



Defence Research and  
Development Canada

Recherche et développement  
pour la défense Canada



# In Unison

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Annual Report

FOR THE YEAR ENDING 31 MARCH 2006

Canada

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# Message from the Chief Executive Officer



*In the defence and security context, the case for strong leadership in science and*

*technology has never been more compelling.*

*The defence and security challenges facing Canada and Canadians are many and increasing. In response, the Canadian Forces have embarked on transformation that is intended to ensure that they meet the needs of the new environment at home and abroad. Defence R&D Canada (DRDC) is positioning itself to be a key contributor to this transformation, and indeed to the broader public security needs of the nation.*

DRDC must be able to inform, enable and respond to the defence and security priorities of the Canadian Forces and the nation while continuing to have impact and relevance in all that we do. We must ensure that our organization is well aligned with the directions of the Canadian Forces and the needs of Canada.

Building on a strong tradition of more than sixty years of excellence in defence science and technology, DRDC has continued progressively

onward. Through the advice we provide and the studies we conduct, we have contributed to the development of strategy and policy for the Department of National Defence and the Canadian Forces. Our technologies have enhanced the capabilities of the Forces and influenced their development and generation. We have strengthened the security posture of the nation by demonstrating how the full science and technology capacity of Canada can be brought to bear on pressing security concerns. And we have helped to fortify the science foundation within the federal government and within Canada's innovation system by showing how diverse scientific communities can work together to address the nation's priorities.

I am proud of our accomplishments over the past year. Our strength as an organization is founded on our values and on the commitment of each and every one of our employees to the realization of our goals. This Annual Report highlights some of our achievements that support the transformation of the Canadian Forces and that respond to the security needs of Canadians. It demonstrates that we are indeed moving forward, in unison.

A handwritten signature in black ink, appearing to read 'R. S. Walker'. The signature is fluid and cursive, written over a white background.

Robert S. Walker  
*Chief Executive Officer, Defence R&D Canada*



# Overview of Defence R&D Canada

*Defence R&D Canada (DRDC) is Canada's leader in science and technology for national defence and public security. DRDC operates seven research centres across Canada, each with a unique combination of expertise and facilities to carry out world-class research and development. With a broad scientific program, DRDC actively collaborates with industry, international allies, academia, other government departments and the national security community.*



## Our Mission

DRDC's mission is to ensure that the Canadian Forces are technologically prepared and operationally relevant by:

- Providing expert science and technology advice to the Canadian Forces and the Department of National Defence;
- Conducting research, development and analysis to contribute to new and improved defence capabilities;
- Anticipating and advising on future science and technology trends, threats and opportunities;
- Engaging industrial, academic and international partners in the generation and commercialization of technology; and
- Providing science and technology for external customers to enhance defence science and technology capacity.

## Our Vision

DRDC's vision is to be known worldwide as the best in science and technology for defence and security.

## Our Values

DRDC's values guide how we accomplish our mission and maintain excellence in science:

- **Commitment:** We demonstrate dedication and pride in working towards our vision.
- **Client Focus:** We bring excellence to clients, both internal and external, by focussing efforts on discovering and meeting their needs.
- **Creativity and Innovation:** We generate innovative solutions, approaches, products and services that improve the status quo.
- **Leadership:** We actively and enthusiastically seek to exert influence and originate action to achieve our goals.
- **Professionalism and Integrity:** We focus our effort on achieving quality results, and we behave in an honest, ethical manner, dealing with others respectfully and fairly.
- **Trust and Respect:** We are open, honest and responsible in our relationships and we recognize and value the contributions of others.
- **Teamwork:** We demonstrate effective interpersonal skills, and work cooperatively and productively within and across DRDC to achieve common goals.

# The Structure of the Report

*Critical elements of DRDC's drive to strengthen its position as a key enabler of Canadian Forces transformation and to enhance the broader security capabilities of the nation provide the structure for the following chapters of this Annual Report.*





- The chapter entitled “Contributing to Canadian Forces Transformation” highlights those of our activities that support the core internal processes of the Department of National Defence and the Canadian Forces.
- The next chapter, “Enhancing Public Security,” outlines some of our efforts to respond to the public security needs of Canada and our allies.
- The following chapter, “Growing our Capacity for Science and Technology,” describes the augmentation of our scientific and technological capabilities through international and national collaboration and the engagement of our clients, partners and stakeholders.
- The chapter, “Making Success Possible,” focusses on increasing our effectiveness in the areas of people, processes and tools in order to build a competent, stable and sustainable capacity for the future.
- This report concludes with our “Financial Statement,” in which we present our revenues and expenditures for fiscal year 2005–2006, and the “Appendices and Tables,” which provide additional information about our operations, research centres and our program.

# Contributing to Canadian Forces Transformation

*The current security environment calls for professional, highly-trained armed forces capable of using new technologies effectively in joint, interagency and multinational operations. To face the challenges of this new environment, the Canadian Forces have embarked on transformation – a change process designed to make Canada's military more relevant, responsive and effective.*





Transformation focusses on people, technology, the conduct of operations and new ways of thinking. It does not seek to restructure the Canadian Forces completely, or re-equip them, but rather to blend existing and emerging systems and structures to create greatly enhanced capabilities relevant to future missions, roles and tasks.

In February 2006, the Canadian Forces celebrated a critical milestone in their transformation with the establishment of the new Canadian Forces operational command structure, which includes Canada Command, Canadian Expeditionary Force Command, Canadian Special Operations Forces Command, Canadian Operational Support Command and the Strategic Joint Staff. This command structure represents a bold and fundamentally new approach to the manner in which the Chief of the Defence Staff will ensure the success of Canadian Forces missions abroad and here in Canada.

DRDC is keeping in step with the advances made by the Canadian Forces by ensuring that science and technology is a key contributor to their transformation. We have positioned ourselves to provide science and technology that informs, enables and responds to the priorities of the Canadian Forces and our nation, to make certain that all we do is relevant and has impact.

This chapter highlights some of our accomplishments over the past year that demonstrate how DRDC contributes to the transformation of the Canadian Forces in the areas of strategy and policy development, force development, capability production, force generation and force employment.

## Strategy and Policy Development

DRDC contributes to the formulation of corporate policies and strategies by conducting studies and providing support that assist the Department of National Defence and the Canadian Forces in meeting the defence and security objectives of the Government of Canada. Two examples of our work in this domain follow.

### Supporting capability-based planning

To support the implementation of capability-based planning within the Canadian Forces, DRDC was a key participant on the Chief of the Defence Staff Action Team (CAT) 3 that developed an assessment method known as the Capability Assessment Methodology (CATCAM). The methodology is a tool that assists subject matter experts in articulating the impact capabilities have on the frequency with which the Forces can conduct missions and on their ultimate level of success. CATCAM allows defence planners to generate a priority list of capabilities required by the Canadian Forces and can also examine how various options for future forces contribute to defining required capabilities. While the methodology is evolving as capability-based planning is implemented, it is currently being used to help define Canadian Forces capability goals.

**Capability-based planning is the process of determining the right blend of plans, people, equipment and activities to optimize the capacity of the Canadian Forces to fulfill their assigned roles.**

### Modeling and simulating strategic lift

To support the Canadian Forces in their overseas deployments, DRDC conducted a study that explored different approaches to strategic lift with a view to rapidly transporting the Forces to areas around the globe. Strategic lift is the ability to convey the Canadian Forces to missions abroad from home soil.

DRDC developed an aircraft loading optimization model to determine the most favourable loading plans for a fleet of transportation vehicles. The output from the loading model was then fed into a simulation framework that permitted the researchers to study the effectiveness of various options for strategic lift. Analysis indicated that pre-positioning equipment at various international locations and increasing the use of C-17 aircraft for airlift – where economically viable – were potential approaches for improving the strategic lift of the Canadian Forces.

## Force Development

During the last year, DRDC made significant contributions to the conceptualization and planning associated with the creation, maintenance and adaptation of military capabilities in the face of changing security and resource circumstances. The following stories highlight some of our successes in these areas.

### Improving maritime surveillance

In October 2005, DRDC led the international Maritime Sensor Integration Experiment (MarSIE) off the coast of Nova Scotia. The objective of the three-week exercise, one of the largest of its kind ever carried out in Canada, was to collect data from multiple sensors that could be used to enhance the surveillance and security of Canada's coastline. During the trial, sensors, aircraft, ships and high frequency



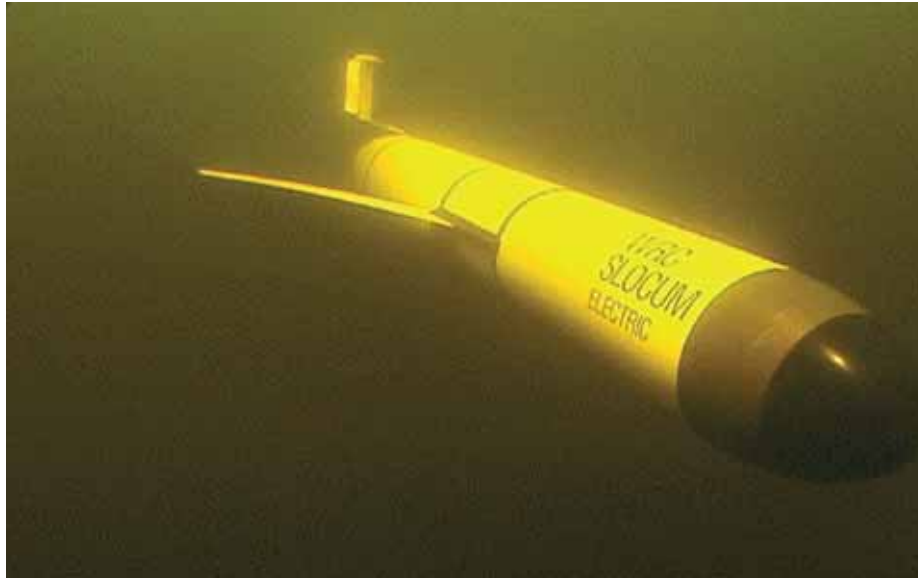
*Personnel aboard a Canadian patrol frigate and rigid hull inflatable boats participate in the MarSIE trial*

surface wave radar tracked three simulated smuggling operations from the United Kingdom to Nova Scotia. The trial provided valuable data to help scientists and authorities evaluate the effectiveness of current and future technologies for the security of Canadian waters.

Conducted under the auspices of The Technical Cooperation Program (TTCP), the MarSIE trial involved several government departments and agencies with responsibility for marine security for Canada, the United States and the United Kingdom. Australia and New Zealand participated as observers and provided analytical support. Canadian participants included the Navy, the Royal Canadian Mounted Police, the Canadian Coast Guard, Transport Canada, Canadian Border Services Agency and the Department of Fisheries and Oceans, as well as local agencies in the Atlantic provinces.

**The international and inter-governmental collaboration was absolutely necessary to build the complete maritime security picture. This also served as an excellent and productive opportunity for all the marine-oriented government departments to share ideas and to work together for a common security cause.**

*– Commander Anthony Cond (retired),  
Trial Coordinator, DRDC*



*Deploying the SLOCUM Glider and the Stealth Buoy*

Several technologies developed by DRDC and our partners were featured during the trial, such as the Stealth Buoy, the SLOCUM Glider, the Infrared Eye, the Enhanced Low-Light Visible and Infrared Surveillance System, the High Frequency Surface Wave Radar, the Automatic Information System and the Compact Airborne Spectrographic Imager CASI-550.



## Determining the cost of the Canadian Forces

A key initiative that is fundamental to the transformation of the Canadian Forces is an improved approach to strategic costing, one that supports decision making on critical investment and divestment. In response to a request from the Department of National Defence, DRDC developed the Strategic Costing Model, which was built upon previous work related to the department's Program Activity Architecture. The work focussed on "effects" as departmental outputs, and has proven to be compatible with capability-based costing. The research adopted a strategic approach towards integrated force planning that embraces two central tenets: whole cost capture and military value assessment.

The model incorporates features such as attributed costing – using formulas to capture the secondary, tertiary and time-varying costs of the Navy, the Army and the Air Force – and simplifies the whole to an overall view of the true costs of the Canadian Forces. The model has been used to produce novel perspectives on how the Forces spend their limited resources, and is a key component of the Defence Capability Plan.

## Testing intelligent aviation interfaces

Complexity, dynamics and information overload are characteristics of military systems that impose severe constraints on personnel. Some of the critical activities that are affected are piloting displays, sensor operations, tactical management and intelligence gathering, and surveillance and reconnaissance activities, such as controlling multiple unmanned aerial

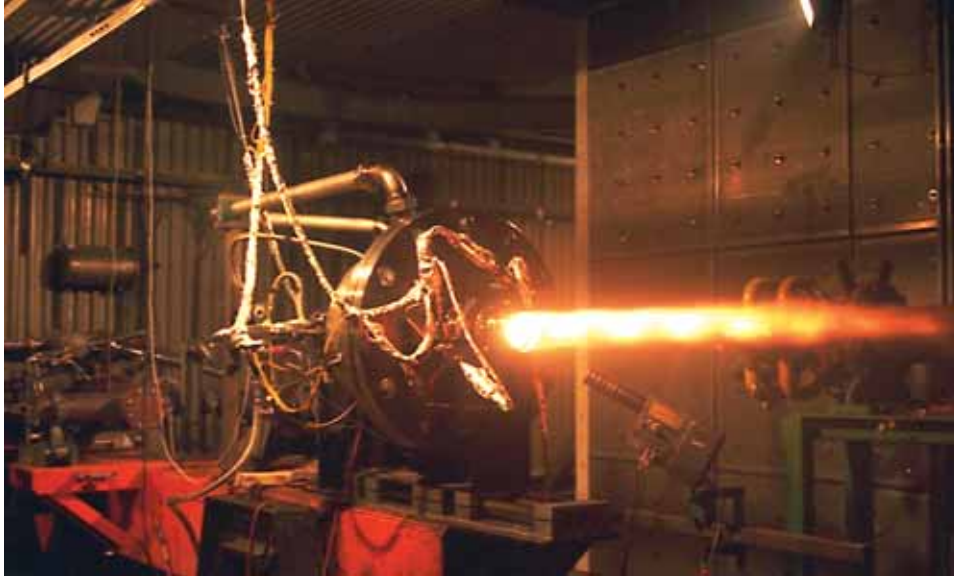
vehicles (UAVs). To address this issue, DRDC designed and tested advanced intelligent adaptive interface technologies that increase human information processing capabilities and improve decision making.

The trial involved the control of multiple UAVs, a cognitively complex task with high workload. DRDC developed a workstation with three control consoles which replicated the CP-140 tactical compartment, with appropriate displays and controls for a UAV pilot, a sensor operator and a tactical navigator. The system was designed to operate in two modes – normal and with intelligent interfaces. The research examined operator workload, task complexity and interface adaptability.

Intelligent adaptive interface technology was shown to have a real potential to improve the effectiveness of the crew. The trial demonstrated that its use improved situational awareness and reduced workload. Operators were able to work under high pressure and complete critical tasks in less time. These results will enable the Canadian Forces to make informed decisions on investment in advanced technologies for operator-machine systems and their applications.

## Understanding supersonic missile technologies

To obtain an in-depth understanding of current and future propulsion, aerodynamic and integration technologies for supersonic missiles, DRDC undertook the Stand-off Precision Strike project. These technologies provide the basis for trade studies to aid in the acquisition of future Canadian Forces missiles as well as for threat assessments.



*Test firing of a DRDC ramjet solid propellant fuel*

We developed expertise in experimental and numerical air-breathing capabilities, pulse detonation engines, and new control methods for projectiles and missiles. In addition, the project offered options for replacing air-to-air and air-to-ground weapons, and provided data that permit the intelligence community to evaluate threats.

### **Modelling underwater warfare engagement**

Tasked by the Canadian Forces Maritime Warfare Centre (CFMWC) with developing the ability to simulate underwater torpedo engagement, DRDC adapted the modeling package ODIN and built models of a Canadian Patrol Frigate (CPF), a VICTORIA class submarine and threat torpedoes. This simulation capability can be used to develop and enhance anti-submarine warfare tactics, both defensive and offensive, for ships and submarines. It can also support procurement decisions as well as exercise and trial rehearsals.

ODIN was chosen for development because it is capable of simulating the kinematic, sensor, signature and environmental aspects of ship-submarine-torpedo engagements. The CPF and torpedo models were combined in simulations and this combined modelling was used to complete a study on the effectiveness of the CPF's torpedo defence evasive manoeuvres, resulting in enhanced tactical doctrine for Canadian warships. The model was also used for trial rehearsal, which brought about changes to trial plans, thus making better use of trial resources. The DRDC and CFMWC collaboration continues as more ODIN models are developed to study torpedo defence against a wider range of threats and to produce a VICTORIA class model of higher fidelity so that submarine tactics can be developed and assessed.

# Capability Production

During the last year, much of DRDC's work was directed at increasing the capabilities of the Canadian Forces. The work we accomplished aided the Forces in developing options for capability implementation; in acquiring equipment, personnel and infrastructure; and in developing training, doctrine, capability support and supply systems. The integration of these activities leads to increased operational capabilities. The following stories demonstrate some of our achievements that resulted in capability production.

### Sensing danger from a distance

The objective of the MultiAgent Tactical Sentry (MATS) project was to equip the Department of National Defence Joint Nuclear, Biological and Chemical Defence (JNBCD) Company with a state-of-the-art ability to detect NBC threats

from a distance. To accomplish this, DRDC integrated the current suite of Canadian Forces NBC sensors and a number of secondary sensors, such as meteorological, visual and infrared sensors, into a remotely-operated, robotic vehicle platform.

This integration of sensors into a single suite has reduced the manpower required to perform NBC surveillance, while at the same time extending the length of time operators can spend at their stations. The data collected by the sensors are transmitted to the robot control station where they are incorporated into a rolling map display monitored by the operator. This permits identification and localization of the threat from within the safety of the command post vehicle. The vehicle operator can be kilometres away from potential threats while monitoring multiple types of threats. DRDC delivered two MATS systems to the JNBCD Company in December 2004 and an additional two systems in November 2005.



*The MultiAgent Tactical Sentry*



## Detecting difficult targets through sensor integration

In 2006, DRDC completed the Trials and Integration Concepts for Advanced Imaging Sensors project. The objective of the project was to collect data from experimental airborne imaging sensors to determine how disparate sensors complement each other when imaging common targets, and to determine a path forward for future projects on sensor integration.

DRDC collected the data to support the project during the CAMEVAL trials, which involved the XWEAR airborne synthetic-aperture radar and the Infrared Eye, both developed by DRDC, and the HyperSpectral Imager from the National Research Council. We produced a unique data set that showed imagery of vehicles in various states of camouflage and concealment. We also determined the effectiveness of the camouflage currently being procured by the Canadian Forces, and presented the results to the Department of National Defence, to support the capital project to procure new camouflage for the Canadian military.



*Collecting data during the CAMEVAL trials*

## Navigating in greater safety

In 2003, DRDC had participated in the KINGSTON Class Seaworthiness Study, which determined that this class of ships is vulnerable to slamming, a problem exacerbated by the difficulty in identifying when the ship is in high-risk conditions. The Department of National Defence subsequently asked DRDC to develop a Slam Warning Operator Guidance System to alert the bridge crew to conditions that present a risk of damage due to slamming.

DRDC conducted a sea trial on HMCS KINGSTON to collect slamming structural response data in order to refine the design and calibration of the slam warning system. The prototype Slam Warning Operator Guidance System was successfully installed and used on HMCS SHAWINIGAN during the 2005 BLUE GAME exercises which involved a trans-Atlantic crossing. The system consists of a bridge display unit and sensor package measuring ship motion, structural acceleration and strains, and wave pressures. The system provides the operators with an indication of the severity of any slams when they occur and is able to predict how changes in the ship's operation or the wave environment could affect the risk of slamming.



*Collecting slamming structural response data aboard a KINGSTON class ship*

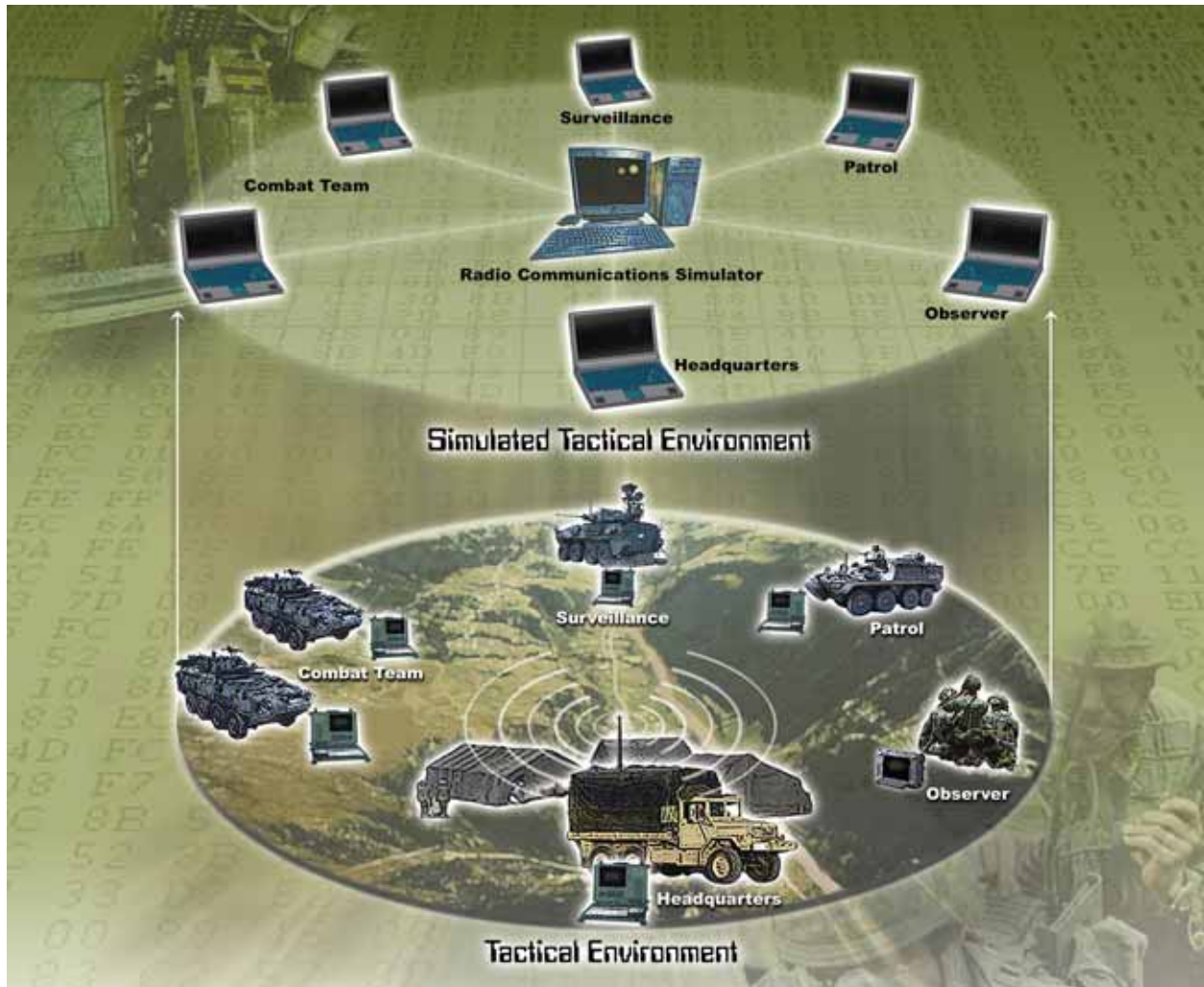
## Enhancing communications in the field

As the Army develops command-centric, knowledge-based and soldier-focused capabilities, the requirement for robust and pervasive wireless communications is critical. These systems need to provide connectivity and maintain an adequate flow of information between sensors, soldiers and vehicles at all levels.



*Demonstrating the features of the High Capacity Tactical Communications Network*





*Simulation environment developed to study information management over tactical radio networks*

DRDC completed the High Capacity Tactical Communications Network (HCTCN) project to explore technologies in wireless communications and information management aimed at increasing the capabilities of the Army's tactical communications system. The project's objective was to enable a tactical radio internet based on internet protocol (IP).

In a live field demonstration, we displayed the features of the HCTCN, which include automatic configuration and self-healing of the network, a network-capable radio with four times the capacity of current radios, voice-over IP with point-to-point and conference calling, and information management strategies that adapt to changing battlefield and network conditions.



### A new centre for mission training

In November 2005, DRDC established the Aerospace and Undersea Medical Science (AUMS) Centre, which focusses primarily on the support required by the Canadian Forces to accomplish their missions in austere operational environments, in the air or beneath the sea. The Centre combines the expertise of defence scientists, flight surgeons, pilots, aerospace engineers, bioscience officers and clearance divers. The AUMS Centre's multi-environmental life-support devices are available for training and for test and evaluation; they include diving chambers, an altitude chamber and a human centrifuge for fast-jet training. Since its establishment, over 120 high-performance aircrew and a large number of clearance divers and medical officers have received specialized training at the Centre.

## Force Generation

An important element in the transformation of the Canadian Forces is the process by which they are trained, equipped and assembled for potential operations. The following stories demonstrate how DRDC has facilitated the generation of forces that are operationally ready to fulfill their missions.

### Developing new body measurement standards for pilots

The Canadian Forces are the first in the world to adopt new anthropometric selection standards for pilots based on technology developed by DRDC. The previous standard was based on body size limits established in the 1960s, with the result that many otherwise qualified candidates were being rejected. The new standard is based on an individual's ability to perform a pilot's task; in other words, on Bona Fide Occupational Requirements (BFOR).



*The centrifuge control room at the DRDC Aerospace and Undersea Medical Science Centre*

Using a version of the Body Scanning System and the Pilot Anthropometric Selection Tool, DRDC developed a method of digitally scanning the physical dimensions of aircrew candidates. We also assessed the cockpits of all Canadian Forces aircraft fleets to determine the body measurements required to safely operate the aircraft. The ability to perform required tasks in a particular cockpit determines the anthropometric standards for that aircraft. A computer program analyzes the data to identify the types of aircraft the candidate is physically suitable to fly.

The new standard has the flexibility to adapt to modifications made to current aircraft, to new aircraft that is added, or to a change in BFOR,

while remaining true to a selection process that is fair and equitable. The new anthropometric procedures and standards are expected to increase the number of candidates, particularly women, eligible to pursue careers as military pilots.

**This is an excellent example of how we are employing leading-edge technologies to transform into a relevant, responsive and effective force for the 21st century.**

*– Lieutenant-General Steve Lucas, Commander of Air Command and Chief of the Air Staff*



*Taking measurements in the cockpit of the Grob, the new primary flight trainer for the Canadian Forces*

## Managing the military training pipeline

The Canadian Forces process for training pilots is a highly intricate system and it is extremely difficult to predict the effects of changes in course loading and scheduling. In 2005, the Air Force was seeking a desktop computer-based tool to assist in managing and optimizing the training pipeline for pilots. The pipeline refers to a training system that determines all elements of the training program from registration to graduation and includes schools and other training establishments.

Since managing the training pipeline is important for all military occupations, DRDC created a generic tool applicable to any training system. The desktop application consists of an end-to-end training pipeline simulation model that supports both short-term management of the training system and long-term strategic planning, nested within a user-friendly interface. We delivered the tool, as applied to the occupation of pilot, to the Air Force in 2006, and its introduction to other Air Force occupations is under way.

## War-gaming in an urban setting

Canadian Forces missions into urban warfare environments are complicated and significantly different from those conducted in open terrain. Short of full-scale military exercises or combat, the only practical way of testing new Army tactics, doctrine and equipment effectiveness in urban settings is simulation.

DRDC, in close collaboration with partners in the United Kingdom, completed a number of studies for the Department of National Defence using the war-game Close Action Environment (CAEn). This high-fidelity, soldier-in-the-loop simulation allows the players to conduct engagements that could involve an entire company of soldiers, using realistic parameters. The studies, conducted in 2005, examined new soldier sensors, weapon suites and various organizational models. The results provided the Army with credible recommendations on the best options to pursue for equipment acquisition and training.

## Simulating a helicopter deck-landing

In response to a request from the operators of the Canadian Forces' *Sea King* helicopter, DRDC developed a virtual reality simulator to enhance helicopter deck-landing skills. The task involved landing a *Sea King* aboard a Canadian Patrol Frigate in heavy seas. The goal of the project was to build a helicopter deck-landing simulator, using head-mounted displays, from commercial off-the-shelf (COTS) components. These devices are usually much less expensive, have fewer safety problems, require less maintenance and have minimal infrastructural requirements, in comparison with custom-designed components.



DRDC conducted an experimental investigation that compared our virtual reality simulator with a high-end simulator employing state-of-the-art components, which was developed under a contract with the University of Toronto Institute for Aerospace Studies and validated through testing by qualified pilots. The flight dynamics and other critical elements of the virtual reality simulator, such as the ship's appearance and behaviour, were identical to those of the state-of-the-art simulator. The idea was to substitute a low-cost, COTS component for each of the expensive, special-purpose components of the state-of-the-art simulator.

The results of the investigation suggested that the virtual reality approach is a viable alternative for training in deck-landing skills, and could provide the means for low-cost simulation of helicopter training tasks, such as hovering, hoisting, auto-rotations or other tasks where strong reliance on visual and motion cues is not critical.



*Simulating a helicopter deck landing*

## Providing emergency gas to divers

Having an additional supply of gas on hand during deep diving operations can significantly increase the level of safety for divers. DRDC developed the prototype of the Auxiliary Gas System (AGS), which provides an emergency breathing system to divers in the event their Canadian Underwater Mine-countermeasures Apparatus (CUMA) fails in deep waters. The CUMA is a self-contained, underwater breathing apparatus developed by DRDC. The AGS also provides additional gas to complete the required decompression, should the on-board gas supply in the CUMA be insufficient. The AGS is valuable in that it provides an emergency capability as well as increased endurance to CUMA diving and enhances Canadian mine-countermeasure operations.

In operation, the AGS is lowered into the water at a depth greater than the diver's first anticipated decompression stop. If the CUMA fails, the diver can swim to the AGS and don the available mask, utilizing the AGS as the alternative breathing apparatus. If there is insufficient gas to complete the scheduled decompression, the diver can connect to the AGS and utilize its gas to replenish the gas in the CUMA.

## Making better moral and ethical decisions

The increasing range and complexity of modern Canadian Forces operations can create situations and require decisions that may give rise to conflicts between opposing values or beliefs. Current models of moral and ethical decision making tend to overemphasize rationality and fail to consider the factors of emotions, intuition and of close relationships, as well as the decision maker's perceived social role and the expectations that arise from that role. Thus training that is based upon current decision models may fail to prepare the Canadian Forces for the realities of decision making in current operations, and could affect their operational effectiveness.

DRDC embarked on a research project to understand and facilitate decision making in the context of the moral and ethical dilemmas that Canadian Forces personnel could confront, especially during the course of operational deployments. The project aims to integrate state-of-the-art research in judgement and decision making, as well as in theories of stress and coping, with the operational realities experienced by members of the Forces.

The project utilized a multidisciplinary approach that included a comprehensive

literature review, in-depth interviews with Canadian Forces commanders, and field studies in high-stress training environments, such as the Peace Support Training Centre (PSTC) at the Department of National Defence. The work resulted in the development of a conceptual framework of factors regulating moral and ethical decision making in operational contexts.



*DRDC diver tests the Auxiliary Gas Supply*

Results of the field studies have been reported to the PSTC. Moreover, the results of this research form the basis of lectures in the Advanced Military Studies course at the Canadian Forces College. This work has made, and will continue to make, both theoretical and pragmatic contributions to the Canadian Forces, and will promote a better understanding of moral and ethical decision making in a military operations context.

### **Studying marksmanship of soldiers exposed to battlefield noise**

Knowing how soldiers react to noise and other distractions on the battlefield is essential in developing effective training programs. DRDC conducted a study to measure the impact of noise on a soldier's ability to detect, identify and

engage targets. The study examined the differences between individual and two-man team performance in target detection, identification and marksmanship using the Small Arms Trainer with noise as a stressor.

These valuable trials provided the Department of National Defence with evidence that a moderate level of battlefield noise has no impact on a soldier's ability to detect, identify and engage targets. They also demonstrated that soldiers value accuracy over engagement time, which is consistent with their training, but suggested that soldiers will adjust their behaviour in a team situation where they will reduce engagement time in an apparent bid to outperform their partners. This knowledge could influence doctrine on soldier training and on the conduct of operations in the field.



*Soldiers participate in a simulated mission in the Small Arms Trainer*



## Surviving in cold conditions

Working in adverse weather conditions is one of the realities the Canadian Forces personnel face on deployed missions. To provide the Forces with options to improve their cold-weather shelter system and survival equipment, DRDC created the prototype of a tent that incorporates a patented zipperless entrance, a lighter tent fabric, a convection system to minimize frost build-up and temperature gradient inside the tent, and a light-emitting diode (LED) lighting system. We also developed a novel sleeping system to minimize the accumulation of frost inside the sleeping bag.

As well, DRDC developed a new camouflage material that minimizes the signature of the cold shelter and its occupants, and a heating vest that maintains the manual dexterity of soldiers exposed to cold. This research will enhance the soldier's ability to fight and survive in cold environments and will assist the Canadian Forces in selecting the next generation of winter shelter, sleeping systems and camouflage equipment.

## Force Employment

Force employment refers to the planning, directing, coordinating and controlling of assigned forces in the conduct of operations. The following examples demonstrate some of DRDC's accomplishments that have improved the effectiveness of the Canadian Forces during operations.

## Automatic Identification System for HMCS ATHABASKAN

To prepare HMCS ATHABASKAN for a seven-month deployment as flagship for the NATO fleet, the Navy asked DRDC to provide operational support by integrating information from the Automated Information System (AIS) into the ship's command and control system. AIS is a self-reporting system for commercial ships which regularly broadcasts the ship's identity, position and speed, as well as data related to the ship's voyage, such as its cargo and the next port of call. This information is very valuable to naval decision makers aboard ships and at shore-based operations centres where they wish to maintain complete awareness of marine traffic in their areas of responsibility.

DRDC developed the self-contained relay system known as the AIS Vessel Monitoring System, adapting its interface to allow HMCS ATHABASKAN to effectively integrate AIS contacts into its command and control system and to share this enhanced situational awareness with the NATO Maritime Command and Control System.



*Installing an AIS Vessel Monitoring System remote station*

## Providing support in Afghanistan

For the first time in recent history, DRDC deployed one of its scientists to provide direct operational research and analysis support to the Canadian development mission in Afghanistan. The deployment of a civilian defence scientist with a military overseas operation is part of DRDC's plans to move towards more front-line support to Canadian Forces operations.

The scientist was deployed for one year with the Strategic Advisory Team (SAT). The SAT's mission in Afghanistan is to assist the local government in building its own human capacity and the processes needed to design and implement its own development program. The group works exclusively for the Afghan government and not to further any specific Canadian agenda or interests. The scientist provided analytical support to the Afghan government's team that produced the Afghanistan National Development Strategy.

DRDC has been very active in providing support for ongoing operations in Afghanistan. In response to the Chief of the Defence Staff Action Directive on improvised explosive devices (IEDs), we created an action team to respond with short-, medium- and long-term proposals for science and technology enhancements to personnel and vehicle protection, IED detection and countermeasures, and training. DRDC also directed the creation of a project to address a range of science and technology initiatives and to deliver capability as soon as possible to the Canadian Forces. Finally, with our partners in the Department of National

Defence, DRDC has undertaken a series of evaluations, trials and proposed modifications to Canadian Forces fleets to increase their level of protection from IED threats. Coupled with support for systems developed by DRDC that have already been deployed in the field – such as the Improved Landmine Detection System and the FERRET small-arms fire localization system – DRDC is making great contributions to keeping the Forces technologically capable and prepared to meet present and future challenges.

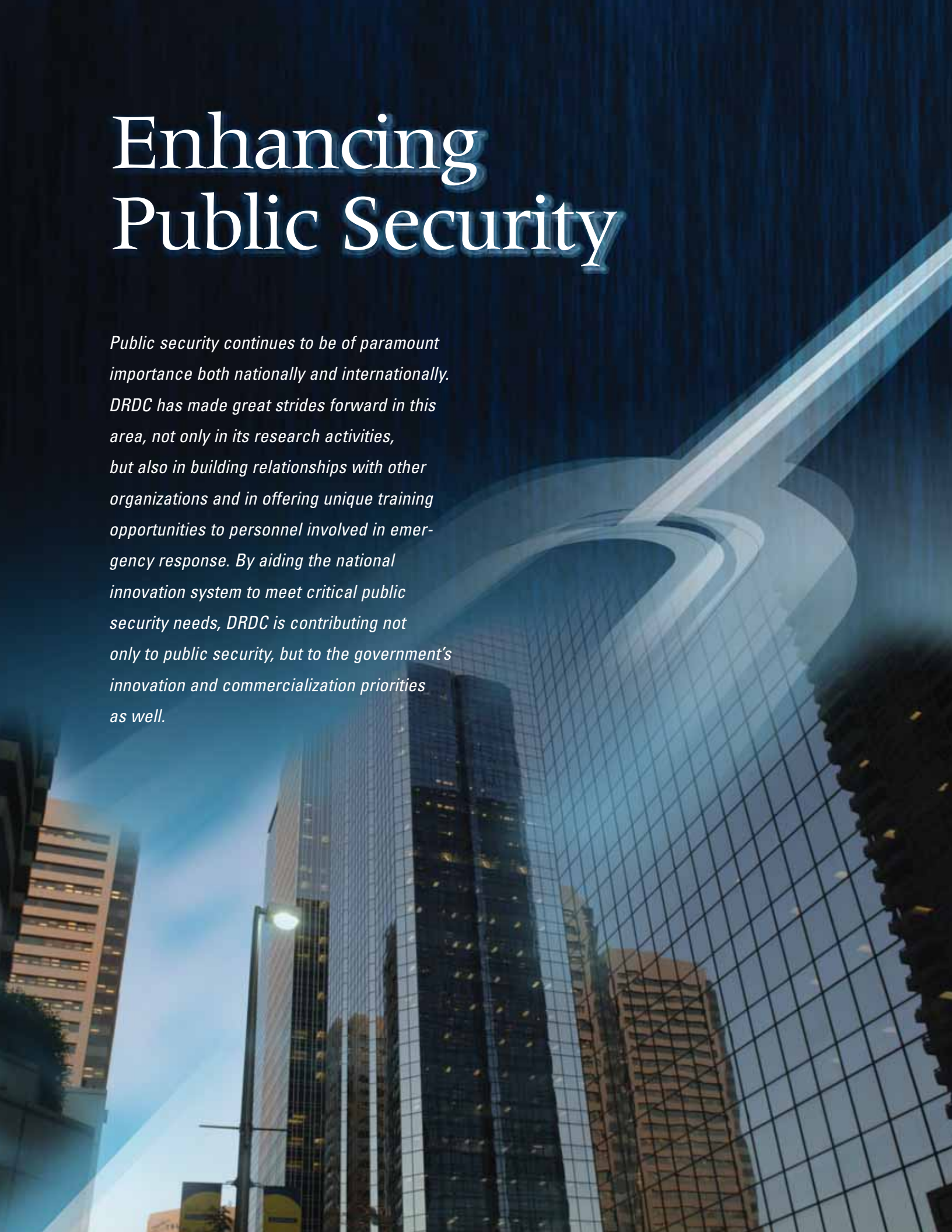
## Optimizing maritime patrol plans

The Canadian Forces have access to various means of performing maritime patrols, including CP-140 *Aurora* patrol aircraft, Navy ships, maritime helicopters and civil aircraft contracted by the Government of Canada. The Forces must periodically prepare operational plans to coordinate patrol activities and to ensure that the limited resources available are applied where needed, while maximizing fleet capabilities and avoiding duplication of efforts.

DRDC developed the Patrol Rota Optimization Tool for Effective Coverage of Targeted Sites (PROTECTS), which helps military planners determine the combinations of patrols that should be performed in order to adequately cover risk areas and meet surveillance objectives in the most resource-efficient way. PROTECTS can also be used to ascertain the minimal amount of resources required to achieve specific objectives, or to lessen the impact of resource cuts.

# Enhancing Public Security

*Public security continues to be of paramount importance both nationally and internationally. DRDC has made great strides forward in this area, not only in its research activities, but also in building relationships with other organizations and in offering unique training opportunities to personnel involved in emergency response. By aiding the national innovation system to meet critical public security needs, DRDC is contributing not only to public security, but to the government's innovation and commercialization priorities as well.*





## New DRDC Centre for Security Science

In December 2005, DRDC created a new centre dedicated to science and technology for public safety and security. The centre, named the Centre for Security Science (CSS), establishes a unique partnership between Public Safety and Emergency Preparedness Canada (PSEPC) and DRDC with the goal of positioning science and technology to respond to Canada's public security needs. As a consequence, it also addresses the capability needs of the Canadian Forces, specifically Canada Command, in their public security support role.

Created in 2003, PSEPC has the mandate to keep Canadians safe by ensuring coordination across all federal departments and agencies responsible for national security and safety. Accordingly, the department delivers a range of programs designed to protect national security; improve Canada's collective capacity to handle emergencies, including natural disasters and terrorist attacks; combat crime; and promote community safety. This partnership with the CSS provides leadership in bringing science and technology and our national innovation system to bear on pressing public security issues.

DRDC CSS manages the Chemical, Biological, Radiological and Nuclear (CBRN) Research and Technology Initiative (CRTI) and the Public Security Technical Program (PSTP). It also delivers a broad spectrum of specific science and technology services and is intricately networked with national and international partners and public security communities.

## Chemical, Biological, Radiological and Nuclear Research and Technology Initiative

The CRTI has a mandate to fund projects in science and technology that will strengthen Canada's preparedness for, prevention of, and response to potential CBRN terrorist attacks. Through this collaborative, coordinated initiative, the federal science and technology community and its partners are working to enhance Canada's ability to respond to CBRN threats to public security.

Comprising 17 federal government departments and agencies, the CRTI's unique, cross-organizational structure has provided new opportunities for the sharing of knowledge across organizations and disciplines. It has resulted in measurable gains in Canada's CBRN response capabilities; in increased expertise, knowledge and capabilities for Canadian CBRN science and technology performers; and in stronger links between diverse science and security communities, both domestic and international.

The following stories highlight some of the CRTI's achievements over the past year.

## Expert team conducts radiological incident exercise

In 2005, more than 140 of Canada's top radiological-nuclear experts took part in Exercise MARITIME RESPONSE (EXMR), a three-day field exercise designed to train participants to respond to terrorist attacks involving radiological-nuclear sources. The exercise was the largest CRTI exercise to date.

EXMR was designed for maximum realism while ensuring the safety and security of the participants. During the exercise, various federal teams responded as a unit to a situation involving unknown sources of radioactive materials. The teams were expected to locate, identify and secure all sources of radioactive materials. The exercise ran through many diverse scenarios, including the detection of radiological contraband. In addition to the training it provided, EXMR also offered an opportunity to test technologies and systems developed under the CRTI.

The event marked the first integrated, national-level radiological-nuclear counterterrorism exercise ever held in Canada involving both federal and provincial partners. Participants came from eight federal organizations and one

provincial agency: DRDC; Health Canada; Natural Resources Canada; the Canadian Nuclear Safety Commission; Atomic Energy of Canada Limited; the Canada Border Services Agency; the Canadian Forces Joint Nuclear, Biological and Chemical Defence Company; the Royal Canadian Mounted Police and the New Brunswick Emergency Measures Organization.

**This is the sort of training that we hope we will never have to use in Canada, but we must prepare for all possible eventualities in order to protect Canadians.**

*– Helen Griffiths, Health Canada, Nuclear Emergency Preparedness and Response Division*

## Combating the Ebola and Marburg viruses

The Ebola and Marburg viruses are among the most dangerous pathogens known to mankind. Consequently, they have the potential to be used as biological weapons. There are currently no treatment or preventive strategies and up to 90 percent of infected individuals succumb to these diseases.

Under the CRTI, several public- and private-sector organizations, led by the Public Health Agency of Canada, worked together to develop monoclonal antibodies against the two viruses. These antibodies are now being used for in vivo testing. The work is contributing significantly to the development of a vaccine against these viruses and the resulting haemorrhagic fevers.



*Radiological-nuclear experts take part in Exercise MARITIME RESPONSE*

## Rapid detection of animal diseases

Foot-and-mouth disease, hog cholera, avian influenza and Nipah virus are existing high-threat animal viruses. Canada is currently free of these diseases and therefore its livestock is susceptible and its agricultural economy vulnerable to bioterrorist attack using these agents. Both avian influenza and Nipah virus pose additional threats in that they have the potential to be transmitted to humans. An interdepartmental CRTI project recently developed rapid, highly sensitive diagnostic tests for use during emergency response to outbreaks of these viruses.

The Canadian Food Inspection Agency, Health Canada and the National Research Council of Canada developed an avian influenza virus assay that is now used for analytical purposes, such as an avian influenza survey of wild bird populations. The collaboration also resulted in the creation of an avian influenza network of federal and provincial veterinary laboratories, as well as a rapid pen-side assay for Nipah virus.

The tests are mobile and robust and suitable for use in laboratory networks and under field conditions. They produce reliable and accurate results rapidly, support differential diagnosis, allow for automation to handle large numbers of samples, and accommodate electronic collection and transmission of data. These new tests for foreign animal diseases will reduce the impact of any naturally-occurring or terrorist-introduced diseases into the Canadian livestock population.

## Detecting radiation sources

In the current global environment of heightened security, risk assessments conducted by the Canadian government and other national and international agencies indicate the need for the ability to prevent and manage attacks that use

radioactive materials as a terrorist agent. Key potential targets for these attacks include communities, critical facilities, and high-value government assets. Under the aegis of the CRTI, a collaborative project between government and industry set out to develop a radiological security system that would detect high levels of radiation and distinguish them from typical radiation sources (such as some construction materials).

The production-ready, mobile, real-time radiological surveillance system was designed for use in the field by first responders and emergency management personnel. It was tested in the National Capital Region where it collected over seven million radiation measurements to be used as background data. The system includes radiation sensors controlled by a Mobile Detection Unit with an on-board computer providing a global positioning system, telecommunications, and power management. In practice, this surveillance equipment will be able to detect radiological anomalies, or illicit sources of radiation, prior to a serious incident.

## The fight against ricin

Ricin is a highly toxic protein found in castor beans. It is readily produced, has a history of use by terrorist groups, and is viewed as a high-potential threat agent. At present there are no medical countermeasures against ricin poisoning.

Researchers at DRDC tested antibodies that neutralize ricin that were developed through collaboration between two private sector organizations. The test provided the first evidence that antibody therapy could manage the effects of ricin. A solution of this type could potentially both reduce the threat of ricin being used as a bioterrorist weapon and lessen the likelihood of death from this poison.



# Public Security Technical Program

In June 2003, DRDC established the Public Security Technical Program (PSTP), aimed at enhancing collaboration throughout government and delivering science and technology solutions across many dimensions of public security. The program currently focusses on four mission areas: (1) chemical, biological, radiological, nuclear and explosive (CBRNE) threats; (2) critical infrastructure protection; (3) disruption and interdiction; and (4) systems integration, standards and analysis.

The PSTP embraces a two-pronged approach, with a Canadian program that includes many federal government departments and agencies, and a Canada/United States program, which engages the U.S. Department of Homeland Security. Its goal is to integrate ongoing collaboration into a single, overarching bi-national strategy to ensure efficient and effective use of national resources.

The following stories demonstrate some of the work accomplished by the PSTP to further the achievement of its goals.

## PSTP hosts Defence Security Innovation 2005

In November 2005, the PSTP hosted Defence Security Innovation (DSI) 2005, the third in a series of DSI conferences. DRDC, Public Safety and Emergency Preparedness Canada (PSEPC), the U.S. Department of Homeland Security (DHS) and PÔLE Québec Chaudière-Appalaches sponsored the conference, which attracted over 300 participants. The event addressed four major challenges in public security: Prevent, Prepare for and Respond to CBRNE Threats; Critical Infrastructure Protection; Human Aspects of Counter-terrorism and Borders and Territory Protection; and Capability Integration towards Emergency Preparedness. More than 70 presentations were made during the conference, which was attended by experts from Canadian and United States government departments and agencies, and from industry.



*The Canada/United States Public Security Team: (left to right) Robert S. Walker, DRDC; Margaret Bloodworth, PSEPC; Holly Dockery, DHS; and Charles McQueary, DHS*

## CBRNE workshop explores PSTP collaboration opportunities

In July 2005, DRDC hosted a three-day workshop to discuss scientific and technological solutions to CBRNE threats. The workshop was the third CBRNE meeting to be held over the last 18 months and focussed on two aspects: CBRN decontamination and restoration, and volumetric explosives technology.

The workshop represented the first formal meeting of PSTP experts in the area of explosives. Discussions focussed on the unique challenges presented by volumetric explosives and included an overview of technologies and techniques to detect and neutralize explosives and the medical aspects of blast effects. Participants also worked on a proposal for a way ahead and their work will probably culminate in a future white paper addressing priorities for collaborative science and technology investment in this field.

The workshop generated a number of recommendations that, it is hoped, will translate into better targeted science and technology investments under both the Canadian and Canada/United States PSTP collaborations.

**The workshop provided the opportunity to exchange current knowledge and experience, and to further explore project collaborations.**

*– Alain Goudreau, PSTP Explosives Portfolio Manager*

## DRDC hosts Prospective Protective Futures Workshop

In March 2006, DRDC hosted the Prospective Protective Futures Workshop, a joint project of PSEPC and DRDC. The objective of the event was to generate foresight to feed into “Vision 2015” for the PSTP’s systems integration, standards and analysis mission area. “Vision 2015”

has three principal aims: to provide a perspective for the federal public safety and security community on possible future challenges to public safety and national security in the 2015 timeframe, to target national capabilities for meeting those projected challenges, and to seek out opportunities presented by science and technology to obtain the identified capabilities.

Over 60 experts from academia, industry, and all levels of government attended the workshop, where discussions were centered on four core questions: (1) What sort of world can we expect to see in terms of major global and societal technological trends and potential discontinuities? (2) What are the likely risks related to borders, infrastructure, and public security and safety? (3) What new or enhanced capabilities in emergency management and national security will be needed for mitigation, preparedness, response and recovery to reduce risks? and (4) How can current and foreseeable advances in science and technology help?

The results of this workshop will be used to drive the next phase of interdepartmental discussions of challenges to PSEPC, the capabilities needed to meet the challenges and the ways science and technology could be exploited to acquire those capabilities.

**By focussing on the technical challenges and strategies, and the anticipatory research and development and science and technology needs, the workshop aims to contribute to the establishment of a robust and resilient research and innovation strategy for national security.**

*– Anthony Ashley, Director General of DRDC Centre for Security Science*

### Demonstrating blast effects

To protect our society from the threat of explosives, it is crucial that we develop ways to prevent, prepare for and respond to this danger, regardless of whether it occurs as a result of terrorist or criminal activities, natural causes or an accident.

DRDC conducted a demonstration of the effects of a fuel-air cloud when detonated near a structure, in this case a sea container. The aim was to show the comparative effects of the detonation of the same quantity of fuel, first with an explosive charge applied against the reservoir, and second with the fuel explosively dispersed in a fuel-air cloud before initiation with a secondary explosive detonation. The effects experienced in the latter case were significantly greater. This demonstration served to inform discussions between the United States and Canadian experts in the areas of blast effects, mitigation, explosive detection and blast trauma. These discussions were meant to guide future Canada/United States PSTP science and technology investment in the area of explosives and blast effects.

## Counter Terrorism Technology Centre

The Counter Terrorism Technology Centre (CTTC) is Canada's centre of excellence for chemical, biological, radiological and nuclear (CBRN) training, testing and evaluation. Co-located with DRDC Suffield, the CTTC delivers live-agent training, testing and scientific advice to clients to enable them to conduct operations safely in a high-risk CBRN environment.

In the past year, the CTTC continued to grow in both capability and capacity. Major construction of facilities that support CTTC activities included the completion of the Indoor Training Arena and the continued progress on the Lecture Training Facility, which is near completion. The CTTC began construction of the last phase of the Bio-safety Forensic Lab, as well as new training complexes which will feature train, aircraft and cave simulations.

In a steadily increasing training and trial schedule, 1,478 students from 11 nations participated in 6,170 student training days. The training included the largest live-agent CBRN exercise ever conducted with the United Kingdom's CBRN Regiment. This unit, designated as the NATO CBRN Battalion for 2006, took part in a three-week exercise program during which 270 members were trained. The First Responder Training Program successfully completed five advanced-level courses as well as seven intermediate courses in Ottawa.



*Participants at a Counter Terrorism Technology Centre training exercise*



# Growing Our Capacity for Science and Technology

*DRDC makes concerted efforts to offer to clients and stakeholders the most cost-effective scientific and technological solutions to the challenges they face. One of the ways we do this is by collaborating with international and national organizations and partnering with the Department of National Defence and the Canadian Forces. Through particular areas of niche technology, DRDC is able to increase opportunities for research and development, build capacity to meet the needs of the Canadian Forces, and enhance public security.*



DRDC has unique expertise and facilities which attract external organizations and augment capacity to provide science and technology to the Canadian Forces and national security partners. This concept is exemplified in the recent launch of the *Human Sciences Hub™*. This hub of innovation facilitates partnering arrangements that enhance DRDC capacity by providing access to scientific and support personnel across a broad spectrum of human sciences disciplines: behavioural, physiological and biomedical scientists; ergonomists and human factors engineers; and life-support systems and medical specialists. The synergy of having such integrated human sciences expertise under one roof is unique nationally and internationally and has attracted collaboration initiatives from industry, other government departments, and academia.

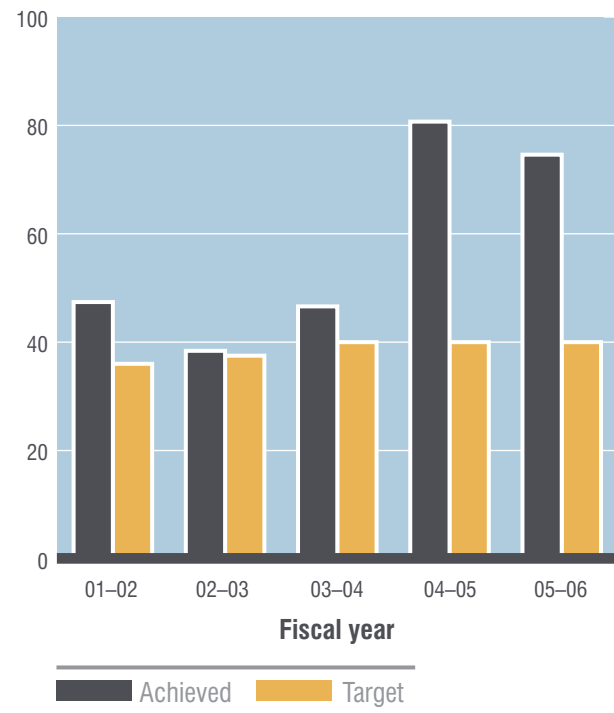
This chapter features examples of our successful collaborations, both national and international, and show how we augment our capacity for science and technology through investments from organizations external to DRDC and through our networking activities.

## Collaborating with Our Allies

DRDC engages in many collaborative activities with other nations. In this way we benefit from joint research, obtaining increased value by leveraging financial and human resources.

DRDC's goal is to leverage a value of about \$40 million each year through our international collaborations. We estimate the value of our collaborations based on the expected cost of acquiring similar value through research contracts. We approximate the value of our international collaboration in fiscal year 2005–2006 to be over \$70 million. The following chart shows a five-year history of the value of our leveraging from international collaborations.

Value of international leveraging (\$M)



Our collaborations are carried out with allied countries under a number of different international agreements, most notably The Technical Cooperation Program (TTCP) and the North Atlantic Treaty Organisation (NATO) Research and Technology Organisation (RTO). DRDC actively participates in all of the TTCP groups and NATO panels, which span the wide range of their research and technology activities. (For more information on these organizations, visit their web sites at [www.dtic.mil/ttcp](http://www.dtic.mil/ttcp) and [www.rta.nato.int](http://www.rta.nato.int).)

DRDC also participates in other international agreements, such as the Technology Research and Development Projects agreement and the Master Data Exchange Arrangement with the United States, the Memorandum of Understanding concerning cooperative science and technology with The Netherlands, and the Trilateral Technology Research and Development Projects agreement with the United States and the United Kingdom. These

agreements are of particular importance as they promote interoperability, facilitate collaboration, and help us obtain the most efficient and cost-effective results through cooperation in joint research activities.

The following stories demonstrate some of our collaborations with our allies.

### Cutting a wide swath

Last year saw the successful completion of the SWATHBUCKLER multinational experiment conducted to develop synthetic aperture radar technology capable of producing imagery in real time at an ultra-high resolution and across an extremely wide area.

The experiment was carried out under the auspices of TTCP Sensors Group. The U.S. Air Force Research Laboratory contributed to the initiative with their High-Performance

Computer and Joint Battlespace Infosphere information management system; the U.K. Defence Science and Technology Laboratory was responsible for the high-speed data capture and distribution processor; and DRDC's Radar Systems section provided the experimental radar test bed, the signal processing design and the test aircraft.

The flight tests demonstrated not only real-time image formation across a swath up to 40 kilometres wide, but also real-time exploitation and operational reachback from the ground. Data were quickly transmitted to system operators, creating images in a matter of seconds.

The concepts and technologies demonstrated during the SWATHBUCKLER experiment will be exploited to meet the future requirements of the Canadian Forces.



*The XWEAR radar is installed on the Convair 580 during the SWATHBUCKLER experiment*



## Training for coalition missions

Militaries of allied nations around the world are increasingly called upon to participate in coalition missions. These militaries not only fight in the same theatre; they must also coordinate their activities and rely on each others' capabilities. One of the challenges presented by coalition exercises is training. Since the nature of combat is becoming progressively more complex, better and more innovative training approaches are required.

Under the auspices of TTCP, DRDC collaborated in the Coalition Mission Training Research (CMTR) project, with the U.S. Air Force Research Laboratory and the U.K. Defence Science and Technology Laboratory. The purpose of CMTR was to determine the effectiveness of distributed mission training technologies in preparing warfighters for coalition tactics and procedures, and to explore new training strategies and novel uses of technology. The project examined behavioural and engineering issues related to wide-area, networked mission training, and the exercises linked the simulators of the three participating nations in real time.

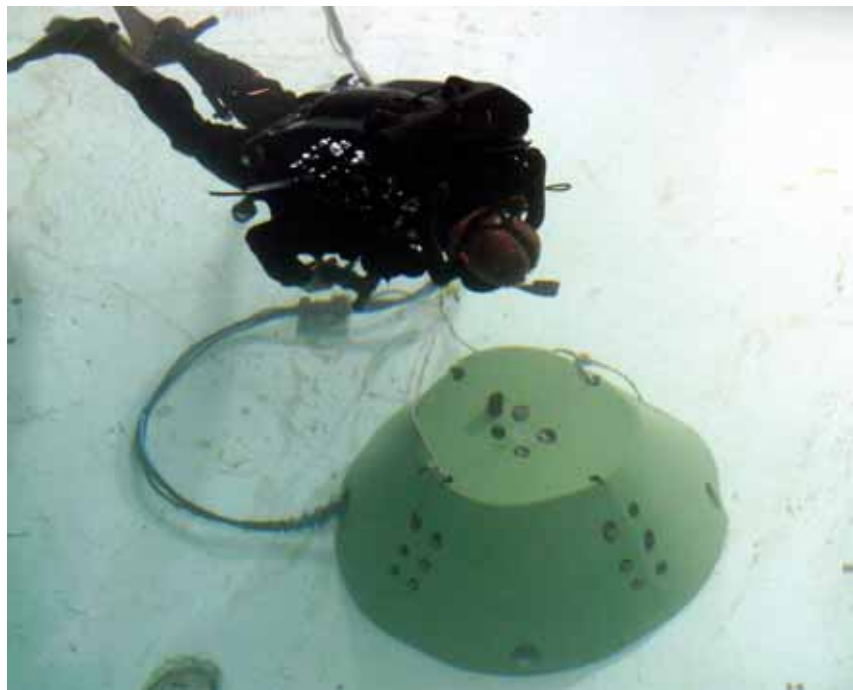
The partners in this collaboration developed and validated training strategies and technology for improving coalition training. The research produced guidelines for distributed mission operations and for mission training through distributed simulation, and demonstrated technologies that accomplish that training. CMTR showed that a significant amount of coalition training can be done through virtual and constructive means, affording better use of flight time in actual aircraft.

## Measuring divers' signatures

To clear mine fields, naval dive teams currently wear anti-acoustic and anti-magnetic clothing and life-support equipment. The main component of these systems is a

version of the Canadian Underwater Mine-Countermeasures Apparatus (CUMA). To assess the vulnerability of the CUMA and the procedures employed to approach and dispose of a modern sea mine, DRDC developed the Diver Signature Integrated Measurement System (DSIMS). DSIMS combines a user-friendly interface with real-time signature analysis and mine logic processing. Dive team leaders on the surface can see and hear how manoeuvres and kit configuration affect a diver's signature levels and also how a mine interprets these signatures. DSIMS's playback feature allows the diver to review the recorded operations.

NATO's DEEP DIVING Exercise 2005, hosted by the Canadian Forces Fleet Diving Unit (Atlantic), provided the opportunity to test DSIMS. As part of the exercise, dive teams from The Netherlands, Norway, Portugal, Finland and Sweden employed the DRDC saltwater tank to evaluate their mine-countermeasure life support equipment using DSIMS. During the trial, the DSIMS software interface demonstrated its ease of use and effective display of the signature data and mine logic.



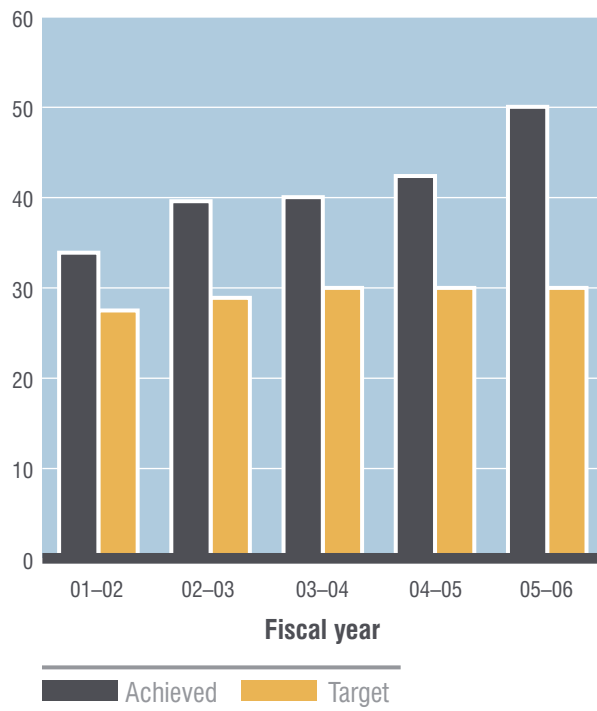
*Measuring a diver's signatures*

# Collaborating with National Organizations

DRDC collaborates with many Canadian organizations, including industry, academia and government, on joint projects. Leveraging the expertise and resources of our partners increases the rate of return on our investment and optimizes the funding we receive from the Department of National Defence.

The goal of DRDC is to leverage a value of \$30 million each year from national collaborations. We estimate that the value of our national leveraging in fiscal year 2005–2006 was approximately \$50 million. The following chart shows a five-year history of the value of our leveraging from national organizations.

Value of national leveraging (\$M)



The following stories are examples of our collaborations with national organizations.

## Surveillance of space at low cost

To illustrate that small space assets can perform militarily useful missions at a cost the Canadian Forces can afford, DRDC scientists worked with academic and industry partners to use a low-cost, world-leading Canadian Space Agency spacecraft to track other spacecraft. The Microvariability and Oscillations of Stars (MOST) microsatellite, designed to monitor low-level brightness variations from sun-like stars, houses a 15-centimetre optical telescope and costs less than \$12 million to design and build – a trivial sum by space standards. Microsatellites, being small in size and focussed in scope, use a mix of cutting-edge technology and commercial off-the-shelf components to deliver a useful capability.

DRDC scientists worked with the MOST science team, led by the University of British Columbia, and the MOST prime contractor and operator, Dynacon Incorporated, to image two



Preparing the Microvariability and Oscillations of Stars microsatellite for testing



global positioning system satellites streaking across a stellar background, and used these data to obtain information required to update the orbital parameters for these spacecraft. Similar information is used every day to contribute to the situational awareness of the space environment, a mission that Canada is sharing under the North American Aerospace Defense Command (NORAD). This experiment represented the first time that Canadians obtained this type of data from a space-based platform, and the first time that anyone in the world acquired it from such a small, low-cost satellite.

### Equipping the future soldier

A stellar example of collaboration between DRDC, allied forces, industry, the Department of National Defence and the Canadian Forces, the five-year old Soldier Information Requirements (SIREQ) project came to a close in 2006. SIREQ supported the Integrated Soldier System Platform (ISSP) project, the objective of which was to acquire and integrate the most promising and effective technologies for Canadian soldiers of the future.

SIREQ involved the collaboration of several DRDC research centres as well as key industrial partners. Close collaboration with army staff and field units was paramount to project success. Funding and logistical support from the Department of National Defence enabled SIREQ to conduct studies at organizational levels higher than before and with an elevated degree of realism. Hundreds of Canadian soldiers, from almost every regular force infantry battalion, participated in SIREQ as study subjects. Recognizing the unique user-centred human factors approach taken by SIREQ, allied soldier modernization programs collaborated by providing prototypic test equipment, field test facilities, scientific collaborators and trainers.

These allied programs included the Night Vision and Electronics Sensing Directorate of the U.S. Army; the Soldier Battle Lab and the Human Research and Engineering Directorate at Fort Benning; Australia's Defence Science and Technology Organisation; and the U.S. Marine Corps Systems Command, Marine Expeditionary Rifle Squad project.



*Soldier participating in a SIREQ field trial*



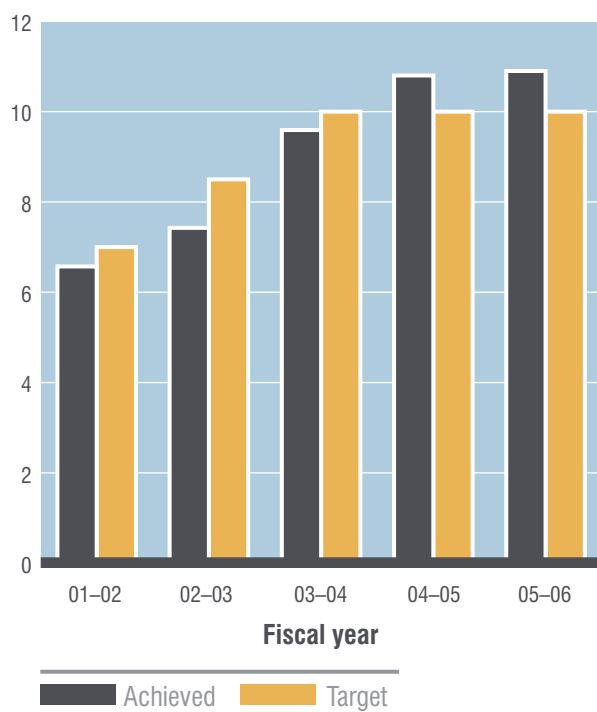
In addition to over 70 published reports, SIREQ developed and delivered detailed performance-based and empirically validated requirements and specifications to the ISSP project. SIREQ results have already been exploited in the near-term acquisition of intra-section communications and surveillance, in target acquisition, and in night observation equipment which is now in use by Canadian troops in Afghanistan.

## Investments from External Sources

We augment our scientific and technological capacity through the investments made in DRDC by external organizations. By taking advantage of our expertise in niche technology areas, DRDC is able to increase opportunities for research and development, build capacity to meet the needs of the Canadian Forces, and enhance public security.

DRDC's goal is to generate about \$10 million in investments each year from business development activities. This year, we were able to realize investments of \$10.9 million from external sources. The following chart shows the history of investments made in DRDC over the last five years.

Investments from external sources (\$M)



The following stories are examples of the investments in DRDC made by external organizations.

### Extending the service life of the ERYX

Assessing the service life of munitions is of prime importance to ensure the safety and effectiveness of military operations and to reduce overall costs during their life cycle. In this context, the Norwegian Defence Materiel Agency and the Department of National Defence asked DRDC to carry out a service life-extension program for the ERYX missile. This missile is a short-range multi-purpose and antitank system that is compact enough to be carried by soldiers. DRDC conducted chemical, mechanical and ballistic analyses in 2005 on the 11-year-old missiles. The overall results showed that the ERYX missiles would be chemically stable and able to function without a catastrophic failure due to aged propellant for at least another four years. DRDC therefore recommended that another series of analyses be performed before the



Canadian Forces members participate in tests on the ERYX missiles

missiles reach 15 years of age. Such a periodic assessment will help to determine future courses of action required to ensure the safety of personnel and the suitability of the missile for service. This work represented an investment of over \$250,000 by the Norwegian Defence Materiel Agency and the Department of National Defence.

## Testing vehicle restraint systems

DRDC possesses unique facilities and expertise in the domain of safety systems and human survivability. Transport Canada benefited from that expertise when it entered into an agreement with DRDC to conduct tests and evaluations on vehicle restraint systems for passenger cars. DRDC scientists used sophisticated anthropomorphic mannequins containing complex instrumentation to measure the acceleration forces to which various parts of the human body would be exposed in a real crash. We conducted the research in our high-impact facility, a unique instrumented facility used to simulate high-impact vehicle crashes. Transport Canada used the results of this work to evaluate the compliance of children's restraint systems with national standards. This project earned for DRDC an investment of \$185,000.

## Partnering with the Canadian Forces

DRDC's continuing relevance to the Canadian Forces depends on promoting close and effective relationships with the Forces as they transform and evolve. Aligning our activities with theirs helps strengthen these relationships, and results

in strategies and technological developments that serve their current and future needs. The following stories illustrate some of our successes in building these vital partnerships.

## Remote Minehunting System joins the Navy

In July 2005, DRDC signed a collaborative agreement to provide the Navy with the Remote Minehunting System (RMS) for use 20 days a year. The RMS is a remote-controlled, semi-submersible system that can detect and classify underwater mines in depths of 200 metres at survey speeds of up to five metres per second (10 knots).

This 20-day-per-year implementation phase will help the Navy gain practical experience in the tactical operation and technical support of the system. It will also add a remote minehunting capability to Navy operations prior to the formal acquisition of the system in 2010. Under the terms of the agreement, the Navy will provide funding to offset DRDC's incremental costs for providing the RMS. DRDC will contribute scientific and technical training and support to assure the successful operation of the system.

## Enhancing naval situational awareness

At present, the Navy's ability to predict the performance of its ships' sensors is limited to radio frequency systems using software and input data that are limited in scope. DRDC developed the Shipborne Integrated Environment System for Tactics and Awareness (SIESTA) as part of the Shipboard Integrated Sensors and Weapons Systems (SISWS) project. SIESTA was designed to make use of higher quality data from the ship's own systems as well as from Environment



*Infrared cameras on board the CFAV QUEST acquire images of small targets during the SISWS trial*



*Measuring the radar cross section of CFAV QUEST during the SISWS trial*

Canada to predict the performance of a ship's infrared and radio frequency sensors, and to estimate the ship's visibility to external infrared and radio frequency sensors.

SIESTA, a software and hardware package, was demonstrated on board the Canadian Forces Auxiliary Vessel (CFAV) QUEST. The

September 2005 trial involved the collaboration of the Naval Engineering Test Establishment, the Department of National Defence and Environment Canada's Meteorological Centre. The trial demonstrated that the system was able to acquire environmental data from sources on board the ship and from information supplied via internet by the Canadian Forces Weather Office. The system was also able to process these data and to provide sensor prediction and ship visibility prediction outputs for infrared bands and radio frequencies. To evaluate the accuracy of the SIESTA predictions, DRDC also collected an extensive set of infrared and radio frequency sensor measurements made from CFAV QUEST, as well as from sensors stationed at external points.

The results of this work are expected to provide the Navy with a system that ships can use to predict the performance of their own sensors, as well as the visibility of their ships at infrared and radio frequency wavelengths. This technology could have a profound effect on the ability of a ship's Captain or Fleet Commander to determine the standoff ranges that ships should maintain to allow for sufficient

time to react to any particular threat. The Fleet Commander could use this information to establish where to position forces, to make choices about tasking, and to decide when and where operations should be performed.



## Supporting Defence Experimentation

Defence experimentation is the application of scientific methods to the examination of concepts in order to solve complex problems faced by the military. The Canadian Forces Experimentation Centre (CFEC), as the centre of excellence for the exploration of emerging concepts at the joint operational level, employs a structured campaign of experimentation to investigate new military capabilities that support the transformation of the Canadian Forces. DRDC has two teams of defence scientists embedded within CFEC to provide expert advice on the design, conduct and evaluation of these experiments. The following stories highlight some of DRDC's contributions to defence experimentation.

### Effects-based approach to operations

CFEC is the lead organization in Canada for the series of multinational experiments sponsored jointly by the U.S. Joint Forces Command (JFCOM) and NATO Allied Command Transformation. The Multinational Experiment 4 (MNE 4), conducted in March 2006, was a major event aimed at assessing and refining processes, organization, and supporting technologies related to the emerging concept of Effects-Based Approach to Operations (EBAO). The experiment involved more than 800 military and civilian personnel

from Australia, Canada, Finland, France, Germany, Sweden, the United Kingdom and the United States, as well as from NATO.

DRDC scientists helped design and execute the experiment and engaged in concept development. DRDC also provided the lead controller and analyst for Canada, the overall lead for knowledge management, and a number of observers and data collectors. These individuals will also work with U.S. JFCOM and other multinational partners to analyze data collected during the experiment and make recommendations to its sponsors.

MNE 4 addressed issues relevant to the transformation of the Canadian Forces as well as the Government of Canada's "3-D" approach of integrating defence, diplomacy and development. EBAO represents a powerful advance in developing a comprehensive strategy that harmonizes military and civilian agency efforts towards stabilization and reconstruction in war-torn societies.



*DRDC scientist works with a Canadian Forces participant at the Multinational Experiment 4*

## A new method of crew selection

The first two major experiments sponsored by CFEC, the Pacific Littoral ISR Experiment (PLIX) in 2003 and the Atlantic Littoral ISR Experiment (ALIX) in 2004, studied the ability of unmanned aerial vehicles (UAVs) to enhance situational awareness with respect to intelligence, surveillance and reconnaissance (ISR). During these experiments the question was raised as to whether there might be a better way to select crews for new military systems.

In the summer of 2005, DRDC scientists at CFEC worked with the Department of National Defence to plan and conduct the Crew Selection Experiment which investigated a novel method for selecting crews for new defence systems, such as a UAV. The experiment made use of the DRDC UAV BattleLab, a synthetic environment used in UAV-related experiments. The hypothesis was that military personnel occupying positions that have more job elements in common with those predicted for the new system would perform better than personnel in positions with fewer job elements in common.

The results of the experiment indicated that participants performed fairly well regardless of the commonality of job elements. The data suggested that the participants had enough general skill and knowledge to perform the tasks and successfully complete the experimental mission. Nevertheless, this new crew selection method may form the basis of a viable alternative for selecting crews, particularly when job incumbents do not exist.

## Conducting better defence experiments

Under the auspices of The Technical Cooperation Program (TTCP), scientists from Australia, the United Kingdom and the United States, along with DRDC staff embedded with CFEC, collaborated to produce *TTCP Guide to Understanding and Implementing Defense Experimentation (GUIDEx)*. The document, which was published by CFEC, provides guidance to support successful defence experimentation and presents a number of principles for conducting such experimentation. The document is organized into three themes: Designing Valid Experiments, Integrated Analysis and Experimentation Campaigns, and Considerations for Successful Experiments.

*GUIDEx* also includes a flowchart for planning experiments and campaigns, a list of obstacles to good defence experimentation, and a number of case studies. In addition to the full *GUIDEx*, CFEC also published a pocketbook version, called the *Slim-Ex*, and a tri-fold brochure which highlights the essential elements of the guide.

TTCP *GUIDEx* provides practitioners of defence experimentation with strategic guidance based on the collective experience of a panel of international experts. The intention is to enhance the effectiveness of allied experimentation efforts, provide a common language to improve collaboration and, indirectly, accelerate the transformation of allied militaries.

## Networking

DRDC participated in a variety of corporate marketing events with the aim of increasing collaborative opportunities and enhancing our visibility with allies, industry and academia. These events provided a showcase where we could demonstrate our capabilities and make our research and development partners and the Canadian Forces more knowledgeable about the science and technology at their disposal. Following are some of the notable events of the past year.

- Sponsored by the Canadian Association of Defence and Security Industries (CADSI), CANSEC 2005 brought together defence and national security practitioners and their supporting industry counterparts. This annual event provides an excellent opportunity for DRDC to demonstrate its capabilities in both the defence and the national security arenas.
- In conjunction with CADSI, we presented the DRDC Technology Opportunities Day. The event focussed on “Working with Industry to meet Canada’s Critical Defence and Security Requirements” and included presentations that highlighted DRDC’s contributions to defence and provided an overview of potential opportunities for collaboration or for business development with industry.
- The Federal Partners in Technology Transfer Annual Conference & Workshop 2005 had for its theme “Identifying and Assessing the Opportunity.” DRDC was involved in the planning of the conference and participated in the panel session entitled “Inventor Expectations, Invention Disclosure and Moving Forward.”



*The DRDC Booth at CANSEC 2005*



- The International Paris Air Show at Le Bourget is the world's premier aerospace business event. The theme for 2005 featured the combined research, development, test and evaluation capability of the Department of National Defence and included the Aerospace Engineering Test Establishment (AETE). This capability across the science and technology spectrum attracted quite a bit of attention as it also included the civilian capabilities of National Research Council's Institute of Aerospace Research, as well as the capabilities of AETE and DRDC.
- The Defence Systems and Equipment International Exhibition, organized in association with the U.K. Ministry of Defence, is the largest tri-service defence exhibition in the world. Representatives from DRDC attended the event, at which a wide variety of military platforms and capabilities were displayed, spanning the land, sea and air services.

# Making Success Possible

*At DRDC, we recognize that our success relies not only on the quality and relevance of the science we conduct, but also on the excellence of our internal operations, the skills of our workforce, the effectiveness of our work environment and the maintenance of our facilities. We celebrate our success by recognizing our achievements. Our approach to our activities reflects our commitment to continuous improvement to achieve the best results possible.*



## Embarking on Expedition 07

Just as the Canadian Forces are advancing purposefully to establish an effective and relevant capability to address the security of Canada and Canadians, DRDC is moving ahead to ensure that science and technology, under our leadership, is a key contributor to Canadian Forces transformation and the broader public security needs of the nation.

To bring this about, DRDC initiated a two-year action plan entitled Expedition 07, which will build on our strong foundation and lay the groundwork for achieving our goals. The plan has outlined three strategic objectives: (1) to lead the development of the Defence Science and Technology Strategy and to position DRDC to respond to this strategy; (2) to solidify DRDC's role in support of public security; and (3) to strengthen the enablers of success, with a particular focus on the capacity of our management and corporate services.

DRDC has already made good progress in moving forward on these objectives. In 2005–2006 we obtained agreement in principle in two critical areas – from our Deputy Minister and the Chief of the Defence Staff to develop the Defence Science and Technology Strategy, and from our Deputy Minister and the Deputy Minister for Public Safety and Emergency Preparedness Canada (PSEPC) to become PSEPC's de facto science and technology arm through the creation of the DRDC Centre for Security Science.

## Enabling a Supportive Workplace

DRDC's success is fundamentally based on its skilled and professional people supported by state-of-the-art equipment and facilities. The investments we make in our employees – in providing them with valuable training opportunities, in creating a motivating environment and in maintaining a world-class infrastructure – all contribute to realizing our vision of being known worldwide as the best in science and technology for defence and security.

DRDC strives to support its people by developing new initiatives and building on government and departmental programs that enrich the work environment. The following stories demonstrate our efforts to create a supportive workplace.

### Building a bilingual workforce

In 2005, DRDC implemented an Official Languages strategy consisting of a second-language training program that continued to promote the development of a bilingual workforce.

DRDC encouraged all its centres to make a commitment to this initiative and various means were used to allow employees to gain access to second-language training. One such mechanism was a Memorandum of Understanding with the Department of Foreign Affairs' Centre for Language Training, permitting employees from the National Capital Region to receive various forms of second-language training. These included personalized and group training, "brown bag" sessions, and on-line training.



## Working towards employment equity

DRDC is a strong advocate of the Government of Canada's Employment Equity Policy. We strive to build a workforce that is reflective of the Canadian population and to create an environment that is respectful and inclusive of all designated group members. There are four designated employment equity groups: women, Aboriginal peoples, persons with disabilities and visible minorities. DRDC sets clear employment equity goals for its managers. Consultation sessions are made available to supervisors to ensure that they are appropriately trained to fulfill their employment equity responsibilities and to manage in a culturally sensitive and bias-free manner.

To meet our employment equity goals, DRDC ran various job competitions targeted to specific designated groups as potential candidates. Successful results enabled us to narrow existing gaps. In order to monitor the results of our activities, we continued to compile demographic statistics and put in place corrective measures where necessary. Please refer to Appendix 5 for further information on our employment equity representation.

## Implementing Human Resources Modernization

The new *Public Service Modernization Act* (PSMA) came into effect in April 2005 in all federal government departments and agencies. In order to manage the modernization of our human resources regime and to equip DRDC managers and employees with the knowledge they require to work within the new PSMA, we offered "train-the-trainer" sessions to our

human resources advisors so that they could provide intensive training sessions, particularly in staffing, to their clientele. Our labour relations expert also provided training sessions to employees across DRDC. These sessions included well-being issues such as a harassment-free environment.

The new *Public Service Employment Act* (PSEA) places significant emphasis on human resources planning to allow departments and agencies the flexibility to hire the right person for the right job at the right time. Of particular significance under the PSEA is the opening of civilian job postings to members of the Canadian Forces, resulting in pools of qualified civilian and military personnel from which future vacancies can be filled. In accordance with departmental direction, DRDC prepared a 2006–2007 Human Resources Plan, to enable managers to plan for both current and future organizational needs. Throughout this process, we engaged in active consultation with the Professional Institute of the Public Service of Canada, in adherence to the new *Public Service Labour Relations Act* which supports consultation with unions as an operating practice.

## Defining competencies for technology workers

In 2001, DRDC initiated the Competency and Career Management project to define the competencies required by our employees. After defining core competencies for all employees based upon our organization's values, we turned our efforts to determining the competencies for the four career streams: science, technology, management and corporate services.

The development of competencies for the technology stream was completed in 2005.

The Technology Stream Working Group (TSWG) accomplished its task in two phases. Phase I resulted in the development and validation of five career-stream competencies for members of the technology stream, which consists of employees within 12 occupational groups working in roles that directly support science. Phase II saw the development and validation of four technical/professional competencies for each of these occupational groups.

The TSWG was composed of representatives from each DRDC research centre, who participated in working group discussions and facilitated local advisory groups in soliciting feedback. The work of the TSWG, as well as that of the local advisory groups, was conducted in the spirit of co-development, with members of management and unions working together towards a common goal.

DRDC is now exploring options for career management of our workforce, enabled by the federal government's modernized human resources regime. The significant work accomplished by the TSWG in developing competencies will be considered as part of the continuing effort on career management.

### **Improving career management for defence scientists**

As part of the ongoing update of the Defence Scientist Salary Administration System, DRDC developed a new Performance Evaluation Report format, which involved consultation with senior management and union representatives. We introduced a common training package

throughout DRDC for the new Report format and published the *Defence Scientist Promotion and Salary Advancement Guidelines* to aid in managing career progression. A Questions and Answers web site supports these tools.

DRDC scientists and managers alike viewed the new documentation as a significant improvement and used it successfully to make decisions regarding the management of career progression during the 2005–2006 Defence Scientist Merit Review process. DRDC also conducted a Lessons Learned exercise to obtain feedback and identify any remaining features that could be improved.

### **Raising our standards to achieve excellence in publishing**

This year DRDC completed a new Publication Standard Toolbox, a valuable resource for authors that will significantly enhance the quality of their publications. To help DRDC and Canadian Forces scientists prepare their documents for publishing, the Toolbox provides them with a revised version of the *Publication Standard for Scientific and Technical Documents*, new and improved document preparation tools, guides for using the tools and a tip sheet.

The revised *Publication Standard for Scientific and Technical Documents* replaces the previous *Standard* which was introduced in 2000. In addition to detailing the formatting requirements for scientific and technical documents, the updated *Standard* provides authors with pertinent information on the publishing process, document categories, document security and protection of intellectual property. The Publication Standard Toolbox is scheduled for release in the spring of 2007.

## Strengthening communications

Over the past year, DRDC demonstrated a commitment to delivering timely, relevant and clear information regarding our new strategic direction and the way forward. We achieved this through regular updates on our progress by the Chief Executive Officer in our weekly newsletter, *Leo Online*, and through his annual tour of the DRDC research centres.

Every year, DRDC brings together all managers for a three-day workshop to foster an effective level of management engagement. At this year's event, managers explored ways to reinvent DRDC as an organization, increase our impact and respond to changes in our environment as we embark on Expedition 07. The workshop provided the opportunity for managers at all levels to discuss issues critical to the future direction of our organization, to share their opinions and perspectives, and to strengthen communications within, and the commitment of, the management team.

## Upgrading our intranet system

DRDC relies heavily on its intranet system, the DREnet, to conduct its business. Electronic mail and the World Wide Web have become just as important as telephones. DRDC must maintain the integrity of the DREnet to eliminate downtime, which results in loss of productivity, and to protect DRDC intellectual property against theft.

Over time the DREnet had moved away from its intended purpose as a research and development network and no longer served the best interest of the scientists. In the past year, DRDC undertook a major upgrade of the DREnet infrastructure, which has returned the network to the DRDC scientists.

We procured additional network firewall devices and deployed them at all DRDC centres. These devices segregated the research and development systems from corporate servers and workstations by creating several security zones. As a result, corporate systems continue to be afforded the usual levels of protection, while research and development systems are able to communicate in a relatively unobstructed fashion with other local systems as well as with those connected to the global Internet. An additional security zone for public servers now hosts DRDC site systems that provide public services accessible from the Internet. Furthermore, there are now "Sandbox" zones with web servers, portals and work areas where scientists outside the DREnet can collaborate on projects without causing security concerns. The new DREnet infrastructure provides DRDC with the needed protection for its corporate systems, while once again establishing the DREnet as the network of choice for conducting defence-related research.

## Renewing Our Infrastructure

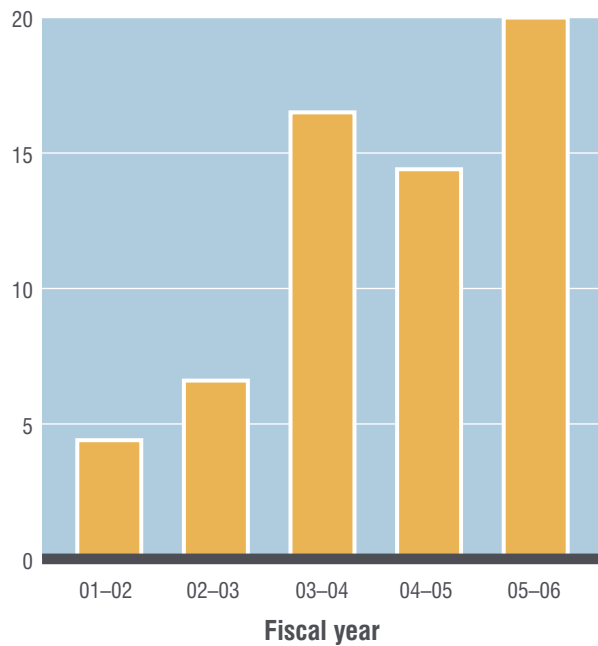
The renewal of our infrastructure continued to be a major focus for DRDC. This last year, DRDC established a record in terms of the funding we received for capital expenditures and for the work we accomplished. DRDC spent over \$20 million in a wide variety of projects. One of these was the modernization of the building systems within the main laboratory complex at DRDC Toronto, completing the first of four phases. We also delivered the first facility of a three-facility complex – an Indoor Training



Arena – to enhance the capability of the Counter Terrorism Technology Centre at DRDC Suffield. In addition, we made further improvements to the municipal systems in the Experimental Proving Grounds at DRDC Suffield. These enhancements included both the modernization of the electrical distribution system and the upgrading of the most used roads to Alberta rural road standards, making them both safer and easier to maintain.

The following chart shows our expenditures on capital construction over the last five fiscal years.

Capital construction expenditures (\$M)



## Protecting Our Environment

DRDC continued to forge ahead in its commitment to protecting the environment. In line with our environmental policy, founded on our mission, vision and values, DRDC has an ongoing, multi-year environmental program which funded over 40 projects in the past year, with expenditures over \$1.5 million. Examples of projects that are part of the environmental program range from the implementation of environmental management systems for individual research centres, to the development of a marine-mammal vocalization detection system that enhances existing mitigation efforts which are in place during oceanic acoustic research trials.

In addition, DRDC continued to support the remediation of sites contaminated by past research activities. We spent more than three-quarters of the budget allocated to the environment program on this effort. We placed particular emphasis on better understanding the nature of the contamination at several sites at DRDC Valcartier, which included monitoring the situation of the groundwater contaminated by trichloroethylene, and on preparing for a major remediation project in the Experimental Proving Grounds at DRDC Suffield where nine sites have been targeted. Finally, we advanced the cleaning of the last old disposal pits at DRDC Ottawa to a point that will allow this project to be considered for closure in the near future.

# Recognizing Our Achievements

Recognizing the achievements and successes of employees is an integral part of DRDC's organizational culture. We are committed to recognizing employees for the excellence of their work and will continue to demonstrate our appreciation of them. Exemplary qualities such as initiative, integrity, leadership, teamwork, dedication and perseverance are vital to our continuing success, and we proudly acknowledge these attributes when they are displayed by our personnel.

### TTCP awards

The Technical Cooperation Program (TTCP) is the most important defence collaboration program in which Canada participates. Each year, TTCP recognizes individuals who have made significant contributions to cooperative research activities as well as to enhancing the technological strength of military forces. This year, TTCP achievement awards were granted to nine scientists from DRDC:

**Mark Hazen, Jason Murphy, William A. Roger and Tania Wentzell**, for their work developing the infrastructure and experimentation process using virtual environments to explore command and control and information management issues in coalition network-centric maritime warfare;

**Stuart Grant and Lochlan Magee**, for their collaborative research that addressed the behavioural and technical issues necessary to perform effective training for coalition air operations using networked synthetic environments (**Jack Landolt, Don Turner and Robert Wolfe** were also recognized for their contribution to this research);

**Shawn Rhind and Pang Shek**, for their work in demonstrating the physiological, immunological and medical advantages of a hypertonic fluid resuscitation capability for casualty care; and

**Eugene Yee**, for the development, release and maintenance of the world's most comprehensive database on urban flow and dispersion processes.

### NATO awards

**Jean Dumas** received a NATO RTO Scientific Achievement Award as a member of the Joint SCI/SET/CDT Experiment and Symposium on Sensors and Sensor Denial by Camouflage, Concealment and Deception.

**LCdr Mario Boutin, Tim Hammond, Mark McIntyre and Lloyd Whitehorne** received a Certificate of Appreciation from the NATO Maritime Group 1 and from the Canadian Navy, for their rapid response to the request for operational support to HMCS ATHABASKAN as it prepared for a seven-month deployment as the flagship of the NATO fleet.

### International and national awards

**Maj Linda Bossi** received the 2005 Human Factors and Ergonomics Society Best Paper Award for the paper entitled "Ergonomics in Design."

**Patrick Brousseau** was awarded the prize for the Best Poster at the 36th International Annual Conference ICT (Institut Chemische Technologie) for his poster on Ultrathin Polymer Coating of Nanoparticles.

**Irina Goldenberg** received the Canadian Psychological Association Award of Academic Excellence for her doctoral thesis entitled "The Role of Emotional Intelligence, Attachment and Coping in Mediating the Effects of Childhood Maltreatment" for the 2004–2005 academic year.

**Stephen Murray** and **Kevin Williams** received medals from the United States Central Intelligence Agency for their contributions to the second round of the NORTHERN LIGHTS Trials. The purpose of the trials was to collect spectral information for detonation fireballs using ground-based and aerospace platforms.

**Michel Paul** received the William E. Collins Award from the Aerospace Human Factors Association for Outstanding Human Factors Publication of the Year for his article entitled "Motion-Sickness Medications for Aircrew: Impact on Psychomotor Performance," which he co-wrote with **Gary Gray** and **Mike McLellan**.

**Michel Paul** also received the 2006 Arnold D. Tuttle Award from the Aerospace Medical Association for his original research resulting in a significant contribution to aerospace medicine.

**Glen Selkirk** received the Graduate Student Research Award in Environmental Physiology from the American College of Sports Medicine.

**David Shaw** received the ORBITA Award for his report entitled *A Pilot Study of Sparing and Maintenance for the Air Defence Anti-Tank System*.

The **Canadian Centre for Mine Action Technologies** received an award from the Royal Thai Government's Ministry of Foreign Affairs for its work in mechanical mine-neutralization and lightweight personal protective equipment with the Thailand Mine Action Centre.

The **Radar and Space Technology Group** and the **Radar Systems Group** were recognized with the Best Paper Award at the 6th European Conference on Synthetic Aperture Radar in Dresden, Germany. The paper, entitled "Using Ambiguities to Aid in Moving Target Detection in PolSAR Images," was co-authored by **Chen Liu** and **Christoph Gierull**.

## Departmental awards

**Regan Reshke** received the 2005 Deputy Minister Commendation for his outstanding contribution as the Scientific Advisor to Army Capability Development. His superior technical expertise has been crucial in determining the impact of technological developments on the Army's capability development initiatives. His visionary work has brought much acclaim to the Department of National Defence and the Canadian Forces, and has demonstrated the benefits of science and technology to Army operations.

**Paul Chouinard** received the Vice Chief of the Defence Staff Commendation for his foundational work in the costing of capability-based planning which led to the development of the Department of National Defence's first ever integrated costing model.

**Pieter de Jong** and **Norman Corbett** received the 1 Canadian Air Division Commander's Commendation as part of the Strategic Plans Cell for their Outstanding rating during the NORAD Operation EVALUATION – 2005.

**Isabelle Julien** received the Deputy Commander NORAD Award of Excellence for her exceptional service to the Directorate of Analysis, NORAD-U.S. NORTHCOM from August 2002 to July 2005.

**David Shaw** received the Assistant Deputy Minister (Materiel) Command Commendation for designing and implementing complex algorithms for analysis of strategic airlift operations.

**Ahmed Ghanmi** and **David Shaw** were presented with the Assistant Deputy Minister (Materiel) Merit Award for their efforts in operational analysis.



**Sean Bourdon** and **Steve Guillouziec** received the Assistant Deputy Minister (Materiel) Merit Award for developing a statistical method to predict centre wing lifetime fatigue on the CC-130 *Hercules* aircraft.

The **DRDC Valcartier Communications Team** received the Public Affairs Award of Excellence for developing and delivering a winning public affairs strategy which highlighted the progress made by the Department of National Defence in innovation. Team members included **Jocelyne Audy, Dominique Blais, Mélanie Brousseau, Lise Ladouceur, Yannick Lirette, Jocelyn Tessier** and **Michel Vigneault**.

## DRDC organizational awards

The following employees received the 2006 DRDC Performance Excellence Award:

**Paul Chouinard**, for his commitment to the development of Canadian Forces capability-based planning, particularly the rapid development of a novel approach to costing and its attribution to capabilities;

**Pierre Meunier**, for successfully applying leading-edge technologies and new methods to the selection of aircrew and clothing for the Canadian Forces;

The **HMCS CHICOUTIMI Fire Investigation Team**, for its exemplary work in the examination of material evidence collected after the fire in support of the HMCS CHICOUTIMI Board of Inquiry. Team members included **Robert Armstrong** (retired), **Gary Fisher, Randall Haggett, John Hiltz, Irvin Keough, Dan Morehouse, John Power** and **Dwight Veinot**; and

The **MultiAgent Tactical Sentry (MATS) Team**, for the outstanding impact that its efforts have had on Canadian Forces nuclear, biological and chemical doctrine and operation through the creation of four complete MATS systems for the Forces. Team members included **Douglas Benson, Chris Brosinsky, Ron Eirich, Blaine Fairbrother, Henry Hudema, Steven Penzes, Doug Purdy** and **Dave Schmaltz**.

**Paul Desmier** received the Assistant Deputy Minister (Science and Technology) Commendation in recognition of his exceptional services to DRDC.

**Technopole Defence-Security, PÔLE Québec Chaudière-Appalaches** and **DRDC Valcartier** received the Assistant Deputy Minister (Science and Technology) Commendation for the outstanding success of the 2005 edition of Defence Security Innovation conference.

## DRDC research centre awards

**Greg Baker** received the DRDC Atlantic Stockhausen Award for his outstanding contribution of over 30 years to the development and field testing of sonar systems; for his ability to form effective teams and lead them in delivering capabilities, both in the lab and in the field; for his leadership in the local PSAC executive; and for his efforts to enrich the work environment through the organization of social events in Halifax and in foreign ports.

**John Bowen** received the DRDC Toronto Commendation for making DRDC Toronto a better place to work, through many years of outstanding service and dedicated leadership in social and recreational activities.

**Julie Choffe** received the DRDC Ottawa Performance Recognition Award, in recognition of her initiative in improving business in DRDC Ottawa Stores.

**Ed Emond** received the DRDC CORA Commendation for his work within the division in all its forms over the past 35 years.

**Claude Fortier** received the Exceptional Performance Award, in recognition of his contribution to the promotion of DRDC Valcartier values by the exceptional impact of his work on the Canadian Forces and international allies.

**Paul Harris** received the Exceptional Performance Award, in recognition of his contribution to the promotion of DRDC Valcartier values through his respected leadership and his exceptional scientific accomplishments for the Canadian Pulse Detonation Engine Program.

**Mike Hughes** received the DRDC Toronto Achievement Award for sustained dedication and outstanding creative technical support which enabled the recommissioning of DRDC Toronto's Human Centrifuge.

**Bumsoo Kim** received the DRDC Ottawa Leadership and Creative Management Award, in recognition of his leadership in the development and management of the JSMARTS II project.

**Conny Kluver** received the DRDC CORA Award for Excellence and Support for outstanding, consistent impact on, and contribution to, DRDC CORA objectives.

**Marc Lemoine** received the DRDC Ottawa Performance Recognition Award, in recognition of his support to the Technology Stream Working Group as part of the DRDC Competency and Career Management project.

**Chuck Livingstone** received the DRDC Ottawa Leadership and Creative Management Award, in recognition of the mentorship he provided to a large number of scientists and colleagues in various disciplines, and the resulting impact on countless projects.

**Phyllis Marinoff** received the DRDC CORA Leadership Award for the leadership she provided to DRDC CORA over the past year of change.

**Susan McIntyre** received the DRDC Corporate Office Outstanding Performance Award for establishing, growing and leading Knowledge Management within the CRTI and DRDC.

**Pang Shek** received the DRDC Toronto Leadership Award for providing a supportive and empowering work environment that enabled effective teamwork among science and technology workers in operational medicine and related disciplines.

**Alain Simard** received the Exceptional Performance Award, in recognition of his contribution to the promotion of DRDC Valcartier values through his proactive management of the electromagnetic team.

**Maj Donald Van Loon** received the DRDC Corporate Office Outstanding Performance Award for exceptional management of, and commitment to, complex and key defence medical countermeasure development projects.

**Joan Young** received the DRDC Corporate Office Outstanding Performance Award for her professionalism and commitment in developing and delivering the 2004–2005 Annual Report, representative of DRDC's excellence and values.

**Andrew Billyard** and **Debbie Blakeney** received the DRDC CORA Achievement Award for their support to the Chief of the Defence Staff Action Team 3 and the CATCAM model.

**Graham Fines** and **Mike Cowell** received the DRDC Ottawa Outstanding Contribution Award, in recognition of their efforts towards the development of the Radar Characterization Laboratory.

**Rachel Apps**, **Elizabeth McGoldrick** and **Michael Cowhey** received the DRDC Ottawa Outstanding Contribution Award, in recognition of their accomplishments in reorganizing the DRDC Ottawa Library.

**Jacques Bédard**, **Liette Boutot** and **Christian Ferland** received the Exceptional Performance Award, in recognition of their contribution to the promotion of DRDC Valcartier values through the development of the FERRET, a small-arms fire localization system.

**David DiFilippo**, **Hank Leong** and **Ryan Riddolls** received the DRDC Ottawa Performance Recognition Award for their support to the Canadian Navy in the High Frequency Surface Wave Radar program.

**Andrew Billyard**, **Neil Carson**, **Michael Crawford** and **Paul Saunders** received the DRDC CORA Teamwork Award for their team efforts on maritime force protection.

**Jocelyne Audy**, **Dominique Blais**, **Mélanie Brousseau**, **Geneviève Duchesne**, **Ginette Champagne**, **Lise Ladouceur**, **Jocelyn Tessier** and **Michel Vigneault** received the Exceptional Performance Award, in recognition of their contribution to the promotion of DRDC Valcartier values through their organization of the DRDC Valcartier 60th anniversary activities which contributed to the outreach of the organization and rallied all staff.

**Éric Bergeron**, **Marc Brassard**, **Michel Côté**, **Rocco Farinaccio**, **Hélène Gagnon**, **Thérèse Gamache**, **Paul Harris**, **Jean-Guy Hervieux**, **Michel Kervarec**, **Marc Légaré**, **Daniel Lemieux**, **Louis-Simon Lussier**, **Robert Stowe**, **Sylvie Villeneuve**, **Christian Watters** and **Frank Wong** received the Exceptional Performance Award, in recognition of their contribution to the promotion of DRDC Valcartier values by facilitating the surveillance and increasing the life cycle of munitions of the Canadian Forces.

**Patrick Bafaro**, **Tony Belleau**, **Alain Cinq-Mars**, **Guy-Philippe D'Amours**, **Daniel Desharnais**, **Pascal Duchesne**, **Pierre Garon**, **Mario Gauvin**, **Pierre Giroux**, **Sylvain Gros-Louis**, **André Houde**, **Alain Jacques**, **Jocelyn Lecours**, **Daniel Lemieux**, **André Maheux**, **Roch Malouin**, **René Martel**, **Georges Ménard**, **Pierre Morin**, **Pierre Ouellet**, **Bruno Paradis**, **Pierre Paradis**, **André Roussel**, **Gilles Sévigny**, **Nelson Viel** and **Benoît Villeneuve** received the Exceptional Performance Award, in recognition of their contribution to the promotion of DRDC Valcartier values by the excellence and the efficiency of their services which contributed to the growth of productivity in research and development and in business collaboration.

**Robert Bélanger**, **Guy Bergeron**, **Gilles Bérubé**, **Marco Boivin**, **Louis Bourret**, **Marc Châteauneuf**, **Alain Cinq-Mars**, **Michel Côté**, **Rémi Coulombe**, **France Da Via**, **Jacques Dubois**, **Richard Durand**, **Rocco Farinaccio**, **Jean Fortin**, **Éric Fournier**, **Nicolas Hamel**, **Paul Harris**, **Jean-Guy Hervieux**, **Marcellin Jean**, **Capt Pierre Lafrance**, **Marc Lauzon**, **Denis Leclerc**, **Marc Légaré**, **François Lesage**, **Pierre Lessard**, **Richard Lestage**, **André Maheux**, **Dennis Nandlall**, **Bruno Paradis**, **André Roussel**, **Robert Stowe**, **Jocelyn Tessier**,



**Christian Watters** and **Frank Wong** received the Exceptional Performance Award, in recognition of their contribution to the promotion of DRDC Valcartier values through their participation in the HEMi project which developed technologies necessary for the accomplishment of an antitank missile evolving in a hypersonic regime.

The **Canadian Defence Information System (CANDIS) Team** received the DRDC Corporate Office Outstanding Performance Award for its dedication to developing and continually improving CANDIS, an invaluable archive and research tool for Canadian defence science. Team members included **Terry Campbell**, **Diana Kuseler** (retired), **Carole Laporte**, **Mariam Rauf** and **Jim Russell**. Contractors **Dennis Guertin** and **Bill Page** received a Special Mention for their contribution to the team effort.

The **Information Technology (IT) Team** received the DRDC Ottawa Outstanding Contribution Award, in recognition of its efforts in a large number of IT initiatives and upgrades. Team members included **Jeff Fulford**, **Christine Gardner**, **Mark Gyuraszi**, **Hans Lefebvre**, **Marc Lemoine**, **Claude Marinier**, **Jim Shore** and **Michelle Thompson**.

The **SAX04 Trial Team** received the DRDC Atlantic Teamwork Award for its contribution to the success of the SAX04 sea trial, undertaken to take a difficult measurement of sediment sound speed as a function of frequency, which was organized under exceedingly tight time constraints and was accomplished primarily because of effective collaboration, dedicated effort and expert contribution by all participants. Team members included **Mac Bailey**, **Marg Burton**, **Doug Caldwell**, **David Chapman**, **John Giffin**, **Daniel Graham**, **Paul Hines**, **Linda Kenney**, **Mel MacKenzie**, **Martin O'Connor**, **John Osler**, **Jeff Scrutton** and **Paul Shouldice**.

The **Aerospace, Facilities Engineering Services, Human Performance and Protection, Materiel Management Services** and **Medical groups** received the DRDC Toronto Organizational Achievement of the Year Award, in recognition of their combined contributions to the recommissioning of the Human Centrifuge.

# Financial Statement

This table summarizes the funds DRDC received and expended in fiscal year 2005–2006 to carry out its program. The values shown are in thousands of dollars, with negative variances shown in parentheses.

Fund Type	Revenues (\$000)	Expenditures (\$000)	Variance (\$000)
Salary and Wages	94,852	102,186	(7,334)
Operations and Maintenance	39,288	39,992	(704)
R&D Contracting	92,987	90,964	2,023
Capital – R&D Equipment, Construction	10,991	13,261	(2,270)
Environment	3,161	1,488	1,673
CCMAT – Salary & Wages, Operations & Maintenance	2,911	2,399	512
CRTI – Salary & Wages, Operations & Maintenance, R&D Contracting	27,297	29,158	(1,861)
CRTI – Capital Equipment	3,000	2,501	499
CTTC – Capital	7,000	5,300	1,700
Local Revenues & Intellectual Property	4,567	–	4,567
Revenues from Collaborative Agreements	6,164	4,115	2,049
Transfers from Other Government Departments	1,712	1,712	–
<b>Total</b>	<b>293,930</b>	<b>293,076</b>	<b>854</b>

## Notes:

- The difference between the Revenues and the Expenditures for 2005–2006 is due to the following:
  - Salary and wage costs were higher than anticipated due to allowances, bonuses and salary increases paid to certain employment groups.
  - Capital research and development requirements were higher than anticipated.
- Additional expenditures of \$11.3 million for capital construction were funded by sources other than DRDC's budget allocation.
- CCMAT is the Canadian Centre for Mine Action Technologies.
- CRTI is the Chemical, Biological, Radiological and Nuclear (CBRN) Research and Technology Initiative.
- CTTC is the Counter Terrorism Technology Centre.

# Appendices and Tables





# Appendix 1

## Defence R&D centres

Defence R&D Canada (DRDC) is made up of seven research centres – each with a unique combination of expertise and facilities to carry out world-class research and development – in addition to a programs centre and a corporate services centre.

### Defence R&D Canada – Atlantic

DRDC Atlantic has world-leading expertise in antisubmarine warfare, mine and torpedo defence, air and naval platform technology, maritime information systems, emerging materials and signature management.

### Defence R&D Canada – Valcartier

DRDC Valcartier is our main facility for combat, optronics and information systems. The centre is renowned for its leading-edge work performed through many bilateral and multilateral alliances and under NATO agreements.

### Defence R&D Canada – Ottawa

DRDC Ottawa is our lead authority and centre of expertise for radio frequency communications, sensing and electronic warfare; space systems; network information operations; synthetic environments and radiological defence.

### Defence R&D Canada – Toronto

DRDC Toronto is Canada's centre of excellence for human effectiveness science and technology in the defence and national security environment. Using a systems-based approach, the centre covers all aspects of human performance and effectiveness, including individual and team performance, human-machine interaction and the influence of culture on operational effectiveness. DRDC Toronto also supports the operational needs of the Canadian Forces through research, advice, test and evaluation, and training in the undersea and aerospace environments.

### Defence R&D Canada – Suffield

DRDC Suffield is one of Canada's main defence science and technology assets and has long been active in the development of effective defensive countermeasures against the threat of chemical and biological weapons. DRDC Suffield also has important programs of work in military engineering, mobility systems and weapons system evaluation. The Canadian Centre for Mine Action Technologies and the Counter Terrorism Technology Centre are co-located with and supported by DRDC Suffield.

### **Defence R&D Canada – Centre for Operational Research and Analysis (CORA)**

DRDC CORA provides expert, objective and timely operational research, analytical support and advice to the Canadian Forces and the Department of National Defence. The effort supports force development, resource allocation, acquisition, improved operational effectiveness and efficiency, strategic analysis, scientific and technical intelligence, and the achievement of departmental policy and human resource goals.

### **Defence R&D Canada – Centre for Security Science (CSS)**

DRDC CSS provides support to the department of Public Safety and Emergency Preparedness Canada, and contributes to and supports the capability needs of the Canadian Forces in the area of public security. DRDC CSS also manages the Chemical, Biological, Radiological and Nuclear Research and Technology Initiative and the Public Security Technical Program.

### **Defence R&D Canada – Programs**

DRDC Programs provides central coordination and strategic planning for our science and technology programs through interfaces with our client groups in the Canadian Forces and with external partners.

### **Defence R&D Canada – Corporate Services**

DRDC Corporate Services provides functional direction and central management of our corporate services and acts as an interface between DRDC, the Department of National Defence and the Government of Canada.

# Appendix 2

## Defence R&D Canada's Science and Technology Program

DRDC focusses its science and technology activities in areas of critical importance to future Canadian Forces operations. Our key objective is to ensure that the Forces are technologically prepared for operating in a defence environment that will see increased emphasis on interoperability with allies, technology-driven warfare and new asymmetric threats.

Our Science and Technology Program is comprised of our Research and Development Program and the provision of scientific analysis and advice to the Canadian Forces and the Department of National Defence. The Research and Development Program is developed in consultation with our client groups in the following areas: Maritime; Land; Air; Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance and Human Performance.

The Science and Technology Program is delivered through *thrusts* – packages of scientific and technical activities. Each thrust addresses a broad spectrum of issues and involves a team of our staff working with external partners, including academia, industry and allies. In fiscal year 2005–2006, the total value of our Science and Technology Program was approximately \$309 million. This figure includes internal costs, such as salaries and overhead, research and development contracts, and external and in-kind contributions. Please refer to the tables at the end of this report for additional details on our Science and Technology Program.

### Maritime

The Maritime research and development program is arranged in five thrusts: Maritime Integrated Above-Water Warfare;

Maritime Command and Control; Maritime Underwater Warfare; Naval Platform Technology; and Maritime Intelligence, Surveillance and Reconnaissance.

### Land

The Land Force research and development program is organized along five thrusts: Command, Sense, Act, Shield and Sustain. These thrusts parallel the Army's operational functions.

### Air

The Air Force research and development program is delivered through five thrusts: Air Force Command, Control, Intelligence, Surveillance and Reconnaissance; Air Force Protection and Projection; Air Vehicle Systems; The Human in Air Systems and Air Mission Systems.

### Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)

The C4ISR research and development program comprises four thrusts: Command and Control / Information and Intelligence, Information Operations, Military Information Technology Infrastructure, and Space Systems and Technology for Defence Applications.

### Human Performance

The Human Performance research and development program is packaged into five thrusts: Simulator Training Technologies; Military Operational Medicine; Diving and Underwater Intervention; Human Factors in Military Systems; and Defence against Chemical, Biological and Radiological Hazards.



## Providing scientific analysis and advice

DRDC provides strategic and operational advice to the Canadian Forces and the Department of National Defence on products and services related to science and technology. These activities are arranged in four thrusts: Technology Outlook, Scientific and Technical Intelligence Support and Advice, Science and Technology Services for Operations, and Operational Research.

The Research and Development Program is delivered via two interconnected mechanisms: the Applied Research Program and the Technology Demonstration Program. In addition to these, there are two programs designed to fund smaller projects: the Technology Investment Fund provides funding to DRDC scientists and the Defence Industrial Research Program supports partnerships with Canadian industry. Projects in all four programs span the range of the Maritime, Land, Air, C4ISR and Human Performance client groups.

### Applied Research Program

The Applied Research Program is designed to advance the knowledge base of defence science, investigate novel and emerging technologies, and explore the military application of those technologies.

### Technology Demonstration Program

The Technology Demonstration Program (TDP) is designed to meet the challenges of developing new defence capability in the face of rapidly changing missions. Its objective is to demonstrate new technologies within the context of future capabilities, concepts, doctrine, operations

and equipment for the Canadian Forces. The TDP is typically aimed at concept development and evaluation, with projects spanning three to four years in duration.

### Technology Investment Fund

The Technology Investment Fund (TIF) supports forward-looking, high-risk – but potentially high-payoff – research projects likely to have a significant impact on military applications. External reviewers from universities and other research organizations assess each proposal based on scientific merit, technical methodology, team capability and novelty. Proposals are also evaluated for potential military impact.

Typical projects are three years in duration, with a total contract budget of up to \$750,000. The results of successful TIF projects are subsequently absorbed into our Applied Research Program, thereby ensuring effective impact and uptake of ground-breaking research.

### Defence Industrial Research Program

The Defence Industrial Research Program strengthens and supports the Canadian defence industrial base through the provision of financial and scientific support for eligible industry-initiated research projects relevant to the defence of Canada and/or its allies. The objective is to stimulate research and innovation to enhance Canada's ability to share in the development of technologies to meet Canadian, NATO and other allied defence requirements.

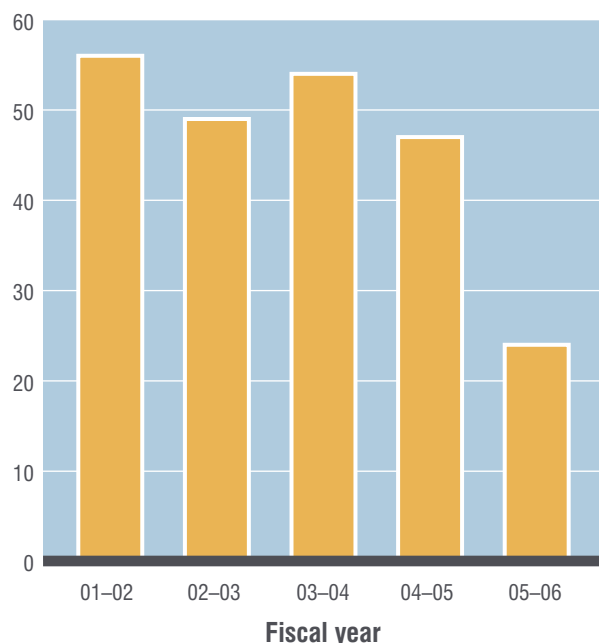
## Appendix 3

### Intellectual property

DRDC manages its intellectual property (IP) through patents, copyrights, trademarks and licences. Over the course of the year, we were granted 10 patents and filed 15 new patents.

The following chart shows a five-year history of our patent activities. The figures indicate a declining trend in the number of patents filed and granted. This decline is the result of a change in the philosophy of managing DRDC's IP assets which has occurred over the past several years. Due to the high cost of legally protecting IP, DRDC has instituted a more business-like approach in deciding if we should formally protect the IP we generate. When we make a decision to protect the IP, patents are typically taken only in Canada and the United States rather than in multiple countries. This has precipitated a continual decline in the number of patents applied for and received over the last several years. It must be noted that only the level of patent activity has declined, not the inventiveness of the organization.

Number of patents filed and issued



In addition, we issued four licences to Canadian companies for the commercial exploitation of our technologies, as follows:

- MacDonald Dettwiler & Associates Limited, for the FERRET Acoustic Small-arms Fire Localization System;
- FTC Enterprises Limited, for Sonication Technology;
- Bureau Veritas S.A. for VSHIP Data Processing Software; and
- Ultra Electronics Maritime Systems, for MAVART.

We received \$1.1 million in royalties; of this amount \$116,000 went to our inventors.

The following patents were granted during fiscal year 2005–2006:

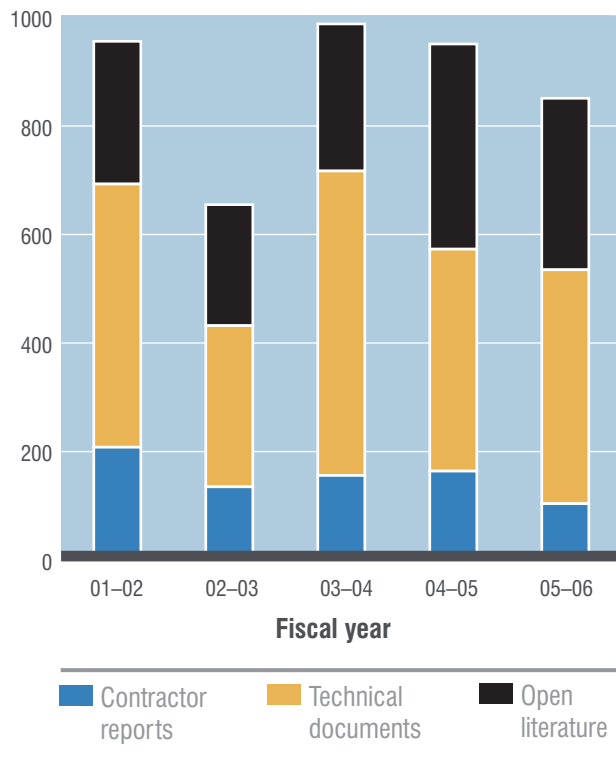
- Process for Preparing Carbon Nanotubes
- Method and Device for Correction of Organ Motion Artifacts in MRI Systems
- Polysaccharide Vaccine to Enhance Immunity Against Brucellosis
- Combination Vaccine for Enhancing Immunity Against Brucellosis (Australia)
- Fourier Transform Spectrometer Configuration Optimized for Self Emission Suppression and Simplified Radiometric Calibration
- LPI Digital Receiver
- Insensitive Melt Cast Explosive Compositions Containing Energetic Thermoplastic Elastomers
- Sun Optical Limitation Illumination Detector
- Combination Vaccine for Enhancing Immunity Against Brucellosis (Germany)
- Portable Low Frequency Projector

# Appendix 4

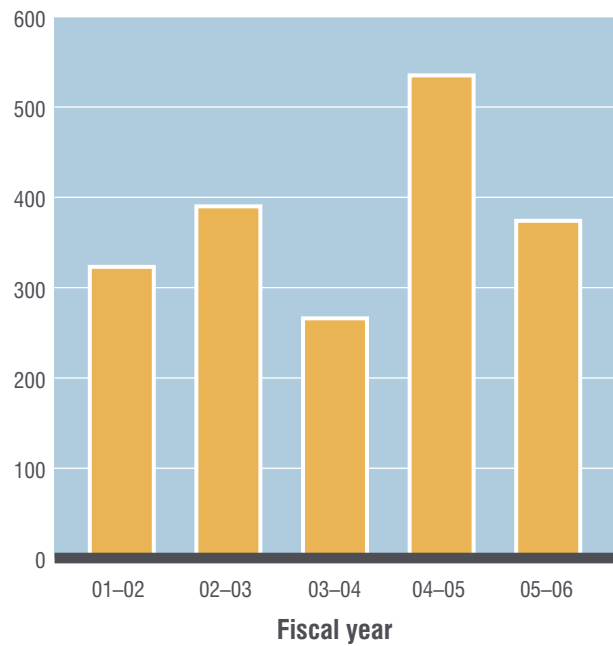
## Publications and conference presentations

By promoting the results of our research and development activities, either through publication or conference presentation, DRDC transfers knowledge to clients in the Canadian Forces and the Department of National Defence, and to colleagues in industry, academia and government. This dissemination is a means of demonstrating our expertise and increasing awareness of our organization. The following charts show histories of our publication and presentation activities over the last five years.

Number of publications



Number of conference presentations





# Appendix 5

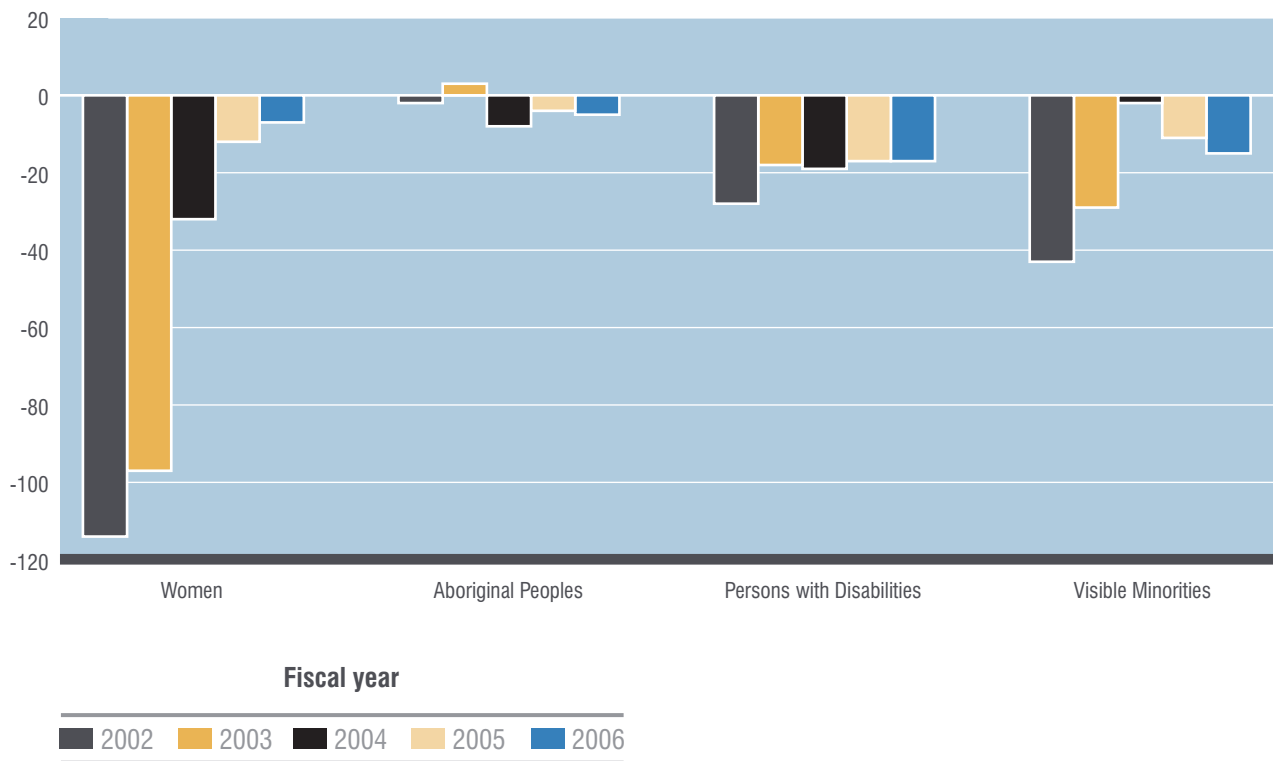
## Employment equity representation

The following chart demonstrates the progress DRDC has made over the past five years towards achieving a representative workforce. The chart shows the gap between the number of DRDC employees by designated group and the number of employees one would expect to see if representation matched the external workforce availability. This availability is established by the Treasury Board of Canada Secretariat and takes into consideration occupational qualifications, eligibility and the geographic recruitment area.

The external workforce availability for the years 2002 to 2004 were based on the 1996 Census. The figures for 2005 and 2006 were based on the 2001 Census which showed an increased number of visible minorities in the workplace

In the past few years, DRDC has placed great emphasis on increasing its representation of women, progressing from a shortfall of 114 employees in 2002 to seven in 2006. Our efforts continue to have good results and we are now turning our attention to increasing representation in the other designated groups, particularly visible minorities.

Employment equity representation by designated group



# Table 1

## Value of DRDC S&T Program<sup>1</sup> by client group

Client Group	Internal Costs <sup>2</sup> (\$000)	R&D Contracts (\$000)	External Contributions <sup>3</sup> (\$000)	Total Value (\$000)
Maritime	24,543	18,184	10,996	53,723
Land	25,396	23,100	15,132	63,629
Air	10,822	15,300	10,513	36,635
Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance	23,773	15,789	17,774	57,337
Human Performance	16,336	17,240	12,948	46,524
<b>Sub-total R&amp;D Program</b>	<b>100,870</b>	<b>89,614</b>	<b>67,363</b>	<b>257,847</b>
Provide Scientific Analysis and Advice	41,836	3,864	5,765	51,465
<b>Total S&amp;T Program</b>	<b>142,706</b>	<b>93,478</b>	<b>73,128</b>	<b>309,312</b>

<sup>1</sup> The S&T Program includes the R&D Program and the provision of scientific analysis and advice. The R&D Program includes the Applied Research Program, the Technology Demonstration Program, the Technology Investment Fund and the Defence Industrial Research Program. For more information on these programs, please refer to Appendix 2.

<sup>2</sup> Internal costs include salary and wages, overhead, and operations and maintenance.

<sup>3</sup> External contributions include cash and in-kind contributions from sources external to DRDC.

## Table 2

### Value of DRDC S&T Program by Canadian Forces capability

Capability	Strategic <sup>1</sup> (\$000)	Operational <sup>2</sup> (\$000)	Tactical <sup>3</sup> (\$000)	Total Value (\$000)
Command and Control	5,629	32,749	16,754	55,132
Information and Intelligence	24,240	18,821	17,610	60,670
Operations: Conduct	1,823	42,658	30,688	75,169
Operations: Mobility	–	–	–	–
Operations: Protect	–	24,622	31,351	55,974
Sustain	2,870	21,618	902	25,390
Generate	21,479	8,759	4,492	34,730
Corporate	2,247	–	–	2,247
<b>Total S&amp;T Program</b>	<b>58,288</b>	<b>149,226</b>	<b>101,798</b>	<b>309,312</b>

<sup>1</sup> Strategic capabilities are those concerned with determining the strategic objectives and the desired end state of the military, outlining military action needed, allocating resources, and applying constraints directed by political leaders.

<sup>2</sup> Operational capabilities are concerned with the carrying out of service, training or administrative military missions and the process of carrying out combat and non-combat military actions.

<sup>3</sup> Tactical capabilities are those concerned with planning and directing military resources in battles, engagements and/or activities within a sequence of major operations to achieve operational objectives. These capabilities focus mainly on combat operations, but the same logic is applicable to military operations other than combat.



## Table 3

### Value of DRDC S&T Program by time horizon

Client Group	Time Horizon I <sup>1</sup> (\$000)	Time Horizon II <sup>2</sup> (\$000)	Time Horizon III <sup>3</sup> (\$000)	Total Value (\$000)
Maritime	15,531	23,270	14,922	53,723
Land	17,696	25,002	20,931	63,629
Air	12,851	14,485	9,298	36,635
Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance	14,490	25,764	17,083	57,337
Human Performance	9,702	22,259	14,563	46,524
<b>Sub-total R&amp;D Program</b>	<b>70,270</b>	<b>110,780</b>	<b>76,797</b>	<b>257,847</b>
Provide Scientific Analysis and Advice	36,443	9,849	5,174	51,465
<b>Total S&amp;T Program</b>	<b>106,713</b>	<b>120,629</b>	<b>81,971</b>	<b>309,312</b>

<sup>1</sup> Time Horizon I refers to the enhancement and maintenance of current capabilities and includes projects that are expected to be completed within one to five years.

<sup>2</sup> Time Horizon II refers to the replacement of current capabilities and includes projects expected to come to fruition within five to 10 years.

<sup>3</sup> Time Horizon III refers to the acquisition of new capabilities and includes projects that extend ten years and beyond.

# Contact Information

DRDC publishes this report annually to describe its operations for the previous fiscal year, and includes information about DRDC's performance and any other information that the Deputy Minister of National Defence may require to be included.

Reports like this one should meet audience expectations. Our goal is to ensure that this report can readily serve as a quick and easy reference, personal or professional, to keep readers up to date on what DRDC and, by extension, Canada is doing in the area of science and technology for defence and security. We invite you to get in touch with us should you have any suggestions or questions.

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Art Direction ADM(PA) DPAPS CS06-0186

ISBN D1-19/2006  
0-662-49618-3