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DEFENCE R&D DÉFENSE

Virtual Reality (VR) as a Disruptive Technology

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Defence R&D Canada
Technical Memorandum
DRDC Toronto TM 2011-114
July 2011

Canada

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Abstract

Defence R&D Canada (DRDC) anticipates, assesses, and provides advice about the impact of emerged and emerging technologies to ensure that the Canadian Forces are technologically prepared. In 2011, DRDC is considering Virtual Reality and Neural Interfaces as a potentially disruptive technology (PDT). The purpose of this position paper is to help inform views on the use of virtual reality (VR) for military training by providing answers to specific questions that were posed by the DRDC examining committee. The questions sought (1) a definition of the technology, (2) analysis of its potential for disrupting defence and security, (3) identification of key barriers and key drivers for the use of the technology, and (4) an assessment of the maturity of the technology. The main conclusions of this position paper are that VR has been and continues to be a disruptive training technology, for friendly and opposing forces, and that VR, if used for embedded training, could provide a means to regain, with the help of other enabling disruptive technologies, a training advantage that has been lost with the proliferation of technology.

Résumé

R &D pour la défense Canada (RDDC) anticipe et évalue les effets des nouvelles technologies et agit comme expert-conseil en la matière auprès des Forces canadiennes afin d'aider celles-ci à demeurer prêtes sur le plan technologique. En 2011, RDDC étudie la réalité virtuelle (RV) et les interfaces neuronales comme technologies de potentiellement perturbatrices (TRP). Dans le présent exposé de principes, nous expliquerons comment la RV pourrait être mise au service de l'instruction militaire en répondant à des questions précises du comité d'examen de RDDC. Ce dernier a demandé que : (1) nous définissions la technologie en question; (2) que nous analysions son potentiel en tant que technologie potentiellement perturbatrice dans les domaines de la défense et de la sécurité; (3) que nous cernions les principaux facteurs favorables et défavorables à l'emploi de cette technologie; (4) et que nous évaluions sa maturité. Nous concluons que la RV est et continuera d'être une technologie perturbatrice qu'utilisent les forces alliées et adverses et que, si nous l'utilisons aux fins d'instruction intégrée, elle pourrait nous permettre de reprendre sur nos adversaires conventionnels et asymétriques un avantage que nous avions perdu en raison de la prolifération de cette technologie.

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Executive summary

Virtual Reality (VR) as a Disruptive Technology:

Magee, L.E.; DRDC Toronto TM 2011-114; Defence R&D Canada – Toronto; July 2011.

Introduction

Defence R&D Canada (DRDC) anticipates, assesses, and provides advice about the impact of emerged and emerging technologies to ensure the Canadian Forces are technologically prepared. In 2011, DRDC is considering Virtual Reality and Neural Interfaces as a potentially disruptive technology (PDT). The purpose of this position paper is to help inform views on the use of virtual reality (VR) for military training by providing answers to specific questions that were posed by the DRDC examining committee. The questions sought (1) a definition of the technology, (2) analysis of its potential for disrupting defence and security, (3) identification of key barriers and key drivers for the use of the technology, and (4) an assessment of the maturity of the technological.

What is this technology?

VR technologies can provide an interface to human-in-the-loop systems and components that can be assembled to enable a user to sense and interact with a virtual environment (VE). VR systems can consist of real or synthetic parts and can include animate or inanimate objects. The human interface of a VR system often stimulates several human senses at the same time to promote the perception of immersion, which is a sense of presence in the VE. The enabling technologies are often first developed for the entertainment market and are repurposed for use in military training. This origin of the enabling technologies as well as their ease of assembly as a flexible, low-cost, portable training system distinguishes VR systems from conventional simulators used for training.

What is potentially disruptive to defence and security?

VR systems are eroding the training advantages that were gained by large investments in military modelling and simulation (M&S). The proliferation of commercial technologies, including computer graphics and high-speed networking technologies, has allowed friendly and opposing forces an opportunity to conduct individual and team training within a distributed virtual environment. While this development provides an opportunity for the Canadian Forces to reduce costs and to avoid the many constraints on training imposed by the availability of people, resources, safety and environmental concerns, adversaries can now train unobserved, at low cost. This could result in training surprise. A means of regaining a training advantage is to exploit VR, and other potentially disruptive technologies, for embedded training,

What are key barriers?

VR is acknowledged as a hard problem; enabling technology for some applications is lacking (e.g., a means for natural locomotion within a virtual environment). A deficiency of human factors knowledge, negative attitudes toward simulator-based training, naïve beliefs about fidelity requirements, clashing commercial objectives and the lack an overarching policy, plan, or body for managing and applying M&S as a corporate resource within the Department of National Defence (DND) are barriers to the use of VR for military training.

What are key drivers?

The rapid change in demands upon the military, non-traditional activities, uncertainty about the strategic environment and a growing use of network-enabled capabilities in operational systems are some reasons why reconfigurable, portable, and embedded VR training solutions are needed. The costs, risks, constraints and resource demands (on people and equipment) associated with training on operational equipment or full-mission simulators at home are other reasons for seeking affordable VR as an alternative. Technological pull is another driver.

What is the maturity of the technology?

VR systems are enabled by components that range in maturity. The efficacy of their assembly as a system depends upon the application, the performance objectives for the system, and the characteristics of the users. Emerging technologies, such as augmented reality and human behavioural modelling are less mature, but offer new possibilities to extend the use of VR as a solution for military training by enabling virtual simulation for embedded training. The continuing advance of technologies such as these, with the advance of a human sciences foundation, affords a means to outpace agile adversaries able to take advantage of the proliferation of technologies that can be adapted to training.

Conclusions

The main conclusions of this position paper are that VR has been and continues to be a disruptive technology, for friendly and opposing forces, and that VR, with the help of other disruptive technologies, could provide a means to gain a military training advantage over conventional or asymmetric adversaries if it is used for embedded training.

Sommaire

Virtual Reality (VR) as a Disruptive Technology:

Magee, L.E.; DRDC Toronto TM 2011-114; R & D pour la défense Canada – Toronto; juillet 2011.

Introduction

R & D pour la défense Canada (RDDC) anticipe et évalue les effets des nouvelles technologies et agit comme expert-conseil en la matière auprès des Forces canadiennes afin d'aider celles-ci à demeurer prêtes sur le plan technologique. En 2011, RDDC étudie la réalité virtuelle (RV) et les interfaces neuronales comme technologies potentiellement perturbatrices (TPP). Dans le présent exposé de principes, nous expliquerons comment la RV pourrait être mise au service de l'instruction militaire en répondant à des questions précises du comité d'examen de RDDC. Ce dernier a demandé que : (1) nous définissions la technologie en question; (2) que nous analysions son potentiel en tant que technologie potentiellement perturbatrice dans les domaines de la défense et de la sécurité; (3) que nous cernions les principaux facteurs favorables et défavorables à l'emploi de cette technologie; (4) et que nous évaluions sa maturité.

Qu'est-ce que cette technologie?

La technologie de RV peut servir d'interface à un système avec intervention humaine en y intégrant des éléments qui, une fois assemblés, permettent à l'utilisateur d'interagir avec un environnement virtuel et de ressentir les choses qui s'y passent. Les systèmes de RV peuvent être composés d'éléments réels ou synthétiques et avoir recours à des objets animés ou inanimés. L'interface humaine d'un système de RV stimule plusieurs des sens humains en même temps afin d'accroître la profondeur de l'immersion, c'est-à-dire le sentiment d'être présent dans l'environnement virtuel. Les technologies habilitantes sont souvent conçues d'abord pour le marché du divertissement, puis sont reconverties plus tard en systèmes d'entraînement militaire. Aussi, leur facilité d'assemblage, leur flexibilité, leur abordabilité et leur mobilité sont autant de caractéristiques qui distinguent les systèmes de RV des simulateurs d'entraînement conventionnels.

En quoi cette technologie est-elle potentiellement perturbatrice sur le plan de la défense et de la sécurité?

La présence des systèmes de RV diminue les avantages sur le plan de l'entraînement acquis grâce aux grandes sommes investies dans les technologies de modélisation et de simulation (M & S) militaires. La prolifération des technologies commerciales telles que l'infographie et les réseaux haute vitesse a permis tant aux forces alliées qu'ennemies de mener des entraînements individuels et collectifs dans un environnement virtuel réparti. Bien que ces avancées offrent l'occasion aux Forces canadiennes de réduire leurs dépenses et de contourner les nombreux obstacles à l'entraînement créés par les manques de personnel et de ressources ainsi que par différents soucis liés à la sécurité et à l'environnement, les forces ennemies peuvent désormais s'entraîner à l'abri des regards et à des coûts peu élevés. Cela peut donc causer quelques surprises. Un bon moyen de

reprendre l'avantage serait d'exploiter la RV et d'autres technologies potentiellement perturbatrices permettant la mise en œuvre d'une instruction intégrée.

Quels sont les principaux facteurs défavorables?

Il est connu que la RV pose un problème complexe. En effet, pour certaines de ses applications, nous ne disposons pas de la technologie habilitante nécessaire (p. ex., qui permettrait une locomotion naturelle à l'intérieur d'un environnement virtuel). Il existe de nombreux facteurs qui font obstacles à l'application de la RV à l'instruction militaire comme : un manque de connaissance à propos des facteurs humains, une attitude négative vis-à-vis l'entraînement sur simulateur, des croyances naïves à propos des exigences en matière de fidélité, des objectifs commerciaux divergents et l'absence d'une politique, d'un plan ou d'un cadre d'ensemble pour la gestion et l'emploi de la M & S en tant que ressource du ministère de la Défense nationale (MDN).

Quels sont les principaux facteurs favorables?

La rapidité avec laquelle change la demande envers les forces militaires, les activités non traditionnelles, l'incertitude ambiante par rapport à l'environnement stratégique et l'usage croissant de ressources réseaucentriques dans les systèmes opérationnels sont quelques raisons qui expliquent pourquoi il serait avantageux de disposer de solutions reconfigurables, portables et intégrées d'instruction en RV. Par ailleurs, si l'on tient compte des coûts, des risques, des difficultés et des besoins en ressources humaines et matérielles associés à l'utilisation d'équipement opérationnel ou de simulateurs de mission complète au pays, il ne peut qu'être profitable de nous tourner vers la RV, qui constitue une solution abordable. Enfin, le courant technologique est aussi un facteur non négligeable.

Quel est le stade de maturité de cette technologie?

Les systèmes de RV fonctionnent à l'aide de composantes dont la maturité technologique est variable. Ainsi, l'efficacité de ces composantes réunies dépend de leur utilisation, des objectifs de rendement du système et des caractéristiques des utilisateurs. Les technologies naissantes telles que la réalité amplifiée et la modélisation de comportements humains n'ont pas atteint un stade de maturité très élevé, mais offrent néanmoins de nouvelles possibilités d'utilisation de la RV comme solution à des fins d'instruction militaire en permettant la simulation virtuelle d'instruction intégrée. En réalisant des progrès constants dans ces domaines technologiques et en y intégrant la composante humaine, nous serons en mesure de distancer des adversaires ingénieux capables de tirer avantage de la prolifération des technologies pouvant être adaptées à l'instruction militaire.

Conclusions

Dans notre exposé de principes, nous concluons que la RV est et continuera d'être une technologie perturbatrice qu'utilisent les forces alliées et adverses et que, jumelée à d'autres technologies perturbatrices, elle pourrait nous permettre de reprendre un avantage sur nos adversaires conventionnels et asymétriques si nous l'utilisons aux fins d'instruction intégrée.

Table of contents

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Acknowledgements

Constructive comments on earlier drafts of this memorandum were provided by Dr Stephen Goldberg, United States Army Research Institute, Orlando, Florida, and Dr. Jerzy Jarmasz and Mr Brad Cain, DRDC Toronto; their feedback is much appreciated.

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1 What is this technology?

Virtual reality (VR) is the name given to the technologies that allow an operator to sense and interact with a three-dimensional environment that is different from the one in which the operator is physically present. Within this domain are teleoperation, teleorobotics, synthetic or simulated environments (SE), cyberspace, first-person shooter games and augmented, fused, or mixed realities. These terms commonly refer to a system composed of a human user, a machine, and a human-machine interface connecting the user to a computer-generated, or remote, spatial environment, often called a virtual environment (VE). The VE can include representations of real, synthetic, animate or inanimate components alone or together. The human interface of a VR system often stimulates several human senses at the same time to promote the perception of immersion within the VE. These effects are usually enhanced with the help of sensors and controls that allow self-directed movement within the spatial environment and natural real-time interactions, including spoken interactions, with animated virtual characters (avatars). The technologies that enable VR are often first developed for the entertainment market; they are then repurposed for use in military training. This characteristic of VR systems, as well as their relatively low-cost, portability and re-configurability, distinguish them from simulators typically used for training.

2 What is potentially disruptive to defence and security?

VR provides an accessible and affordable alternative to full mission simulators, which have been the traditional means of exploiting modeling and simulation (M&S) for training. VR can exploit enormous investments in M&S. The United States (US) has identified M&S as a critical technology [1] and the Department of National Defence (DND) of Canada has identified M&S as an enabling technology for transformation [2, 3]. While VR systems may not provide all the functionality of a traditional simulator, they sometimes provide a more compelling means of achieving immersion within a training environment. This effect is often sought to promote situational awareness and training transfer. VR training systems differ from traditional simulators in several other ways. They are less reliant on physical reproductions of the operational equipment (e.g., a cockpit), and they are more portable, more reconfigurable, less dependent on proprietary software or hardware, and are much less expensive to buy and to maintain. In addition, VR solutions are sometimes better suited to specific training objectives than full mission simulators because the human interface of a VR system can be more easily customized to match a particular training objective and its requirements, for example, the presentation of stereoscopic images for making accurate visual judgements of the distance to an object or a surface. Hence, VR is well-suited to part-task training, mission planning and mission rehearsal applications where specific, rather than comprehensive, learning objectives can be identified. This feature of VR training systems does not necessarily limit the impact that they can have on subsequent task performance since part-task training can be very effective and surprising when put to practice. For example, the terrorists of 9/11 did not need to know how to take off or land the aircraft that they guided to impact.

Since there are many uses of VR, training applications can leverage advances made for other purposes, such as gaming [4]. Moreover, VR systems can train a greater range of tasks than traditional simulators, which are usually used to train only one or a few individuals to operate a vehicle of some kind (e.g., a tank). The Future Immersive Training Environment (FITE) Joint Capability Technology Demonstration (JCTD) illustrates that VR training systems can be applied more broadly. The first operational demonstration of the FITE system provided training for small-unit ground forces by equipping soldiers with a head-mounted display system linked to a "serious" game (Virtual Battle Space 2). An independent assessment of the FITE system provided subjective evidence of its apparent utility and indicated that squads would be ready to use the system as configured to help them prepare for combat deployments [5]. Since VR can take advantage of ready access to open-source data for simulating realistic objects, geo-specific terrain, environmental conditions, dynamic interactions and complex scenarios, VR provides an opportunity for the Canadian Forces (CF) to gain many of the advantages of simulator-based training at low cost.

However, VR also provides a threat since adversaries with few resources can exploit the same capabilities to acquire skills previously taught to the military of wealthy nations. In other words, adversaries can use VR for a training surprise. They can also now make use of computer networking technologies with capabilities that were previously exclusive to our allies for team training. Simulator networking was conceived decades ago to allow a large number of simulators to be interconnected [6], locally or over a wide area, for collective, coalition and joint training. Computer game technologies and commercial, wide band communication systems now allow adversaries ready access to this capability. Consequently, adversaries can train as a team, interactively plan a mission, or rehearse a scenario without having to invest in expensive equipment, conspicuous infrastructure, or travel to a common meeting place.

The affordability and flexibilities of VR training systems allow use of simulator networking for a wide variety of team training applications and there are current examples showing that the CF has begun to take advantage of this opportunity in a limited way; examples include the development of the Mission Rehearsal Tactical Trainer (MRTT) for training aircrew, as part of the Canadian Advanced Synthetic Environment (CASE) project, and the use of Virtual Battle Space 2 by the Land Forces for training small unit command and control. However, experimental evidence of the training effectiveness of these systems remains to be collected [7]. This knowledge gap points to the need for informed decisions about the design and use of technologies for training and the need for objective, human behavior-based evidence of the effectiveness of VR training systems. The knowledge gap also suggests that a promising means of regaining the training advantage that has been lost with the proliferation of technology is to become better informed about its exploitation and the sciences of human learning and knowledge and skill retention. This is consistent with a fundamental shift from the belief that better weapons will provide superior readiness to a belief that well trained soldiers who are able to deal with complex, uncertain operational challenges are vital to success on the battlefield [8].

The use of VR in operational systems has implications for training. VR for teleoperation and telerobotics can potentially benefit system performance by improving the situational awareness, ease of use, and the workload experienced by a human operator. Consequently, the training barrier to proficient performance could be less. This is a training outcome that could have advantages and disadvantages since it could be exploited by both friendly and opposing forces. Another disruptive relationship between operational system design and training is the use of VR for embedded training (ET). The idea of ET is to make maximal use of operational equipment for military training by including or appending enabling technology [9]. The potential advantages of ET include access to training during deployment [10,11] and opportunity for just-in-time training, mission planning and mission rehearsal in theatre. These advantages could allow our forces to avoid knowledge and skill decay during lengthy deployments and also provide a means to modify training in theatre to counter an adapting adversary. ET for mission planning and rehearsal allows intelligence exploitation[1] and could be used to better prepare our forces for upcoming combat operations by harnessing the potential of other potentially disruptive technologies, such as wide-band, mobile, wireless networking and the networked-enabled capabilities of operational equipment. New sensor and display technologies and the growing use of interconnected and interdependent military systems present a new opportunity for gaining training advantages.

Several consecutive studies by the North Atlantic Treaty Organisation (NATO) Research and Technology Organization have evaluated advances of VR (including augmented reality) for military applications (see [12] for a summary). In the first of these, education and training was identified as the most promising application area. Subsequent Research Task Groups have narrowed in on the potential of embedded virtual simulation (EVS) as a means of enhancing ET, which could help military units deploy on short notice and help them adapt to changing

[1] VR can also be used to capture the knowledge of subject matter experts for use in training novices

operational situations. Schlick & Alexander [12] have recently drafted a position paper for NATO concerning long term capability requirements and they conclude that EVS is a potentially disruptive technology, in need of human sciences research. They point out that EVS has been successfully employed in large computer-controlled systems, for example, aboard a ship, and that recent improvement in computing, energy efficiency, and the miniaturization of components allow the use of EVS for smaller ground and air systems. The concept of ET for air or land vehicle systems is not well known or understood within the CF, although some allies have embraced the idea. The Royal Netherlands Air Force (RNLAF) for instance has explored the use of ET with the F-16 aircraft in anticipation of the use of ET in the F-35 Joint Strike Fighter aircraft [13]. Simulated threats were fed to the on-board sensors allowing several pilots to practice tactical manoeuvres beyond visual range. Emerging technologies such as flexible, translucent displays may soon permit EVS for training tactical manoeuvres within visual range, although many human factors will need to be addressed [14].

3 Key Barriers

The US National Academy of Engineering has identified VR among the 14 grand challenges for engineering in the 21st century [15]. The engineering hurdles include advances of visual, sound, touch and motion displays for high fidelity representations of the real world. The need to simulate touch and realistic "virtual people", which interact naturally with the user, are identified as particularly formidable problems. Haptic interfaces, including force reflection and touch, are now inadequate and often expensive. Realistic virtual humans are still beyond the capabilities of real-time computer graphics and artificial intelligence. Yet, we have known for a long time that high fidelity is often not needed for effective training [16 - 23]. There is also evidence now that humans can respond to crude representations of virtual people the way they respond to other humans [24], and there is evidence that humans can learn their part of a challenging team task in a VE that includes relatively simple, interactive models of their team mates [e.g., 25]. Hence, knowledge about the extent to which we need to provide haptic cues or to simulate human appearance or behaviours for particular applications is a barrier to the use of VR for training.

Although VR could help the CF modernize individual training and education (IT&E) as well as collective, joint and coalition training by providing inexpensive and effective technologies, it might undermine some established defence industries in Canada that now sell expensive, full mission simulators. In weapon system design, VR can impact the need for training and force early consideration of ET as a system requirement, thereby affecting the initial specifications and life cycle management of operational platforms. Resistance to change firmly entrenched concepts about how to design and use training technology effectively presents a barrier to the use of VR, particularly EVS. The many uses of VR provide opportunities to leverage "know how" and advancements in other fields, such as internet-based social networking, for use in training. However, the variety, rapid pace of development, and many uses of the enabling technologies for VR-based systems, coupled with a lack of knowledge about their potential impact on human behaviour is a scientific and engineering challenge.

Current barriers to the use of VR for training are user acceptance and unwanted side effects, such as simulator-induced sickness or visual problems, which can cause discomfort or a safety risk [26]. Consequently, a key barrier to the use of VR is a better understanding of the limitations and capabilities of VR, which is an ongoing human factors and behavioural sciences problem. Other significant barriers include the following: (1) general ignorance about the behavioural sciences of training technology, as illustrated by naïve beliefs in high fidelity by lay persons as well as engineering and procurement officers [22], (2) user opposition to the use of any type of simulator technology because it is perceived as a threat to the continued use of operational equipment for training, (3) lack of verification, validation and accreditation (VV&A) of training simulators by DND, (4) use of specifications by civilian regulators to define military training systems [27], (5) an uncoordinated approach to the exploitation of M&S (e.g., expensive simulators are purchased by a program manager to train a few individuals with little regard for wider team training, reuse of components, or compatibility with other simulators within DND or outside), (6) the lack of an overarching policy, plan, or body for managing and applying M&S as a corporate resource within DND, and (7) decentralized, ad hoc solutions for training problems without reference to similar problems or solutions within the CF [28]. The lack of a holistic, enterprise-wide approach to the procurement and management of M&S or IT&E solutions is a barrier to the use of VR for training.

4 Key Drivers

Strategic drivers, such as the rapid change in demands upon the military, non-traditional activities, uncertainty about the strategic environment and a growing use of network-enabled capabilities in operational systems are some reasons why reconfigurable, portable, and embedded VR training solutions are needed. The need to deploy on short notice and the need to learn to adapt to an agile adversary are reasons for pursuing embedded training solutions. The costs, risks, constraints and resource demands (on people and equipment) associated with training on operational equipment or full-mission simulators at home are other reasons for seeking affordable VR as an alternative. Technological pull is another driver; as sensory displays, computer graphics, computer networking, and gaming technologies advance, and as data sources and open-source software become more readily available for use in VR, they entice use, by novices and knowledgeable training developers alike. Since there are gaps among the human sciences, engineering, uses and acceptance of VR as a solution for training, R&D and education are needed to advance VR and its understanding within a larger framework for M&S and IT&E. Also, the potential use of VR for capturing the knowledge of subject matter experts is a driver since many experienced personnel will soon retire from the CF and their expertise could be lost without an intervention. Similarly, embedded VR may be able to capture data from training or battlefield environments to obtain and preserve lessons that will aid future military readiness.

5 Technological Maturity

Although some successful applications of VR for training have existed for many years [29], inflated expectations abounded in the early 1990s with the popular enthusiasm that was generated by low-cost, head mounted displays. Since then, an appreciation of the human factors of VR has informed many productive applications [30]. Because VR is enabled by technologies covering a range of maturities, as illustrated by their plot on an innovation cycle [31], it is not possible to make a general statement about the maturity of VR for training since the readiness of a solution will depend upon the particulars of the application, the performance objectives, the characteristics of the trainees, the implications of these factors for interface design, and the limitations and capabilities of the enabling components that are chosen for the solution. In short, VR is ready now for some training applications. Emerging technologies, for example, augmented reality, EVS, and human behavioural modelling are less mature, but offer new capabilities by extending the use and efficacy of VR as a solution for military training. The continuing advance of VR technologies with the advance of a human sciences foundation afford a means to outpace agile adversaries able to take advantage of the proliferation of technologies that can be adapted to training.

6 Discussion & Conclusion

This paper proposes that VR has been and continues to be a disruptive technology because it provides a means for friendly or opposing forces to gain the benefits of large investments in M&S without the associated expenses of traditional simulators. VR is disruptive because it allows an adversary to train individuals and teams with commercially-available hardware and software, at low-expense, unobserved. VR coupled with other disruptive technologies, such as wide-band wireless communications and intelligence gathering, could provide a future means for Canada and her allies to regain a military training advantage if VR is used for embedded training. Major benefits could be obtained with deployed, just-in-time training, mission planning and mission rehearsal. The use of VR for these purposes would require the use of (expensive) operational equipment and early consideration of the human factors that affect learning and training transfer.

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List of symbols/abbreviations/acronyms/initialisms

CASE	Canadian Advanced Synthetic Environment
CF	Canadian Forces
DND	Department of National Defence
DRDC	Defence Research & Development Canada Embedded Training
ET	Embedded Training
EVS	Embedded Virtual Simulation
FITE	Future Immersive Training Environment
IT&E	Individual Training and Education
JCTD	Joint Capability Technology Demonstration
M&S	Modelling and Simulation
MRTT	Mission Rehearsal Tactical Trainer
NATO	North Atlantic Treaty Organisation
RNLAF	Royal Netherlands Air Force
SE	Synthetic (or Simulated) Environment
US	United States of America
VV&A	Verfication, Validation and Accreditation
VE	Virtual Environment
VR	Virtual Reality

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.) Defence R&D Canada – Toronto 1133 Sheppard Avenue West P.O. Box 2000 Toronto, Ontario M3M 3B9	2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.) UNCLASSIFIED (NON-CONTROLLED GOODS) DMC A REVIEW: GCEC JUNE 2010

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

Virtual Reality (VR) as a Disruptive Technology:

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

Magee, L.E.

5. DATE OF PUBLICATION (Month and year of publication of document.) July 2011	6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.) 31	6b. NO. OF REFS (Total cited in document.) 31

7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Technical Memorandum

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)

Defence R&D Canada – Toronto
1133 Sheppard Avenue West
P.O. Box 2000
Toronto, Ontario M3M 3B9

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.) Projects 14df & 14dn	9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)
10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.) DRDC Toronto TM 2011-114	10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)

UNLIMITED

12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.))

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(U) Defence R&D Canada (DRDC) anticipates, assesses, and provides advice about the impact of emerged and emerging technologies to ensure the that Canadian Forces are technologically prepared. In 2011, DRDC is considering Virtual Reality and Neural Interfaces as a potentially disruptive technology (PDT). The purpose of this position paper is to help inform views on the use virtual reality (VR) for military training by providing answers to specific questions that were posed by the DRDC examining committee. The questions sought (1) a definition of the technology, (2) analysis of its potential for disrupting defence and security, (3) identification of key barriers and key drivers for the use of the technology, and (4) an assessment of the maturity of the technological. The main conclusions of this position paper are that VR has been and continues to be a disruptive training technology, for friendly and opposing forces, and that VR, if used for embedded training, could provide a means to regain, with the help of other enabling disruptive technologies, a training advantage that has been lost with the proliferation of technology.

(U) R &D pour la défense Canada (RDDC) anticipe et évalue les effets des nouvelles technologies et agit comme expert conseil en la matière auprès des Forces canadiennes afin d'aider celles ci à demeurer prêtes sur le plan technologique. En 2011, RDDC étudie la réalité virtuelle (RV) et les interfaces neuronales comme technologies de potentiellement perturbatrices (TRP). Dans le présent exposé de principes, nous expliquerons comment la RV pourrait être mise au service de l'instruction militaire en répondant à des questions précises du comité d'examen de RDDC. Ce dernier a demandé que : (1) nous définissions la technologie en question; (2) que nous analysions son potentiel en tant que technologie potentiellement perturbatrice dans les domaines de la défense et de la sécurité; (3) que nous cernions les principaux facteurs favorables et défavorables à l'emploi de cette technologie; (4) et que nous évaluions sa maturité. Nous concluons que la RV est et continuera d'être une technologie perturbatrice qu'utilisent les forces alliées et adverses et que, si nous l'utilisons aux fins d'instruction intégrée, elle pourrait nous permettre de reprendre sur nos adversaires conventionnels et asymétriques un avantage que nous avions perdu en raison de la prolifération de cette technologie.

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.)

(U) Virtual reality, disruptive technology, military training, virtual environments, emerging technology, embedded training, embedded virtual simulation

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