitively, this suggests that virtual environments such as VBS2 may be realistic enough to be effective training tools. Interestingly, we found that there was no significant correlation between realism and threat assessment, also suggesting that further enhancements to realism may not be necessary for participants to make a realistic threat assessment. However, future research is needed to provide a better understanding of realism and the different dimensions that are relevant in this type of study.

The findings of this study suggest that virtual environments maybe realistic enough, especially with CAMX, to create scenarios for training purposes in the CF. Our results emulated past research investigating IED detection and threat assessment (Thomson et al. (2009) and Bruyn Martin & Karthaus (2009)), thereby suggesting that it may be possible to replicate a real mission to the degree required for participants to react similarly to how they would in a real mission. Of course, there are limitations limitations of deducing information from subjective data and therefore further research should aim to determine the value and realism of simulated environments for training purposes.

4.3 Challenges and Limitations

One major challenge we encountered in this study was the technological issues associated with the CAMX software. While developing the scenarios for this study, the developers encountered problems with the CAMX civilians that were placed in the VBS2 environment. Because CAMX is relatively new software, it may still have compatibility issues when integrated with VBS2 to produce a realistic simulation. While creating the scenarios in VBS2 we ran into a problem with the compatibility between the VBS2 maps and the CAMX maps. As a result we were required to use featureless maps in CAMX, which therefore required us to create exclusion zones on the CAMX map to mimic real environmental features that were used in the corresponding VBS2 map. For instance, CAMX entities do not recognize items such as rocks in the VBS2 environment and therefore walk through them in the scenarios. If exclusion zones were created in the CAMX map around the area where the rocks were on the VBS2 map, CAMX entities would know to avoid the areas where the rocks are. Many participants in our study also noticed anomalies such as these in the scenarios and one reported that this was a drawback of using virtual environments for training. Another challenge we encountered was that there was very limited time to generate the scenarios required for testing. Given more time, it may have been possible to more carefully place the CAMX civilians in the VBS2 environment including more exclusion zones around problem areas in the VBS2 maps, which could have made the scenarios appear more realistic.

One limitation of the system that may have impacted the realism of the study was that participants were limited to just viewing the scenarios, and thus not able to interact with the simulation in any way. While this was done to maintain control over the experimental setting, during a real operation participants could spend more time focussing on specific points of interest and stop at points when they need to investigate. In the videos presented to participants in this study, participants were forced to look at the items in the FOV presented at the time and were not able to zoom in or slow down while passing. Fixing the participants' FOV may be problematic as it deters from the realism of the study, which in turn would negatively affect the validity of this tool for training purposes.

Another limitation was that we did not have the same number of CAMX entities in the two high civilian activity conditions relative to the differences in size between the Afghan village and stop and cordon scenarios. As previously noted, this may have been why participants did not rate the level of threat significantly lower in the Afghan village high civilian condition compared to the low civilian activity condition. We were unable to have the same relative number of CAMX entities in the two high civilian conditions because project time constraints and technical issues encountered with CAMX and VBS2, as mentioned above.

Threat assessment is likely a more complex issue than simply the number of people present in the scenario. For example, age, gender, and activity/mannerisms of the civilians may play a large role in threat assessment in addition to the number of civilians present. Another issue that may have affected the results is that participants may have forgotten the things that they saw by the end of the scenario when they were asked to write down their thoughts. Although participants were given the option to write down anything that they wanted throughout each scenario, not all participants did and therefore they may simply not have remembered all of the indicators they saw. By asking participants retrospectively what they saw, we ran the risk of receiving less accurate details from participants. It is unlikely, though, that this would affect overall threat ratings.

Another limitation with regards to the design of the scenarios was that the panning in the videos was not completely consistent between conditions. The inconsistent panning may have meant that certain indicators in the scene were more or less visible in one condition compared to the other. For example,

in the Afghan village scenario with high civilian activity, many participants reported seeing an object on top of the culvert. In the Afghan village scenario with low civilian activity not a single participant reported seeing this object. After repeatedly watching the videos, the only explanation that we could come up with was that the panning in the video was slightly differently in each condition which highlighted the sides of the culvert possibly making it look like there was an object on top of it.

A final limitation of this study was the reliance on subjective data from participants. Although informative, participant feedback about their experience with and the realism of the simulation should be corroborated by further research in which objective data can be collected.

5. Conclusions and Recommendations

5.1 Conclusions

Threat assessment in asymmetric environments is a complex judgement task involving numerous variables such as the POL, combat indicators, and the civilian population. This study examined the impact that civilian activity had on soldiers' threat assessment in a simulated asymmetric threat environment using CAMX software combined with VBS2. This study was exploratory in nature and valuable information was collected from participants, which will inform future research in this field.

Based on the participant responses and on the similarity of results from Thomson et al. (2009), this study was successful in evaluating the way in which civilian activity impacts a soldier's threat assessment in a simulated environment. We believe that by using the CAMX software in conjunction with VBS2, we were able to simulate certain types of civilian behaviour fairly realistically. This was shown by how the participants assessed the level of threat much in the way they would in a real-world environment. In this case, soldiers associated high civilian activity in a simulated environment with a lower level of threat and would therefore take less aggressive COAs. Furthermore, results suggest that participants appear to use cues from previous scenarios to "build a story" on which they based their threat assessment, even though we intended for the scenarios to be independent. This strategy of "building a story" was also observed by Thomson et al. (2009).

5.2 Recommendations for Future Research

Since research in this area is very new, there are many more avenues to explore regarding the factors that affect threat assessment in virtual environments. Participants in this study provided us with valuable feedback, which will surely be taken into account in future studies. At this stage, future research should stem from the current limitations addressed in this study and from the recommendations based on our findings.

5.2.1 Recommended Ways to Address Current Study Limitations

The exploratory nature of this study has identified opportunities to improve the current study, as well as directions for new research. As a starting point, future research should focus on addressing the current limitations identified in this study, as summarized below:

- **Study participants over an extended period of time, and present them with either only one complex, multi-part scenario, or multiple sequential scenarios**. By presenting scenarios in sequential order, or in all one scenario, rather than in independent scenarios, participants may be able to build the contextual cues that they need to make a more realistic and reliable IED threat assessment. This would also allow participants to have a better understanding of the POL in the scenario by allowing participants to discover abnormal patterns that may develop in the scenario over time.
- **Design a study that includes more civilians in the high civilian activity condition**. Increasing the civilian density in this condition may help explain why we did not find significant results in the Afghan village scenario while finding significant results in the stop and cordon scenario.
- **Add a third scenario to the existing study.** Rather than creating sequential scenarios, a third, independent scenario could be added to the current study design. The additional

scenario could be another area in Afghanistan such as an urban market containing threat indicators similar to those used in the other two scenarios. This third scenario would also include two conditions: high civilian activity and low civilian activity, which would provide us another means for comparison to see if participants rate threat similarly in this scenario. If the threat assessment scores change based on low or high civilian activity, it can be concluded that the original scenario (Afghan village with high civilian activity) likely did not include enough CAMX civilians to make an impact on threat assessment.

- **To the extent possible, allow participants to interact with the simulation rather than passively watching video.** Participant responses indicated that they would prefer to be able to control the simulation through the ability to zoom in, pan, and stop the video. By adding in this component, we will be able to determine if threat assessment scores change based on this and therefore will be able to tell if this added level of realism is important in simulations. The extent to which participants can control the simulation will have to be balanced with the need to control the viewpoint for experimental purposes, however.

5.2.2 Further Investigation

The findings from our study suggest that future research in two particular areas would be useful; first, verifying that external factors did not impact our study assessing whether more realistic scenarios are needed and second, investigating the complex interactions between the scenario and characteristics of simulated civilian activity and their impact on threat assessment.

- **Rule out possible factors that impact threat assessment.** A future study should, to the extent possible, aim to rule out all other possible factors that impact threat assessment. A study of this nature should allow researchers to conclude that results were definitely due to the impact of civilian activity on threat assessment in a simulated environment, as opposed to possible external factors such as the composition of the civilian crowd.

- **Determine the dimensions of realism relevant to threat assessment in a simulated environment.** In the case that enhanced realism is found to improve participants' ability to gauge threat assessment, future research in this area would be valuable. A potentially valuable future study would be one that attempts to determine what are the dimensions of realism that are relevant to threat assessment in a simulated environment. For example, the extent to which the simulated patrol task mimics a real-life patrol task can be considered one aspect of realism that is could impact threat assessment while another dimension would be the extent to which elements of the scenario (e.g. people) look, behave and interact with other elements in a way you would expect. Once the dimensions of realism are better understood research can then investigate how much realism is required for training and experimentation purposes.

- **Compare trainees to SMEs.** Comparing trainee responses to SME responses similar to what was done in Thomson et al. (2009) would be an important next step in determining the realism of virtual environments and their validity as training tools.

- **Vary the characteristics of the simulated civilians as well as the context.** The behaviour and type of civilians as well as characteristics of the context appear to also be important factors (in addition to the mere presence or absence of civilians) in evaluating the threat level of a situation. It is therefore recommended that future research investigate the apparently

complex interactions between the scenario and characteristics of simulated civilian activity and their impact on threat assessment.

By addressing the current limitations of this particular study, and by exploring the avenues presented for potential future research, researchers should begin to gain a better understanding of the overall value of using simulated environments to determine threat assessment, and thus provide the CF with a useful training tool.

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Annex A: Participant Information Sheet

Participant Information Sheet

Evaluation of the impact of civilian crowds on threat assessment judgements in simulated "asymmetric threat" scenarios

Background	The Canadian Forces (CF) are interested in improving training for operations involving civilians, including both combat and humanitarian missions, through the use of first-person, game-like simulations. One such system in use by the CF, Virtual Battle Space 2 (VBS2), is well suited to training combat missions but does not simulate all civilian behaviours well. DRDC has developed software called Civilian Activity Modelling for eXercises and eXperimentation (CAMX) to improve the ability of simulations like VBS2 to represent civilian crowd behaviours.
Study Overview	The primary objective of this study is to gain an understanding of the value of CAMX as a tool for improving training in VBS2. The investigators will observe you as you complete brief scenarios, similar to reconnaissance patrol missions, in VBS2, both with and without simulated civilians generated by CAMX. You will be asked to report on notable threats and incidents you observe during the scenarios. The experimenters will also ask you about your overall impressions of the scenarios and will record your responses (on paper or electronically). The feedback thus obtained will be used to assess the effectiveness and value of CAMX as a tool for improving training in VBS2 for missions involving civilians.
Your Rights as a Participant	Your participation in this study is completely voluntary. You may ask questions of the researchers at any time. You may end your participation at any time, without prejudice or hard feelings, and are free to skip over any task or question you do not wish to complete. If you do choose to complete this study, we ask that you answer as honestly as possible so that our data accurately reflect your training experience.
Confidentiality	To ensure your identity remains confidential, your data will be assigned a unique identification number. Neither your name nor your service number is a part of the data file. Only authorized personnel will have access to the data and only group results will be presented. Your individual information will not be released to commanding officers and will not be used for performance evaluation purposes. In the unlikely event of an Access to Information request, please be advised the Access to Information Office is required, by law, to protect your identity under the Privacy Act. Thus, no information may be released that will identify you as an individual.
Benefits	This study will allow you to help the CF develop better training tools to better prepare soldiers deploying on humanitarian and "asymmetric threat" missions.
Risks	The risks in this study are not considered significant (minor postural fatigue, eye strain, mental effort).
Contact Information	Dr. Jerzy Jarmasz Tel: 416-635-2000 x3081 e-mail: Jerzy.Jarmasz@drdc-rddc.gc.ca For research ethics issues, you may also contact the Chair, HREC at DRDC Toronto Dr. Jack Landolt Tel: 416-635-2120 CSN: 7-0-634-2120 e-mail: Jack.Landolt@drdc-rddc.gc.ca

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Annex B: Voluntary Consent Form

VOLUNTARY CONSENT FORM

Evaluation of the impact of civilian crowds on threat assessment judgements in simulated "asymmetric threat" scenarios

Principal Investigator: Jerzy Jarmasz (DRDC Toronto)

Co-Investigators:

1. I, _____ (name), of

_____ (address and phone number) hereby volunteer to participate in the study, "**Evaluation of the impact of civilian crowds on threat assessment judgements in simulated "asymmetric threat" scenarios"** (Protocol #L831). I have read the experimental protocol and have had opportunity to ask questions of the investigators. All of my questions have been answered to my satisfaction and I have received a copy of this protocol and consent form. However, I may obtain additional information by contacting Dr. Jerzy Jarmasz, (DRDC Toronto, 416-635-2000 x3081, Jerzy.Jarmasz@drdc-rddc.gc.ca).

2. I am aware that the study aims to gain an understanding of the effectiveness of a simulation-based training system under investigation for the Canadian Forces (CF), designed for missions requiring interactions with civilians, including (but not limited to) humanitarian operations and combat in "asymmetric threat" situations (e.g., counter-insurgency). The information gained will be used to assess the strengths and weaknesses of the system with a view to future improvements. I will be asked to perform a few brief reconnaissance patrol-type scenarios in the simulation, requiring me to report on notable events and threats in the scenario. I will then be asked to respond to a number of questions about my experiences using the simulation. The interview team will record my answers in written or electronic (video) form. I will not identify any individuals, other than myself, and I will not discuss any intelligence collection methods or sources. All information collected from me will be anonymous and will be kept confidential and stored under lock and key.

3. I understand that the investigators believe that the risks or discomforts to me are not significant, being similar to those associated with using a computer to perform a decision making task and with a face-to-face interview about the decision making task I will have performed (postural fatigue, eye strain, mental effort). I understand and accept these minor or remote risks. Also, I acknowledge that my participation in this study, or indeed any research, may involve risks that are unforeseen by DRDC.

4. I understand that I am considered to be on duty for disciplinary, administrative, and Pension Act purposes during my participation in this study. I understand that my name will not be identified in any manner to any data arising from this study. Moreover, should it be required, I agree to allow the

experimental data to be reviewed by an internal or external audit committee with the understanding that any summary information resulting from such a review will not identify me personally.

5. I understand that I am free to refuse to participate and may withdraw my consent without prejudice or hard feelings at any time. Should I withdraw my consent, my participation as a subject will cease immediately, unless the Principal Investigator determines that such action would be dangerous or impossible (in which case my participation will cease as soon as it is safe to do so).

6. I understand that my duty status has no effect on my right to withdraw my participation in the research portion of this exercise, refusing to give consent to my data being used by the investigators in this study. If I do withdraw my consent, I will not be allowed to take part in the study and any data that has been gathered relating to me will be destroyed. I also understand that the investigators may terminate my participation at any time, regardless of my wishes.

7. Benefits associated with this study include contributing to the improvement of simulation-based training for missions involving civilians in the CF.

8. My confidentiality during the study will be assured by the following safeguards by assigning me a coded identification number. My name will not be directly associated with any data once the study is finished. The confidentiality of the information related to my participation in this research will be assured by maintaining records only coded by identification numbers. Written transcripts will be made of audio in any video recordings in order to minimize the possibility of "voice" recognition of research subjects. Video recordings will not be released without my specific written permission.

9. I understand that my experimental data will be protected under the Government Security Policy (GSP) at the appropriate designation and not revealed to anyone other than the DRDC-affiliated Investigator(s) or external investigators from the sponsoring agency without my consent except as data unidentified as to source.

10. I understand that, as a Government Institution, DRDC is committed to protecting my personal information. However, under the Access to Information Act, copies of research reports and research data (including the database pertaining to this project) held in Federal government files, may be disclosed. I understand that prior to releasing the requested information, the Directorate of Access to Information and Privacy (DAIP) screens the data in accordance with the Privacy Act in order to ensure that individual identities (including indirect identification due to the collection of unique identifiers such as rank, occupation, and deployment information of military personnel) are not disclosed.

11. I understand that for my participation in this research project, I am entitled to remuneration in the form of a stress allowance in the amount of $24.32. Stress remuneration is income and is subject to income tax. As a CF member, my Service Number (SN) is required for remuneration.

12. Since the Veterans Review and Appeal Board adjudicates cases of disability or death on an individual basis, I understand that there is no guarantee that any disability or death sustained as a

participant in this study will be viewed as having arisen out of or having been directly connected with work/military duty. Consequently, such disability or death may not be pensionable or compensated.

13. I understand that by signing this consent form I have not waived any legal rights I have as a result of any harm to me occasioned by my participation in this research project beyond all risks I have assumed.

14. I have informed the Principal DRDC Investigator that I am currently a subject in the following other DRDC Toronto research project(s):_____ (cite Protocol Number(s) and associated Principal Investigator(s)), and that I am participating as a subject in the following research project(s) at institutions other than DRDC Toronto:_____ _____ (cite name(s) of institution(s)).

Participant's Name_____

Signature_____ Date _____

Address_____ Telephone number _____

Name of Witness_____

Signature_____ Date _____

Commanding Officer's Name _____

Signature_____ Date _____

Principal DRDC Investigator's Name_____

Signature_____ Date _____

In the event that I may have any further questions regarding this study before, during or after participation, I am encouraged to contact Defence R&D Canada- Toronto, P.O. Box 2000, 1133 Sheppard Avenue West, Toronto, Ontario M3M 3B9. This contact can be made by surface mail, in person, by phone or e-mail to any of the contacts listed below:

Principal Investigator: Jerzy Jarmasz, Ph.D.

Phone: (416) 635-2000, ext. 3081, e-mail: jerzy.jarmasz@drdc-rddc.gc.ca

For research ethics issues, I am encouraged to contact:

Chair, DRDC Human Research Ethics Committee (HREC): Jack P. Landolt, PhD.

Phone: (416) 635-2120, e-mail: jack.landolt@drdc-rddc.gc.ca

I understand that I will be given a copy of this consent form so that I may contact any of the above-mentioned individuals at some time in the future should that be required.

Annex C: Mission Briefing

Mission Briefing

You and your unit are conducting counter insurgent operations in Afghanistan. Your unit conducts regular presence patrols in LAVs through local Afghan villages and towns in search of insurgent activity. Your typical task consists of observing the surroundings, noting any potential threats. There have been some recent insurgent hostilities toward ISAF, including IED attacks (emplaced IEDs, suicide bombers, and vehicle borne IEDs) as well as small arms and mortar fire. Your unit should remain alert and prepared. The current threat level in your area is medium.

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Annex D: Questionnaire

Questions Following Each Scenario

1a. Please rate the level of threat in the scenario that you just watched.

1----------2----------3----------4----------5

Low Medium High

1b. Please describe all of the elements in the environment that support your threat assessment.

1c. Please describe the course of action you would take in response to this level of threat.

2. The scenario I just watched had enough information for me to make a reliable threat assessment.

1----------2----------3----------4----------5

Strongly Disagree

3. Please describe what other information you would need to make a more reliable threat assessment.

Annex E: Exit Survey

Exit Survey

1a. I found the scenarios to be highly realistic.

1----------2----------3----------4----------5

Strongly Disagree

ıgly ee

1b. Please describe why you gave it this rating.

1c. Please tell us what would have made the scenarios more realistic.

2. Please describe any anomalies that you observed in the scenarios (e.g., people walking through walls, etc.).

3. Please list the benefits of using virtual environments such as this one for training purposes.

4. Please list the drawbacks of using virtual environments such as this one for training purposes.

Annex F: Demographic Questionnaire

Demographic Questionnaire

PARTICIPANT NUMBER: _____

Please provide your background information in the spaces provided.

What is your current Rank?	**What is your elemental command?**
	○ Army ○ Navy ○ Air Force ○ Other _____
What is your service/trade in the armed forces? (Please indicate your current position.)	**Please indicate how many years you have served in the military in the space below.**
What tours have you completed? For each tour, list location of tour, year, and your job during the tour.	**What is your highest level of education?**
	○ Some high school ○ High school diploma ○ Some university or college ○ University or college degree ○ Graduate degree
What relevant training have you received? (e.g. classroom briefing)	**What is your official first language?**
Please indicate your age below.	**Sex**
	○ Male ○ Female

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Annex G: Researcher Script

CAMX Evaluation
Experimental Brief

Introduction and Purpose of the Study:

We are Humansystems Inc., helping DRDC Toronto investigate the use of computer simulation for Land Forces training opportunity. The primary objective of this study is to gain an understanding of the value of simulation tools like Virtual Battlespace 2 for improving CF training.

The purpose of this study is twofold:

- First, we are interested in assessing operational threats in a simulated environment. For this, you will be asked to view a total of 4 scenarios. These scenarios are similar to reconnaissance patrol missions. Your task will be to make observations in your environment, noting any potential threats or incidents you see. Following each of these scenarios, you will be presented with a brief questionnaire. You will be asked to provide a threat assessment on a 5-pt scale, followed by open ended questions, which ask you to explain why you gave it this threat rating. We ask you to be as detailed as possible as we're curious to know what elements in your environment are relevant for a threat assessment.
- Second, we are interested in the realism of using a computer simulated environment for Land Forces trg. For this, we will ask you open ended questions about your general experience using this simulated environment at the end of the 4 scenarios. We're interested in things like: How real you thought it was? What you see as some of the benefits of using this kind of trg tool? What are some of the drawbacks?

The feedback we obtain from you will be used to assess the effectiveness and value of such computer simulation tools for CF training for future missions.

Rights as a Participant

As a researcher, I am obliged to tell you your rights as a participant.

Your participation in this study is completely voluntary. You are free to ask questions of the researchers at any time. You may end your participation at any time, without prejudice or hard feelings, and you are free to skip over any task or question you do not wish to complete. We've set the online questionnaire so that each question requires some input. If there is a question that you do not want to answer, please just hit the space bar to advance to the next question.

Everything that you report will be kept confidential. The information that you provide will be kept confidential. We will only report aggregate results. Nothing will be attributed to you personally. Nowhere will your name be connected to your responses. Only those on the research team will have access to the data.

In the unlikely event of an Access to Information request, please be advised the Access to Information Office is required, by law, to protect your identity under the Privacy Act. Thus, no information may be released that will identify you as an individual.

Risks

Any kind of research using human participants must identify and share any foreseeable risks during the experiment. For this study, the risks are considered minimal. You may experience minor eye strain, motion sickness, postural fatigue from sitting at a computer, mental effort.

_____

This study should take no more than an hour of your time, and you will receive remunerations from us, following your participation.

What we ask of you is that you answer honestly and thoroughly to reflect your actual experience using this kind of trg instrument. Your input will ultimately help the CF develop better training tools to better prepare soldiers deploying on overseas missions.

If you don't have any questions at this time, please go ahead and read and sign the informed consent. Following this, I'll take you through the specific procedures of the study.

Study Instructions:

What we're going to ask you to do is watch 4 operational scenarios in Virtual Battlespace 2 each approximately 11/2 minutes long. These have been pre-recorded, so you will only have to watch the screen (your mouse is unnecessary). You will be in a LAV on presence patrols in Afghanistan. In some you'll be moving in others you'll be stopped. While viewing each scenario, your task will be to observe the situation and look for any potential threats in the area. It is important that you consider all of the elements in your environment. We have provided paper and pen for you if you want to take any notes while observing, that's up to you.

As I mentioned before, once the scenario is completed, you will be presented with a brief questionnaire on your screen, which will ask you a few questions regarding the scenario you just watched. Most of the questions are open-ended, asking you to provide information regarding the scenario. We ask that you include, in detail, all of the relevant information. Once the questionnaire is completed, you will be presented with another similar scenario. The same process will repeat itself another 3 times. Our goal here is to get a sense of the kinds of things you as soldiers would look for when making threat assessments in an operational context.

Once you have completed all 4 scenarios, you will be asked to complete an exit survey and a demographic questionnaire. The exit survey will ask you questions about the realism of the computer simulation. Our goal here is meant to assess the use of computer simulations for Land Forces trg and what improvements could be made.

The study will take approximately 1 hour of your time. We ask that you try to answer all questions in as much detail as possible, as the answers you give us will be very valuable in assessing these kinds of trg tools. Please follow the prompts on the screen, and do not hesitate to ask us any questions during the study.

Questions?

Training Scenario

Before we get started, we wanted to give you an opportunity to experience Virtual Battlespace 2. This example video will help orient to the experimental task. It is very similar to the scenarios you will be viewing during the experiment.

Your screen should be at the training video. Please go ahead now and initiate that. Once you're done let us know, and we'll get started on the mission scenarios.

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This project was conducted in support of the Defence Research and Development Canada (DRDC) Technology Demonstration Program (TDP) on counter improvised explosive device (CIED) technologies, which aims to deliver useable technologies to front-line users to mitigate the improvised explosive device (IED) threat in current Canadian Forces (CF) operations. This project aims to evaluate the impact of civilian activity as modelled by Civilian Activity Modelling for eXercises and eXperimentation (CAMX) on threat assessment and related actions by CF personnel in a first-person synthetic environment. The goal was to assess the impact of civilian activity in two different tactical scenarios that represent missions where civilians are not the primary focus (i.e., the task does not involve direct interaction with civilians) but where we have reason to believe that the presence of civilian activity may alter a soldier's assessment of the level of threat in the environment and the actions he or she would take as a result. To our knowledge, this exploratory project is the first of its kind, and the results of this study will inform future research in this area and help to answer key research questions. Our exploratory study had participants assess the level of threat in four tactical scenarios, two in which there was high civilian activity and two in which there was low civilian activity. The tactical scenarios were simulated presence patrol missions in Afghanistan developed in Virtual Battlespace 2 (VBS2). Aside from the civilian activity, the scenarios contained a number of IED indicators that would increase the threat level of the scene. After participants watched each video, they were required to complete a questionnaire that collected participant judgments on specific aspects of the scenario (e.g., asking them how threatening particular scenarios were, and asking what made that scenario more or less of a threat). At the end of the four videos, participants were presented with an exit survey asking them about realism, the validity of the scenarios as a training tool, and a demographics questionnaire. Results suggest that CAMX used in conjunction with VBS2 can create virtual environments realistic enough to be able to study and eventually train soldiers' threat assessment in response to civilian activity. Support for this finding was shown when the participants rated low civilian activity present in an area as a higher threat than in an area with high civilian activity. This study informed us about the information soldiers use to make threat assessments in virtual environments and about the utility of virtual environments as training tools in this context. Further research investigating other factors that may affect threat assessment is recommended to support our findings.

Ce projet a été mené en appui au Programme de démonstration de technologies (PDT) de Recherche et développement pour la défense Canada portant sur les technologies de lutte contre les dispositifs explosifs de circonstance (C-IED). Ce programme vise à fournir des technologies utilisables aux utilisateurs de première ligne afin d'atténuer la menace de C-IED durant les opérations des Forces canadiennes (FC). L'objectif du projet est d'évaluer l'incidence des activités civiles telles que celles créées à l'aide de l'outil de modélisation d'activité civile aux fins d'exercices et d'essais (CAMX) durant l'évaluation de la menace, ainsi que les actions connexes des membres des FC en situation de premier intervenant virtuel. Deux scénarios tactiques différents serviront à examiner les répercussions des activités civiles lors de missions où l'objectif premier n'est pas d'intervenir auprès de civils (p. ex., tâche sans interaction directe avec la foule), mais plutôt lorsque l'on estime que la présence d'une activité civile pourrait modifier l'analyse de la menace réalisée par un soldat et les mesures prises par ce dernier. À notre connaissance, il s'agit d'un projet exploratoire unique en son genre. Les résultats de cette étude orienteront les futures recherches dans le domaine et aideront à répondre à des questions clés liées à la recherche. Durant l'étude préliminaire, les participants ont évalué l'importance de la menace dans quatre scénarios tactiques : deux avec une grande activité civile et deux avec une faible activité civile. Les scénarios simulaient une patrouille de présence en Afghanistan créée dans le jeu Virtual Battlespace 2 (VBS2). Outre l'activité civile, les scénarios comportaient un certain nombre d'indicateurs d'IED élevant le niveau de la menace. Après avoir visionné la vidéo, les participants ont rempli un questionnaire, donnant leur avis sur des aspects spécifiques du scénario (p. ex., le niveau de la menace du scénario, les éléments rendant le scénario plus ou moins menaçant). À la fin des quatre vidéos, les participants ont rempli un questionnaire de fin d'exercice dans lequel ils devaient répondre à des questions sur le réalisme et l'utilité des scénarios comme outil de formation, en plus de remplir un questionnaire démographique. Les résultats indiquent que l'utilisation combinée de CAMX et VBS2 crée un environnement virtuel suffisamment réaliste pour examiner l'évaluation de la menace réalisée par un militaire à l'égard d'une activité civile. Cette conclusion a été appuyée par le fait que les participants ont jugé que la menace était élevée dans la zone où l'activité civile était faible et que la menace était faible dans la zone où l'activité civile était élevée. Cette étude nous a permis de connaître l'information utilisée par les militaires pour évaluer une menace dans un environnement virtuel, de même que la pertinence de tels outils d'entraînement dans ce contexte. Il est recommandé d'effectuer davantage de recherche sur d'autres facteurs pouvant altérer l'évaluation de la menace afin d'appuyer nos conclusions.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

IEDs; Simulation; game-based training; civilian activity; CAMX; VBS2; Virtual Battle Space 2; threat assessment; crowds