Defence Research and Development Canada | Recherche et développement pour la défense Canada

DEFENCE R&D DÉFENSE

Annual Report for the year ending 31 March 2008

Shaping Defence and Security Capabilities Through Science and Technology

Canada

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Message From the Chief Executive Officer

As the scope and complexity of security challenges facing Canada and Canadians continue to grow, it has become imperative that Canada have a tightly coupled security and defence agenda. The Government of Canada, the Department of National Defence and the Canadian Forces are working to shape common defence and security capabilities. Among these actions is the transformation of the Canadian Forces to ensure operational success in the new defence and security context, and the most important reorganization of the Canadian military command and control structure in several decades.

The shared needs and interests of the defence and security agenda benefit from a combined approach to providing scientific and technological solutions. Defence R&D Canada (DRDC) plays a key role in shaping defence and public security capabilities through science and technology. We deliver knowledge and technologies to enable defence and security operations, both at home and abroad. We anticipate and advise on future and emerging risks and potential solutions, thus influencing decision making and providing options for future capabilities. And we are working to position science and technology as a strategic enabler for the federal defence and security agenda.

To increase the return on our investment, DRDC relies on the international science and technology base and on national providers outside the Department of National Defence and the Canadian Forces. These collaborative activities open the window to global scientific and technological advancements critical to defence and security. Leveraging the expertise and resources of our allies, other government departments, and of our partners in industry and academia augments our capabilities in areas where other sources are more economical, offers alternative solutions, avoids duplication of effort and provides surge capacity when needed.

None of DRDC's achievements would be possible without the dedication and commitment of our employees. Their unrelenting perseverance and drive propel our organization towards new discoveries and developments that ultimately enhance the capabilities of the Canadian Forces and provide for the safety and security of Canadians.

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 that enable it 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.

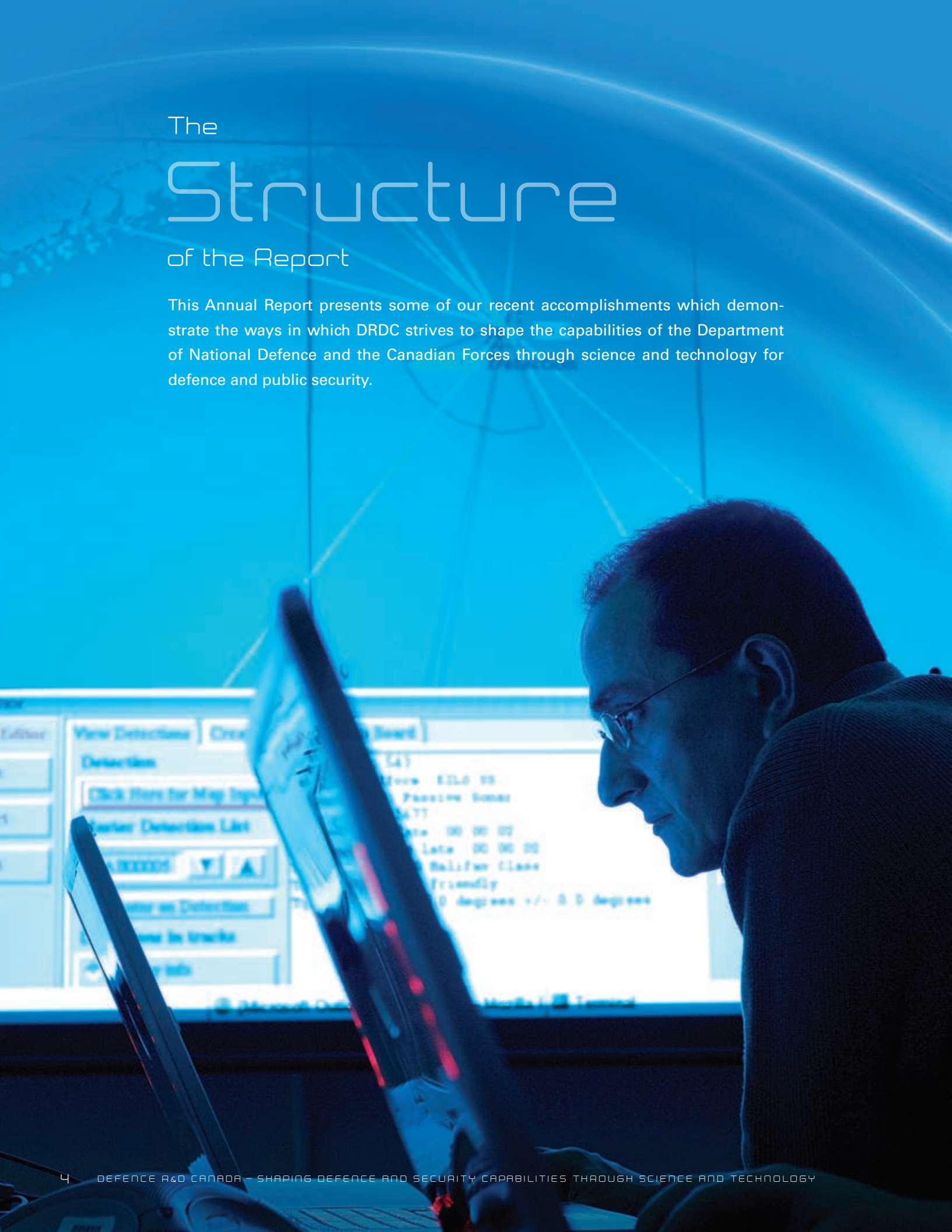
Our Values

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

This Annual Report presents some of our recent accomplishments which demonstrate the ways in which DRDC strives to shape the capabilities of the Department of National Defence and the Canadian Forces through science and technology for defence and public security.



- The chapter entitled "Increasing Defence Capabilities Through S&T" describes the role played by science and technology in developing new solutions to the challenges faced by the Department of National Defence and the Canadian Forces.
- "Support to Current Canadian Forces Operations" highlights those of our activities that support the Canadian Forces in their operations at home and abroad.
- "Strengthening Canadian Public Security Capabilities" outlines some of our efforts to improve capabilities in the public security and safety arena.
- "Partnering for Increased S&T Capacity" describes the augmentation of our scientific and technological capabilities through international and national collaboration and the engagement of our partners and stakeholders.
- "Enhancing Capacity Through a Strong Foundation" 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 2007–2008, and the "Appendices and Tables," which provide additional information about our operations, our research centres and our program.

A Canadian Forces avionics technician carries out a before flight check on a CC-177 *Globemaster*

Increasing Defence Capabilities Through S&T

This chapter highlights some of DRDC's accomplishments over the past year that demonstrate how our activities in science and technology contribute to the Department of National Defence and the Canadian Forces in influencing decision making and in enhancing their capabilities in the functions of command, sense, act, shield, generate and sustain.

Influencing Decision Making

DRDC undertakes research and analysis and provides strategic advice that assists the Department of National Defence and the Canadian Forces in making important decisions. Three examples of our work in this area follow.

Supporting the development of Canadian Forces capabilities

DRDC is working with the Department of National Defence to develop the Strategic Capability Roadmap which will outline the capabilities the Canadian Forces will require over the next 20 years to be able to carry out their anticipated missions. DRDC played a lead role in creating the necessary processes, analytical frameworks and tools required for the initiative.

Defence scientists embedded within the Chief of Force Development organization played a key role in the development of force planning scenarios to define the future security environment demand on the Canadian Forces. To help articulate, delineate and prioritize the capability goals of the Forces, we incorporated the CATCAM (Chief of the Defence Staff Action Team [CAT] Capability Assessment Methodology) tool into the process.

DRDC also created the Capability Outlook, Risk Outlook and Activity-based Neoteric Deficiency Rank Evaluation Worksheet (ANDREW) tools and processes to assess the current and planned ability of the Canadian Forces to meet their capability goals, identify and prioritize existing and future capability deficiencies, and evaluate the impact of these deficiencies on the ability of the Forces to conduct future operations. We also developed a tool to identify alternatives for maximizing the capability of the Forces within a set budget.

Our work in this area provides a degree of analytical rigour to the Department of National Defence's Strategic Capability Roadmap and helps to ensure that funding decisions of future programs can be traced back through the force development process to government direction and defence strategy. These tools provide transparency and expose the risk tradeoffs behind Canadian Forces capability and equipment decisions.

A Canadian Forces convoy circulates in a village not far from Kandahar, as part of their mission in Afghanistan

The CP-140 *Aurora*

Assessing intelligence under conditions of uncertainty

The International Assessment Staff (IAS), an intelligence assessment and coordination group with the Privy Council Office (PCO), prepares intelligence assessments for the PCO and senior policy makers in the Canadian government. Scientific assessments of intelligence analysis using well-established quantitative metrics for assessing the quality of judgements under conditions of uncertainty are exceedingly rare in the intelligence community.

In 2007, DRDC partnered with the IAS to scientifically validate the calibration of about 600 predictive judgements from 51 real intelligence assessments produced by the IAS Middle East and Africa Division. The resulting calibrations showed that the quality of the division's predictive assessments was very high. On a calibration index of 0 (perfect calibration) to 1 (worst possible calibration), the division's score was 0.01 — a highly favourable measure of predictive performance under conditions of uncertainty.

The IAS and DRDC continue to work together to monitor objective metrics of judgement quality such as calibration. The two organizations signed a Memorandum of Understanding in 2008. As part of this collaborative effort, DRDC is helping the IAS to develop standards for communicating uncertainty in intelligence assessments. We are also assisting in an IAS seminar for the Canadian intelligence and security community on judgement and decision making under conditions of uncertainty.

DRDC's work in this area provides expert advice to a key source of Canada's strategic intelligence and credible scientific evaluations of their assessments. It will also validate the scientific basis for supporting capability development for the Chief of Defence Intelligence.

Determining the best replacement time for CP-140 aircraft

When a fleet reaches a certain age, it becomes more economical to replace it than to repair it. In response to a request from the Defence Planning Board, DRDC analysts embedded within the Department of National Defence Materiel Group developed an intergenerational economic model to determine the optimum replacement strategy for the air force's long-range patrol CP-140 *Aurora* fleet. The model, which considers the aircraft's operational availability, estimates operating and maintenance costs per available year.

The model determined the optimal replacement age and demonstrated that each additional year beyond this age produces incremental costs. These costs are relatively low for the first few years but become significant if the replacement is further delayed. The study indicated that the air force could potentially save money if it adopted the proposed approach.

DRDC is now using the model to evaluate options for repair or replacement of nine other systems. The model is flexible, allowing it to be easily adapted and applied to other platforms, such as helicopters, ships, tanks and trucks.

Shaping Command and Sense Capabilities

During the past year, DRDC's work made significant contributions at the strategic, operational and tactical levels of Canadian Forces operations. We also provided science and technology to support the generation of knowledge.

Improving maritime security

Canada's extensive coastal and ocean jurisdictions require comprehensive surveillance and full awareness of maritime activity. As part of this surveillance effort, the Canadian navy maintains an image of maritime activity known as the Recognized Maritime Picture (RMP). The RMP compiles data from various sources — brought together by the Global Command and Control System – Maritime (GCCS–M) — to produce a single integrated picture.

DRDC's MUSIC (Multi-Sensor Integration within a Common Operating Environment) project aims to fuse diverse data from existing and new sensors and additional information sources to create a more accurate,

Command capabilities refer to the creative expression of human will necessary to accomplish a mission through the exercise of the authority vested by the national government and the chain of command for the direction, coordination and control of military forces.

Sense capabilities refer to a single comprehensive entity that collects, collates, analyses and displays data, information and knowledge at the tactical, operational and strategic levels.

SOURCE: DEPARTMENT OF NATIONAL DEFENCE

Maritime track fusion used to generate the Recognized Maritime Picture

comprehensive RMP. This requires a set of data management tools and applications capable of integrating pertinent data and disregarding irrelevant information.

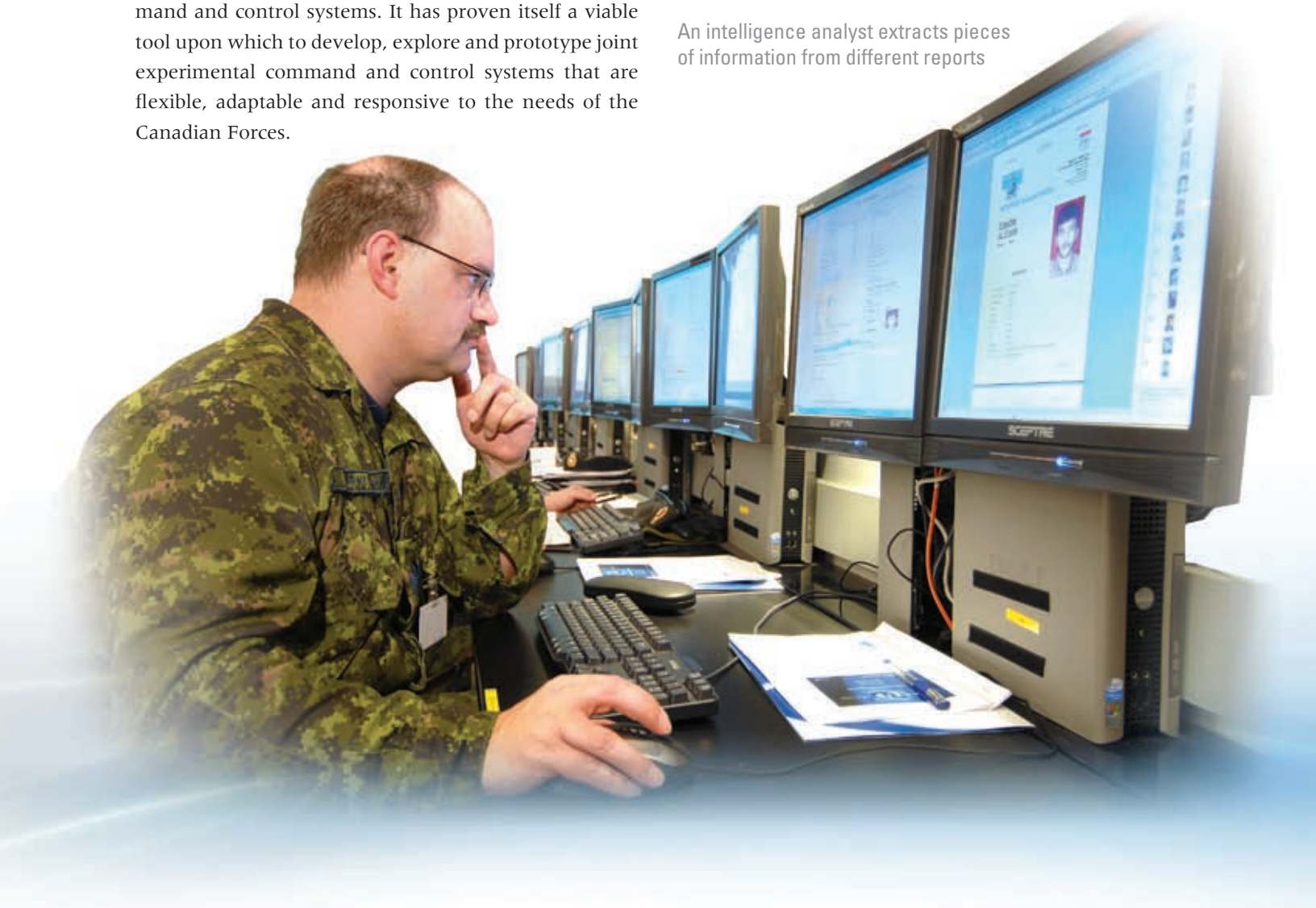
The MUSIC project made two significant advances. It created an "RMP track correlator" that is compatible with planned and future versions of the GCCS–M. The track correlator, based on fuzzy logic, automates the process of associating and fusing multiple maritime tracks that represent the same ship into one track. It has been validated for operation on the next official release of the GCCS–M. The project also created a service-oriented architecture (SOA) framework upon which the next generation of command and control systems for shore-based operations centres can be built.

The MUSIC SOA framework demonstrated its ability to incorporate the MUSIC data fusion capability, new services and sensors, and to interface with other command and control systems. It has proven itself a viable tool upon which to develop, explore and prototype joint experimental command and control systems that are flexible, adaptable and responsive to the needs of the Canadian Forces.

Organizing intelligence information for easier access

Collators in intelligence cells are responsible for recording documents, extracting pertinent data and then, if necessary, organizing, indexing and merging new information with previously exploited data. Ideally, all of this intelligence would be integrated into structured directories to make it easier for analysts, not just in one cell but across cells, to research and use. A new tool suite, the result of a five-year research and development effort by the Department of National Defence, DMR Conseil Inc. and DRDC, now makes this possible.

An intelligence analyst extracts pieces of information from different reports



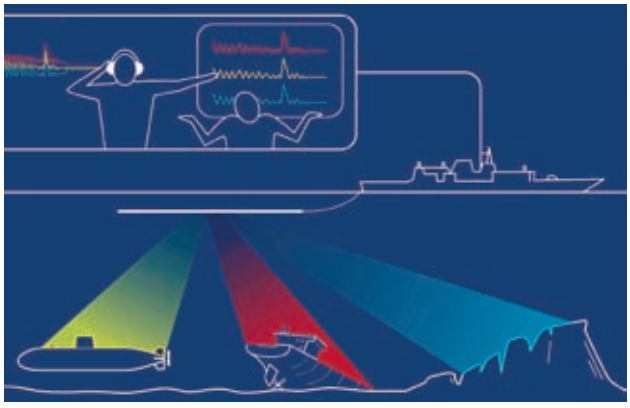
The Collation And Link Analysis (CoALA) tool suite has the ability to collate, organize and store unstructured textual information in one structured, searchable repository that is accessible to all of the intelligence cells. It allows the analysts to work collaboratively and exchange the compiled data. CoALA is specially adapted to the needs and tasks of Canadian Forces intelligence operators.

In January 2008, the Chief of Defence Intelligence (CDI) ordered the official introduction of CoALA into the inventory of intelligence tools deployed to support our troops for the first rotation of 2009 in Afghanistan. The CDI identified the CoALA suite as one of the best options available for the development, introduction and evolution of new technologies in support of intelligence operations.

Advancing sonar capabilities

The Canadian Forces use military sonar to detect, locate, classify and track potential underwater threats from safe distances. To increase detection ranges against modern (that is, quiet) targets, active rather than passive sonar is often required. However, in coastal environments, active sonar frequently mistakes echoes from geological features (clutter) for targets of interest, resulting in degraded performance.

The sonar community has generally accepted that humans are better than the equipment they operate at distinguishing echoes. However, this capability has never been quantified nor has the human faculty ever been used to improve sonar performance.



Graphical representation of aural discrimination versus a visual display

DRDC's Aural Discrimination project measured the ability of human operators to distinguish clutter from true echoes, identified the specific aural features the operators employ, and integrated those features into an automatic classifier. The researchers then measured the performance of both the human operator and the automated classifier. They found that the human operator and the automatic classifier performed equally well in identifying broadband acoustic echoes. They also discovered that the automated device was able to classify underwater echoes in essentially the same way as a human operator. Automation such as this will be an important component of future military platforms which will have to support smaller crew complements.

A new approach for domestic coastal maritime surveillance

In response to the changing global security environment, the Canadian Forces has turned part of its attention inward to prepare for a potential threat in a domestic theatre of operations. This effort includes re-examining their surveillance capability off Canada's east and west coasts covering the 200-Mile Exclusive Economic Zone and beyond.

DRDC worked with the Forces on the east coast to develop a methodology for planning surveillance activities in a logical manner and to measure the operational effect of these surveillance activities. With the help of operational staff from the Joint Task Force Atlantic and the Maritime Forces Atlantic, DRDC established a scientifically sound approach to developing surveillance requirements on a quarterly basis. Building on previous work conducted on the west coast, we also developed a capability to quantify and display the operational effect of surveillance activities, based on the probability of identifying a non-emitting vessel. These planning and measurement tools support surveillance activities of other government departments in addition to those of the Canadian Forces. DRDC then integrated these new tools and approaches with the west coast techniques.

A previously unidentified vessel just outside of Canada's Exclusive Economic Zone

As a result, the Canadian Forces and the Government of Canada now have a way to measure a key aspect of situational awareness in our coastal waters. As well, the Department of National Defence now has a consolidated set of maritime surveillance planning and measurement tools for the east and west coasts. It also has a more rigorous approach to estimating required surveillance hours and the ability to plan based on capability rather than on available resources.

These concepts, methodology and tools were presented to other government departments and form the foundation of a three-year plan for coastal maritime surveillance research.

Improving anti-ship missile defence

DRDC's INCOMMANDS (Innovative Naval Combat Management Decision Support) project aims to develop, demonstrate and evaluate advanced computer-based capabilities to aid command decisions for above-water warfare threat evaluation and weapon assignment, focussing on anti-ship missile defence scenarios. The goal is to improve the detect-to-engage process by enhancing situational awareness, exploiting a priori information and optimizing combat power resources.

In 2007, DRDC, with support from the Canadian Forces Maritime Warfare Centre (CFMWC) and several Canadian industry contractors, developed a Command Decision Support laboratory to conduct experiments aimed at measuring the decision-making effectiveness of new decision support concepts. We also designed a prototype for a single-ship decision support system in order to develop and demonstrate the decision aid capabilities for above-water warfare threat evaluation and weapon assignment. DRDC will test the prototype on board a HALIFAX Class ship in 2008 to prove the effectiveness of the INCOMMANDS prototype and increase its technology readiness level and potential for exploitation.

Using simulation to develop and evaluate tactics

The Canadian Forces are acquiring a new maritime helicopter, the CH-148 *Cyclone*, and upgrading the CP-140 *Aurora* patrol aircraft. These platforms will have a wider range of capabilities than their predecessors. Simulation systems have enormous potential to support the use of these capabilities both before the delivery of the aircraft and once they are in service. DRDC launched the Maritime Air Littoral Operations (MALO) project to support the modelling and simulation requirements for these new vehicles.

Due to the high cost and low availability of live trials, the number of unexplored, or untrialled, proposed tactics, known as tactical notes or *Tacnotes*, is growing. DRDC developed two simulation technologies to support the tactics evaluation process: a stand-alone system that aircrew, at squadrons or during operational downtime, can use to quickly develop and test new tactical ideas; and a high-fidelity distributed simulation system that provides an immersive synthetic environment, combining both constructive (computer driven) and virtual (human driven) forces. DRDC also developed database management and analytical tools to assist the military in managing simulation scenarios and the data obtained as a result of the tactics development process.

The simulation tools delivered to the CFMWC were designed to develop and trial *Tacnotes* in simulation. Instead of creating a *Tacnote* in text format or on paper, users can quickly describe their idea for a new tactic on a deployed laptop; this results in a *digital Tacnote* that is submitted to the CFMWC for further analysis.

The MALO project will have an impact on the efficiency and quality of tactics development both now and in the future, as the CFMWC increases its use of simulation and integrates data-driven processes that exploit the simulation tools.

Participants at the MALO modelling and simulation exercise assume the roles of mission commander and CP-140 tactical coordinator, system operator and observer during a fleet battle

Shaping Act and Shield Capabilities

An important part of DRDC's work involves enhancing the capabilities of the Canadian Forces to influence events in conflict situations to achieve desired effects. We also focus significant attention on protecting the survivability of the Forces and their freedom of action. The following examples demonstrate some of our achievements in these areas.

Analyzing personal protective equipment for increased protection

DRDC collaborates with the Canadian Forces to conduct research into and analysis of the personal protective equipment that soldiers use in theatre, with the goal of protecting soldiers to the highest possible degree. DRDC, the Canadian Forces Environmental Medicine Establishment (CFEME) and the Department of National Defence embarked on an initiative to extract lessons learned from the personal protective equipment of each Canadian Forces fatality in Afghanistan.

Act capabilities refer to the ability to influence events across the spectrum of conflict and in either or both of the physical and moral domains. Act is the operational function that integrates manoeuvre, firepower and offensive information operations to achieve the desired effect.

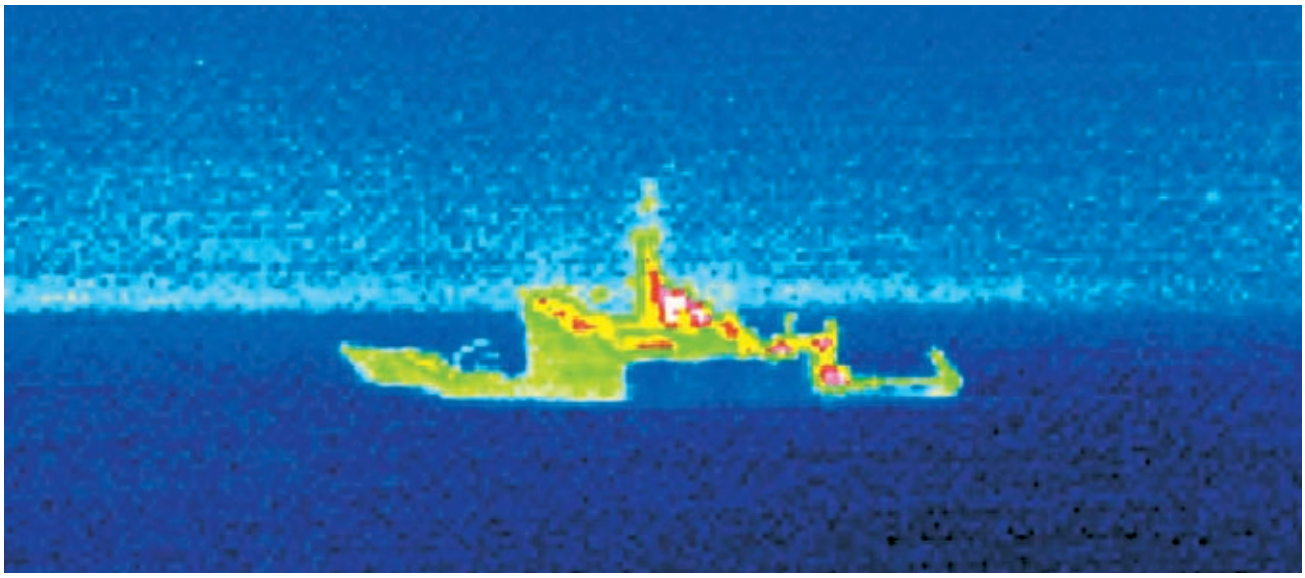
Shield capabilities refer to force protection measures taken to contribute to mission success by preserving freedom of action and operational effectiveness through managing risks and minimizing vulnerabilities to personnel, information, materiel, facilities and activities from all threats.

SOURCE: DEPARTMENT OF NATIONAL DEFENCE

When fatalities occur amongst Canadian Forces personnel, a multidisciplinary team from DRDC, the CFEME and the Department examines the soldiers' personal protective equipment. The team comprises medical officers, life support equipment specialists, and experts in human factors, ballistics and blast.

The results of the analysis have helped to prioritize projects concerning personal protective equipment and vehicle protection, and to develop tactics, techniques and procedures. Under the auspices of the Casualty Protective Equipment Analysis (CASPEAN) project, the initiative was recently expanded to include the analysis of equipment of wounded soldiers.

DRDC's analysis of personal protective equipment ensures that Canadian Forces personnel in theatre have equipment that helps to keep them safe while also being functional



An infrared image of CFAV QUEST shows a rectangular area of the hull that is cooled by seawater, an infrared suppression technique

Reducing the infrared signature of ships

Naval platforms can be detected by infrared surveillance systems and engaged by infrared-guided missiles. One way to counter the increasingly sophisticated infrared threat is to reduce the signature of ships, making them more difficult to detect.

Working with W.R. Davis Engineering Ltd. and the U.S. Naval Research Laboratory, DRDC developed two novel technologies to reduce the infrared signature of the hull and the exhaust plume, the two main contributors to a ship's infrared signature. The first system, Active Hull Cooling, controls the temperature of the hull by spraying sea water on it. The resulting infrared radiance allows the ship to blend in with its infrared background. The second system, Sea Water Injection, reduces the temperature of exhaust gases by injecting an aerosol of sea water into the exhaust uptakes. The cooler exhaust dramatically reduces the infrared signature of the plume.

Using the research vessel CFAV QUEST, researchers conducted a trial to assess the performance of the two experimental systems. The trial demonstrated that using sea water to control a ship's infrared signature is extremely effective. It also provided the data required to develop algorithms to maintain specific infrared signature levels. The systems are inexpensive when they are included in the design of a new ship.

Sea Water Injection in operation

New artillery safe distances

In October 2006, the Royal Canadian Artillery School asked DRDC to review all actual artillery and mortar safe distances used by the Canadian Forces and to produce updated safe distances, with a particular emphasis on splinter safe distances. The school expressed concern that present safe distances could be inapplicable to currently used rounds and guns and that the underlying methodology used to determine the safe distances was sometimes unclear.

DRDC used computer simulations to calculate new operational and training splinter (induced by fragment rather than round dispersion) safe distances for current Canadian artillery and mortar rounds. It calculated new safe distances for soldiers in the open and in the *Bison*, light armoured vehicle-III and *Leopard*-1 vehicles, with emphasis on firings at targets placed laterally, in front of and behind our own troops. In each case, four sets of safe distances were estimated. Each set corresponded to a different acceptable risk level (expected percentage of casualties applicable to friendly troops) in the operational and training contexts. DRDC also clarified the rules and procedures to be applied by Canadian artillery in order to account for risks related to round dispersion (how far from the target, on average, the round actually lands) and salvo effects (when several rounds are fired at the target).

The Canadian Forces are about to implement the new safe distances and operational procedures. The safe distances fill gaps that had existed in the artillery-mortar safety procedures, especially operational, and in those for soldiers protected inside vehicles. They also apply to newer rounds, for which no reliable data had been available.

The new safe distances and procedures help to protect the lives of our soldiers, to guide the Canadian Forces artillery to use material in an optimal way, and to improve the confidence of artillery and infantry soldiers.

Protecting computer networks

Because computer networks underpin so many military activities, understanding the state of the networks and maintaining their health is important, particularly as the networks themselves become targets of potential adversaries. The network environment is viewed today as another battlespace that must be controlled and defended.

DRDC's Joint Network Defence and Management System (JNDMS) project developed and demonstrated a monitoring system that helps make computers more resistant to attack. DRDC, MacDonald Dettwiler and Associates Ltd., NRNS Inc. and CA Inc. developed the JNDMS for the Canadian Forces Network Operations Centre (CFNOC) to improve network situational awareness and allow analysts to better understand and report to users of the network services the impact of network events. The third round of JNDMS development and trials was completed in the last year.

In 2007, the JNDMS team participated in a Coalition Warrior Interoperability Demonstration. The operators using JNDMS reported that the system helped them make faster risk assessments and decisions because they had more information about the networks all within one system. They also stated that it accelerated their work processes because the system fused data and automatically correlated the information.

The JNDMS demonstrations played a key role in having the utility of such a system recognized by the Canadian Forces capability development community and in obtaining authorization for CFNOC to initiate a capital project to implement an integrated situational awareness capability within a network command and control framework.

Shaping Generate and Sustain Capabilities

Science and technology supports the ability of the Canadian Forces to generate mission-tailored forces. The following examples demonstrate how DRDC contributed to readying the Canadian Forces for potential operations.

Generate capabilities refer to the process by which military forces are assembled, equipped, trained, certified and deployed to meet a force development requirement.

Sustain capabilities refer to the grouping of all functions necessary to generate, deploy, employ and redeploy a force.

SOURCE: DEPARTMENT OF NATIONAL DEFENCE

Integrating occupational knowledge into performance modelling

Computer modelling and simulation, which takes into account human operator variables such as age and anthropometric measurements (measurements of the human body), has existed for many years. However, representation of operators' occupational characteristics, knowledge and skills acquired through military training has not been systematically studied before. In a recent project to integrate operators' occupational attributes into a software modelling toolkit, DRDC incorporated data captured in the Canadian Forces Military Occupational Specifications into an existing human performance modelling software, the Integrated Performance Modelling Environment (IPME). DRDC led the project and CAE (Canada), Alion Science and Technology Corp. (United States) and QinetiQ (United Kingdom) provided support.

The Military Occupational Specifications were originally created to support human resources activities rather than to facilitate the creation of human performance models. Consequently, researchers filtered through the occupational data, identified the performance-related attributes and integrated them into the IPME's internal constructs. They also developed software to enable direct access to the occupational data directly from the IPME.

This project makes it possible to create future human performance models that are sensitive to military occupations and allow analysts to investigate personnel and manning aspects of military system design. From UAV (unmanned aerial vehicles) operator definition to frigate crewing analysis, the newly-developed capability in the IPME enhances the ability of analysts to create operator models with improved accuracy and generate simulation data that provide more insight into system effectiveness.

Flight engineer was one of the occupations the characteristics of which were incorporated into the Integrated Performance Modelling Environment

Researching the effects of family support on military members

Many people assume that the military lifestyle has an impact on Canadian Forces families and that spousal support has crossover effects on Forces members. To date, however, little research has been done to examine these relationships. At a time when the frequency and intensity of operational deployments is increasing, it is particularly important to assess the impact of personnel tempo on military members and their families.

DRDC conducted two studies that examined the effects of personnel tempo on Canadian Forces members, their families and the military organization. The first study looked at the link between family support and operational readiness. It found that spouses play a vital role in promoting the well-being, readiness and performance of military members and their ability to carry out missions.

Given the importance of spousal support, it is crucial to understand how families maintain or enhance resiliency during and after military deployments and separations. For its second study, DRDC surveyed a random sample of spouses and partners. The results revealed some of the stressors that military families experience and the potential individual, family and organizational outcomes of such stressors, as well as factors that could mitigate or exacerbate these outcomes.

The studies led to a greater appreciation of the important role that families play in ensuring the well-being and operational readiness of military members. The results were also instrumental in developing plans to provide a consistent approach to family services and support, including identifying the key areas on which to focus, such as mental health, access to medical care and the economic impact of the military lifestyle.

DRDC's research into family support helps the Canadian Forces to develop ways to improve the lives of their members

A Landing Signals Officer lands a helicopter aboard a moving ship in a virtual environment using the SimON model

Modelling and simulating human behaviours

The Department of National Defence increasingly looks to computers to model and simulate human behaviours and predict human performance in a range of scenarios. To address the growing need for real-time computational models of human behaviour that can replace individuals or small teams within a network of connected simulations, DRDC developed the Simulated Operator for Networks (SimON), operator models intended for use in simulation-based acquisition, operational analysis, mission planning, accident investigation, training and mission rehearsal.

SimON is an engineering representation of operators that integrates relevant human science knowledge into a model using the Integrated Performance Modelling Environment (IPME). SimON translates human behaviours into computational performance models that are moderated by human science theory and data without necessarily replicating processes such as human information processing or motor control.

The SimON project used this approach to demonstrate a model of a *Sea King* pilot that interacts with a human Landing Signals Officer (LSO), allowing the LSO to land a helicopter aboard a moving ship in a virtual environment. Using SimON, the Canadian Forces are able to train a LSO in this task before going to sea, without the need for a flight crew, deck crew or ship's complement, reducing the risk of preliminary training with real equipment and optimizing training at sea.

Support

to Current Canadian Forces Operations

The Canadian Forces undertake many and varied operations in Canada and around the world. DRDC develops new and innovative technologies to assist the Forces in their missions. The following stories illustrate some of our initiatives in this area.

Modelling innovative vehicle screening for the Vancouver 2010 Winter Olympics

DRDC is assisting in the planning efforts for the 2010 Winter Olympic Games in Vancouver. In our first project, we conducted a quantitative analysis of vehicle screening capacity. Our goal was to determine whether the design of the vehicle screening process, the areas designated for conducting the screening and the resources allocated to the task would generate sufficient capacity to handle the anticipated vehicle traffic loads.

We worked closely with the Integrated Security Unit (ISU) of the Royal Canadian Mounted Police to identify the scope of the problem while creating a sophisticated analytical engine in the form of an innovative simulation model. We also adapted the vehicle screening areas model to handle new and complex design considerations and created ad hoc analysis tools to assess the results. The end result is an operationally relevant scientific analysis product. Consequently, the ISU requested that we extend the vehicle screening areas model to help plan other related issues.

The vehicle screening areas project illustrated the important role that defence science can play in integrated security efforts as we move towards the Vancouver 2010 Olympic Games.

Gauging public opinion in Kandahar, Afghanistan

DRDC is contributing to public polling endeavours in Kandahar province to help assess progress in attaining Canada's objectives in Afghanistan. Public opinion research is a critical tool in these efforts. As of early 2008, more than 5,000 Afghans had expressed their views in four waves of polling.

A military police officer demonstrates the proper method for screening a vehicle as members of the Canadian Forces look on

An Afghan farmer responds to polling questions

DRDC designed the survey questionnaires with input from a wide variety of partners, worked with a polling contractor based in Afghanistan, analyzed the data, and briefed Canadian Forces and Government of Canada leaders. The polling results now form an integral part of the assessment process and play a role in planning decisions. The results are generating interest among other Canadian Forces circles, and federal and international partners involved in Afghanistan.

Reducing the time required for relief in place

Planning and executing the relief in place between rotations in Afghanistan is a difficult process. Relief in place refers to the replacement of outgoing troops with incoming troops, along with the transfer of responsibilities. It requires a balance between maximizing the times for unit and personnel handovers and minimizing the time required to conduct the overall relief in place, while keeping an operational capacity in place throughout. DRDC's task, at the request of the Commander Joint Task Force Afghanistan, was to reduce the time required for the relief in place between rotations from two months to 30 days or less.

Improvised explosive device testing on a wheeled light armoured vehicle

DRDC developed a tool and a methodology to analyze options for the relief in place. These options considered the training, handover and out-clearance requirements of personnel; the transfer of command dates between units; and various aircraft options. It also tracked the number of personnel in Kandahar and in third location decompression (decompression at a separate location prior to returning home) to ensure that the locations did not exceed capacity.

The model allows operators to test various airflow options and determine the ramifications of using the Forces' CC-150 aircraft as opposed to chartering larger aircraft. The model also develops passenger manifests for incoming and outgoing personnel and tracks other statistics such as the percentages of units in theatre, the number of quarters required and the flow of personnel into third location decompression.

DRDC considered more than 69,000 variables in total and had the model running in theatre within a month. The next relief in place took 30 days.

Better protection of occupants of deployed vehicles

Many Canadian Forces soldiers deployed in Afghanistan are exposed to life-endangering attacks from blast and projectiles, both in a conventional mode and from improvised explosive devices. There is an urgent need to improve the safety of vehicles deployed in operations. DRDC is working with the Department of National Defence on a trial program to better protect the occupants of deployed vehicles.

Since February 2006, the program has completed 21 major tasks. These included 53 destructive tests on vehicles or full-scale mock-ups. The testing included characterization of baseline and add-on protection for both the hull and the exposed crews, improvement of the hull and the seating arrangement, and protection against behind-armour effects. The trials focussed primarily on light armoured fighting vehicles and personnel carriers. DRDC also tested the *Leopard* C2 and the 10- and 15-tonne vehicles. Many simulation and modelling tasks complemented the destructive testing.

Testimony from the front line indicates that the improvements have saved many lives. As well, the intensive trials program and the accelerated development of new test methodologies and analysis will assist future capital acquisition projects in the field of vehicle occupant survivability.

JCDS 21 project members use command decision support tools

Supporting decision making for the Vancouver 2010 Winter Olympics

In November 2007, DRDC and the Canadian Forces Experimentation Centre (CFEC) conducted the PEGASUS GUARDIAN experiment to assist the Royal Canadian Mounted Police's (RCMP) Integrated Security Unit (ISU) to examine command and control process considerations for the Vancouver 2010 Winter Olympic Games.

In parallel with PEGASUS GUARDIAN, DRDC's Joint Command Decision Support for the 21st Century (JCDS 21) project team conducted an experiment to validate the reactive time-sensitive decision-making process of the Canadian Forces for dealing with events, providing support to civil authorities and suppressing sophisticated threats during the games. The experiment focussed on analyzing the flow and management of information internal to the Joint Task Force Games (JTFG) with regard to maintaining shared situational awareness and responding to requests for assistance and transfers of authority. The JCDS 21 team produced several analysis reports and briefs to support the JTFG in developing its command and control solutions, taking into account human and organizational factors as well as processes and technologies.

The successful execution of the PEGASUS GUARDIAN and JCDS 21 experiments was the result of a collaborative effort among DRDC, CFEC, the JTFG and the ISU. This efficient networking led to the official recognition of the role of science and technology support operations in the military as well as in the public security domain. Consequently, DRDC has been asked to provide coordinated support to the JTFG and the ISU. This request led to the creation of the Major Events Coordinated Security Solutions (MECSS) project. This project will enable DRDC to leverage national science and technology resources to strengthen the Government of Canada's major events security architecture. MECSS will focus on assisting authorities in reducing the security risk associated with the Vancouver 2010 Olympic Games through the coordinated application of science and technology tools, support and services while providing input to the broader Major Events Framework being developed by the RCMP.

Strengthening

Canadian Public Security Capabilities

New, complex and emerging threats require forward-looking solutions. Investing in science and technology can advance Canada's security capabilities to prevent and prepare for short- and long-term safety and security threats, whether caused by terrorist or criminal activity, accident or natural disaster.

DRDC continues to place priority on public security, both nationally and internationally. Our work in this area focusses not only on research, development, testing and evaluation, but also on collaboration with other organizations, at home and abroad, to share and learn about the latest innovations in national public safety and security.

DRDC Centre for Security Science

The DRDC Centre for Security Science (CSS) is a joint endeavour with Public Safety Canada. Its mandate is to provide science and technology services and support to address national public safety and security objectives. It is part of the Government of Canada's approach to public security science and technology and one of DRDC's seven research centres.

DRDC CSS leads and administers the research, development, testing and evaluation of technologies, and identifies future trends and threats. It also helps to develop a network of national and international science and technology partners in the public safety and security communities. DRDC CSS works with fellow DRDC centres, Public Safety Canada and 19 other science-based federal departments and agencies involved in the safety and security of Canadians. Its goal is to deliver science and technology research in support of an all-hazards approach to natural and accidental disasters, and to terrorist and criminal acts.

DRDC CSS manages three programs — the Chemical, Biological, Radiological-Nuclear and Explosives [CBRNE] Research and Technology Initiative (CRTI); the Public Security Technical Program (PSTP); and the Canadian Police Research Centre (CPRC), which became the responsibility of DRDC in September 2007. The CPRC is Canada's national focal point for technology research and development efforts in support of the law enforcement community. The relationship between DRDC CSS and the CPRC strengthens the linkages between the federal science community and Canada's first responders.

DRDC CSS works with responders to provide science and technology advice and solutions to enhance preparedness

Chemical, Biological, Radiological-Nuclear and Explosives Research and Technology Initiative

The CRTI makes investments in science and technology projects that provide methods of responding to CBRNE threats. The program brings together the federal science and technology community with other levels of government, industry and academia to enhance Canada's ability to prevent, prepare for, respond to and recover from potential CBRNE threats to public safety and security.

The CRTI creates new opportunities for knowledge sharing across organizations and disciplines. It has produced important gains in Canada's CBRNE response capabilities and in the expertise, knowledge and capabilities of Canada's CBRNE science and technology performers. It forms important links between diverse science and security communities, both domestic and international.

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

Explosives exercises train emergency response teams while showcasing security technologies

The CRTI sponsored three post-blast exercises which were carried out by the Royal Canadian Mounted Police. The purpose of these exercises was to better prepare first responder and law enforcement communities to respond to a terrorist event involving explosives by presenting them with various post-blast scenarios to exercise forensics investigation procedures and roles. In total, more than 200 members of police services from all levels of government participated in these exercises.

The first of the exercises simulated a high-risk security environment, where participants practised responding to and interacting with each other during an aircraft explosion, as well as collecting and analyzing evidence found at the post-blast scene. The event involved the detonation of a bomb hidden in a laptop computer that was placed in the cargo bay of a decommissioned Boeing 727.

The second exercise, organized by the Canadian Bomb Data Centre, involved two scenarios: approximately 100 pounds of explosives destroying a VIP motorcade, and a roadside bomb blasting apart a military vehicle. This exercise allowed responders from several jurisdictions to test new scene-survey and forensic technologies and wireless communication pathways, including video streaming from the field to a command post.

The third blast exercise examined three scenarios relevant to the transportation sector. The first involved a suitcase bomb placed on a public transportation vehicle; the second featured a cube van equipped with explosive and fertilizer that was detonated; and the third featured a tractor trailer armed with explosive which was neutralized using a large barrel disrupter.

Since the creation of the Explosives Cluster in December 2006, the CRTI has made great strides in bringing together members of the explosives domain to create a community of experts where innovation and the exchange of knowledge and expertise are fostered through various initiatives. Sponsoring and participating in exercises are among the many ways that the Explosives Cluster contributes to enhancing Canada's ability to prevent, prepare for and respond to a terrorist incident.

Experts and first responders participate in biological incident exercise

In October 2007, a team of federal science and technology experts, as well as members of operational and first responder communities from all levels of government, participated in the largest multi-jurisdictional bioterrorist field exercise ever held in Canada. Exercise BI-EX-WEST provided a valuable learning experience to assist in the development of a more efficient and coordinated response to an emergency situation involving a zoonotic agent.

BI-EX-WEST was held in Delta, British Columbia (BC). It allowed participants to strengthen their skills, improve procedures and identify vulnerabilities. It was designed for maximum realism while ensuring the safety and security of the community, participants, equipment and the environment. Federal participants included the Canadian Food Inspection Agency, the Department of National Defence, the Public Health Agency of Canada, Public Safety Canada and the Royal Canadian Mounted Police. Provincial participants included the BC Ambulance Service, the BC Centre for Disease Control, the Ministry of Agriculture and Lands, the Provincial Emergency Program, the Fraser Health Authority and the Vancouver Coastal Health Authority. Staff from the Corporation of Delta and volunteers from Delta's Emergency Social Services and Amateur Radio Society also took part in the exercise.

Participants at BI-EX-WEST practise giving first aid to a victim in an emergency situation

Exercise BI-EX-WEST provided an opportunity to test the preparedness of federal experts and their ability to work with other levels of government and first responders during an emergency situation. It also contributed to improving national response capabilities in responding to bioterrorism threats and to enhancing the safety and security of Canadians.

A participant is sprayed with a decontaminant during BI-EX-WEST

New assays for detecting potential biological weapons

Being able to detect and quickly identify potential biological weapons is a critical step in confining an outbreak. However, until recently, front line personnel had only a limited number of assays to make these determinations, especially in the case of viral pathogens.

A CRTI project has changed this situation by developing assays with high sensitivity, accuracy and speed for several types of potential biological weapons. Frontline personnel now have tests to detect the following agents: Ebola, Marburg, Lassa fever, the Crimean-Congo haemorrhagic fever, alphaviruses, New World arenaviruses, Severe Acute Respiratory Syndrome (SARS), influenza, Henipah viruses, hantaviruses, Brucella, Burkholderia, Chlamydia, Coxiella and Rickettsia.

The project was conducted under the leadership of the Public Health Agency of Canada's National Microbiological Laboratory, in collaboration with DRDC and Cepheid Inc.

Addressing the needs of health-care workers

The SARS outbreak in Toronto in 2003 yielded some valuable lessons. Among these lessons was the importance of considering the needs of health-care workers in the development of response plans, policies and training for CBRNE emergencies. A series of reports, produced with funding from the CRTI, provides new assistance in this regard.

A team of public- and private-sector researchers, under the leadership of Health Canada's Bureau of Women's Health and Gender Analysis, studied how the SARS outbreak affected health-care workers as first responders and examined the support mechanisms available to them. The team identified gaps in the support mechanisms and recommended solutions.

Based on the research results, the team produced a series of reports designed to shape public health policy and planning in the event of an infectious disease outbreak or similar CBRNE threat. One report outlines a risk management framework for public health emergency preparedness for outbreaks of infectious disease. Others focus on risk communications, personnel policy and managing work-family conflict from a gender perspective.

These reports are widely quoted in international scientific journals. The body of knowledge generated helps greatly in understanding how to manage the public health response to high-impact events such as the SARS outbreak.

Detecting animal disease threats in real time

Canada's food system, including livestock, is a potential target for agro- and bio-terrorism. The best defence against such an attack is early detection and rapid response. Using the innovative application of science and technology, members of the CRTI are developing the tools Canada needs to better protect our food system. One such tool is the Canadian Animal Health Surveillance Network (CAHSN), which allows health authorities to detect potential animal health threats in real time and initiate a rapid response, thus minimizing human health and economic impacts.

The CAHSN was established by the Canadian Food Inspection Agency, in conjunction with provincial veterinary authorities. It consists of federal, provincial and university animal health diagnostic laboratories across Canada and is directly linked to the Canadian Public Health Laboratory Network, also developed through the CRTI.

The network combines surveillance data from many sources and simultaneously alerts both human and animal health authorities when a potential animal disease threat is identified. This allows a national early warning system, rapid diagnosis of the threat and early implementation of mitigating responses.

In 2007, the CAHSN project team received a Public Service Award of Excellence for Innovation.

Essential data at responders' fingertips

Global CBRNE threats are forcing governments to more efficiently identify trends and detect patterns of potential risk to critical infrastructures, people and agri-food targets.

Led by the Canadian Bomb Data Centre, this CRTI project brought together the Royal Canadian Mounted Police, the Canadian Security Intelligence Service and the Canadian Food Inspection Agency to develop a national and international CBRNE Incident Database (CID) to track and analyze CBRNE incidents, including hoaxes. The CID also stores the information needed for planning a response to CBRNE threats, such as lists of hazards, mitigation and render-safe tools and procedures, and relevant methodologies and protocols.

The project team worked with Carleton University's Psychology faculty to ensure the CID would be user-friendly. Work is currently under way to devise a strategy for implementing the CID across Canada making it accessible to police, fire, hazardous material and emergency medical services, as well as regulatory agencies, government legislators and incident commanders.

Public Security Technical Program

The Public Security Technical Program (PSTP) expands on the success of the CRTI. Beyond the CRTI's CBRNE focus, the PSTP broadens the scope of DRDC CSS' activities to include three additional mission areas: critical infrastructure protection; surveillance, intelligence and interdiction; and emergency management and systems integration.

The following example highlights the PSTP's work during the reporting period.

Increasing the preparedness and resilience of Canadians

The PSTP created a new psychosocial cluster that brings together academia, government agencies and volunteer associations to conduct research to increase the preparedness and resilience of Canadians towards terrorism, emergencies and crises.

Psychosocial factors are the basic social, psychological and cultural aspects of human interactions and their effects on mental well-being. In the context of an emergency situation, psychosocial factors refer to the range of reactions exhibited by those affected by the event, directly or indirectly, and how perception, behaviour, work organization and community can significantly affect the ability of responders to carry out their response and recovery activities.

It has become apparent in recent years that an effective response plan to natural disasters, major accidents and criminal and terrorist acts must include strategies to manage psychosocial factors. The Psychosocial Cluster will enable DRDC CSS and its partners to focus on these critical factors and to help develop more effective emergency plans by providing valuable knowledge and expertise on the psychological and social consequences of a crisis to emergency planners.

Counter Terrorism Technology Centre

The Counter Terrorism Technology Centre (CTTC) conducts live-agent chemical, biological and radiological (CBR) training, testing and evaluation. Its activities aim to enable clients to conduct operations safely in a high-risk CBR environment. Following is an example of the CTTC's work in 2007–2008.

Training first responders in Southeast Asia

DRDC and the Department of Foreign Affairs and International Trade (DFAIT) delivered a comprehensive series of training courses in Southeast Asia to help countries in the region build their CBRNE response capacity. The courses were designed to train first responders and policy makers in the event of a CBRNE incident. Over the past three years, DRDC and DFAIT have delivered 42 courses to 1,962 participants.

The training is part of the ongoing CBRNE assistance Canada is providing to the Philippines, Malaysia, Thailand and Indonesia at the request of their governments. In 2006 and 2007, DRDC sent 1,200 CBRNE suits collected from Department of National Defence surplus stocks. We also provided CBRNE detection and monitoring capabilities, as well as 800 respiratory protection systems, and gloving and other ancillary equipment worth more than $5 million in total.

DRDC staff provide theoretical CBRNE instruction to the first responder community in Thailand

The training and equipment proved valuable on October 19, 2007, when an explosion in a downtown mall in Makati, Philippines, killed 11 people and wounded over 100 more. Responders used the equipment DRDC had sent and acted in accordance with the sequence and incident command system they had learned during their CBRNE training.

Partnering

for Increased S&T Capacity

DRDC aims to provide clients and stakeholders with the most cost-effective scientific and technological solutions to the challenges they face. We work with other organizations, nationally and internationally, and partner with the Defence Science and Technology (S&T) Enterprise, to leverage resources, knowledge, experience and technology.

This chapter features examples of our collaborations with national and international organizations and with the Defence S&T Enterprise.

Partnering Within the Defence S&T Enterprise

The Defence S&T Enterprise manages the Department of National Defence's investment in science and technology. It is a matrix organization that connects the individuals in the Canadian Forces and the Department who direct, deliver and exploit the outputs from the investment.

The Enterprise achieves maximum impact through coordination and harmonization of effort. It maintains purpose-built linkages with external stakeholders such as other federal organizations, the defence and security science and technology community of Canada's allies, and Canadian industry and academia. As such, the Enterprise provides a window on the global science and technology knowledge base.

Examples of DRDC's partnerships with members of the Defence S&T Enterprise follow.

Making better, faster decisions in joint fires

Based on lessons learned from the counter-insurgency warfare in Afghanistan, the Canadian Forces need better situational awareness and tools to ensure that resources are optimized and decisions are made faster to address time-sensitive targets and reduce the risk of fratricide. DRDC is responding to this need by investigating and prototyping a joint fires support capability that will allow any land, sea, air or coalition spotter to call for fire on a land-based target, and the best shooter, whether air, land, sea or special operations, will be assigned based upon factors that include response time, accuracy and rate of fire, desired effect, collateral damage and rules of engagement.

DRDC's goal is to develop a capability that will enable the Forces to undertake and successfully execute more firing missions. The net-centric battlefield of the future requires new tools and new techniques to perform today's tasks better, faster and possibly differently.

In a collaborative effort, DRDC and the Canadian Forces Experimentation Centre developed a concept of operations that was adopted by The Technical Cooperation Program's Joint Strategic Analysis group to create the Combined Fires Concept of Operations. The Joint Fires programs in Australia, the United Kingdom and the United States are leveraging the concept of operations to build their projects. We also produced a weapons review and made changes to the Ship Area Air Defence Model that will be used to help identify the optimal mix of weapons for the Canadian Surface Combatant ship to support forces ashore. In addition, we facilitated improvements that enhance the transfer of information between the command and control systems of the army, navy and air force.

Halfway through the life cycle of the project, it earned "Gold Card Status," which is reserved for DRDC projects that are not only meeting all of their scientific and technical and program objectives, but are also engaging broadly and effectively with the Department of National Defence, the Canadian Forces and our allies.

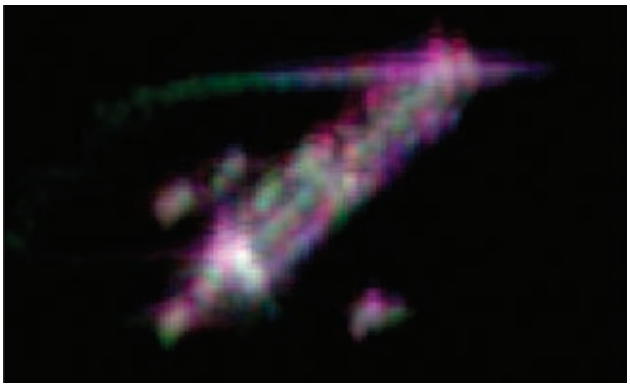
Improving Arctic surveillance

Canada's RADARSAT-2, launched in December 2007, provides better performance and new capabilities that will bolster the Department of National Defence's surveillance activities. DRDC is working with the Polar Epsilon Project Management Office to use RADARSAT-2 to improve the surveillance of Canada's Arctic by the Canadian Forces and to reinforce Canada's ocean monitoring and environmental sensing capabilities.

A tanker vessel and tug boats that were captured by synthetic aperture radar

The Polar Epsilon project is implementing new capabilities for joint space-based wide area surveillance and support with a focus on synthetic aperture radar (SAR) data from RADARSAT-2. Polar Epsilon will implement Arctic surveillance and near-real-time ship detection using RADARSAT-2. This will be facilitated by the construction and commissioning of reception stations on the east and west coasts, and the implementation of new maritime surveillance modes for RADARSAT-2.

Our contributions to the project include support for the development of the operational ship detection software, along with the implementation of new target models to reduce false alarms. DRDC also demonstrated mission planning software and the use of polarimetry for maritime surveillance to enhance ship detection while minimizing the impact on other federal RADARSAT-2 users such as the Canadian Ice Service. This and ongoing work with Polar Epsilon will result in enhanced surveillance capabilities, not only for the Department of National Defence, but also for other government departments engaged in surveillance activities.

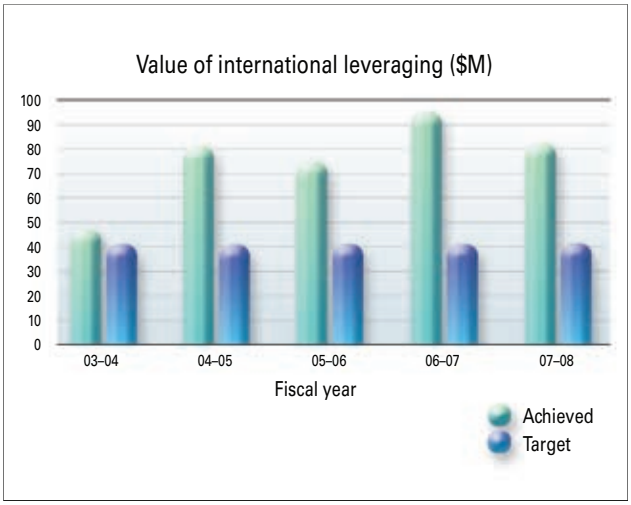


A polarimetric synthetic aperture radar image of a large tanker vessel along with several tug boats

International Collaborations

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 $40 million each year through our international collaborations. We estimate the value of collaborations on the likely cost of acquiring similar value through research contracts. We approximate the value of our international collaboration in fiscal year 2007–2008 to be $82 million. The following chart shows a five-year history of the value of our leveraging from international collaborations.



A large number of DRDC's collaborations are carried out with allied countries under international agreements, most notably The Technical Cooperation Program (TTCP) and the North Atlantic Treaty Organization (NATO) Research and Technology Organization (RTO). DRDC actively participates in all 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 and www.rta.nato.int.)

DRDC also participates in other international agreements, such as the Multilateral Master Information Exchange Memorandum of Understanding with Australia, New Zealand, the United Kingdom and 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 Kingdom and the United States. 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.

A list of the international agreements in which we participated in the period covered by this report and the approximate number of projects we undertook under each agreement can be found in Appendix 6.

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

Examining coalition mine-countermeasure capabilities

In June 2007, a TTCP technical panel examining mine warfare conducted a collaborative trial called MONGOOSE '07 at the U.S. Naval Surface Warfare Center in Panama City, Florida. The trial investigated the scope of interoperability between the evolved mine-countermeasure capabilities of TTCP nations, focussing on unmanned vehicles. Four TTCP nations deployed 25 separate systems, with 80 to100 people participating, making this one of the largest, most complex TTCP trials ever held.

At the international level, MONGOOSE '07 exposed military commanders to potential gains in capability efficiency and effectiveness offered by enhanced coalition interoperability with unmanned systems and network-enabled warfare. It also addressed problems associated with safely operating unmanned underwater vehicles in waters with divers present, and the application of cross-national standards for signature measurement and vulnerability assessments.

The Remote Minehunting System was one of the technologies developed by DRDC that was tested at MONGOOSE '07

At the national level, MONGOOSE '07 was an important milestone in the continuing development of a mine warfare capability for the Canadian navy. MONGOOSE '07 represented the first operation of the Remote Minehunting System as an operational capability manned with a dedicated Canadian Forces navy detachment. This enabled the navy to explore the interoperability of the system with other coalition assets and, in particular, to interface with the United States' Mine Warfare Environmental Decision Aids Library.

During the trial, DRDC tested and evaluated the Diver Signature Integrated Measurement System (DSIMS) and compared its operational characteristics to similar systems from coalition nations. As a result of the successful operation of DSIMS at exercises such as MONGOOSE '07, DRDC advanced this technology to the point where the Canadian navy will put it into operational use in the next year.

Developing vaccines against bio-threats

Under the auspices of TTCP, DRDC is working with Australia, the United Kingdom and the United States to develop a safe, fast-acting vaccine to protect war fighters and civilians from the bio-threat of three alphaviruses: Venezuelan equine encephalitis virus (VEEV), eastern equine encephalitis virus (EEEV) and western equine encephalitis virus (WEEV). These are potential biological weapon and bioterrorism agents because they are relatively stable in a natural environment, highly infectious after being aerosolized and easy to produce in large quantities. They could be used as either an incapacitating or a lethal agent.

Antiviral drugs against alphaviruses do not exist and treatment focusses only on easing clinical symptoms. However, researchers have developed inactivated vaccines for VEEV, EEEV and WEEV to protect laboratory workers at risk of exposure to these viruses. These vaccines are safe, but they require multiple injections and annual boosters to be effective. Researchers also developed a live attenuated vaccine for VEEV that requires only a single injection to be effective, but it causes severe side effects.

To make safer and more effective vaccines for alphaviruses, DRDC developed an adenovirus vector platform for vaccine development. The adenovirus vector is a harmless virus that delivers vaccine but does not cause disease. DRDC scientists have found that the alphaviral vaccine delivered by the adenovirus vector is safe and has the potential to be used as a single-dose, fast-acting vaccine against the alphavirus threat.

Replacing the small arms fleet

The Canadian Forces will soon start the process of replacing its small arms fleet. The Small Arms Replacement Project 2 (SARP 2) is taking a systems approach and aims to produce a comprehensive suite of weapons to enhance the capabilities that form a sub-system of the larger soldier system. The SARP 2 will look for improvements by including areas such as lethality and multiple effects, human factors integration, fire control, and power and data transmission within the weapon. In support of that process, DRDC has been participating in a NATO RTO working group on future small arms development.

This group, representing 10 NATO countries, was established in 2005 and is investigating a variety of capabilities related to the development of future small arms. It has three teams, each addressing a different area: human factors, power and technical interface design.

The working group has so far completed a study of the effects of changes in weapon weight and centre of mass on soldier performance, developed a prototype weapon rail capable of transmitting power and data, and recommended specifications on power architecture for small arms. Participation in this working group will allow DRDC to leverage research and development conducted by our NATO partners to support the SARP 2.

The SARP 2 has led to the creation of the Soldier Integrated Precision Effects System project that aims to demonstrate the viability, utility and usability of integrated and high-payoff novel small arms-related lethal and non-lethal technologies for future lightweight, small-calibre weapons systems for the Canadian Forces.

DRDC leads NATO working group on modelling and simulation for network-enabled capability

Many NATO nations and NATO Partnership for Peace nations are transforming, driven by a desire to achieve effects-based operations through a more network-centric force. Effects-based operations are military operations that use both traditional military means and non-traditional, non-military means to achieve a goal. One such means which NATO is exploring is the development of network-enabled capability.

The fundamental concept in network-enabled capability is that shared knowledge and shared technical connectivity dramatically enhance mission effectiveness and efficiency. Further modelling and simulation, as a lead science and technology investment, facilitates analysis, design and experimentation with network-enabled capability-based approaches to improve understanding, interoperability, doctrine development, mission rehearsal, training and acquisition support.

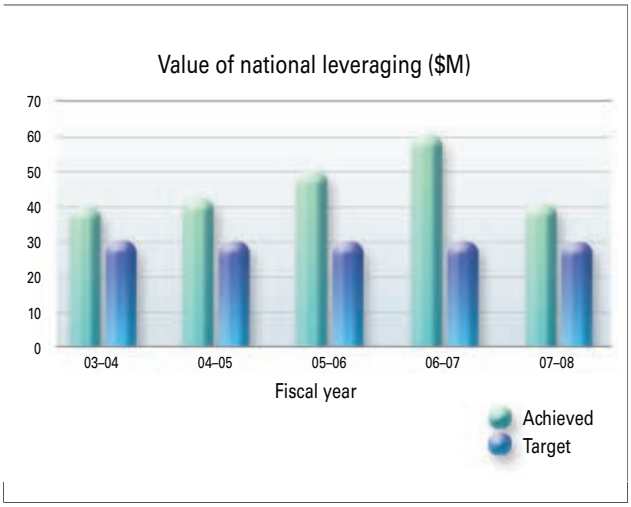
The extent to which NATO countries have embraced these processes and technologies varies considerably, and there is a critical need to develop a shared understanding between countries through the exchange of views and approaches. Consequently, NATO established a working group to explore how modelling and simulation can support network-enabled capability development across the defence and security domains. Canada, through DRDC, is leading this working group in the development of a guide to modelling and simulation for network-enabled capability based on best practices, with participation from Australia, the Czech Republic, The Netherlands, Norway, Turkey and the United Kingdom.

The group's kick-off meeting took place in Paris, followed by workshops in Ottawa, London, The Hague and Oslo. Each workshop featured state-of-the-art briefings and demonstrations by the host nation. The final outcome will be a guide based on the best evidence from real-world case studies presented at the workshops, and a set of agreed-on principles that document how best to employ modelling and simulation for NATO network-enabled capability. This will ensure that NATO and all member nation programs are able to support the development of force and public security capabilities in a smart, net-enabled approach.

National Collaborations

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 2007–2008 was approximately $41 million. The following chart shows a five-year history of the value of our leveraging from national organizations.



Examples of our collaboration with national organizations follow.

Mapping the Arctic Ocean floor

Mapping the Arctic Ocean floor to determine the outer limit of the continental shelf is a key step in supporting Canada's jurisdictional claim in the Arctic. DRDC assisted in the mapping work by helping Natural Resources Canada (NRCan) and the Department of Fisheries and Oceans (DFO) to extend their surveys into the more remote northern regions.

NRCan and DFO have been conducting Arctic surveys for the past three years. Their goal is to substantiate Canada's submission to the United Nations Convention on the Law of the Sea (UNCLOS) concerning jurisdiction over the area beyond the 200-Mile Exclusive Economic Zone in the North. The implementation of

A Natural Resources Canada ice camp set up for an appurtenance field experiment

One of the geobuoys embedded in the ice

Article 76 of the UNCLOS requires the analysis and interpretation of the depth of the sea floor and the thickness of the underlying sedimentary layer, as well as determining the appurtenance of submarine elevations (plateaux, rises, caps, banks) by ascertaining whether they are natural prolongations of the land territory of the coastal state.

NRCan and DFO scientists were using sound waves to probe the geological characteristics of undersea ridges and sediments. However, they had difficulty mapping the more remote reaches of the survey due to the logistics of deploying and recovering instruments in those areas. Using technology developed for submarine surveillance in the Arctic and deployed by a Canadian Forces CP-140 *Aurora*, DRDC helped the scientists to significantly extend the range of the survey into the remote areas.

The *Aurora* dropped seismic receivers known as geobuoys. The sensors embedded themselves in the ice and then transmitted the under-ice ocean-acoustic data back to the aircraft, where they were recorded and processed. Rather than listening for submarines, the geobuoys detected the sound waves generated by NRCan personnel at ice camps further south.

DRDC helped to develop the concept, assess the suitability of the geobuoy for this experiment and plan the scientific aspects of the mission. DRDC personnel also participated in the *Aurora* flights.

Responders and federal S&T experts collaborate at counter-terrorism exercise

In February 2008, the Chemical, Biological, Radiological-Nuclear and Explosives [CBRNE] Research and Technology Initiative (CRTI) sponsored Exercise Initial Thunder 2008 (ExIT-08), the largest and most realistic multi-jurisdictional CBRNE counter-terrorism exercise ever held in Canada. ExIT-08 was one in a series of exercises conducted across Canada to evaluate various tools, systems and procedures that were developed through the CRTI's investments in science and technology projects. Each exercise built on the lessons learned from the previous exercise and provided an opportunity to learn from the federal, provincial and municipal responder communities, develop best practices, and identify areas where further science and technology developments are needed.

Over the course of ExIT-08, teams of federal, provincial and municipal responders worked through a number of mock scenarios. Federal participants included the Atomic Energy of Canada Limited, the Canada Border Services Agency, the Canadian Nuclear Safety Commission, DRDC, the Department of National Defence, Environment Canada, Health Canada, Natural Resources Canada, the Public Health Agency of Canada, Public Safety Canada, the Royal Canadian Mounted Police,

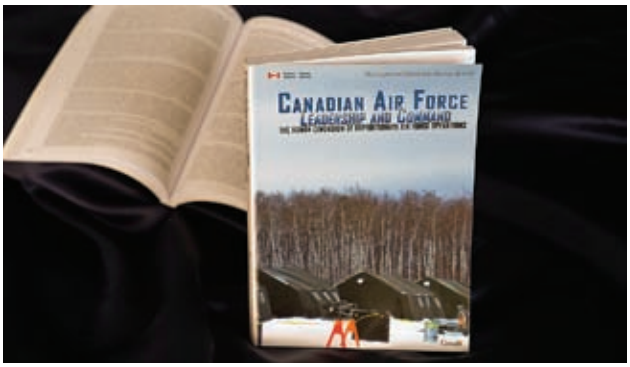
Participants at ExIT-08 prepare to transport a victim exposed to radiation

Transport Canada and the Vancouver Port Authority. Provincial and municipal participants included the British Columbia (BC) Ambulance Service, the BC Centre for Disease Control, the Provincial Emergency Program, the Vancouver Fire and Rescue Services and the Vancouver Police Department. Private sector partners included International Safety Research Inc. and the Centerm container terminal operated by P&O Ports Canada Inc.

The first segment of the exercise took place in the Port of Vancouver and involved the illegal shipment of radiological materials, as well as the triage and transport of casualties that had been exposed to radiation.

The second segment of the exercise took place at Canadian Forces Base Esquimalt. Scenarios involved radiological, chemical, biological and explosives materials and practice in detecting these materials as well as handling them for the purpose of forensics. All exercise activities were conducted under strict security protocols and procedures to ensure the safety and security of the participants, the surrounding communities and the environment.

Participants practice detecting radiological material at ExIT-08



Canadian Air Force Leadership and Command book

Examining leadership and command in the air force

The Canadian army, navy and air force each manifest certain elements of the Canadian Forces ethos, such as culture, leadership styles and command arrangements, in different ways. A new book, *Canadian Air Force Leadership and Command*, prepared by DRDC and KMG Associates and published in 2007, examines how the culture and working environment of the Canadian air force have influenced the development of unique leadership styles and command arrangements.

Written in support of DRDC's Human Dimension of the Expeditionary Air Force project, the book analyzes how operations, culture and group identity affect air force leadership and command in both a historical and a contemporary context. It also provides models and frameworks of leadership and command to help the air force address current and future challenges in these areas. The book offers a foundation for research and debate and identifies the need to develop an overarching model of command and control in the Canadian air force.

Enhancing Capacity

Through a Strong Foundation

DRDC's success arises from a combination of several factors working together. These factors include the quality and relevance of our science, the excellence of our operations, the skills of our workforce and the effectiveness of our work environment. These factors create a strong foundation on which to build and strengthen our capacity. We celebrate our success by recognizing and rewarding our achievements.

Moving DRDC Forward to the Next Level

DRDC operates in an environment of unprecedented and accelerating change. To remain relevant and maximize the impact of our investment in science and technology for defence and public security, DRDC must continually anticipate, adapt and remain agile. DRDC manages its ongoing strategic transformation through the Expedition Series.

Released in 2006, the ***Defence S&T Strategy*** established the conditions for maximizing the impact of the Department of National Defence's investment in science and technology by ensuring that it is aligned with departmental priorities, is properly harnessed to be a force multiplier, and is supportive of the defence institution and its core business processes.

Launched in 2005, Expedition 07 had three objectives: (1) develop and implement the *Defence S&T Strategy*; (2) solidify DRDC's support to public security; and (3) strengthen the enablers of success, particularly corporate services. With most of its objectives accomplished, DRDC concluded Expedition 07 in September 2007.

In January 2008, DRDC launched Expedition 09. Structured around three areas, (1) capabilities and capacity, (2) science and technology programs and activities, and (3) influence and relationships, Expedition 09 will move DRDC to the next level as a full-service science and technology organization. It will ensure that science and technology is a key contributor to all departmental core processes, maximize the impact of the departmental investment and ensure that DRDC leads in shaping the way ahead in science and technology for defence and security.

The examples that follow illustrate some of DRDC's activities to increase its capabilities and capacity.

DRDC Infrastructure Strategy

The *Defence S&T Strategy* identifies 11 areas of science and technology expertise for which capability is required to support the Department of National Defence and the Canadian Forces. As part of its new science and technology capability management system, DRDC is currently evaluating its existing capabilities to carry out the *Defence S&T Strategy*. Consequently, DRDC conducted an assessment of its research centres to determine whether they had the infrastructure required to address the identified areas of expertise. The assessment revealed that the current infrastructure is inadequate to perform modern-day science and achieve required results. To remedy this situation, we developed the DRDC Infrastructure Strategy, which outlines the investment necessary over the next 10 years to ensure that our buildings and research equipment can support the expertise areas defined in the *Defence S&T Strategy*.

The DRDC Infrastructure Strategy analyzes the current state of DRDC's realty assets and equipment and proposes a roadmap to ensure that suitable facilities are in place to enable effective scientific and technological support to the Department of National Defence and the Canadian Forces.

The DRDC Infrastructure Strategy outlines seven action areas for upgrading and sustaining our infrastructure over the long term. Among them are the development of an infrastructure portfolio management framework and the continued implementation of renewal programs for construction, equipment and the environment.

Implementing Good Laboratory Practice

DRDC recently implemented Good Laboratory Practice in selected laboratories as part of a project to advance the use of HI-6, a nerve agent antidote. The Good Laboratory Practice capability, a first in DRDC, is necessary for the regulatory acceptance of drugs and devices developed in DRDC laboratories.

Development of the resource-intensive Good Laboratory Practice capability began in 2005. The writing of the standard operating procedures alone required some 4,500 hours by 18 individuals. The system currently has more than 100 standard operating procedures and a quality assurance program is in place.

When the first Good Laboratory Practice study is completed in November 2008, DRDC will be able to provide critical information on administering the HI-6 drug intravenously. Together with other Good Laboratory Practice studies, DRDC laboratories will be able to accelerate the development of drugs and devices to protect or treat those exposed to chemical warfare agents. NATO partners are already interested in learning more about this new DRDC capability.

A new vision for knowledge, information and technology management

DRDC is defining and articulating a bold new vision for its Knowledge, Information and Technology Management (KITM). The vision moves DRDC towards an organization that manages and shares information and knowledge in ways that improve our influence and links with external partners and stakeholders, while doing cutting-edge science that is leveraged in meaningful ways. It is supported by an organization-wide capability that brings the full scientific, technical, support, management and technology resources of DRDC to bear on achieving its aims.

This capability is underpinned by a governance structure that manages a broad KITM program that meets organizational requirements based on agreed-upon priorities. The program features common tools to carry out standard processes but is flexible enough to allow the development of unique solutions to unique problems. It is strengthened by an integrated technology program that supports management, administration and scientific requirements.

DRDC completed the first steps of the process — an environmental scan that led to the production of a KITM Functional Planning Guidance. The Guidance outlines DRDC's plans to support the implementation of the *Defence S&T Strategy* and Expedition 09, and to solicit KITM activities from the research centres and corporate divisions in four key areas: (1) building a strategic KITM capability, (2) managing KITM activity as a corporate program, (3) enhancing KITM capability and (4) rationalizing and optimizing KITM resources and services. The next steps will be to propose priorities and an overall direction for the KITM program, and obtain input from stakeholders on the development of a KITM strategy.

Nurturing leadership among our employees

DRDC implemented several initiatives under Public Service renewal. Among them are a number of strategic activities under Expedition 07 and Expedition 09, and the integration of human resources and business plans to better address corporate and employee needs. These needs include an informed, effective workforce; learning and career growth opportunities; and preparing staff for senior leadership roles.

In support of leadership development, DRDC defence scientists attended a "Becoming Leaders" pilot workshop aimed at providing career guidance to women who work in science and technology, and a "Scientists as Leaders" program. Also in support of learning, training and development, we provided employees with on-site action learning events.

Under the DRDC Mentoring Program, we matched 49 employees with mentors from within and outside the organization, including some former senior DRDC staff. Following favourable feedback from 2007–2008 participants, DRDC will expand the "mentee" pool in future roll-outs and use the program as a recruitment enticement.

Increasing workforce diversity

DRDC is committed to promoting a diverse workforce representative of the Canadian population. This commitment is reflected in our representation of employees from the four employment equity designated groups: women, Aboriginal peoples, persons with disabilities and visible minorities. In 2007–2008, DRDC ran various promotional campaigns to raise employee awareness of workforce diversity, including the release of a multicultural calendar that increased employee awareness of festivals and events around the world. DRDC's progress in employment equity over the past five years is presented in Appendix 5.

Fostering a bilingual culture

DRDC employees took part in a range of adaptive training programs to meet the organization's linguistic business needs. For example, some Regular Force military members, along with their civilian colleagues, took departmentally coordinated second-language training to meet their required language levels. Some employees participated in on-site, after-hours second-language training, while others took part in a 6- to 12-week immersion period in the Quebec region to help prepare for second-language proficiency evaluation.

Recognizing Our Achievements

Recognizing the achievements and successes of employees is an integral part of DRDC's organizational culture. We are committed to rewarding 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 11 DRDC employees:

Rob Stowe received the France Beaupré Award from TTCP's Conventional Weapons Technology (WPN) Group Technical Panel 4 for his contribution in the area of air-breathing weapons. This award recognizes Mr. Stowe's leadership and initiative as the Canadian point of contact for the Air-Breathing Propulsion Group and the Propulsion Design Optimization Tool engaged in system propulsion design. It also recognizes his role as a Canadian leader within the Aerospace Systems (AER) AG-5 Group on hypersonic systems technology and pays tribute to his commitment to numerous other projects relating to air-breathing propulsion;

Raymond Burrill (retired), **Anthony Damini**, **George Haslam** (retired), **Robert Noyes**, **Chris Parry** and **Norman Reed**, for their significant contribution to the real-time wide-swath synthetic aperture radar image formation, dissemination and exploitation. The outcome of this teamwork simultaneously extended surveillance volume coverage and image resolution, while decreasing system cost and making the imagery available to TTCP participants across the nations within seconds;

Gerry Rude and **John Slater**, for the WPN Group KTA 1-36 study of underwater explosion (UNDEX) effects in the littoral that benefit the shore defence capabilities of TTCP nations. Measurements of the response of structures to explosions in shallow water were used to enhance numerical modelling of non-ideal explosive charges. Large-scale trials tested the operational use of explosive charges and channelling in shallow waters. The study enables breaching of anti-invasion mine and obstacle fields in the surf zone; and

Daniel Corriveau, **Nicolas Hamel** and **Franklin Wong**, for their significant contribution to the WPN KTA 2-21-02 multinational research team in the development and application of a novel flight control actuation system relevant to precision flight control strategies. The team advanced the analysis and fabrication of miniaturized flight control actuation systems. Future growth in the use of compact, high-control authority actuation systems may be attributed to this TTCP program.

NATO awards

Joe Baranski was a co-recipient of a NATO Human Factors and Medicine (HFM) Panel Excellence Award for his contributions to the HFM-087/RTG-23 Technical Team on Military Command Effectiveness.

Brad Cain received the NATO Research and Technology Organisation (RTO) 2008 Scientific Achievement Award for his work on the HFM-128 Human Behaviour Representation in Constructive Simulation and the HFM-143 Human Behaviour Representation in Constructive Modelling teams, in recognition of an exceptional effort in significant RTO activities and outstanding results in terms of military benefit.

Bob Cheung was a co-recipient of a NATO HFM Panel Excellence Award for his excellent contributions to two HFM Technical Courses, with educational sessions in four European nations in 2005 and 2007 on survival at sea for mariners, aviators and search and rescue personnel.

International and national awards

John Anderson received The Netherlands Organisation for Applied Scientific Research (TNO) 1A22 Recognition Award for his work with the Force Protection Against Enhanced Blast technology demonstration project.

Patrick Brousseau won third prize for his poster at the 38th International Annual Conference of ICT (Institut Chemische Technologie) on Energetic Materials — Characterisation and Performance of Advanced Systems, held in Karlsruhe, Germany.

Michel DuCharme received the prize for the Best Scientific Presentation at the 15th SAFE (Europe) Symposium held in Geneva, Switzerland. His presentation was entitled "Evaluation of the LASA (Luftgekühlter ABC — Schutzanzug) ventilated NBC suit in hot and cold environments."

Giovanni Fusina received the Best Paper (Student) Award at the 2007 Unmanned Vehicle Systems Canada Conference for his paper entitled "Realization on a field-programmable gate array of a genetic algorithm for the planning of trajectories for autonomous airplanes."

Ming Hou was elevated to Senior Membership of the Institute of Electrical and Electronics Engineers. Senior membership status indicates a high professional competence that is recognized throughout the world.

Bumsoo Kim was elected national president of the Association of Korean Canadian Scientists and Engineers.

Paul Labbé received a Best Paper Award at the International Conference on Global Defense and Business Continuity in San Jose, California, as lead author of the paper entitled "Creating a Dynamic Picture of Network Participant Geospatial Information in Complex Terrains."

David Mandel was awarded the title of Fellow by the Society for the Psychological Study of Social Issues (Division 9 of the American Psychological Association) for a career of outstanding contributions of research addressing social issues.

Bill Martell received the SAFE Award for Career Achievement. The SAFE Association is a non-profit international professional association dedicated to the preservation of human life by providing a forum for the sharing of problems, ideas and information. Its Career Achievement Award is presented annually to individuals who, throughout their career, have made significant contributions in the field of safety.

Don Neill received the 2007 ORBITA Award for his technical memorandum entitled *The Chemical Weapons Convention at the Second Review Conference and Beyond*. The award recognizes outstanding operational research and analysis in a given year. ORBITA is an association of former DRDC CORA employees.

John Osler was elected a Fellow of the Acoustical Society of America (ASA) for his contributions to seabed geo-acoustics. To be elected a fellow, ASA members must have rendered conspicuous service or made notable contributions to the advancement or diffusion of the knowledge of acoustics, or the fostering of its practical applications.

Mark Trevorrow was awarded the Medwin Prize in acoustical oceanography from the Acoustical Society of America. The award honours scientists in acoustical oceanography whose work demonstrates the effective use of sound in the discovery and understanding of physical and biological parameters and processes in the sea.

Insp Lance Valcour received the Motorola Canada Award for his work in addressing the need of Canadian public safety agencies and first responders to communicate among themselves to improve response to the public and communities during emergencies.

Étienne Vincent received the South-West Asia Service Medal for his deployment to the Persian Gulf. The Medal recognizes participation while deployed or in support of the operations against terrorism in South-West Asia.

Hakima Abou-Rachid and **Sylvain Désilets** received the Best Poster Award for their poster entitled "Novel Nanoscale High Energetic Materials: Nanostructured Polymeric Nitrogen and Polynitrogen" at the 7th International Symposium on Special Topics in Chemical Propulsion held in Kyoto, Japan.

Guy Ampleman and **Sonia Thiboutot** received an Award of Excellence from the Steering Committee of the Canada-Netherlands-Sweden Memorandum of Understanding on cooperative science and technology for their work on a research project concerning the environmental aspects of energetic materials.

Maj Steve Bassindale and **Maj Bruce Chapman** each received the General Campaign Star (International Security Assistance Force) for their deployment to Afghanistan. The General Campaign Star recognizes military service in a theatre of operations in the presence of an armed enemy.

Franklin Lue and **Lochlan Magee** received the Air Force Association of Canada's Golden Hawks Award for outstanding contribution to military aviation in Canada, as members of an interdisciplinary team that provided the Air Force with the successful Helicopter Maritime Environment Trainer (HelMET).

Rob Dickson, **Pete Smith**, **Elizabeth Speed** and **Tania Yazbeck** each received the General Service Medal (International Security Assistance Force) for their deployment to Afghanistan. The General Service Medal acknowledges civilian and military service in direct support of operations in the presence of an armed enemy.

DRDC Valcartier received the 2008 Omond Solandt Award from the Canadian Operational Research Society. The Omond Solandt Award is presented to an organization, private or governmental, that is deemed to have made an outstanding contribution to operational research in Canada.

Departmental awards

Lt John Beavis received a Commanding Officer Canadian Forces Environmental Medicine Establishment (CFEME) Commendation for his professionalism and dedication in progressing a wide range of mine countermeasure projects, the most significant of which is the ongoing development and validation of Trimix Decompression tables. His efforts have revitalized the undersea research program and will lead to a reduction

in the risk of decompression illness to Canadian Forces operations clearance divers.

Maj Bruce Chapman received a Commander Canadian Expeditionary Force Command (CEFCOM) Commendation for his outstanding dedication and initiative displayed as an Operational Analyst in Joint Task Force Afghanistan Headquarters from August 2007 to February 2008. His numerous realizations included a relief in place optimizer program, which single-handedly made it possible to complete a formation relief in place in thirty days with existent integral air assets.

Lt(N) David Finlay received a Commanding Officer CFEME Commendation for his outstanding leadership in the revitalization of the Experimental Diving and Undersea facilities. His dedication and teamwork lead to the return to operational status of DRDC Toronto's hyperbaric facilities, as well as the harmonization of CFEME's and DRDC Toronto's science and technology capabilities to support a long-term undersea research program.

André Fortin received a Commanding Officer CFEME Commendation for his dedicated effort in returning the Diving Training Facility to operational status. His work improved the ability of the CFEME and DRDC Toronto to ensure due diligence in the provision of safe hyperbaric operations.

LCol Dwayne Hobbs received the Commander Land Force Command Commendation for his initiative and leadership in preparing the Composite Reserve Infantry Company for Rotation 13 of the Bosnia-Herzegovina Task Force.

Raman Pall received an Assistant Deputy Minister (Materiel) Merit Award for his development of the PANTHER model for analyzing ammunition consumption in theatre and forecasting stockpile levels.

Lt(N) Gordon Peckham received a Commander CEFCOM Commendation for his outstanding efforts on deployment to Afghanistan in 2006.

Capt Mark Rutley received a Commanding Officer CFEME Commendation for his scientific and technological efforts in Afghanistan while deployed as a bioscience officer, streamlining procedures for the repatriation of the personal protective equipment of wounded soldiers and facilitating the acquisition of video footage in support of improvised explosive device training.

Pete Smith received a Commander CEFCOM Commendation for the outstanding dedication and perseverance that he displayed as an Operational Analyst in Joint Task Force Afghanistan Headquarters from August 2007 to February 2008. His numerous realizations included the development of a Combat Logistic Patrol scheduler, which has a significant impact on the security of National Support Element patrol members. This tool allows planners to generate random and unpredictable patrol schedules for any given month, while taking into account human and logistical constraints.

Nena Snyder received a Commanding Officer CFEME Commendation for her superb professionalism and extensive coordinating capabilities in promoting the dynamic, scientifically exciting and relevant capabilities of the CFEME and DRDC Toronto to the Canadian public through a number of television productions.

Fariya Syed received an Assistant Deputy Minister (Human Resources-Civilian) [ADM(HR-Civ)] Merit Award for helping to further the research and analysis discipline in the ADM(HR-Civ) organization and for leading the design, administration and results analysis of the organization's client satisfaction survey.

Grant Vandenberghe received the Canadian Forces Network Operations Centre (CFNOC) Certificate of Appreciation for his outstanding support and achievement in delivering the Fast Packet Recovery tool as well as the new platform redesign for CFNOC's analyst workstation and Intrusion Detection System (IDS) sensor.

Bruno Gilbert and **Pierre Lafrance** received a Deputy Minister Commendation for their outstanding leadership and significant contribution to the capabilities of the air force in electro-optical warfare.

The **DRDC Ottawa Network Information Operations Section** received an Assistant Deputy Minister (Information Management) Certificate of Appreciation for exceptional leadership and resolve in scoping pervasive cyberspace problems. Team members

included **Luc Beaudoin**, **Craig Burrell**, **Maxwell Dondo**, **Marc Grégoire**, **Julie Lefebvre**, **Joanne Treurniet** and **Grant Vandenberghe**.

DRDC organizational awards

Larry Allin received the Performance Excellence Award for exemplifying DRDC values and for his outstanding leadership and commitment to furthering DRDC's vision and mission through innovative corporate management practices.

Serge Choquette received the Performance Excellence Award for the vision, outstanding leadership and determination he demonstrated during the development of the first DRDC Infrastructure Strategy, which benefited the entire Department of National Defence.

Calvin Hyatt received the Management Excellence Award for his outstanding leadership and management excellence which have transformed the Emerging Materials Section into a highly motivated high-performance team resulting in the delivery of leading-edge science that has great impact on the Canadian Forces.

Anthony Kellett received the Performance Excellence Award for his scientific accomplishments and the inspiration and motivation he provided to two generations of strategic analysts, scholars and military professionals.

Zakia Bouayed and **Tania Yazbeck** received the Award of Public Distinction for their hard work and dedication in collecting and distributing used clothing and shoes to schools and orphanages in Afghanistan in 2006–2007.

The **Heat Shield Scientific Team** received the Performance Excellence Award for the innovation and determination it showed in quickly and effectively developing a heat shield for Canadian Forces combat vehicles deployed in the theatre of operations. Team members included **Patrick Bafaro**, **Jean Dumas**, **Michel Dupuis**, **Stéphane Giroux**, **Bruno Gravel** and **Daniel Lemieux**.

The **Force Protection Against Enhanced Blast Technology Demonstration Project Team** received the Performance Excellence Award for its excellence, innovation and dedication to increasing the survivability of Canadian Forces personnel and assets. Team members included **John Anderson**, **Darrell Boechler**, **Capt Mike Dunning**, **John Fowler**, **Keith Gerrard**, **Sheri Hlady**, **Maj Kent Hocevar**, **Robin Laing**, **Patricia Lambert**, **Luc Légaré**, **Maj Geoff McCarthy**, **Kiril Mudri**, **Stephen Murray**, **Kevin Scherbatiuk**, **Scott Trebble**, **Akio Yoshinaka** and **Fan Zhang**.

DRDC research centre awards

Larry Allin received the DRDC Toronto Leadership Award in recognition of his outstanding leadership as Business Line 4 Manager and Organizational Alignment Manager.

Leanne Callery received the DRDC Ottawa Outstanding Performance Recognition Award for improving the capabilities of the DRDC Ottawa Supply Services Group.

Fred Cameron received the DRDC CORA Individual Achievement Award in recognition of his outstanding efforts in support of the Land Staff and DRDC CORA.

James Clark received the DRDC Toronto Leadership Award in recognition of his dedicated and effective leadership as President of the DRDC Toronto Staff Association.

Fred Dilkes received the DRDC Ottawa Outstanding Contribution Award in recognition of the many improvements he brought this year to the DRDC Ottawa Seminar Series.

Stewart Harrison received the DRDC Toronto Achievement Award in recognition of his outstanding services as Library Technician.

Abe Jesion (retired) received the DRDC CORA Leadership Award in recognition of his exceptional leadership as a senior defence scientist, team leader and as the Professional Institute of the Public Service of Canada union steward for DRDC CORA.

Anthony Kellett received the DRDC CORA Director General Commendation in recognition of his scientific accomplishments and the inspiration and motivation he provided to two generations of strategic analysts, scholars and military professionals.

Janice Lang received the DRDC Ottawa Leadership and Creative Management Award in recognition of her efforts in enhancing communications at DRDC through leadership in implementing the DRDC Open House initiative.

Jim Lee received the DRDC Ottawa Outstanding Contribution Award in recognition of his years of dedication, achievement and contribution to the field of radar specific emitter identification.

Janet Michelson received the DRDC Ottawa Outstanding Contribution Award in recognition of her dedication and outstanding contribution to the safe and secure operations of DRDC Ottawa.

Richard Pederson received the DRDC Atlantic Outstanding Achievement Award recognizing his outstanding contribution to the successful transition of the Remote Minehunting System (RMS) technology demonstration project to an interim operational system that provides the Canadian navy with an improved capability.

Corey Pike received the DRDC Ottawa Outstanding Contribution Award in recognition of his contribution of radio-frequency technical expertise throughout DRDC Ottawa.

Lynn Rockwell (retired) received the DRDC Corporate Office Leadership and Creative Management Award for her dedication to furthering learning and development within DRDC.

Merzban Rustom received the DRDC Corporate Office Outstanding Performance Award for his significant role in developing the 2008–2009 DRDC Business Plan, which resulted in an augmentation of DRDC's A-based budget and growth in its program and operational capacity.

David Schlingmeier received the DRDC Ottawa Outstanding Performance Recognition Award for his excellence and perseverance in establishing the Canadian Virtual Lab.

Sheila Sparkes received the DRDC Ottawa Outstanding Performance Recognition Award for her dedication in improving the safety of radiation research at DRDC.

Suzanne Vallée received the DRDC Corporate Office Outstanding Performance Award for her outstanding contribution and professionalism in the area of Human Resources in support of the defence scientist community within DRDC.

Col Carl Walker received the DRDC Toronto Commendation in recognition of his leadership, support and dedication to the success of the Canadian Forces Environmental Medicine Establishment.

Sue Watson received the DRDC Ottawa Outstanding Contribution Award in recognition of significant positive contribution to the KRONOS technology demonstration project.

LCol Michel Gareau, **Pierre Michaud** and **Gaétan Thibault** received a DRDC Valcartier Outstanding Performance Award in the Scientific and Technical category for the development of the CoALA tool suite and its deployment within the Canadian Forces, providing an effective functionality to the intelligence production cycle.

Shawn Hoag, **Paul Ohrt** and **David Saint** received a DRDC Corporate Office Outstanding Performance Award for their dedicated effort and application of expertise in establishing the first three technology exploitation projects, all related to the protection and survivability of combat vehicles and their occupants.

Alexandra Ostaniewicz, **Judy Smith** and **Grace Wu** received the DRDC Toronto Team Award in recognition of their dedicated, efficient and highly productive performance as members of the Human Resources Services.

The **Intentional Modulation on Pulse (IMOP) Team** received the DRDC Ottawa Outstanding Contribution Award in recognition of contributions to the implementation of the CP-140 *Aurora* electronic support measures IMOP capability. Team members included **Fred Dilkes**, **Todd Faulkner**, **Heather Fitzgerald**, **J.F. Gravel** and **Alain Labonté**.

Patrick Bafaro, **Jean Dumas**, **Michel Dupuis**, **Stéphane Giroux**, **Bruno Gravel** and **Daniel Lemieux** received the DRDC Valcartier Outstanding Performance Award in the Scientific and Technical category for the swift and innovative development of the heat shield for Canadian Forces tanks deployed in theatre.

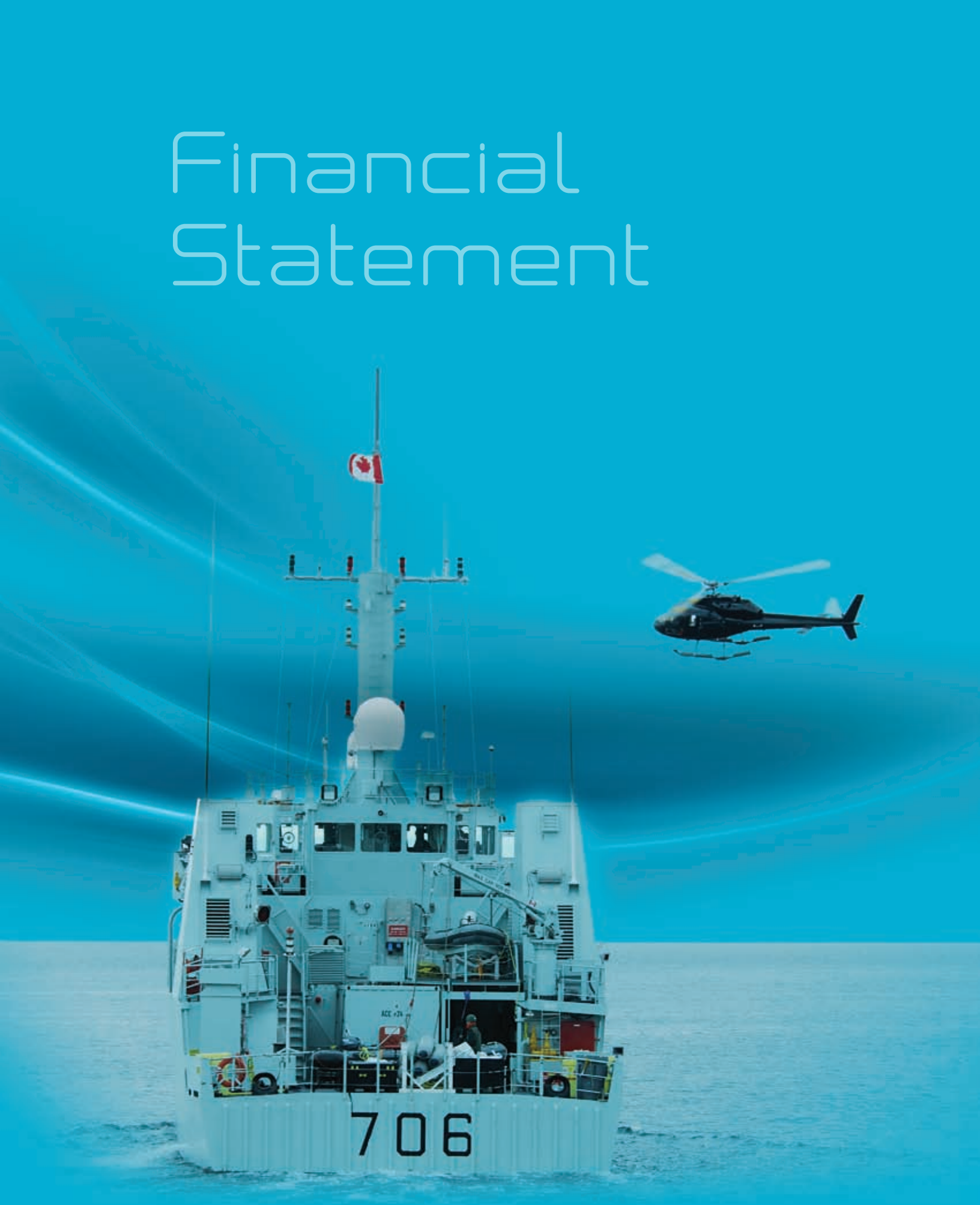
Patrick Armstrong, **Nebojsa Bjelakovic**, **Corey Dvorkin**, **Brian Greene**, **Peter Johnston**, **Anthony Kellett**, **Ben Lombardi**, **James Moore**, **Don Neill**, **Eric Ouellet**, **Jonathan Quinn** and **Christina Yeung** received the DRDC CORA Team Achievement Award in recognition of the outstanding team effort displayed in the preparation and publication of the annual Strategic Assessment 2006–2007.

Nancy Allen, **Marg Burton**, **Jim Colwell**, **PO1 Nancy Kent**, **Bob MacDonald**, **Lt (N) Blaine Mayo**, **Doug Perrault**, **Alex Ritchie**, **Bill Roger**, **Maj Bob Schwartz**, **LCdr Bob Thwaites** and **Dave Wright** received the DRDC Atlantic Teamwork Award in recognition of their valuable contribution to the success of the QUEST trial Q303 on Human Performance at Sea, through their ability and willingness to exercise exceptional cooperation and collaboration as members of the multi-discipline trial team composed of both national and international representatives.

Roger Alain, **Réjean Beaupré**, **Réjean Bédard**, **Sylvie Doyon**, **Patrick Garant**, **Richard Lambert**, **Raoul Lemieux** (certificate only), **Hugo Lévesque**, **Michel Racine**, **Martin Roy**, **Guy Théberge**, **Éric Verge**, **Michel Verreault** and **Gilles Thivierge** received the DRDC Valcartier Outstanding Performance Award in the Service category for their snow-removal efforts during the course of the winter of 2007–2008, which was remarkable for its exceptional accumulation of snow.

The DRDC Toronto Organizational Achievement of the Year Award was presented to the **DRDC Toronto Renovation Project** in recognition of its outstanding contribution to the implementation, coordination and impact mitigation of the project. The award was presented to past and present members of the **Infrastructure and Environment** and **Information Technology Services Groups** of Corporate Services, the **Section Relocation Coordinators**, the **Military Administration Group**, **DRDC Infrastructure and Environment**, **Defence Construction Canada** and the **DRDC Toronto Corps of Commissionaires**.

Financial Statement



Financial Statement

This table summarizes the funds DRDC received and expended in fiscal year 2007–2008 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	98,921	111,287	(12,366)
Operations and Maintenance	32,570	37,702	(5,132)
Research & Development (R&D) Contracting	84,000	96,875	(12,875)
Capital — R&D Equipment, Construction	7,490	19,601	(12,111)
Environment	3,000	478	2,522
DRDC CSS — Salary & Wages, Operations & Maintenance, R&D Contracting	41,486	19,948	21,538
DRDC CSS — Capital Equipment	6,000	749	5,251
Revenue	(3,500)	(3,957)	0,457
Total	**269,967**	**282,683**	**(12,716)**

Notes

- DRDC CSS is the DRDC Centre for Security Science.
- The variance in salary and wages is due to increased expenditures in terminable allowances, retention pay for defence scientists and higher staffing requirements.
- The variance in R&D contracting is due to a budget adjustment to support higher levels of activity.
- The variance in capital funding is due to an increase in funding to benefit from capital investment opportunities such as the upgrade of Information Management / Information Technology and other equipment.
- The variance in DRDC CSS expenditures is due to the carry forward of unspent funding to future years. Since DRDC CSS is still in the developmental stage, it needs more time to establish its relationships and partnerships before it becomes fully operational.

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 science and technology — in addition to a Chief of Staff organization, an operations centre and a corporate services centre.

Defence R&D Canada — Atlantic

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

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 — 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 and artificial intelligence systems. The Counter Terrorism Technology Centre is co-located with and supported by DRDC Suffield and specializes in live agent training and chemical/biological testing and evaluation.

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 — 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 — Centre for Operational Research and Analysis (CORA)

DRDC CORA is our centre of excellence for operational research and the prime delivery center for decision support to the Canadian Forces and the Department of National Defence. Its efforts span 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 science and technology services and support to Public Safety Canada to address national public safety and security objectives. DRDC CSS also manages the Chemical, Biological, Radiological-Nuclear and Explosives Research and Technology Initiative, the Public Security Technical Program and the Canadian Police Research Centre.

Defence R&D Canada — Chief of Staff (Science and Technology)

The Chief of Staff (Science and Technology) organization is responsible for providing corporate leadership for DRDC. The Chief of Staff is a member of the DRDC executive and represents the organization on behalf of the Assistant Deputy Minister (Science and Technology).

Defence R&D Canada — Science and Technology Operations

DRDC Science and Technology Operations provides central coordination and strategic planning of science and technology programs through interfaces with our partner 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 S&T 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 developed in consultation with our partner groups in the following areas: Integrated Capabilities; Maritime; Land; Air; Personnel; Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance; and Personnel Protection. We also provide strategic scientific and technical policy and advice.

The DRDC 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 2007–2008, the total value of our science and technology program was approximately $358 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.

Integrated Capabilities

The Integrated Capabilities science and technology program aims to achieve objective and timely decision support, anticipate future challenges, and foster innovation through various projects and initiatives to ensure that the Canadian Forces and the Department of National Defence have the capabilities necessary for assigned missions in line with defence policy. The program is executed through three research thrusts: Strategic and Future Environment; Capability Development, Maintenance, Support and Costing; and Special Forces.

Maritime

The Maritime science and technology program identifies specific objectives and activities to be pursued, and outputs to be produced, for the Maritime partner group. It also identifies the resources required to meet the science and technology priorities established by the partners for ships, submarines and maritime aircraft, and their systems. The program is arranged in six thrusts: Above-Water Warfare, Maritime Command and Control, Underwater Warfare, Naval Platform Technology, Maritime Domain Awareness and Integrated Maritime Decision Support.

Land

The Land science and technology program provides leadership and expertise to the army and other stakeholders to define concepts, analyze options and develop capabilities for land operations. The program complements the forward-looking developments with support to the capabilities currently being acquired under capital equipment projects. The program is organized along six thrusts: Command, Sense, Act, Shield and Sustain, which parallel the army's operational functions, and Integrated Land Analysis.

Air

The Air science and technology program supports the air force goals of integrated Canadian Forces operations at home and abroad by the discovery, development and integration of advanced sciences and technologies. The program is delivered through six thrusts, created in accordance with the air force functions terminology from the aerospace doctrine: Command, Sense, Shape, Move, Sustain and Analyze.

Personnel

The Personnel science and technology program is designed to provide scientifically valid advancements in human resources and social science knowledge in areas that substantially benefit the Department of National Defence and the Canadian Forces in the pursuit of operational tasks and missions or departmental priorities today and in the future. The program is executed through three thrusts: Plan, Recruit and Train; Prepare, Support and Recognize; and Individual and Organizational Operational Effectiveness.

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

The C4ISR science and technology program supports the joint and national-level commander and staff in fulfilling the roles outlined by the Defence Planning, Reporting and Accountability Structure. Its scope includes work on communications, information and knowledge management, information architecture and information technology, information operations, national-level and joint command and control, surveillance, intelligence and space. The program comprises five thrusts: Command and Control, Communications and Computer Network Operations, Intelligence, Surveillance and Space, and Scientific and Technical Intelligence Support and Advice.

Personnel Protection

The Personnel Protection science and technology program aims to improve operational effectiveness and to decrease morbidity and mortality in military personnel. To effect these ends, the program covers a broad spectrum of short- to long-term activities, embodies technologies and defence applications relevant to optimizing the protection of personnel, and is achieved through the efforts of DRDC, scientists, contractors, military personnel, and our national and international collaborators. The program is packaged into three thrusts: Human Integration, Hazard Protection and Medical Intervention.

Strategic scientific and technical policy and advice

DRDC provides strategic policy and 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 DRDC Science and Technology 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 seven partner groups.

Applied Research Program

The Applied Research Program is DRDC's main research and development program and is made up of projects distributed among the seven partner groups previously mentioned. Its objective is to advance the knowledge base of defence science, investigate novel and emerging technologies, and explore the military application of those technologies within the Canadian Forces.

Technology Demonstration Program

The Technology Demonstration Program (TDP) demonstrates technologies fostered by DRDC and Canadian industry in the context of real and potential future Canadian Forces capabilities, concepts, doctrine, operations and equipment. The TDP is aimed at concept development and evaluation for force design purposes and is therefore typically not focussed on hardware development.

Technology Investment Fund

The Technology Investment Fund supports forward-looking, high risk — but potentially high-payoff — research projects to ensure a dynamic DRDC technology portfolio consistent with the *Defence S&T Strategy*, and that will lead to important new in-house competencies.

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
Patents, Licences and Royalties

DRDC manages its intellectual property (IP) through patents, copyrights, trademarks and licences. Over the course of the year, we were granted 16 patents and filed 18 applications.

The following patents were granted during fiscal year 2007–2008:

- Flared Wave-Guide Projector
- Axial Drive Resonant Pipe Projector
- Hidden Markov Modelling for Radar Electronic Warfare
- Standoff Radiation Imaging Detector
- Genetically Biotinylated Recombinant Antibody in Immunofiltration Assay by Light Addressable Potentiometric Sensor for Identification of Venezuelan Equine Encephalitis Virus
- Use of Cross-Protection to Identify Novel Vaccine Candidates for Infectious Agents
- Comfort Liners for Chemical Protective and Other Impermeable Polymer Gloves
- DNA-Based Vaccine against the Encephalitis Alphaviruses
- Construction and Characterization of Monoclonal Antibodies against Western Equine Encephalitis Virus
- A Method for Estimating Systolic and Diastolic Blood Pressure and Heart Rate in Noisy and Vibration Intensive Environments
- High Resolution 3D Ultrasound Imaging System Deploying a Multi-Dimensional Array of Sensors and Method for Multi-Dimensional Beamforming Sensor Signals
- Regionally Thinned Microstructures for Microbolometers
- Simplified Biofidelic Lower Leg Surrogate
- Infrared Imager
- Depositing Metal Particles on Carbon Nanotubes
- Independent Temperature and Apparent Colour Control Technology for Adaptive Camouflage Applications

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

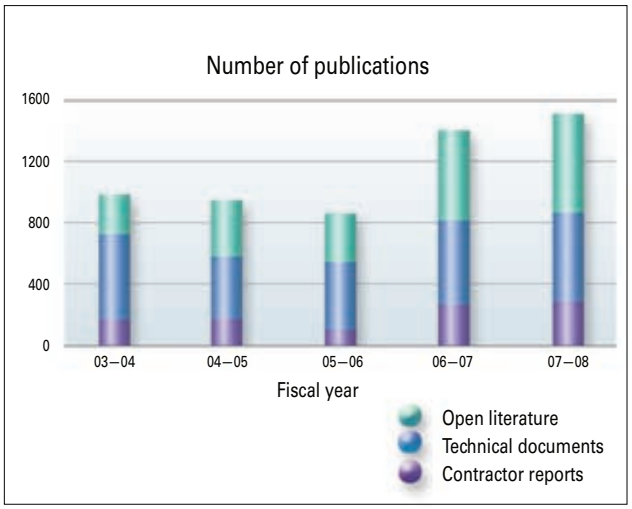
- Crawley Creatures Limited for the CB^{plus} Mannequin
- AirBoss-Defense for the C4 Mask
- University of Waterloo for the Urban Flow and Dispersion Software
- Les Ateliers Non-Tech Inc. for the Thermal Heat Shield Fabric
- EMS Technologies Canada Ltd. for the Cold Exposure Survival Model (CESM) Algorithm
- Cyto Bio Technics Inc. for Brucellosis Vaccine Technologies
- Mustang Survival Corp. for the Sting Lower Garment

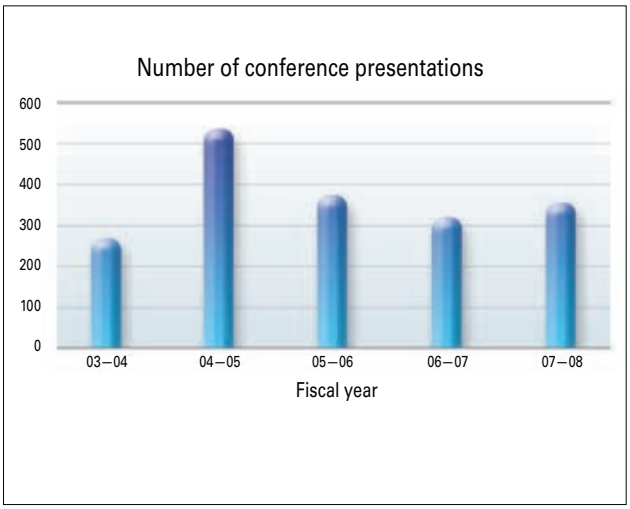
We received $1.8 million in royalties; of this amount $451,608 went to our inventors.

Appendix 4
Publications and Conference Presentations

By promoting the results of our science and technology 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.



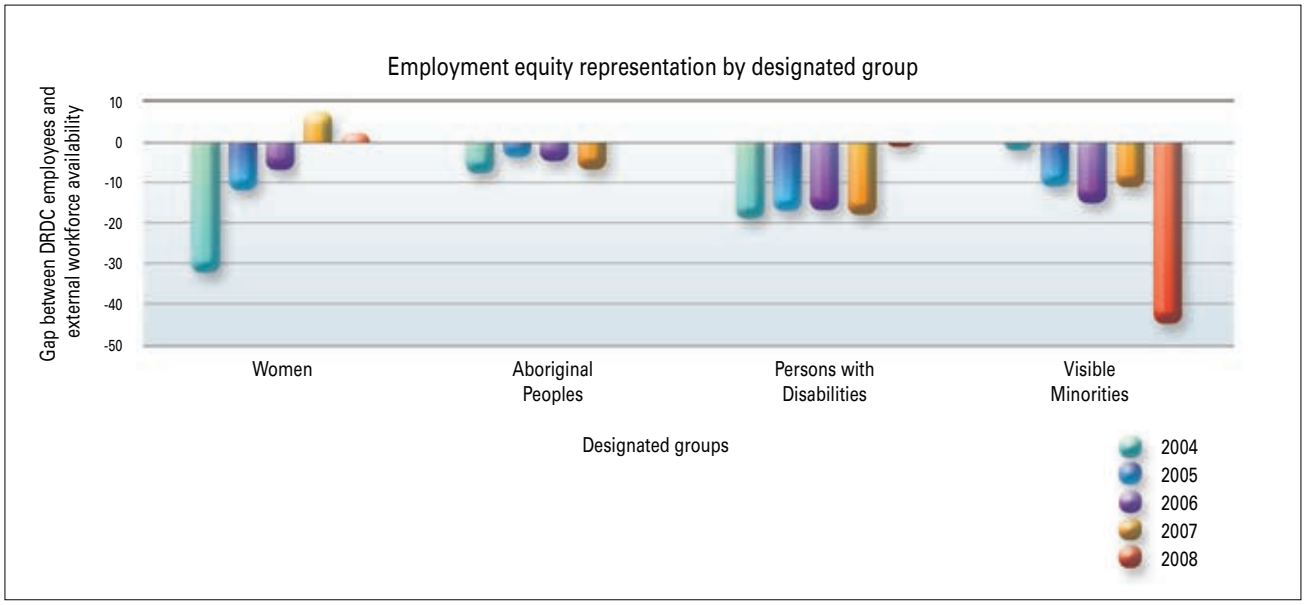


Appendix 5
Employment Equity Representation

The chart below shows DRDC's progress over the last five years in building a workforce that is increasingly representative of the composition of the Canadian population.

The data show the gap between the number of our employees from designated groups and the external workforce availability, and highlights a significant variance with regard to the representation of visible minorities.

However, DRDC has continued to make progress, particularly with regard to the representation of women and Aboriginal peoples. These improvements were made possible due to recruitment efforts sensitive to those in designated groups. In addition, we continued our efforts to raise awareness of diversity within the organization and particularly within our leadership cadre. DRDC will continue to find ways to reduce the gaps, with a particular emphasis on visible minorities. One of the actions we are taking to address the challenge with respect to visible minorities is to encourage self-identification, which helps to ensure an accurate representation of the composition of our workforce.



Appendix 6
International Agreements

DRDC's collaborations are carried out with allied countries under a number of international agreements, such as The Technical Cooperation Program (TTCP); the North Atlantic Treaty Organization (NATO) Research and Technology Organization (RTO); the Multilateral Master Information Exchange Memorandum of Understanding (MOU) with Australia, New Zealand, the United Kingdom and the United States; the MOU concerning cooperative science and technology with The Netherlands; and the Trilateral Technology Research and Development Projects agreement with the United Kingdom and the United States. These agreements are very important to DRDC as they promote interoperability with our allies, facilitate collaboration, and help us obtain the most efficient and cost-effective results through cooperation in joint research activities.

The table below lists the international agreements in which DRDC participated and the approximate number of projects associated with each agreement in fiscal year 2007–2008.

AGREEMENT	NO. OF PROJECTS
Bilateral with Australia	9
Bilateral with France	16
Bilateral with Germany	3
Bilateral with The Netherlands	6
Bilateral with the United Kingdom	10
Bilateral with the United States	25
Counter Terrorism MOU with the United States	14
Trilateral with The Netherlands and Sweden	13
Multilateral on chemical, biological and radiological defence	13
Multilateral Master Information Exchange MOU	4
Multilateral with other countries	21
Trilateral Technology Research and Development Projects	1
North Atlantic Treaty Organisation (NATO)	17
NATO Research and Technology Organisation	116
Other agreements	5
Public Security Technical Program	10
The Technical Cooperation Program	300
Total	**583**

Table 1

Value of DRDC S&T Program by partner group

PARTNER GROUP	INTERNAL COSTS[1] ($000)	R&D CONTRACTS ($000)	EXTERNAL CONTRIBUTIONS[2] ($000)	TOTAL VALUE ($000)
Integrated Capabilities	705	420	240	1,365
Maritime	25,471	17,541	19,011	62,023
Land	26,050	26,908	21,888	74,845
Air	13,942	14,979	22,280	51,201
Personnel	0	0	0	0
Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance	26,194	24,402	34,544	85,141
Personnel Protection	18,813	18,802	22,306	59,922
Strategic S&T Policy and Advice	14,406	4,304	4,648	23,358
Total S&T Program	**125,582**	**107,357**	**124,917**	**357,855**

[1] Internal costs include salary and wages, overhead, and operations and maintenance.

[2] 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[1] ($000)	OPERATIONAL[2] ($000)	TACTICAL[3] ($000)	TOTAL VALUE ($000)
Command and Control	9,500	31,012	16,887	57,400
Information and Intelligence	26,160	16,074	18,904	61,138
Operations: Conduct	2,311	30,994	33,219	66,525
Operations: Mobility	1,284	1,373	0	2,656
Operations: Protect	0	36,371	61,191	97,562
Sustain	11,204	27,542	4,386	43,133
Generate	12,545	9,888	6,291	28,723
Corporate	718	0	0	718
Total S&T Program	**63,722**	**153,254**	**140,879**	**357,855**

[1] 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.

[2] 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.

[3] 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

PARTNER GROUP	TIME HORIZON I[1] ($000)	TIME HORIZON II[2] ($000)	TIME HORIZON III[3] ($000)	TOTAL VALUE ($000)
Integrated Capabilities	956	341	68	1,365
Maritime	25,749	22,961	13,314	62,024
Land	20,846	29,980	24,020	74,845
Air	20,709	17,920	12,572	51,201
Personnel	0	0	0	0
Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance	32,261	29,673	23,207	85,141
Personnel Protection	26,482	18,701	14,738	59,922
Strategic S&T Policy and Advice	17,461	3,850	2,048	23,358
Total S&T Program	**144,463**	**123,426**	**89,966**	**357,855**

[1] 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.

[2] Time Horizon II refers to the replacement of current capabilities and includes projects expected to come to fruition within five to ten years.

[3] Time Horizon III refers to the acquisition of new capabilities and includes projects that extend ten years and beyond.

Contact Information

DRDC publishes its Annual Report to describe its operations for the fiscal year covered by the report, and includes information about its performance and any other information that the Deputy Minister of National Defence may require.

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 public security. We invite you to get in touch with us should you have any suggestions or questions.

For more information or additional copies of this report, please contact:

Director Science and Technology Enterprise Affairs
Defence R&D Canada
Department of National Defence
Constitution Building, 8th Floor
305 Rideau Street
Ottawa ON K1A 0K2

The electronic version of this report is available on our web site:

www.drdc-rddc.gc.ca

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