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RESEARCH AND DEVELOPMENT TO COMBAT TERRORISM

Review of Activities for the Technical Support Working Group

The foremost responsibility of the Government of Canada is to protect Canada and the safety and security of Canadians. As a result, Canadians can expect that their Government will take every reasonable step to prevent individuals from turning to terrorism, to detect terrorists and their activities, to deny terrorists the means and opportunities to attack and, when attacks do occur, to respond expertly, rapidly and proportionately.

To take reasonable steps to combat terrorism, the Government's activity is directed towards the following mutually reinforcing elements:

- *PREVENT individuals from engaging in terrorism;*
- *DETECT the activities of individuals and organizations who may pose a terrorist threat;*
- *DENY terrorists the means and opportunity to carry out their activities; and*
- *RESPOND proportionately, rapidly, and in an organized manner to terrorist activities and threats to mitigate their effects.*

A fundamental belief is that combating terrorism requires collaboration with international partners and key allies, such as the United States (US). One such collaboration involves the development and advancement of science and technology (S&T) solutions to reinforce security initiatives between Canada and the US — this occurs under the Canada–US Memorandum of Understanding for Research and Development to Combat Terrorism (MOU RDCT).

This pamphlet highlights recent collaborations between Canada and the US under the MOU RDCT.

Research and Development to Combat Terrorism

First signed in 1995 and renewed through to 2019, the MOU RDCT is jointly administered by Defence Research and Development Canada's Centre for Security Science (DRDC CSS) and the Technical Support Working Group (TSWG) within the US Department of Defense's Combating Terrorism Technical Support Office (CTTSO). It enables bilateral S&T cooperation at the federal level with the participation of local governments, end users, academia, and industry. Through this arrangement, partners engage in joint projects that aim to make the best use of each country's respective research and development (R&D) capacities, leverage state of the art and emerging technologies, eliminate unnecessary duplication of work, and share the resulting benefits.

Over the years, Canada and the US have collaborated on R&D projects of mutual interest that address various areas of concern for combating terrorism — ranging from investigative and forensic science to irregular warfare and evolving threats.

Defence Research and Development Canada's Centre for Security Science

DRDC CSS is a joint endeavor between the Department of National Defence and Public Safety Canada that provides S&T support and services to address Canada's public safety and security priorities. Activities of DRDC CSS include:

- Taking steps towards improving Canada's public safety and security;

- Investing in public safety and security S&T solutions;

- Contributing S&T to inform decisions related to public safety and security; and

- Maintaining and promoting collaboration, both nationally and internationally.

"Our cooperation with TSWG is an important part of what we do at DRDC CSS," said Mark Williamson, Director General at DRDC CSS. "This arrangement represents a longstanding collaboration between Canada and the U.S., one that has helped both countries to address our common public safety and security challenges. Through the arrangement, we share information on risk and vulnerabilities so that we can address capability gaps. Thus, we can leverage our investment dollars and maximize their impact in key areas."

Canadian Partners

Successful collaboration under the MOU RDCT has been made possible by participation from the following federal departments and agencies:

- Canada Border Services Agency
- Canadian Food Inspection Agency
- Canada Revenue Agency
- Canadian Security Intelligence Service
- Defence Research and Development Canada
- Department of National Defence and the Canadian Armed Forces
- Public Safety Canada
- Natural Resources Canada
- Royal Canadian Mounted Police
- Transport Canada

Collaborative Projects

Collaboration is an outcome of a strong and trusted Canada–US network within the counter-terrorism domain, developed through meetings, mutually beneficial projects, and shared delivery of results. Through the hard work and dedication of the Canadian partners and TSWG, collaborative projects continue to enhance the safety and security of citizens on both sides of the border.

Chemical, Biological, Radiological, Nuclear, and Explosives

The Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) category supports projects that enhance preparedness and response to CBRNE threats through four areas of focus:

1. Improving capabilities to characterize CBRNE materials;
2. Managing the consequences of CBRNE agents;
3. Improving protection; and
4. Detecting and identifying CBRNE threats.

Technical Response Group for Chemical, Biological, and Radiological Threats

There are a number of ways in which terrorist groups can launch attacks, and some of these include the use of CBR agents. Specific techniques and technologies are required to safely combat attacks that use these agents. Canada and the U.S. worked together with Australia and the United Kingdom to enhance counter-terrorism measures for incidents involving CBR threats under the Technical Response Group. This activity enables the four countries to share information, conduct studies, and assess promising techniques that will help lessen the impact of CBR attacks launched by terrorists. Part of this effort includes participation in exercises to demonstrate their capabilities, share best practices, and undertake peer evaluations every two years.

In 2015, Canada hosted this capability exercise, referred to as CAPEX 2015, or Exercise Northern Lights. It brought together more than 300 military and law enforcement personnel, explosives technicians, forensic experts, firefighters, paramedics, scientists and other experts from the four countries. The theme of the exercise, "Crime-scene to Courtroom," reflected a focus on demonstrating how each country's response to a CBR event includes identifying and gathering information and intelligence to assist investigators in capturing and prosecuting those responsible.

The Effect of Decontaminating Chemical and Biological Agents on Forensic Evidence

During an investigation in which criminal charges may be pursued, it is essential that forensic analysis establishes clear links to an accused with articles of evidence. For investigations that involve chemical and biological threat agents, there was no method that forensic scientists could use to safely handle contaminated evidence. As a result, evidence handling procedures could be compromised in the interest of analyst safety, calling into question the integrity of the evidence itself.

This project explored methods for decontaminating different types of evidence (for example, deoxyribonucleic acid (DNA), fingerprints and documents) and the effect that these methods have on the integrity of the evidence for subsequent forensic analysis. A variety of common decontamination methods for both biological and chemical agents were evaluated. A different process of decontamination was developed for each type of evidence that was evaluated and in some cases the process involved a non-decontamination solution. Guidelines were developed to support safe analysis of chemically and biologically contaminated materials. The results of this project will ensure that the integrity of evidentiary materials is maintained during decontamination so that they remain admissible in court.

Testing a High-Volume Sampler for Trace Explosives in Large Containers

Inspecting the contents of large cargo containers for possible explosives is important for safe transportation, but the task can also be very challenging. Since explosives can be detected in large cargo containers from traces in air samples, there is a need for an effective high-volume air sampler that is capable of detecting trace explosives in large containers.
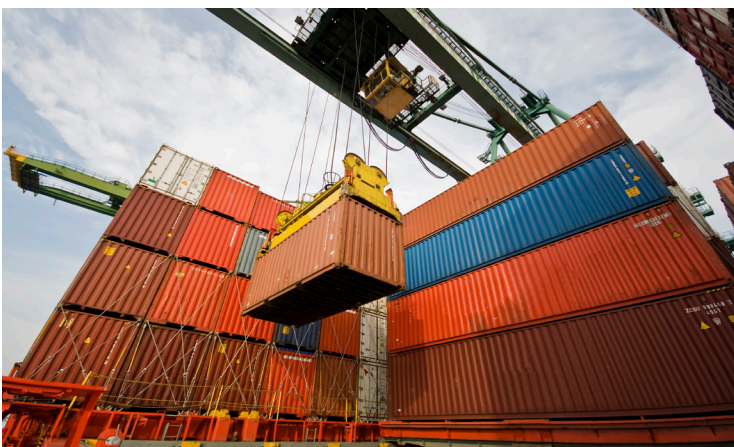
This project combined the capability of the US Department of Homeland Security's Transportation Security Laboratory for testing shipping containers and Canada's high-volume sampler to test the feasibility of detecting explosives hidden in large cargo containers. Testing was done on multiple large cargo containers in a variety of scenarios to evaluate the efficiency of high-volume sampling in detecting known signals that indicate the presence of trace explosives. The sampler also has the potential to detect chemical and biological threats.

Improvised Device Defeat

The Improvised Device Defeat category supports projects related to response operations for explosives in three areas of focus: defeating improvised devices, diagnosing and characterizing improvised devices and threats, and enhancing remote capabilities using robotics.

Neutralizing Homemade Explosive Threats

Improvised homemade explosives (HMEs) can contain a number of different components and mixtures, which poses a challenge for responding to them. Addressing the risks posed by HMEs requires an understanding of the different mixtures used to make them and practical knowledge of which tools can safely and effectively be used to neutralize them.

This project studied the use of existing tools that are available to military explosive ordnance disposal technicians and law enforcement bomb technicians to neutralize various types of HMEs. It also investigated the effectiveness of these tools on an agreed upon list of HME mixtures to determine which tools would be most useful. The results of this investigation

were used to develop and expand an HME field reference tool, along with a mobile application, to be used by the explosive ordnance disposal community. Results also informed the development of a model that can be used to predict the initiation of explosion from HMEs.

Investigative and Forensic Science

The Investigative and Forensic Science category supports projects that enhance the ability of law enforcement agencies to investigate crimes through research in four areas of focus:

1. Assessing the credibility and intent of suspects;
2. Advancing forensic science techniques;
3. Developing digital and multimedia forensic methods; and
4. Enhancing the use of forensic techniques.

Integrated Canine System for Situational Awareness on the Battlefield

Continuous situational awareness is essential for safe and successful operations by law enforcement and military personnel. Trained detection and patrol canines that are equipped with video cameras and other sensors provide information to their handlers when operating out of visual range. This preliminary view of the hostile environment allows the capability to detect threats and protect the lives of soldiers.

This project enhanced the usefulness of detection and patrol canines by developing an integrated, location-based video system that provides a real-time view of the battlefield to a soldier handler's handheld device. This integrated system allows for better situational awareness during operations, which enhances safety. It also provides images and movement data that are tagged with a location, which is useful in developing after action review reports of operations. The integrated canine system that was developed through this project is also integrated into Canadian and US radio systems.

Determining Safe Standoff Distances for Divers in the Presence of Underwater Explosions

Explosive ordnance disposal divers are at risk from blast waves that travel through the water during an explosion. Understanding how blast waves behave underwater can help to determine how far away from an explosion a diver must be to remain safe. A number of countries are exploring standoff distance recommendations for divers in the presence of underwater explosions.

This project investigated how blast waves are propagated underwater, especially in shallow waters, using experimental trials and computer simulations for various types of explosive devices. Two experiments were conducted in Canada using a custom-built set of sensors to record the characteristics of blast waves at varying distances from an explosion site.

Detection and Countermeasures for Improvised Explosive Devices (Douglas Fir II)

Electronic situational awareness and countermeasure systems used to mitigate the threat of improvised explosive devices are an important component of both Canadian and US military capabilities. Ongoing efforts by both countries aim to continuously enhance these electronic systems through better threat detection and mitigation capabilities. Improvements in these two areas will make Canadian and U.S. interoperability more effective and reduce electromagnetic interference.

This project customized, tested, and evaluated application software known as VROD and WIDEGLIDE, and defined radio systems for a variety of light electronic warfare applications that can be applied to different types of military missions.
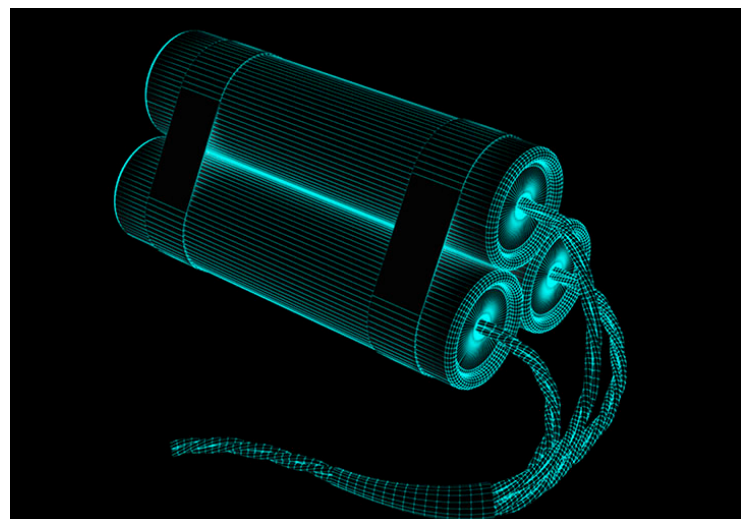
Electronic Countermeasures for Advanced Wireless Communications

With the widespread use of mobile devices, wireless communication has become a potential contributing threat in public security situations. Mobile communication may be used to recruit rioters, coordinate attacks, evade control operations, and quickly disperse to avoid law enforcement. As a result, there is a need for electronic countermeasures that are capable of controlling and restricting the use of wireless communication devices as part of response efforts during emergency situations. Also, these electronic countermeasures need to be more power efficient than the traditional techniques and more robust to address modern, complex communication systems and networks.

This project brought together DRDC CSS and the US Army to collaborate on developing and implementing a platform of up to five intelligent and power-efficient electronic countermeasure techniques.
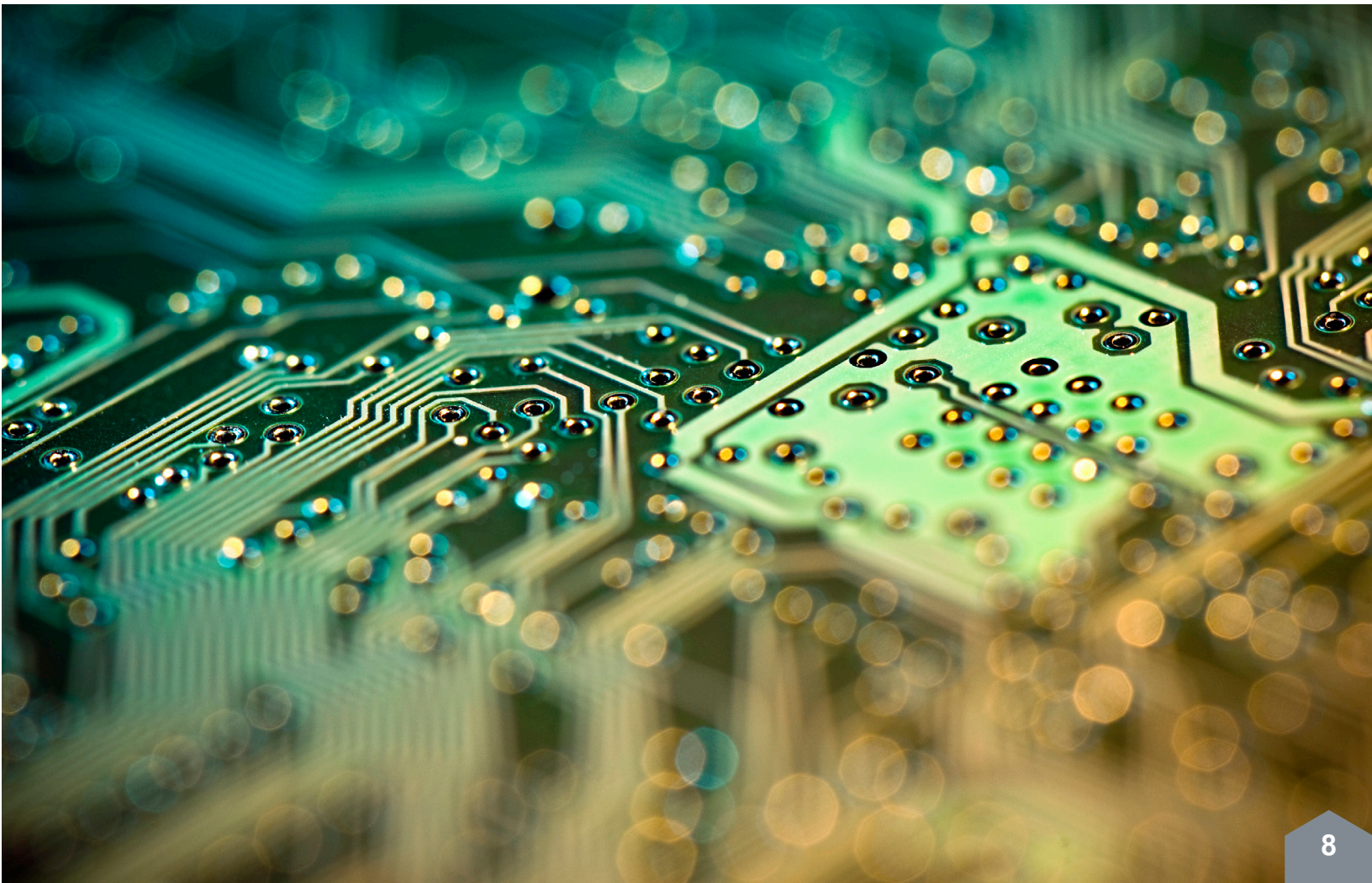
Personnel Protection

The Personnel Protection category supports projects that develop tools, techniques, and guidelines to protect against injury through research in four areas of focus:

1. Improving communications and situational awareness;
2. Advancing individual protection equipment to improve survivability;
3. Developing ways to track and recover personnel; and
4. Gaining a better understanding of the effects of ballistics and blast threats.

Electronic Countermeasure Techniques to Defeat Small Unmanned Aerial Vehicles

Small, commercial quadcopters, also known as unmanned aerial vehicles (UAVs), have not only become readily available and easy to operate, they may also be difficult to detect. This rise in accessibility has led to UAVs becoming a potential tool for criminals and terrorists. The threat from UAVs is varied — they have been used to smuggle drugs and contraband across borders and into prisons, they present a risk to aviation safety when flown near airports, and there have been a number of foiled terrorist plots involving UAVs around the world.

This project developed, tested, and evaluated a suite of electronic countermeasure "soft kill" techniques that can neutralize UAVs. The electronic countermeasures disrupt and defeat the command and control, navigation, and communication functions that UAVs require to operate. UAV countermeasure techniques are important for critical infrastructure protection, public security, and military applications since they include geo-locating a UAV controller, and detecting and tracking the flight path of a UAV before it arrives at its target.

PHYSICAL SECURITY

The Physical Security category supports projects that improve capabilities to protect personnel and infrastructure through four areas of focus:

1. Evaluating and mitigating the effects of explosives;
2. Securing facilities, equipment and resources;
3. Enhancing maritime security; and
4. Enhancing subterranean security.

Operational Infrastructure Protection

Military expeditionary camps are temporary sites that serve as the base for a variety of military operations. While the structures in these expeditionary camps must be mobile and temporary, they must also be resilient to potential threats and provide security to the personnel using them. The Military Blast Effects Expert System (MBEES) is software that was developed collaboratively between Canada and the US and is used to assess the structural vulnerabilities of field structures — such as those found in expeditionary camps — to explosive weapons.

This project used the MBEES software to assess the threat of improvised and conventional explosives in an expeditionary camp setting and to determine the impacts that explosives would have on the temporary infrastructure. The MBEES software was enhanced by validating the numerical predictions against experimental data and adding new predictive algorithms and capabilities such as camp optimization. The project also identified and assessed concepts that could be used to lessen the impact of explosives on temporary structures, including side and overhead protection, and semi-hardened and hardened shelters.

Studying How Historic Masonry Buildings Respond to Blasts

Historic masonry buildings are protected and maintained as a part of our heritage. While beautiful and culturally significant, some historic masonry structures were built prior to national building codes — therefore, it is difficult to know how they will react if subjected to an explosive blast. Such information is relevant to first responders in their execution of emergency measures and can better inform ways to retrofit historic structures to effectively withstand blast forces from explosives.

This project established a method that can be used to determine how historic masonry will respond to an explosive blast, which can be applied to study different types of historic masonry. This was done by identifying different types of historic masonry construction in North America and their characteristics, reviewing previous models and identifying gaps, conducting small and large-scale tests on sample historic masonry material, and updating previous models. The results were used to assess the viability of possible retrofit strategies and provide guidance to first responders.

Tactical Operations Support

The Tactical Operations Support category supports projects that enhance operational capabilities for a variety of tactical areas through six areas of focus:

1. Offensive operations;
2. Unconventional warfare and counter-insurgency support;
3. Tactical communications;
4. Tactical reconnaissance, surveillance, and target acquisition systems;
5. Infiltration, access, and exfiltration; and
6. Survivability systems.

Development of the Air/Ground Tactical Mesh Network

The use of unmanned aerial systems (UAS) has opened up new ways of gathering information during operations, including the capture of full-motion video. However, to maximize the utility of video captured from UAS, it should be sent directly to the personnel that need it. While this capability had previously been an important gap, the Air/Ground Tactical Mesh Network now allows the transmission of encrypted full-motion video and other data from UAS directly to operators on location.

This project reviewed a previous study of an antenna used for such air-ground transmissions. The review determined which antenna provides the ideal balance between the bandwidth required to transmit full-motion video over the network and the appropriate connectivity of ground-to-ground antennas and ground-to-air antennas. The project also developed kits with all the necessary equipment needed to operate the Air/Ground Tactical Mesh Network, and conducted user and operational evaluations of the kits to verify their performance.

Developing the Arrow Light Unmanned Aerial System

Unmanned aerial systems are an extremely useful tool for military operations. They can be used for gathering intelligence, surveillance, target acquisition, and in reconnaissance missions, all while keeping personnel at a safe distance. However, it is increasingly important for these systems to be packable, transportable, and durable.

This project designed and developed the *Arrow Lite*, a micro tactical UAS equipped with collapsible wings and intelligence, surveillance, target acquisition, and reconnaissance capabilities, which can be launched within seconds. *Arrow Lite* can operate in both day and night and boasts an encrypted tactical communication system.

DRONES
AHEAD

Training Technology

The Training Technology Development category supports projects that develop improved training to enhance the readiness and skills of personnel through four areas of focus:

1. Innovative training and educational programs;
2. Human factors and performance technology;
3. Mobile learning; and
4. Immersive learning technology.

Adding Health Effects to the CAMX Emergency Behaviour Model

The Civilian Activity Modelling for exercises and experimentation (CAMX) tool allows exercise managers to model the behaviours of civilians (individual and crowd) in urban environments during emergency simulations. With the possibility of CBR threats, it has become important to account for health effects to the behaviours of civilians during an emergency situation in order to better prepare response operations.

This project enhanced the CAMX tool by incorporating a model of civilian behaviours associated with health effects. The enhanced CAMX tool integrates

CT-Analyst® — a tool that provides three-dimensional predictions of how CBR agents are transported in urban settings. It also integrates Virtual Battle Space 2 (VBS2), which is a military simulator based on video game technology used to simulate battlefield operations. The integration of these two tools with CAMX provides a robust elements to model how health effects will impact the behaviour of civilians in emergency situations.

Evaluating Marksmanship Training Simulators

Law enforcement and military marksman, also known as sharpshooters, undergo significant training to develop precise shooting skills to engage long-range targets. This training includes the use of shooting simulators, which are widely available more to law enforcement and military agencies. Further, each agency relies on their individual, often untested, criteria to decide which product to purchase. A comprehensive review of shooting simulators was needed.

This project addressed this knowledge gap by conducting a comprehensive empirical investigation of the different marksmanship training simulators available on the market. The final report includes details of each system's performance and is available to all law enforcement and military agencies. In addition, the vendors of the simulators that were tested were provided with an individual performance report for each of their products.

Evaluating the Effectiveness of NeuroTracker Training to Optimize Human Performance

NeuroTracker is a training tool that requires users to track multiple objects on three-dimensional screens. This has been shown to improve the dynamic attention and working memory of a user. This type of enhancement in cognitive skills has the potential to improve the performance of many individuals, such as athletes, but may be especially useful for improving the performance of military personnel. Important tasks in military operations such as friend-foe identification, memory, multitasking, shooting accuracy, and weapon handling efficiency may be improved by cognitive training with a tool such as the NeuroTracker.

This project designed and executed a study of the benefits of training with NeuroTracker in order to inform end-users in Canada and the US about the tool's potential for increasing cognitive performance. The study measured the outcomes of NeuroTracker training on various components of cognitive ability — both specific outcomes such as shooting accuracy and complex outcomes such as the overall improvement of combat situations in close-quarters.