Defence Research and Development Canada

Recherche et développement pour la défense Canada

DEFENCE R&D DÉFENSE

# New Challenges New Opportunities

# Annual Report

FOR THE YEAR ENDING 31 MARCH 2007

Canada

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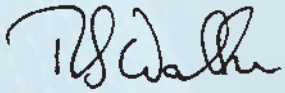
# Message from the Chief Executive Officer

*In response to the defence and security challenges facing Canada, the Canadian Forces are committed to no-fail operations, most notably in Afghanistan, and to transformation to ensure their relevance in future conflict. Science and technology (S&T) can effectively support the Canadian Forces in both areas by contributing directly to the advancement of Canadian military capabilities. However, fully realizing this potential requires the ability to identify and adapt to new opportunities presented by science and technology, and to apply their results across the full spectrum of departmental and Canadian Forces decision making.*

2006 marked a major milestone in defence science in Canada with the release of the *Defence S&T Strategy*, the first ever pan-departmental guidance document for its defence science and technology investment. In a developmental effort led by DRDC, the *Strategy* provides a compelling vision, specific expectations and concrete actions. The implementation of the *Strategy* will strengthen interactions among the many players across the defence institution and with external science and technology performers, and within an effective governance structure.

Our goal is simple: to ensure that Canada's needs in science and technology for defence and security, whether at home or abroad, are consistently met. We do this by striving to maximize the impact of the Department of National Defence's investment in science and technology. We provide crucial support to the Department and the Canadian Forces through planning, research, analysis, development and experimentation. We lay the groundwork to achieve a better return on our investment by engaging in strategic partnerships with other government departments, allies, industry and academia. And we deliver innovative new technologies that offer the Canadian Forces a decisive advantage and that strengthen the security posture of the nation.

I am proud of the progress we have made over the past year. The teamwork, dedication and perseverance that each DRDC employee exhibits have resulted in the many accomplishments outlined in this year's Annual Report. These achievements also show that we are up to the challenges we expect to face as we implement the *Defence S&T Strategy*, and that we are poised to take full advantage of the resulting opportunities.



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 strengthen the impact of science and technology for defence and public security and maximizes the Department of National Defence's investment in science and technology for the Canadian Forces and for Canadians.*

- The chapter entitled "A New S&T Strategy for Defence" describes the role played by science and technology in the transformation of the Canadian Forces and in the alignment of the defence institution, and points the way forward to maximizing the impact of the Department of National Defence's investment in science and technology.

- "S&T Results for Defence and the Canadian Forces" highlights those of our activities that support the core internal processes of the Department of National Defence and the Canadian Forces.

- "Strengthening Public Security" outlines some of our efforts to inform, enable and respond to the public security needs of Canada and our allies.

- "Partnering for Increased S&T Results" describes the augmentation of our scientific and technological capabilities through international and national collaboration and the engagement of our clients, partners and stakeholders.

- "Boosting Impact 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 2006–2007, and the "Appendices and Tables," which provide additional information about our operations, our research centres and our program.

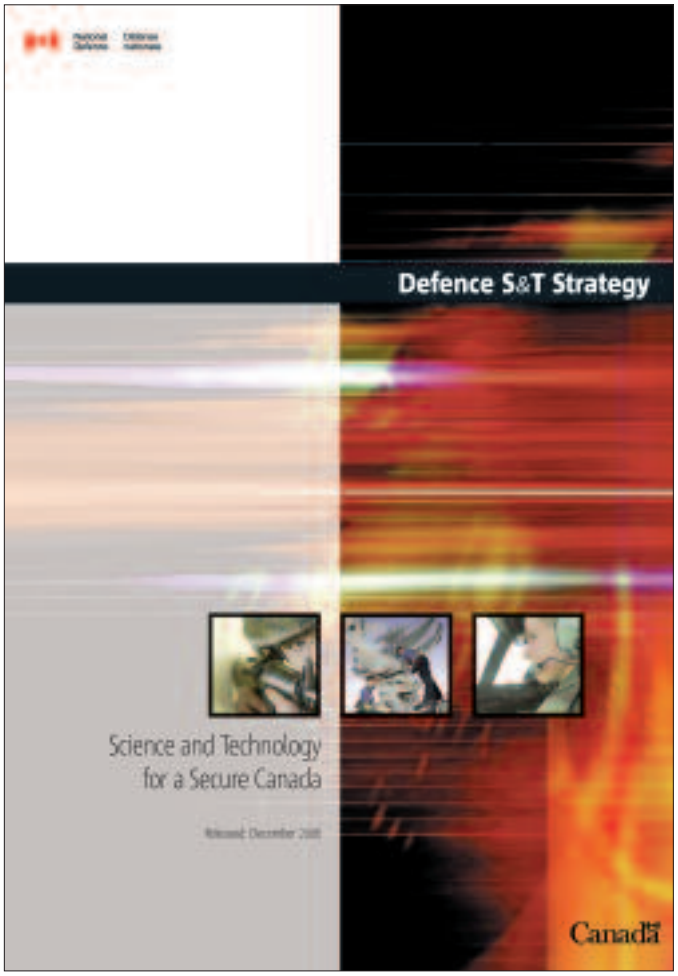
# A New S&T Strategy for Defence

*Science and technology (S&T) plays a central role in military affairs and contributes to the advancement of military capabilities. It also affects the global geo-political and economic systems that shape Canada's interests and, indirectly, the roles assigned to its military.*

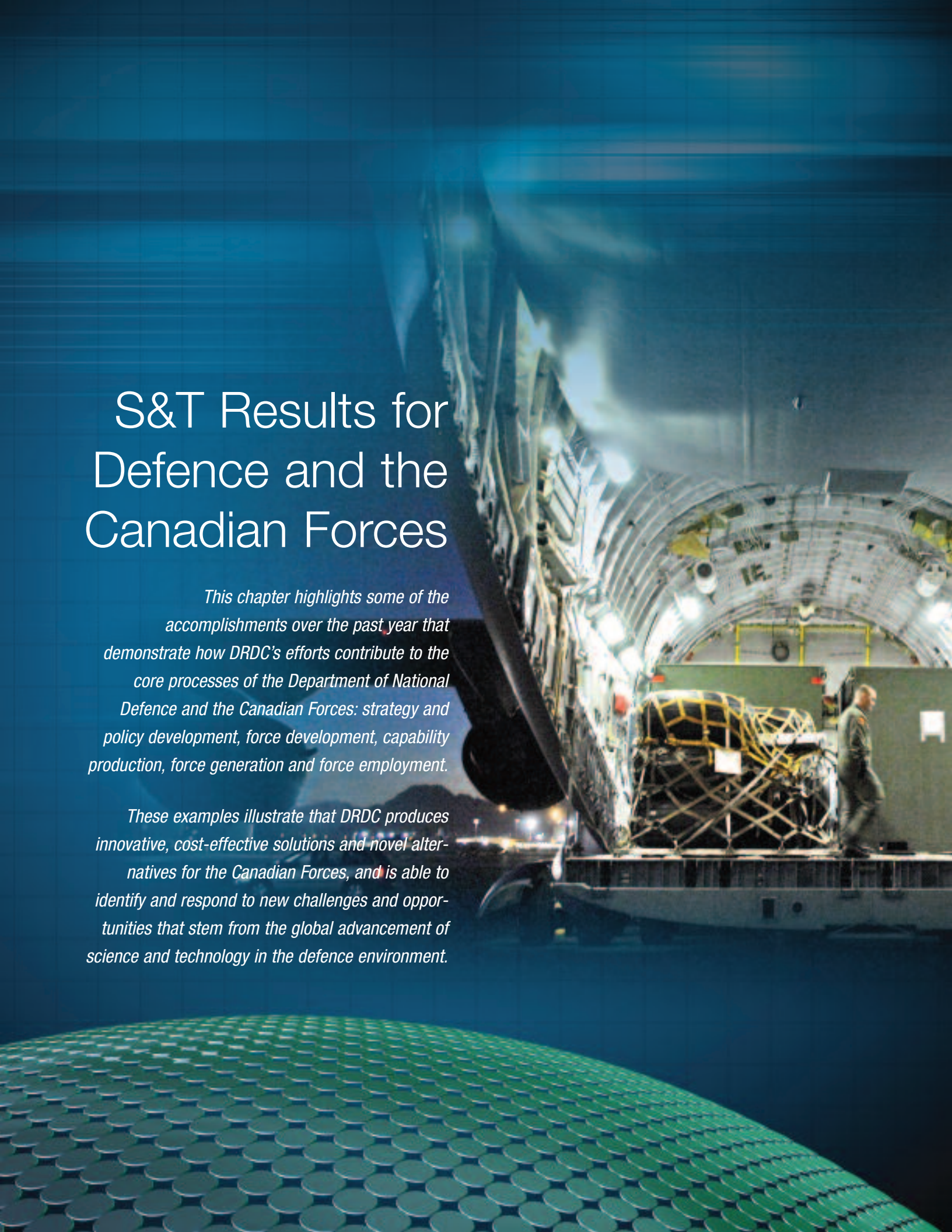
The global advancement of science and technology in this new era presents a significant opportunity for rapid and cost-effective improvements to the Canadian Forces' capabilities that provide decisive advantage. At the same time, this proliferation provides Canada's adversaries with the potential to use asymmetric means to counter our military capabilities or target Canada's vital interests. Therefore, science and technology presents both opportunities and threats, and these influence decisions regarding the departmental investment in science and technology.

Through the investment made in science and technology, the Department of National Defence and the Canadian Forces recognize the important role that science and technology plays in Canadian Forces transformation and operations, and in the alignment of the defence institution with both the transformation and with wider government agendas.

DRDC led the development of the *Defence S&T Strategy* which establishes the conditions for maximizing the impact of the departmental investment in science and technology by ensuring that it is aligned with priorities, is properly harnessed to be a force multiplier, and is duly supportive of the defence institution and its core business processes. The strategy is intended to guide the appropriate positioning of this investment so that science and technology informs, enables and responds to Canada's defence and security priorities in the areas where the Canadian Forces and the Department are expected to contribute. Specifically, the investment is expected to enable the departmental science and technology community to make decisions and resolve important problems; to anticipate, assess and advise on the implications of emerging and potentially disruptive science and technology; and to assess, mature, position and transition technologies for the benefit of the Canadian Forces and the Department.




**The *Defence S&T Strategy***



# S&T Results for Defence and the Canadian Forces

*This chapter highlights some of the accomplishments over the past year that demonstrate how DRDC's efforts contribute to the core processes of the Department of National Defence and the Canadian Forces: strategy and policy development, force development, capability production, force generation and force employment.*

*These examples illustrate that DRDC produces innovative, cost-effective solutions and novel alternatives for the Canadian Forces, and is able to identify and respond to new challenges and opportunities that stem from the global advancement of science and technology in the defence environment.*

# Strategy and Policy Development

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

## OPERATIONAL SUPPORT TO THE CHIEF OF THE DEFENCE STAFF

To support the department's inputs to the *Canada First* Defence Strategy, DRDC personnel embedded with the Department of National Defence, Directorate of Defence Analysis, built a multi-criteria decision aid that would help senior military leaders to make choices amongst different force options within the Canadian Forces. Force options are packages of military capability that are able to meet the objectives of Canadian Forces missions.

DRDC developed a new tool called the Capability Discussion Matrix (CapDiM), which gathers multiple criteria assessments from subject-matter experts and uses these as weights to prioritize the force options. This toolset also incorporates the full thirty-year strategic costs of the force options. DRDC subsequently facilitated CapDiM exercises with senior leaders to populate the tool with the required data.

**A Capability Discussion Matrix gathers multiple criteria assessments and uses these as weights to prioritize the force options**

The toolset produces "Bang for buck" graphs in which the policy relevance of each of the force options is plotted against its cost. The graph identifies which force options are most relevant to policy, and the portion of the defence budget they would require.

Thanks to this project, senior military leaders and strategy developers are able to rapidly and strategically gain a quantitative sense of the value of each force option, identify those that combine policy relevance with supportable resources, and determine the possible trade-offs.

## SUPPORTING THE ACQUISITION OF AIR MOBILITY FLEETS

To provide analytical support to the air force for the establishment of the broader requirements for future fixed-wing air mobility fleets, DRDC first developed a simple "snapshot in time" simulation to replicate the spectrum of future demands on air mobility assets and to evaluate how often the air force could expect to meet the demands, given a range of feasible options for fleet mix. The various fleet mixes under consideration included different numbers and types of existing military aircraft mixed with potential new acquisitions.

Secondly, we conducted a risk analysis of strategic airlift to quantify the risks associated with reliance on chartered commercial transport or on allies' strategic airlift. Thirdly, we acquired AMOS, a detailed "time and space" simulation of airlift operations over an extended period of time, from the U.S. Air Force, for potential use as a vehicle to analyze issues that could arise as the new air mobility fleets come into service.

The outputs of these three activities form an air mobility analysis tool kit that will continue to support decisions on a wide range of issues as the fixed-wing air mobility fleets come into service. As a result of this work, the government's decision to acquire new fleets of transport aircraft was made with a fuller knowledge of the level of capability that was being acquired.

## DEFENDING CANADA'S SOVEREIGNTY IN THE ARCTIC

In 2005, the Government of Canada made a commitment to assert Canada's sovereignty over its Arctic territory. In response to this commitment, DRDC established a northern science and technology working group in April 2006 for the purpose of developing a high-level roadmap of

**The CC-177 *Globemaster* was one of the options included in the study of air mobility fleets**

possible science and technology activities that would address overall northern security capability requirements in the surveillance, enforcement, human and sovereignty dimensions.

The working group met on a regular basis and held two workshops, which resulted in the development of a proposal for a Northern Watch technology demonstration project that has since been approved. The working group also conducted several studies related to northern surveillance and prepared a report on the potential use of hovercraft for conducting patrols in northern ice-covered waters.

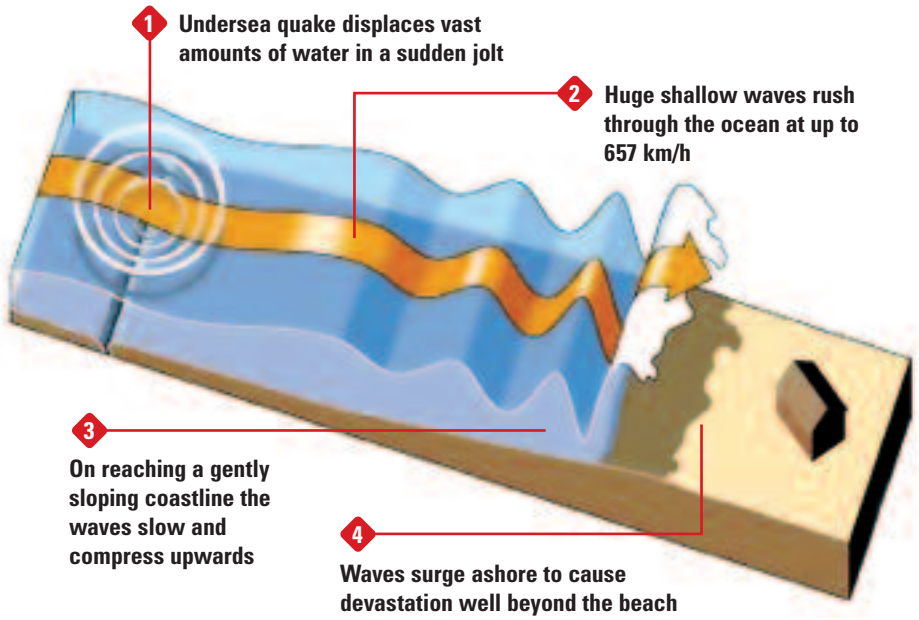
The Northern Watch project aims to identify and characterize combinations of sensors and systems that could provide a cost-effective recognized maritime picture for the Canadian Arctic. This will address gaps in surveillance capability in Canada's North that had been identified by previous research studies and confirmed through consultation with the Department of National Defence, the Canadian Forces and other government departments. The experimental deployment of these systems is required to effectively understand the environmental effects and the full costs associated with carrying out such activities in the North.

## EXAMINING THE EARTHQUAKE AND TSUNAMI THREAT TO CANADA'S WEST COAST

The west coast is the most seismically active region in Canada. As a result, earthquakes are a credible threat to population centres and Canadian Forces assets in this region. The Department of National Defence asked DRDC to assist with analyzing and quantifying the threat posed by earthquakes and tsunamis in the Esquimalt Harbour, the city of Victoria, Vancouver and the lower mainland, and the impact that these phenomena could have on population centres and vital installations.

We collected scientific information on earthquakes and tsunamis through a literature review, as well as by liaising with subject-matter experts. We interpreted this scientific information and condensed it into a form that would be relevant and pertinent to military planners, and then presented the findings to the Commander, Canada Command, and to the Commander, Joint Task Force Pacific.

Through interaction with experts from Natural Resources Canada and Fisheries and Oceans Canada, we opened a two-way communication channel to allow us to gather information relevant to the Department of National Defence, as well as to influence future research so that issues important to the Department would be taken into account. The results of this work will assist in positioning the Canadian Forces to respond effectively to catastrophic earthquake and tsunami events.




**A cross section of the cause and effects of undersea earthquakes and tsunamis**

# Force Development

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

## SUPPORTING THE ARMY OF TOMORROW

The "Army of Tomorrow" force employment concept is a capabilities-based operating theory that projects forward to the army of 2021. It describes the functional and enabling factors and capabilities needed by the army of tomorrow to operate in the strategic and operational settings of that era. The concept includes such elements as non-lethal means, as well as the roles of light and medium forces, the army's approach to organizational structures, and a development methodology to move in the direction of the army of tomorrow.

To support the Army of Tomorrow, DRDC used its Fundamental Investigation of Defence Objectives (FIDO) decision-support package to analyze the priorities of the capability requirements under each of the core elements of the army. With army personnel as subject-matter experts, we used FIDO to assess these elements against the army's commitment to be knowledge-based, strategically relevant, sustainable and tactically decisive. Throughout the year, DRDC personnel participated in several workshops to refine the Army of Tomorrow concepts. In conjunction with army counterparts, they produced an update to the *Future Security Environment* document, described enabling concepts, developed higher-level functional concepts, and helped define adaptive dispersed operations (ADO). They further analyzed and developed the ADO concepts through a series of seminar war games. As has been evident both from conceptual development and from operations in Afghanistan, Canadian land forces will be required in the future to spread resources over wider and wider geographic areas – much greater dispersion than was the case in the Cold War era.

**Training exercises like this one help researchers analyze priorities of the capability requirements of the army**

Army Experiment 9A was a concept-refinement experiment to study the effectiveness of ADO within a whole-of-government campaign in a complex security environment. DRDC supported this experiment by developing war-game databases for the performance of weapons, sensors and platforms by analyzing participant responses to questionnaires regarding the ADO concept, and by examining the level of dispersion and the use of lethal and non-lethal military means in dispersed operations. Traditionally the military has been associated predominantly with lethal means to accomplish its assigned tasks; for example, tank-on-tank engagements. But current and future operations will call upon our military forces to consider many non-lethal means to accomplish their objectives. This may extend to working with local populations to ensure they have sufficient security to develop their own political processes at the community level.


**The Future Sailor Initiative examines how changing Canadian demographics will affect the navy's long-term planning and recruitment structure**

## PLANNING FOR THE FUTURE NAVY

It is a well-known fact that the Canadian population is aging and the size of the working-age population will decline. Future demographic projections indicate that the Canadian workforce will become increasingly diverse as immigration becomes the primary source of future population growth. Over time, Canada will witness the decline of the traditional military recruitment pool. Given the anticipated fierce competition for skilled workers, it is prudent for the navy to consider planning for a reduction in the availability of recruits in the future.

In 2006, the navy embarked upon the Future Sailor Initiative to determine the strategic human resource issues facing Canadian society and, more importantly, how these might impact the navy of the future. The Future Sailor Initiative aims to provide an analytical, strategic input to maritime force development to enable the navy to develop the future fleet in accordance with the societal expectations of the next two decades. This will be achieved through examining demographic and societal trends that will influence recruitment and retention.

To support this initiative, DRDC undertook a study to identify the societal and demographic changes that will impact the navy's future personnel and workforce. We completed the first part of this work – an overview of major Canadian demographic trends and how they are reflected within the navy recruitment population. The study examined a number of Canadian population characteristics to demonstrate the strategic impact that demographics can have for navy planners and naval recruiters.

The results of the analysis will feed into the navy's strategic planning and provide vital information required to support the decision making necessary to determine the way forward for fleet renewal. Two further studies are planned: one on the propensity of youth to join the Canadian Forces and, in particular, the navy; and the other on the impact of these demographic issues on the future personnel system.

## SUPPORT TO CENTRALIZED FORCE DEVELOPMENT

As part of the ongoing transformation of the Canadian Forces, the Chief of the Defence Staff created, in June 2006, a new centralized force development authority, under the Chief of Force Development, to synchronize national and joint force development activities. The intention was to put in place an integrated force development process, guided by strategic intent, which will determine the kinds of capabilities the Canadian Forces will field to meet the demands of future operations.

Through embedded staff in the Chief of Force Development organization, DRDC provided strategic analysis and a science and technology perspective to the new force development process by contributing to the creation and maintenance of the *Future Security Environment* document, the Strategic Operating Concept, and the *Force Planning Scenarios*, and by helping to identify and develop the underlying high-level concepts for future operations and capability.

The *Future Security Environment* document describes the world in which the Canadian Forces might have to operate in 20 years and provides a framework for the development of *Force Planning Scenarios*. The Strategic Operating Concept describes how the Canadian Forces expect to operate in 10 to 20 years and provides conceptual guidance for all follow-on force development activity.

The *Force Planning Scenarios* depict the situations in which the Canadian Forces anticipate conducting operations. They include the full range of domestic, continental and international operations across the full spectrum of conflict, and are intended to inspire the development of concepts and to provide a basis for the development of future military capabilities.

As an ensemble, the *Future Security Environment* document, the Strategic Operating Concept and the *Force Planning Scenarios* help shape the strategic intent of the Canadian Forces and drive the development of future military capability.

## IMPROVED NETWORK SITUATIONAL AWARENESS

The Canadian Forces Network Operations Centre (CFNOC) handles a vast amount of information about the state of Canadian Forces networks. This includes details on incidents, vulnerabilities and network devices and how they are used in operations. DRDC perceived a need for a tool that would assist the CFNOC in interpreting and understanding these and developed the Impact Assessment Tool (IAT).

The aim of the IAT is to improve the CFNOC's capability to interpret and understand network events and to disseminate timely information among its team members. It is a software-based support system consisting of a user interface, a data model and a data repository. The data model allows relationships to be derived between

**CFNOC operators look at a topology view of software that includes the IAT capability**

network events – such as the emergence of a new vulnerability or an alert from an intrusion detection system, and network assets – such as servers and workstations. The IAT provides CFNOC team members with customized user interfaces optimized to support their particular roles.

The CFNOC has embraced the development and the subsequent deployment of the IAT as it has provided them with increased network situational awareness. Feedback from the use of the IAT is finding its way into other projects to help ensure their success for the benefit of the CFNOC.

## ENTITY-BASED MODELLING FOR HUMAN RESOURCES ANALYSIS

Over the last few years, DRDC has been developing the next-generation modelling tools to support the analysis of human resource issues within the Department of National Defence and the Canadian Forces. Using ARENA, a commercial off-the-shelf simulation application for manufacturing, we developed two applications: the ARENA Career Modelling Environment for modelling career progression, and the Production Management Tool to model training pipelines.

Both of these tools use an entity-based approach to modelling, where each individual in the human resources system is represented as an entity, with a select number of attributes representing various demographic and employment characteristics. While spreadsheets and stock and flow models can be useful for solving problems that call for the analysis of effects on one or two attributes, entity-based models are required to examine the interaction of policies and plans in several dimensions or attributes.

Within the Department and the Canadian Forces, these tools were successfully used to forecast individual training and education requirements; to assess the impact of career fields or restructured occupations on recruiting, promotion and attrition; to examine succession planning issues for general officers in the military; and to analyze current and future schedules for human resource production.

This approach to human resources forecasting has gained tremendous interest both in Canada and with our allies in The Technical Cooperation Program. The Canadian distributor of ARENA has embraced its application to human resources issues and has developed a niche market providing analytical human resources services to both the private and the public sectors. Statistics Canada has also embraced the approach as a replacement for their human resources modelling paradigm.

**In the entity-based approach to modelling, each individual in the human resource system is represented as an entity with a select number of attributes**

# Capability Production

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

## IMPROVING SITUATIONAL AWARENESS ON THE BATTLEFIELD

When brought into service in the mid 1990s, the *Coyote* represented the state-of-the-art in battlefield surveillance systems. In many respects, the system is still at the leading edge. However, the advent of tactical battlefield networks, battlefield management systems and improved data processing and communications rates allow us to pursue system improvements in three key areas under the Advanced Linked Extended Reconnaissance and Targeting (ALERT) project. ALERT aims to deliver exploitable results in the areas of fused multi-sensor tactical reports, automated target cueing, and beyond-line-of-sight sensing.

In the period covered by this report, the ALERT project made great strides forward. Drawing on two interactive sessions with Canadian Forces surveillance operators, we developed concepts for a soldier-machine interface to control multiple sensors and effectively display the sensor images and data. The project also delivered both image processing algorithms for automatically cueing a surveillance operator's attention on targets in images, and a facility for assessing the performance of such algorithms. Finally, ALERT provided detailed technical guidance for two Canadian Forces projects developing future capabilities for the *Coyote*.

**Canadian Forces surveillance operators inside the *Coyote***

**The *Coyote* during testing for the ALERT project**

ALERT will bring the *Coyote* into the ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance) -enabled battlefield network. As a result, overall situational awareness is expected to increase at all levels of command.

## PROTECTING THE GLOBAL POSITIONING SYSTEM

The use of the global positioning system (GPS) is fundamental to all of today's military operations and is critical in tomorrow's net-centric environments. It is usually taken for granted that the system is dependable and will always be functioning when required. However, adversaries are aware of the extent of the reliance on the GPS and will attempt to jam, falsify or otherwise disrupt vulnerable GPS signals.

In the past year, DRDC engaged in numerous activities in support of navigation warfare (NAVWAR), which is electronic warfare as applied to global navigation satellite systems (GNSS), the most important of which is the GPS. We completed the development of the NAVWAR Test Range, a set of nine sophisticated field-deployable GPS jammers that are controlled from a single integrated control centre. We also took delivery of a new GPS simulator that replicates the complete GPS constellation and all current satellite signals, as well as a highly sensitive direction-finding system that is being used to test specialized algorithms that we developed to detect and determine the direction of specific jamming threats.

The potential impact of GPS navigation warfare on military operations is significant. The current military GPS signals will be insufficient in tomorrow's GNSS world. As a result of the work being conducted in this area, DRDC is striving to ensure that the best and most affordable NAVWAR-capable GPS equipment is deployed to the field to protect our soldiers in combat situations.

**Electronic warfare tests on military and commercial GPS receivers in an urban environment**

## ENHANCED COMMUNICATIONS BETWEEN AIR, LAND AND SEA

In March 2007, DRDC's Networked Underwater Warfare project showcased significant advances in net-centric warfare during its final demonstration at sea. Through its unique information management system, the project successfully exchanged detailed tactical data between warships, submarines, maritime patrol aircraft and a shore-based support centre, over limited bandwidth connections. The support centre was connected via a satellite connection, while the remaining at-sea assets used the Sub-Net Relay system, a technology developed by DRDC in an earlier research project, which is now a commercial off-the-shelf system that provides a radio frequency network based on Internet Protocol.

Canadian and United States assets were used in the trial and, for the first time, command staff at all levels were able to work collaboratively over the network to create a common understanding of the underwater operating picture. The virtual team of air and surface platforms exchanged information and used chat and common chart tools embedded in the network-enabled combat system.

The demonstration resulted in a common awareness of the battle space and an enhanced ability to detect, localize and track submarines and other underwater targets as an integrated force with synchronized effect.

## FASTER COLLECTION OF SEABED MEASUREMENTS

Historical databases of seabed and water column characteristics, such as water temperature, salinity and pressure, employed to optimize the use of sensors for antisubmarine warfare and mine countermeasures operations, are rare and, when they do exist, often unreliable. To address the requirement for an in situ measurement capability, DRDC took its Free Fall Cone Penetrometer Test (FFCPT), a tool for the rapid environmental assessment of seabed and water column properties that was developed for the Canadian navy, and

**The support centre for the Networked Underwater Warfare trial**

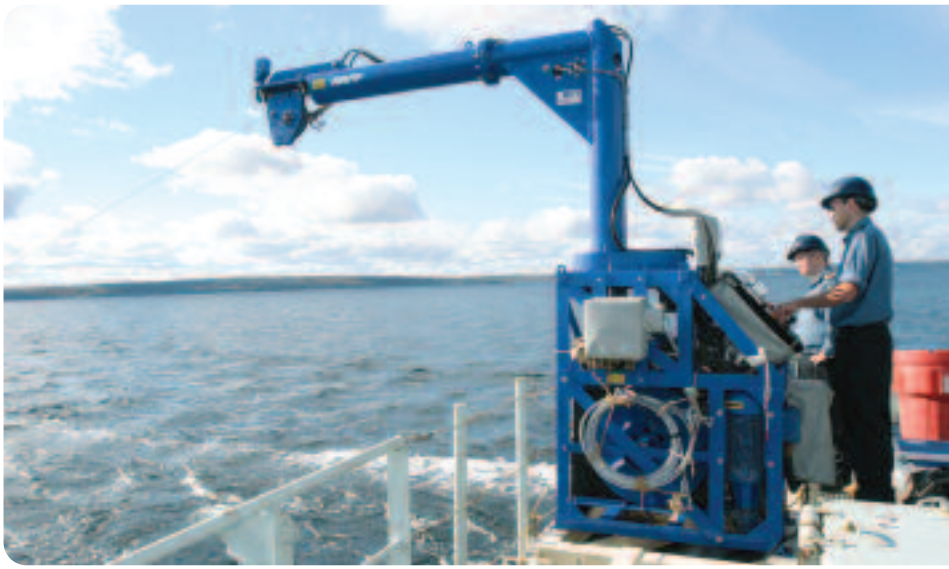
**DRDC personnel recover the Free Fall Cone Penetrometer Test**

integrated it with a computer-controlled winch, the Moving Vessel Profiler (MVP). Rapid environmental assessment involves the collection and dissemination of environmental information in a tactically relevant time frame.

As a result of integrating the FFCPT with the winch, operators of the MVP are able to obtain seabed parameters from a vessel moving at speeds up to eight knots, with minimal impact on other operations. In relation to traditional methods of making in situ seabed measurements from a stationary vessel, such as cores or conventional cone penetrometer tests, this integration offers a tenfold increase in the speed of data collection.

We conducted a developmental evaluation of the MVP on HMCS SUMMERSIDE in October 2006, during which the system was demonstrated to representatives of the Canadian Forces Route Survey and the Meteorology and Oceanography Halifax units. Subsequently, the Canadian Forces have made a request to purchase two systems for operational use.

The Moving Vessel Profiler will enhance the predictions from numerical models of sonar performance and of the presence of buried sea-mines, both of which require accurate seabed characteristics. In addition to its military applications, the system has the potential for exploitation in numerous scientific and commercial areas, such as ground-truth data for acoustic seabed classification systems, surveys for pipelines and cable routes, dredge sites and habitat surveys for sea or lake-bottom organisms.



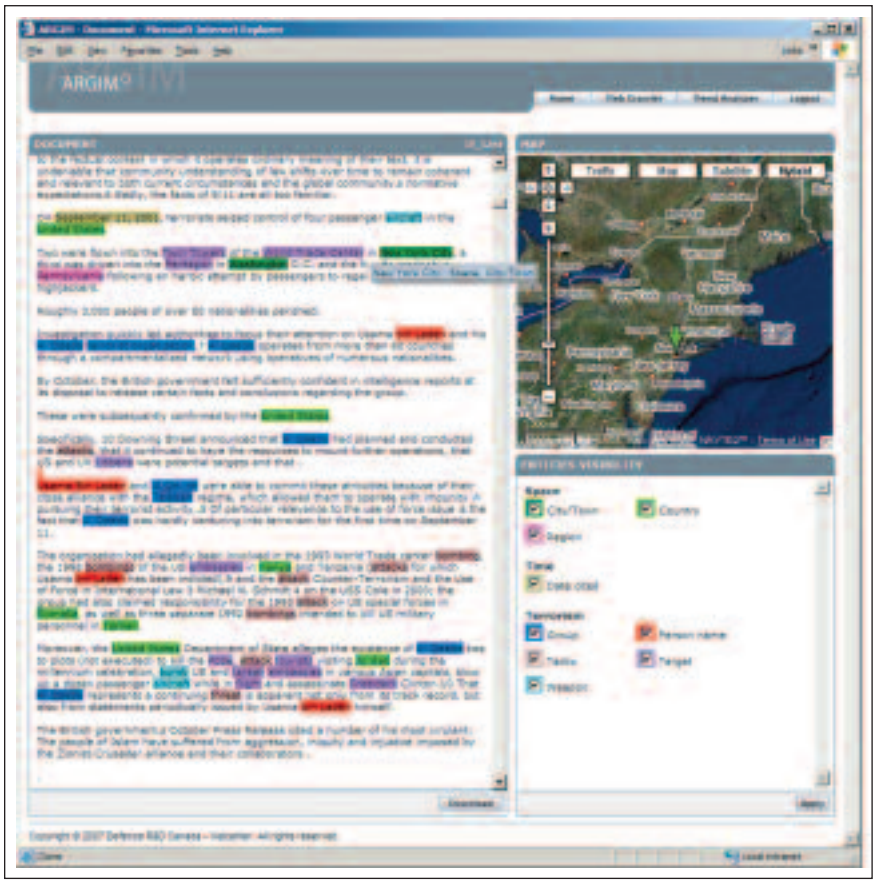
**Personnel operate the Moving Vessel Profiler**

## EXPLOITING GEOSPATIAL INFORMATION

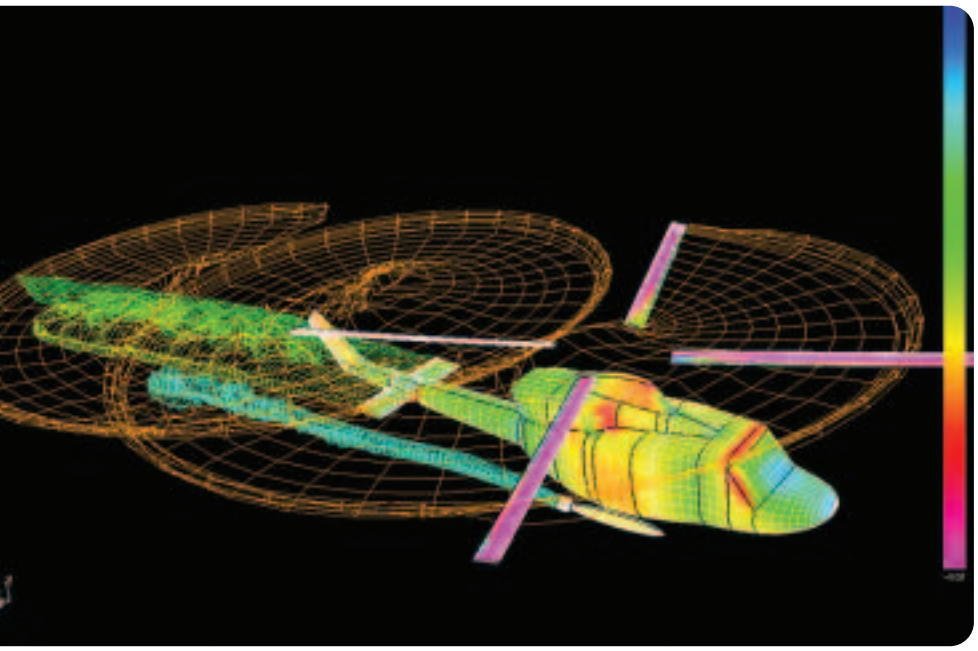
Maintaining awareness of information and intelligence requires analysts to cope with ever increasing amounts of data and information. To facilitate the collection, management and analysis of information, DRDC embarked upon the Applied Research for Geospatial Information Management (ARGIM) project. The primary objective of the ARGIM project is to develop new information exploitation capabilities to rapidly identify place names, person names, organizations, people, dates, times, events and any entity of interest in unstructured text, and to automate and support the analysis of the relationships that might exist among all these references in the context of a specific problem to be solved. A secondary objective is to develop information processing capabilities in knowledge domains so that users can filter unstructured information according to entities from the terrorism domain such as tactics, targets, weapons, groups and individuals.

DRDC conducted a review of two of our information retrieval technologies: the TerroGate and the GRID technologies. The TerroGate technology provides a knowledge domain capability by providing support for a priori knowledge descriptors, such as terrorism, public safety, maritime domain awareness, money laundering and counter-narcotics. The GRID technology supports search and browsing capabilities for geographic data. These two technologies formed the building blocks for the ARGIM technology, enabling the querying and browsing of information according to two sets of parameters: a knowledge domain of interest and a geographic area of interest. We also implemented a new semantic link analysis capability and a trend analysis capability, enabling users to seek patterns in terrorist activities over specific geographic areas.

As a result of the development of the ARGIM technology, analysts can conduct their search for information using both geographic areas and knowledge domains of interest at the same time within the same technology. This new domain- and region-based information retrieval technology allows users to fuse, in real time, data from several sources and from different types of media.




**The ARGIM computer interface**



**Modelling of CH-146 *Griffon* with extensive use of computational fluid dynamics**

## AIR VEHICLE MODELLING IN AN ADVANCED SYNTHETIC ENVIRONMENT

The Canadian Forces embarked on the Canadian Advanced Synthetic Environment (CASE) project to establish the infrastructure and processes required for constructive, virtual and live simulations to be used in concept development, requirements definition, operational test and evaluation training, and mission rehearsal. A major component of the CASE project is the definition of a modelling/crew-station concept and a telecommunication concept of operations for implementation in the CH-146 *Griffon* helicopter, the first air vehicle for which an integrated modelling capability will be developed.

To support this component of the CASE project, DRDC developed an advanced modelling capability using computational fluid dynamics methodologies. In collaboration with the National Research Council Institute for Aerospace Research, the Aerospace Engineering Test Establishment and the U.S. Naval Air Systems Command, the modelling capability is being validated through extensive flight testing of a fully instrumented Bell 412 *Griffon* helicopter. We developed a data set that will allow further examination and evaluation of hangar effects, hovering, forward flight and dynamic manoeuvres. This unique and valuable data set does not appear to exist outside of the original equipment manufacturer's own records, and the validation data will contribute to further model validation.

## IMPROVED DETECTION OF SUBMARINES AND TORPEDOES

The HALIFAX Class Canadian Patrol Frigate entered into service in the early 1990s with one of the most up-to-date sonar systems in the world for antisubmarine warfare. Since that time, however, there have been only minor updates to these systems. Meanwhile, the navy has shifted its focus to coastal waters where the task is to maintain sea lines of communication, and the threat often takes the form of smaller conventional submarines and associated torpedoes. Through its work in the area of sonar development and underwater warfare, DRDC demonstrated that improved sensors and processing can dramatically enhance the navy's ability to detect and track both submarines and torpedoes, and that by integrating the processing of data, a ship's sensors can significantly improve torpedo warning times.

In parallel with technology development, we have also been exploring more effective ways to upgrade new and existing systems. The traditional approach has been to develop an aggressive specification for a system and to maintain that capability for 15 to 20 years, with the added challenge of rising maintenance costs as technologies approach obsolescence. An alternative approach is to implement and support the systems through a series of technology refresh cycles. Within these cycles, both hardware and software are updated to improve performance, address technology obsolescence and provide

incremental improvements in capability. This novel approach enables the use of commercial off-the-shelf (COTS) hardware in a Modular Open Systems Architecture (MOSA).

DRDC developed the PLEIADES advanced sonar concept demonstrator for the HALIFAX Class frigates using the MOSA approach. PLEIADES is a system application built on the DRDC system test bed using technologies developed for other DRDC projects such as the Next Generation Signal Processor; the Towed Integrated Active Passive Sonar; and the Multi-Source Torpedo Detection, Classification and Localization project. The application aims to demonstrate how the performance of existing sonar systems can be improved in a cost-effective way by installing a new suite of signal processing and display systems built on modern COTS technology. It is designed to enable regular and rapid technology refreshes using COTS processing hardware.

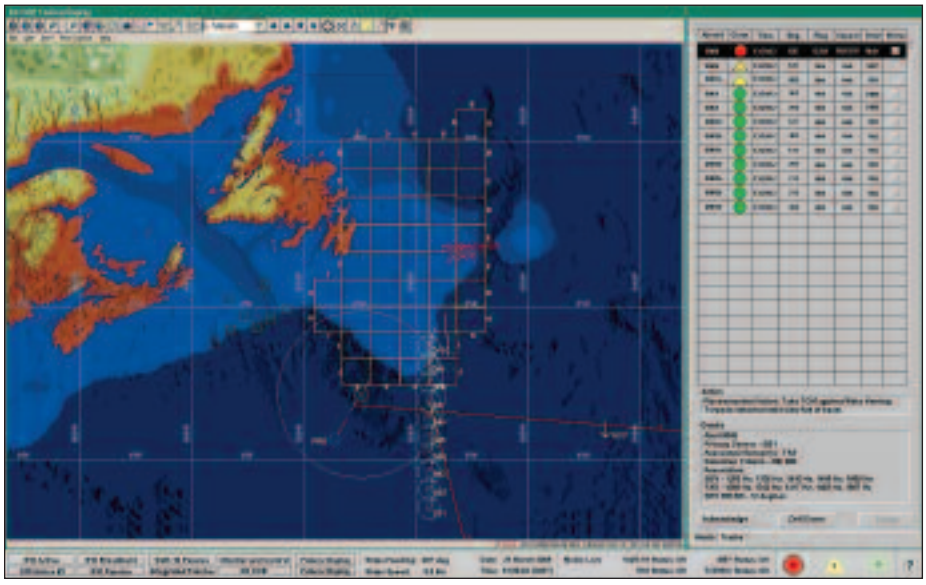
PLEIADES systems were successfully deployed for fleet exercises on HMCS WINNIPEG, HMCS FREDERICTON and HMCS VANCOUVER, and demonstrated significant improvements in the ability to detect and track both submarines and torpedoes. The navy subsequently initiated the Underwater Warfare Suite Update project to deliver an operational capability to the HALIFAX Class as one of a number of refits and updates for the frigates.

## SURVEILLANCE AND TRACKING OF SPACE OBJECTS

Space-based sensors and systems, such as communications, navigation, weather, and intelligence, surveillance and reconnaissance satellites, are integral parts of Canadian Forces operations. As part of the NORAD aerospace warning mission, the Forces participate in safeguarding these assets against accidental impacts from more than 9,000 pieces of uncontrolled debris.

In support of the Canadian Forces Surveillance of Space project, DRDC is developing a fully automated optical sensor system that can obtain orbital information and feed the situational awareness picture of space needed to protect the safety and availability of critical space assets. Over the past year, we examined the existing system and replaced the overall architecture, and tested the improvements using a prototype sensor located at one of our research centres.

Working in partnership with the U.S. Space Surveillance Network (SSN), we validated the quality of the resulting data and verified its usefulness to NORAD. This prototype sensor design is ready to be rolled out to remote sites during the next year, with the aim of undergoing certification by, and inclusion in, the SSN shortly thereafter.



**Concept tactical display and alert menu developed for use on the PLEIADES system**

**A defence scientist at the DRDC Space Surveillance Observatory prepares the telescope to collect imagery to track deep space orbiting objects**

## REVOLUTIONARY PROTECTIVE COMBAT GEAR

Members of the Canadian Forces use chemical protective clothing when needed during operations. However, the current chemical protective suit is not designed as a daily-wear uniform. DRDC developed the CB$^{plus}$ daily-wear uniform to protect Canadian Forces personnel against chemical and biological (CB) agents while maintaining the thermal burden at a level comparable to that of wearing a daily combat uniform. The CB$^{plus}$ uniform will also provide some protection against toxic industrial hazards.

Designed to meet the operational requirements of the Canadian Forces, the CB$^{plus}$ uniform proposes one of the most interesting solutions to just-in-time, transparent protection in a daily-wear uniform. We also developed novel materials for the uniform based on carbon sphere and fibre technologies.

**Testing the CB$^{plus}$ uniform at DRDC's Climatic Facility**

The CB$^{plus}$ uniform is currently being tested in the field by members of the air, land and maritime forces. The protection performance of the uniform is being measured in trials using the unique DRDC CB$^{plus}$ test chamber which is equipped with a simulation-based anthropomorphic mannequin that can perform a wide range of motions. The chamber can also reproduce realistic environmental conditions by combining wind, temperature and relative humidity. The test chamber can produce liquid, vapour and aerosol challenges using chemical or biological simulants.

The CB$^{plus}$ combat uniform will provide the Canadian Forces with superior protection against chemical, biological and toxic chemical hazards. It is also expected to offer response communities a possible uniform to meet civilian protection requirements.

**Canadian Forces personnel test COPlanS**

# Force Generation

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

## SUPPORTING THE OPERATIONAL PLANNING PROCESS

The operational planning process supports the exercise of command. Operational planning has become a very challenging process requiring critical thinking, teamwork, collaboration and synchronization of efforts. Finding an effective collaborative operational planning support system for commanders and their staff demands researching innovative concepts, means and technologies.

In 2002, DRDC initiated the Collaborative Operational Planning System (COPlanS) project in order to address the Canadian Forces requirements in this area. COPlanS is an integrated and customizable suite of planning, decision aid and workflow management tools. The system has since demonstrated that it can support the Canadian Forces operational planning process. It provides the ability to plan an operation in a net-centric environment with integrated collaborative tools. COPlanS offers functions to design and manage multiple concurrent distributed battle rhythms at different planning levels. It helps synchronize workflows, streamline document processes and permits replaying the decision-making path. The planning tools allow sketching courses of action on collaborative maps, performing time and space synchronization, and managing resources and orders of battle. The decision-aid tools rationalize the process, improve the evaluation and comparison of courses of action, and rapidly produce documents to support the Commander's decisions.

COPlanS is the result of a collaborative effort of the Department of National Defence, the Canadian Forces, the Canadian Forces College, DRDC and industrial partners. Its potential was assessed by DRDC operational research teams during the Coalition Warrior Interoperability Demonstration 2005 and, in 2006, at Exercise FRIENDLY LANCE in Toronto.

DRDC's efforts have influenced the Canadian Forces' decision to acquire a broad collaborative operational planning solution based on COPlanS concepts. As a result, the Canadian Forces initiated a Collaborative Operational Planning System capital acquisition project in 2006. A trial and a pilot are planned in 2007 to refine the requirements, test potential solutions, and develop a concept of operations based on the state-of-the-art technology.

## ASSESSING POST-DEPLOYMENT REINTEGRATION

With the extreme demands and operational tempo of current and anticipated future military missions, the psychological health and well-being of individual military personnel and the operational readiness and effectiveness of the Canadian Forces are critical concerns. For many of our soldiers, the period after returning home can be particularly significant. It is a time that helps them put the events of their tour in perspective, facilitating the transition to post-deployment life, or in some cases exacerbating deployment-related stress. Despite its importance, there is surprisingly little research on post-deployment reintegration. Two major weaknesses of the existing work are the lack of a valid measurement instrument and an overwhelming focus on negative outcomes.

Recognition of these limitations led DRDC psychologists to develop a valid and reliable survey that assessed the positive and negative aspects of the post-deployment reintegration experiences of Canadian Forces military personnel who deploy on 6-month overseas tours. This program of research, which involved several studies and approximately 1,000 respondents, isolated the key areas of focus for military personnel – personal, family and work domains. Responses to the Post-Deployment Reintegration Survey have implications for the individual health and well-being of Canadian Forces personnel as well as representing a useful tool to assist in the measurement of organizational readiness and effectiveness.

Early results of this work were incorporated into the Canadian Forces Ombudsman's report *From Tents to Sheets: An Analysis of the Canadian Forces Experience with Third Location Depression after Deployment*. The measure is currently included in the Department of National Defence post-deployment health evaluations assessing the effects of third location decompression programs and in the Human Dimensions of Operations Survey. The work also led to a tasking for a similar research effort concerning the post-deployment reintegration experiences of air force personnel.

**The Post-Deployment Reintegration Survey assesses the quality of reintegration experiences of Canadian Forces personnel returning from overseas deployment**

## REACTIVE SKIN DECONTAMINANT LOTION APPROVED AS A MEDICAL DEVICE

When Canadian Armed Forces personnel were deployed to the Gulf War in 1991, they were equipped with the first bottles of Reactive Skin Decontaminant Lotion (RSDL), a revolutionary advance in the field of personal decontamination and protection against super-toxic chemicals. In development for over 20 years, RSDL is powerful enough to protect against deadly chemical warfare and biological agents, some of which can kill within minutes of skin contact.

Because of the large variety and extreme toxicity of chemical warfare agents, the lotion had to be versatile and effective under varied field conditions, yet benign enough to be used on the skin, in and around the eyes, and safe if carried into wounds. The devastating speed of certain chemical agents meant that pouches and foam applicators of RSDL had to be tailored for immediate, individual use, since battle conditions allow no time to evacuate victims to medical facilities.

In 2006, RSDL was approved as a medical device in the United States and continues to be successfully marketed worldwide. The lotion was ranked by the U.S. Navy as its first priority for acquisition under the Foreign Comparative Testing Program. It had previously been purchased by the Australian army for the Sidney Olympics in 2000.

**The Reactive Skin Decontaminant Lotion kit offers protection and personal decontamination against deadly chemical warfare and biological agents**

# Force Employment

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

## SUPPORTING INTERNATIONAL AND DOMESTIC OPERATIONS

DRDC continued to support the Canadian Forces in Afghanistan through the work of two scientific analysis teams. The first, as part of the Strategic Advisory Team, focussed its work on supporting the military team members in developing and furthering the Afghan National Development Strategy, and in providing analytical support to the Centre for Afghan Peace and Security. The second was an operational analysis team composed of one military and one defence scientist to offer analytical support to the J5 Plans in Kandahar. The focus of this team effort was the detailed analysis of the campaign plan, analysis of survey polling, and in a broad sense, the introduction and support of the effects-based approach to operations.

DRDC also maintained teams that provided direct support to Canada's domestic operational commands. These teams were co-located with the clients in CANADA COMMAND Headquarters in Ottawa, and in three of the six regional commands: Pacific, West, and Atlantic. They contributed to the planning and preparations for the Vancouver 2010 Olympic Winter Games and to contingency planning for other domestic operations, such as maritime coastal patrol, search and rescue operations, response to natural disasters, and advice on domestic air force operations. They also supported NORAD operation planning and provided advice on national air and maritime surface surveillance strategy.

**Canadian soldiers in Kandahar distribute supplies to Afghan children as part of the Afghan National Development Strategy**

## REDUCING THE HEAT STRESS IN THE *LEOPARD* TANK

In the arid heat of Afghanistan, military vehicles can reach internal temperatures in excess of 60 degrees Celsius, which can impair operational performance and endanger the health of the vehicle occupants, and increase the vehicle heat signature, making it an easy target. To address this situation, DRDC developed a novel type of material that would reduce the heat load of the vehicle, and did proof-of-concept testing to demonstrate the efficacy of a commercial off-the-shelf personal cooling system for the crew.

DRDC undertook the design of a solar heat dissipation textile made to be fitted to the exterior of the *Leopard* C2 tank. Tests showed that the material could reduce the internal surface temperature of the vehicle by up to 25 degrees Celsius. Subsequently, DRDC made the material and the assembly of the kit more robust to suit

**The *Leopard* tank draped with its heat shield**

**Soldiers participate as subjects in heat stress tests**

the harsh environmental conditions in Afghanistan. Heat shield kits are currently being produced for the entire deployed fleet of the *Leopard*.

The cooling system for crew members consisted of a chiller unit and a distribution vest, known as a liquid cooling garment (LCG). Tests showed that without mitigation of the heat stress, the warmest days in the Kandahar region of Afghanistan would render the *Leopard* crew members operationally impaired within one to two hours, and result in heat casualties soon thereafter. However, wearing the LCG, crew members would be able to avoid debilitating heat strain for at least three to five hours when the temperature outside the vehicle hovered at 35 degrees Celsius. The LCG system is currently being procured and installed in *Leopard* tanks.

The combined use of the heat shield and the LCG should greatly reduce the internal surface temperature of the *Leopard* and reduce the heat strain for its crew, thus increasing the comfort and operational performance of the occupants, reducing the heat stress on its equipment and lowering its signature.

This direct support to operations was completed within two months as a result of the expertise and experience that had been nurtured and developed over several years within DRDC, and due to international defence research networks that enabled us to build on the experience of allies.

## NEW PROTECTIVE STRUCTURES FOR DEPLOYED OPERATIONS

Enhanced blast weapons (EBWs) generate strong shock waves that propagate through the atmosphere and produce high overpressures and extreme aerodynamic drag forces on objects in their path. To provide our deployed soldiers with better shelter against the threat of EBWs, DRDC produced four new protective structures. Designed to protect against blasts from both improvised explosive devices and conventional military ordnance, the new structures consist of a ground observation post and fighting position; an elevated observation post; the HESCO ISO Bunker; and the rocket, artillery, mortar (RAM) shelter. Their design took into consideration both military and terrorist weapon threats.

Both the ground and elevated observation posts improve the observation capabilities of the soldiers by offering 360-degree surveillance and maximum blast protection. The HESCO ISO bunker and RAM shelter offer greater protection from enhanced blast and fragmenting munitions and are designed to minimize blast ingress.

All four structures are pre-engineered kits that are simple to build using the resources available on deployed operations. Construction time for each structure ranges from 4 to 15 hours, based on a section of eight soldiers and factors such as experience and available equipment.


**Canadian soldiers construct one of the new pre-engineered protective structures**

## REDUCING FORCE ESCALATION IN AFGHANISTAN

In order to facilitate the transition into theatre during the upcoming troop rotation in Afghanistan, DRDC was asked to be part of a team to go on a technical assistance visit to Kandahar Airfield to investigate the problem of force escalation. The team's objective was to produce a series of recommendations and to determine whether non-lethal options could be used as means to reduce force escalation. This term refers to the use of increasingly higher levels of lethal force to accomplish mission objectives, which in the presence of non-combatants may result in unacceptable casualties amongst the civilian population.

Team members covering the disciplines of doctrine, training, requirements and science travelled to Afghanistan and performed their task in three phases: collection of information, data reduction and the production of recommendations. They collected information from a variety of sources, such as discussions, participation in day-to-day military operations and a tour of the camp. The recommendations were drafted following brainstorming sessions that generated a summary of the information and identified the main trends for solution.

The recommendations stated that better training and the use of commercially available non-lethal weapons are crucial to reducing the amount and level of force escalation. Implementation of the

recommendations by the Canadian Forces will result in the development of improved training practices and in soldiers who are better prepared with more appropriate tools before their arrival in theatre.

## REDUCING INJURY DUE TO NECK STRAIN

Aircrew wearing helmet-mounted devices such as night vision goggles are often prone to neck strain. Experiments show that the loading on the cervical spine due to the combined weight of the head, helmet, night vision goggles, battery and counter-weight, plus the force exerted by the cervical muscles, is sufficient to result in damage to cells involved in the maintenance of the cervical disc tissues. A survey of Canadian Forces *Griffon* aircrew indicated that over 80 percent of personnel were experiencing neck pain related to the use of night vision goggles.

Using synthetic and real models of the head mass, DRDC scientists conducted research to determine the risk factors and stresses that contribute to the development of neck pain as a result of wearing night vision goggles. We developed a neck support prototype that could substantially mitigate the strain on the neck, and made recommendations on neck strengthening exercises and improvements that could be made to existing equipment. The results of this research will reduce short- and long-term medical issues related to the use of helmet-mounted devices.

**A pilot adjusts the new night vision goggles during neck strain tests**

# Strengthening Public Security

*Public security continues to be of paramount importance both nationally and internationally. DRDC has made many advances in this area, not only in its research, development, testing and evaluation activities, but also in building relationships with other organizations and in offering unique training opportunities to personnel involved in emergency response. By collaborating with other organizations, both in Canada and abroad, DRDC makes great contributions to national public safety and security.*

# DRDC Centre for Security Science

In December 2005, DRDC created a new centre dedicated to science and technology for public safety and security. Bringing together the Chemical, Biological, Radiological, Nuclear and Explosives Research and Technology Initiative (CRTI) and its sister initiative, the Public Security Technical Program (PSTP), under one roof permits the DRDC Centre for Security Science to leverage existing science and technology strengths with new resources to create a profound impact.

The DRDC Centre for Security Science taps into the enormous science and technology capacity in federal government laboratories, universities and industry for a holistic Canadian capability in public safety and security. The Centre engages responder and receiver communities across Canada at the provincial and municipal levels and works to build stronger relationships with the operational arm of the Department of National Defence. The Centre also works closely with its international partners under international agreements, such as the one currently in place with the U.S. Department of Homeland Security, to leverage their investments.

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

Since 2002, the CRTI has had a mandate to fund projects in science and technology that will strengthen Canada's preparedness for, prevention of, and response to potential chemical, biological, radiological and nuclear (CBRN) terrorist attacks. In 2006, the CRTI received approval for another five years of funding and the addition of an explosives (E) portfolio. The creation of the new Explosives Cluster will allow police, industry and researchers to develop new and novel means to detect explosives, as well as ways to improve safety for bomb technicians conducting render-safe procedures.

Through this collaborative, coordinated initiative, the federal science and technology community and its partners are working to enhance Canada's ability to respond to CBRNE threats to public security. Comprising 19 federal government departments and agencies, the CRTI's unique, cross-organizational structure has provided new opportunities for the sharing of knowledge across organizations and disciplines. It has resulted in measurable gains in Canada's CBRNE response capabilities; in increased expertise, knowledge and capabilities for Canadian CBRNE science and technology performers; and in stronger links between diverse science and security communities, both domestic and international.

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

## TESTING EMERGENCY RESPONSE IN A RADIOLOGICAL EVENT

Recent international events indicate that hospital emergency rooms may be challenged in a radiological-nuclear (RN) mass casualty event. To confirm this, the CRTI Federal Advisory Group, in conjunction with International Safety Research Inc., identified medical response gaps and developed a medical RN emergency response tool. The effectiveness of the tool was tested during the Medical Nuclear Emergency Response Exercise (MEDNEREX) held in October 2006 in Nova Scotia.

MEDNEREX was a multi-jurisdictional, mass casualty exercise involving over 100 participants from 16 organizations at the municipal, provincial and federal levels, including local emergency medical services. In addition to the tool, the exercise also tested the National Biological Dosimetry Response Plan, a CRTI-sponsored concept of operations and casualty management tool kit, for their readiness levels during a radiological emergency.

The MEDNEREX scenario, although unlikely, was exaggerated to result in a release of radioactive material on-board a nuclear-powered vessel. The resulting casualties were decontaminated and then taken to a nearby hospital for further treatment. The tool, which was adapted from the European Union Medical Treatment Protocols (METREPOL) for radiation victims, guided emergency room care.

Results from MEDNEREX will be used to refine the tool as well as the concept of operations for future implementation. As a result, Canadian hospital emergency staff will be better prepared to identify and treat radiological casualties.

## IMPROVED COLLECTION AND ANALYSIS OF FORENSIC EVIDENCE

Following a RN terrorist event, the on-site recovery and analysis of evidence would likely be complicated by widespread radiological contamination. In December 2006, a CRTI project team conducted a field exercise that tested forensic identification and laboratory protocols for RN terrorist incidents.

The exercise simulated an incident that involved a radiological dispersal device. Using live sources, participants from the Metropolitan Toronto CBRN Team, the Canadian Nuclear Safety Commission, Health Canada and DRDC formed forensic teams to take samples from the contaminated zone, process the samples through decontamination and then switch them with lab-prepared samples to send to the nuclear forensic labs. A primary objective of the exercise was to evaluate the methodologies for managing contaminated traditional evidence so that it could be processed in a forensic lab. The goal of the lab portion of the exercise was to ensure interoperability between three government laboratories to achieve consistency of results and appropriate documentation procedures so that the results of the analysis could be used in a court of law.

As a result of the exercise, protocols for forensic identification specialists are being incorporated into the RN portion of the CBRN First Responder Training Program and will be adopted by the Royal Canadian Mounted Police and federal expert response teams. Collaboration with the United States Federal Bureau of Investigation and the United Kingdom's New Scotland Yard allowed for a comparison of international techniques, helping to ensure interoperability. Forensic identification specialists and laboratory staff will thus be better prepared to manage the collection and analysis of samples and assure attribution in a court of law.

**CBRN responders receive instructions in the use of radiation detection devices at the Nuclear Forensic Exercise**

## FACILITATING ACCESS TO PUBLIC HEALTH INFORMATION

During a biological incident, the public health system must deal with thousands, or even hundreds of thousands, of potentially exposed persons. To minimize the impact of such an event, it would be crucial to identify the outbreak and its source as soon as possible in order to limit the spread of the agent, and to evaluate the probable number of persons affected, the geographical spread of disease, its severity, and the potential resources required to respond to and control the incident.

Many pockets of expertise relating to infectious diseases and data collection systems exist in Canada, but a national framework to allow the timely integration of these resources has been lacking. The Public Health Agency of Canada, the Canadian Food Inspection Agency, TDV Global Inc., the Canadian Public Health Laboratory Network, the University of Guelph, TRLabs and the Council of Medical Officers of Health, with funding in part from the CRTI, created the Canadian Network for Public Health Intelligence (CNPHI). The CNPHI facilitates the integration of relevant public health information into a common national framework to support coordination among jurisdictions. Through a secure, Web-based framework, the CNPHI brings together laboratory, epidemiology, public health and other operational communities and provides stakeholders with an integrated surveillance and response framework. Over 2,000 users across Canada are able to collaborate and share information.

Public health stakeholders are now better equipped to detect and respond to infectious disease threats. Users receive more timely and accurate surveillance information, are alerted to rapidly changing events, exchange information, and quickly obtain access to relevant documents and information.

Building on this national system, the Public Health Agency of Canada is adding linkages to enable the incorporation of RN information, pharmaceutical and other medical information, and animal health information from the Canadian Animal Health Surveillance Network.

## DEVELOPING STANDARDS FOR CHEMICAL/BIOLOGICAL PROTECTIVE EQUIPMENT

In 2002, the CRTI community identified the need for the development of Canadian standards for personal protective equipment for CBRN emergency responders. This was confirmed by the release the same year of Rand Corporation's *Protecting Emergency Responders: Lessons Learned from Terrorist Attacks*, which highlighted the inconsistency and inadequacy of protective equipment used in the recovery and remediation of the Twin Towers in New York following the 11 September 2001 terrorist event. The CRTI project was intended specifically to apply rigorous science and technology to the issues and to provide guidance for the development of Canadian standards.

Under the auspices of the CRTI, the Royal Military College of Canada, the Royal Canadian Mounted Police, Health Canada, the Department of National Defence, 3M Canada and DRDC embarked on a project to assess existing personal protective equipment (PPE) for first responders in chemical threat scenarios, to identify deficiencies, and to recommend new standards to guide first responders in selecting and using equipment for terrorist response.

Researchers assessed protection performance against a multitude of toxic chemical and biological risks, provided guidance to equipment users, and established a process for developing a PPE standard. The members of the project team continue to consult with international standards organizations and have rationalized proposed standards where appropriate. This work has led to support for the development of standards at the standards boards.

A variety of activities supported this effort, including the development of scenarios and the modelling of releases, consultation with the

responder community on response activities and protocols, development of evaluation methods and models for protective performance of respirators and clothing, and investigations into dermal toxicity of selected chemical warfare agents and toxic industrial chemicals.

As a result of this work, the research team is providing guidance to first responders on how to respond to a CBRN event as well as on the capability gaps of their protective equipment. The researchers also developed realistic and safe protocols for measuring the protection provided by their protective ensemble.

# Public Security Technical Program

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

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

The following example highlights the work accomplished by the PSTP to further the achievement of its goals.

## PSTP HOSTS POST-BLAST EXERCISE

Recent terrorist attacks in Madrid, London and many of the world's hot zones have shown the use of explosives in new and more intensive ways. The Canadian explosives community sought to better understand what would be required to prevent, prepare for and respond to these types of challenges. The PSTP hosted the POST-BLAST Exercise to give first-hand experience to first responders, post-blast consultants and forensic identification experts in the after-effects of small-scale improvised explosive devices against typical targets. The exercise also allowed the explosives science and technology community to identify knowledge gaps where more investment in research and development should be applied.

The exercise, held in a remote area of Ontario, was designed to help responders to conduct post-blast investigations similar to terrorist attacks

**An explosion in a train car at the POST-BLAST Exercise gives forensic specialists new expertise in evidence gathering**

that have been experienced in other countries. It also provided the opportunity for experts in the domain to transfer knowledge to a new generation of responders, and launched the first in a series of learning opportunities for the new CRTI Explosives Cluster and for the explosives community at large.

# Counter Terrorism Technology Centre

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

In October 2006, DRDC Chief Executive Officer Dr. Robert Walker officially opened the CTTC's new facilities at DRDC Suffield. Since its creation in 2001, the CTTC has provided a unique collective training capability for the Canadian Forces, civilian first responders and foreign allies. With the delivery of three new buildings, including the Lecture Training Facility and the Indoor Training Arena, the centre now has facilities totally dedicated to its training activities. The training will now begin in the new labs and classrooms before moving to field scenarios using live chemical agents, radiological isotopes, biological simulants and explosives. While training is its largest activity, the CTTC is also responsible for test and evaluation, demilitarization and forensic support.

The following examples feature some of the activities of the CTTC over the past fiscal year.

## EXERCISE GREEN GRASS

The Chemical, Biological, Radiological, Nuclear National Response Team conducted Exercise GREEN GRASS at the CTTC. The exercise featured a terrifying scenario: a terrorist attack at a large-scale urea and ammonia production plant on the outskirts of Medicine Hat, Alberta. The training was part of the annual tests that Canadian Fertilizers Limited (CFL) conducts to assess the emergency response system, which usually involves only local first responders and designated CFL employees. This was the first year the exercise included the CBRN National Response Team in a scenario with terrorist implications.

Exercise GREEN GRASS involved the simulated release of anhydrous ammonia at the plant, which meant serious health implications for the city. CFL provided the grounds and shared the scenario with the Canadian Forces Joint Nuclear, Biological, Chemical Defence Company, the Royal Canadian Mounted Police and local first responders.

**Participants at Exercise GREEN GRASS examine evidence after a mock explosion at a fertilizer plant**

The exercise gave the CBRN National Response Team an opportunity to practise dealing with cross-jurisdictional responsibilities in a toxic industrial chemical incident, as well as gain a better understanding of the limitations of working within an operational facility. Since the members of the CBRN National Response Team do not travel or work together year-round, frequent training in realistic situations will increase their effectiveness in the event of a domestic CBRN incident.

## TACTICAL COMBAT CASUALTY CARE COURSE FOR CANADIAN FORCES MEDICS

In January 2007, CTTC hosted the first Tactical Combat Casualty Care (TCCC) course dedicated exclusively to Canadian Forces medical technicians. The two-week course began with classroom instruction on the fundamentals of combat casualty management and battlefield mortality, followed by laboratory and practical training on haemorrhage control, penetrating chest trauma and airway management. Students also had field training in effective casualty treatment under fire, tactical field care and casualty movement.

The Canadian Forces contracted a world-class team of physicians and medics with extensive combat experience to implement the training for their medics prior to their deployment to Afghanistan. The DRDC Medical Therapy Group provided medical training support.

TCCC training focusses on the provision of medical treatment within a tactical context,

**Canadian Forces medics carry out a casualty evacuation during the field training component of the first Tactical Combat Casualty Care course**

with the principal objective being to provide the best possible end result for the casualty without compromising the tactical aspects of the mission.

## TRAINING FOR INTERNATIONAL CHEMICAL WEAPONS INSPECTORS

The CTTC was the site of an inspector training course for the Organisation for the Prohibition of Chemical Weapons (OPCW). This was the first time that this international organization trained in Canada.

OPCW instructors and trainees spent two weeks performing various detection and decontamination exercises, with DRDC employees offering training safety and support. The program covered basic safety procedures and operations in individual protective equipment; detection, characterization and identification of chemical warfare agents; and procedures for decontamination and treatment for exposure to toxic chemicals.

The training took place under the auspices of a Memorandum of Understanding signed by the Department of National Defence and the OPCW, which is responsible for enforcing the Chemical Weapons Convention (CWC), an international treaty banning the development, production, stockpiling, transfer and use of chemical weapons. The convention stipulates the timely destruction of the weapons and the OPCW ensures compliance and verification. Canada is party to the CWC, which came into force in 1997.

**An inspector with the Organisation for the Prohibition of Chemical Weapons practises detection and decontamination exercises at the CTTC**

# Partnering for Increased S&T Results

*DRDC makes concerted efforts to offer to clients and stakeholders the most cost-effective scientific and technological solutions to the challenges they face. One of the ways we do this is by collaborating with international and national organizations and partnering with the Defence Science and Technology (S&T) Enterprise. DRDC attracts top-tier national and international science and technology partners so as to leverage their resources, knowledge, experience and technology.*

This chapter features examples of our successful collaborations, both national and international, and additionally with the Defence S&T Enterprise. It also demonstrates how we increase our opportunities for collaboration through our networking activities.

# Partnering within the Defence S&T Enterprise

The Department of National Defence's investment in science and technology is managed through the Defence S&T Enterprise, a matrix organization that connects those within the Canadian Forces and the Department that direct, deliver and exploit the outputs from the investment. It achieves maximum impact through coordination and harmonization of effort. The Enterprise provides a window on the global science and technology knowledge base. As such, it maintains purpose-built linkages with a number of external stakeholders, including other government departments and central agencies, the defence and security science and technology community of Canada's allies, and Canadian industry and academia.

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

## EXTENDING THE OPERATIONS OF HMCS CORNERBROOK

Addressing the technical challenges associated with the introduction of the VICTORIA Class submarine fleet to the Canadian navy remains a high priority. DRDC was tasked by the Department of National Defence, Director General Maritime Equipment Program Management (DGMEPM) organization, to provide scientific input into a risk assessment of extending the operations of HMCS CORNERBROOK. DRDC undertook to assess the condition of the submarine Nickel Aluminum Bronze (NAB) seawater handling valves, to determine their probability of failure during the proposed extension, and to provide recommendations to the Hazard Identification and Risk Assessment (HIRA) boards.

We conducted a wide variety of assessments, including metallurgical examinations and underwater explosive shock loading, to evaluate the soundness of these critical components. In close collaboration with DGMEPM design authorities, the Naval Engineering Test Establishment, United Kingdom agencies and the Fleet Maintenance Facilities, we developed new procedures for static and dynamic valve examinations. Based on the results of the assessments, we developed and presented recommendations to the HIRA boards, which were accepted. The studies permitted an extension of the operational life of the NAB valves, resulting in an extension of the safe operating period of the submarine.

DRDC's involvement in this project contributed significantly to the establishment of the Department of National Defence as a leading international authority on NAB valve issues. The U.K. Royal Navy recently used the results

**HMCS CORNERBROOK heads to sea**

of the NAB evaluations for similar risk assessment of some of their submarines, and the Royal Netherlands Navy has expressed a desire to collaborate with DRDC on submarine valve issues.

## TRAINING IN REMOTE MINEHUNTING

In early 2007, DRDC and the Canadian Forces Maritime Forces Pacific successfully completed the third and final naval operating period of the Interim Remote Minehunting and Disposal System (IRMDS) under the terms of a service level agreement between DRDC and the Chief of Maritime Staff. In 2006, a team of six naval personnel, regular force and reservists were introduced to the IRMDS and, through specialized training provided by DRDC and industry, have become the first fully trained Canadian naval operating and maintenance detachment for the DRDC-developed Remote Minehunting System (RMS). This trained cadre of naval personnel and the RMS provides the Canadian Forces with a viable operational remote minehunting capability.

**A naval operator pilots the Remote Minehunting System**

**The Remote Minehunting System**

These at-sea operating periods, conducted jointly by naval personnel and DRDC, provided an opportunity to develop a comprehensive set of training plans, operating procedures and concept of operations for remotely operated vehicles. The IRMDS project also served as a public endorsement of the concept of remote minehunting and supports efforts by Canadian industry to market this technology to allied navies.

## IMPROVING WIND VECTOR INFORMATION

DRDC recently completed a joint project with the Department of Fisheries and Oceans' Bedford Institute of Oceanography, Environment Canada's Canadian Ice Service, and operational units within Maritime Forces Atlantic / Joint Task Force Atlantic, such as the Directorate of Meteorology and Oceanography (DMetOc) and the Joint Rescue Coordination Centre. The project was funded through the Government Related Initiatives Program, sponsored by the Canadian Space Agency (CSA). The project leveraged the

various capabilities of each of the federal science and technology departments to develop improved wind vector information for the Canadian Forces using RADARSAT-derived products.

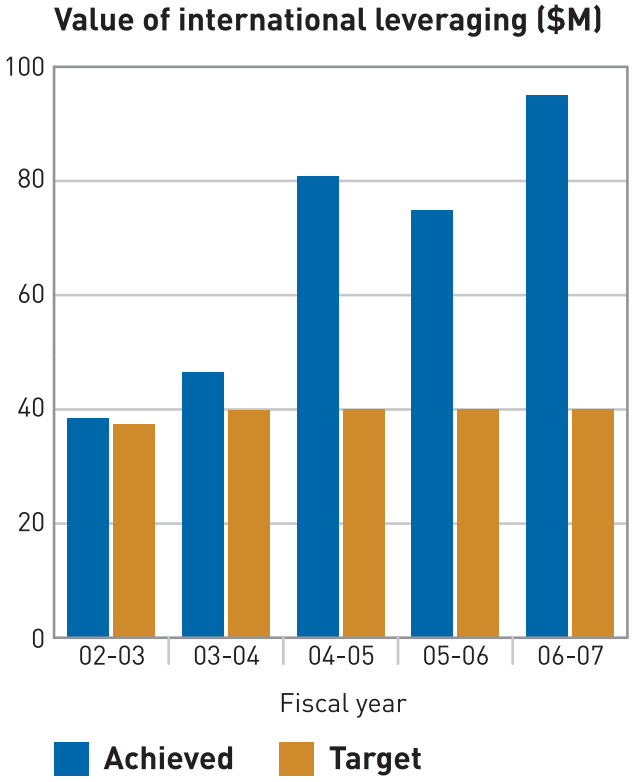
The team developed a pre-operational wind vector retrieval workstation and devised a strategy for the generation of operational oceanographic products derived from RADARSAT and fused RADARSAT/MODIS data. As a result, a new project for the development of an operational Spaceborne Ocean Intelligence Network (SOIN) is being started under the direction of DMetOc with the continued support of CSA. A truly collaborative project involving DRDC, the Canadian Ice Service and several others, SOIN will integrate this new capability with existing and planned defence and security environmental operations and provide the Canadian Forces and other government departments with greater environmental situation awareness.

# 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 about $40 million each year through our international collaborations. We estimate the value of our collaborations based on the likely cost of acquiring similar value through research contracts. We approximate the value of our international collaboration in fiscal year 2006–2007 to be over $95 million. The chart in the column at right 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 of the TTCP groups and NATO panels, which span the wide range




of their research and technology activities. (For more information on these organizations, visit their web sites, at www.dtic.mil/ttcp 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 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.

## DEMONSTRATING THE EFFECTIVENESS AND INTEROPERABILITY OF FUTURE MULTI-ROLE VEHICLES

In December 2006, DRDC presented the latest technological achievements of the Multi-Role Combat Vehicles (MRCV) technology demonstration project, a joint effort between Canada and the United States, to predict the effectiveness of multi-role vehicle concepts in future combat situations.

The MRCV project aims to improve the efficiency of military operations on the ground, and between ground and air elements. The vehicle concept features a single-vehicle crew capable of communicating with allied air defence, ground weapons and dismounted soldiers concurrently. Working within a future net-centric environment, the Canadian and American operators were able to remotely identify and engage targets using both Canadian and United States manned and unmanned air and ground vehicles, and dismounted soldiers in urban terrain.

During the experiment, conducted at General Dynamics Canada facilities in Ontario, 15 occupied vehicle simulators and more than 100 computer-generated allied and hostile elements were engaged in operations. This was the third and last distributed experiment conducted within this project, which was carried out in collaboration with the U.S. Army Tank Automotive Research, Development and Engineering Centre (TARDEC); the U.S. 11th Armoured Cavalry Regiment; the Canadian Combat Training Centre; the 4th Air Defence Regiment; members of the Canadian Advanced Synthetic Environments Acquisition Project (Carleton University); the Department of National Defence, Directorate of Land Synthetic Environments and Directorate of Armoured Vehicle Project Management; DRDC and General Dynamics Canada.

This international demonstration illustrated the benefits of leveraging the research and development knowledge base of allied laboratories to determine the systems engineering and tactics, techniques and procedures before vehicles are built. This experiment helped avoid potential costly and time-consuming field solutions that might have required retrofits to the equipment of coalition forces.

## EXERCISE PRECISE RESPONSE 2006

Soldiers from around the world convened on DRDC's Experimental Proving Ground in Alberta for Exercise PRECISE RESPONSE 2006. The exercise, held in July as a follow-up to NATO's PROTOTYPE RESPONSE 2003, was based on the NATO/Prague nuclear, biological,

**Participants at NATO's Exercise PRECISE RESPONSE secure the scene after a mock car crash, as part of a chemical, biological and radiological training scenario**

chemical defence initiatives that led to the creation of the NATO Response Force in 2002.

Over 160 participants and support staff from six NATO countries – Belgium, Canada, Denmark, France, Germany and the United Kingdom – took part in chemical, biological and radiological (CBR) scenarios. The exercise, designed to develop multinational interoperability in a CBR environment, was hosted by the Counter Terrorism Technology Centre, which builds and expands upon traditional chemical, biological, radiological and nuclear training.

The exercise developed scenarios to challenge NATO's ability to respond to a CBR event. It included sampling and analysis exercises using both chemical and biological simulants, live chemical agents and radiological sources. For many participants, it was their first time training with live agents, as well as their first opportunity to work with other allied soldiers in this type of exercise. Participants also gained experience using their equipment, tested a wide range of tactics, techniques and procedures involving CBR event response, and shared best practices during a series of individual scenarios.

## TESTING ELECTRONIC WARFARE SYSTEMS IN COALITION OPERATIONS

Coalition operations are the norm in today's world and ships are often required to work more closely spaced than they have been in the past, due to operational constraints in coastal waters. It is important to determine the interoperability of equipment between ships equipped with different types of electronic warfare (EW) systems to see if the systems can be deployed simultaneously, and to determine the proper placement of decoys to avoid inadvertent fratricide caused by threat missiles that miss their intended targets only to hit others. Modern threats can use advanced waveforms and it is essential to determine the performance of the current generation of EW systems in reacting to these threats. As Canada is in the process of acquiring new supply ships, it is also important to study the capability of off-board decoy systems to protect this type of ship from missile attack.

DRDC and TTCP partners from Australia, the United Kingdom and the United States conducted a major electronic warfare trial in July 2006 as part of the RIMPAC 06 exercise. TTCP Anti-Ship Missile Defence Program Arrangement (TAPA) trial was the first major at-sea EW trial organized by the four nations, and involved a diverse group of ships ranging from a small commercial vessel to an aircraft carrier. The goals of the trial were to study the interoperability of coalition EW assets in multi-ship environments, examine advanced threat capabilities and assess the capability of off-board decoys to protect assets of high value.

The TAPA trial brought together EW assets from the four nations. Over a week, approximately 170 trial runs against various combinations of ships and assets were carried out. Experimental data were collected from all of the EW systems and distributed to the trial partners.

The trial showed that the on-board and off-board EW systems utilized during the trial could safely be used simultaneously. It also demonstrated that, with proper coordination, the systems could possibly be used together in a synergistic fashion. The ability of off-board decoys to protect large ships was also shown to have a positive future. In addition, the trial showed that it was possible to operate ships more closely spaced than previously thought, without adverse effect on the electronic support measures systems. Lastly, the trial provided an opportunity to exercise EW systems against modern threat signatures.

## INTERNATIONAL SYMPOSIUM ON IED EFFECTS AND INJURIES

In November 2006, DRDC hosted an international symposium on Blast and Improvised Explosive Devices (IED) Health Effects and Injury Mitigations. The symposium was co-sponsored by the U.S. Army Medical Research and Materiel Command and the Office of Naval Research, the United Kingdom's Defence Science and Technology Laboratories, and DRDC, under the auspices of The Technical Cooperation Program.

The meeting was intended to create, for the first time, a common forum for both body-armour protection researchers and blast injury medical care-givers to discuss and develop better blast injury mitigation and intervention science and technology strategies. The meeting resulted in the formation of a Counter IED Injury Mitigation and Intervention working group to facilitate cooperation and collaboration among our allied defence research counterparts. This international working group will set the direction for participating member nations to harmonize their research efforts and science and technology investments in mitigating unconventional blast explosive effects.

## DEFENDING COALITION CONVOYS AGAINST SWARM ATTACKS

The Virtual Battle Experiment – ECHO (VBE-E), held in October of 2006, was the fifth in a series of experiments aimed at building the capacity to conduct coalition command and control research among TTCP nations. Virtual battle experiments are human-in-the-loop exercises conducted using a synthetic environment as the stimulus for the system under test. VBE-ECHO tested two new capabilities: distribution of the experiment elements on a classified network between the nations, and a move to multiple runs of the experiment in order to test hypotheses.

VBE-E examined the hypothesis that using an organic maritime unmanned aerial vehicle (UAV) would significantly improve the survivability of small coalition convoys against surface swarm attacks. The experiment was a first demonstration of the concept of using networked common synthetic environments to link participants of different nations in order to examine tactical level issues.

During the experiment, command teams in Australia, the United Kingdom and Canada worked collaboratively to defend a small convoy of ships against attacks from swarms of nine or fewer watercraft armed with semi-automatic

**Participants in Virtual Battle Experiment ECHO run simulated swarm attacks**

weapons. The teams ran scenarios to determine a ship's ability to ascertain hostile intent and to defend the convoy. The experiment also provided the opportunity to test processes for collecting information on workload, situational awareness and distributed team decision making.

VBE-E showed that this sort of experimentation is feasible between North America and Europe, but that challenges remain in operating with Australia. While too few runs were completed to give rigorous statistical results, the data indicated support for the usefulness of UAVs in the task. More importantly, during the experiment, the command crews of three nations benefited from the opportunity to work with the UAVs and began the development of procedures and tactics for their use.

### STUDYING THE EFFECTS OF WIND TURBINES ON RADAR SYSTEMS

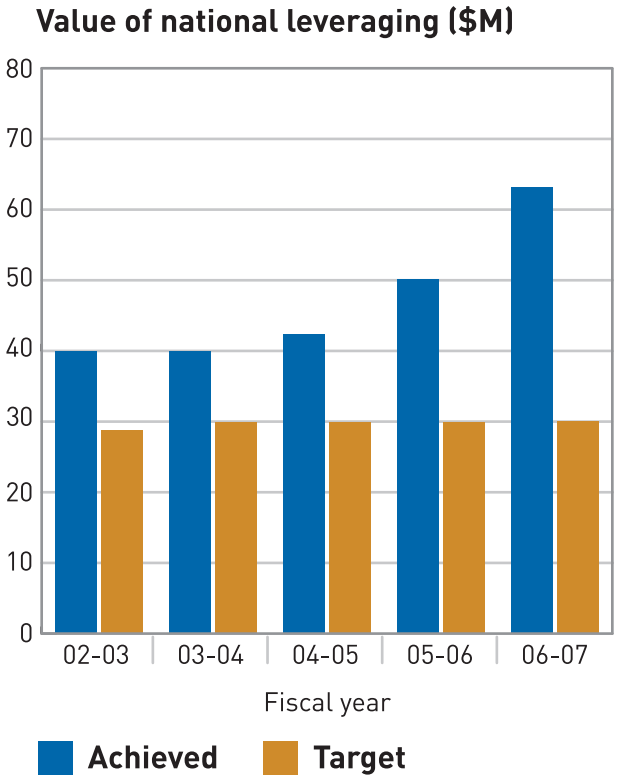
Many countries are supporting the development of offshore and onshore wind turbines as part of their renewable energy strategy. This has resulted in a rapid increase in the number of wind turbine farm projects being planned or in development. Recent studies have indicated that these wind turbine farms can impair the performance of military and civilian radar systems operating within the line of sight of the turbines. Consequently, a strong technical understanding of the implications of the interaction between wind turbines and radar systems is required.

Under the auspices of the Trilateral Technology Research and Development Projects agreement, DRDC conducted experiments and simulations on the effect of wind farms on a space-borne synthetic aperture radar, such as RADARSAT-1. At the request of the Canadian navy, we also investigated the interference caused by placing a wind farm on the various transmitting and receiving systems at the Naval Electronic System Test Range (Atlantic), and on a high-frequency surface wave radar system. As a result of these activities, future wind farm projects can be located so as to minimize adverse impacts, and, where necessary, radar systems can be designed and operated in relation to their presence in the environment.

## 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.

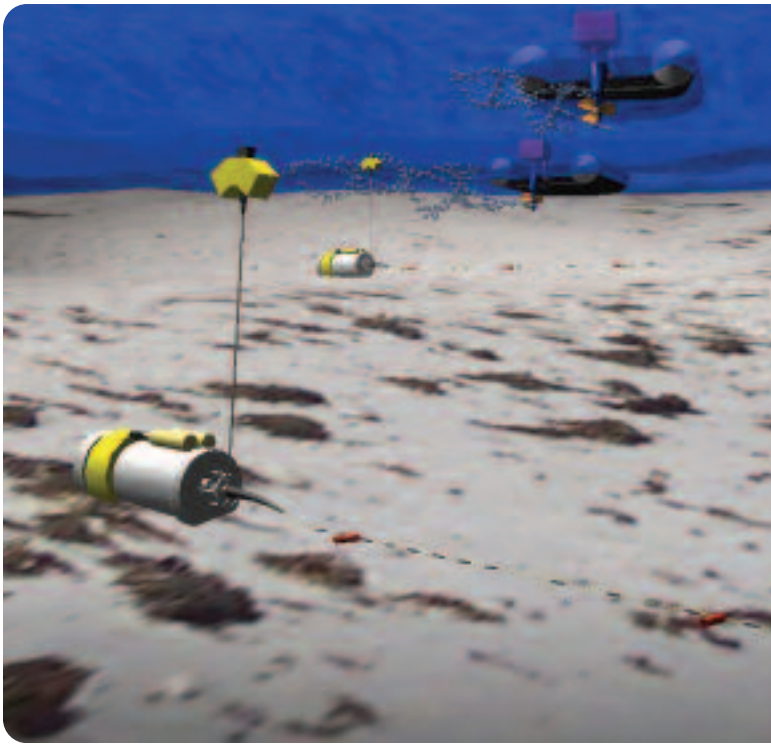
The goal of DRDC is to leverage a value of $30 million each year from national collaborations. We estimate that the value of our national leveraging in fiscal year 2006–2007 was approximately $63 million. The following chart shows a five-year history of the value of our leveraging from national organizations.



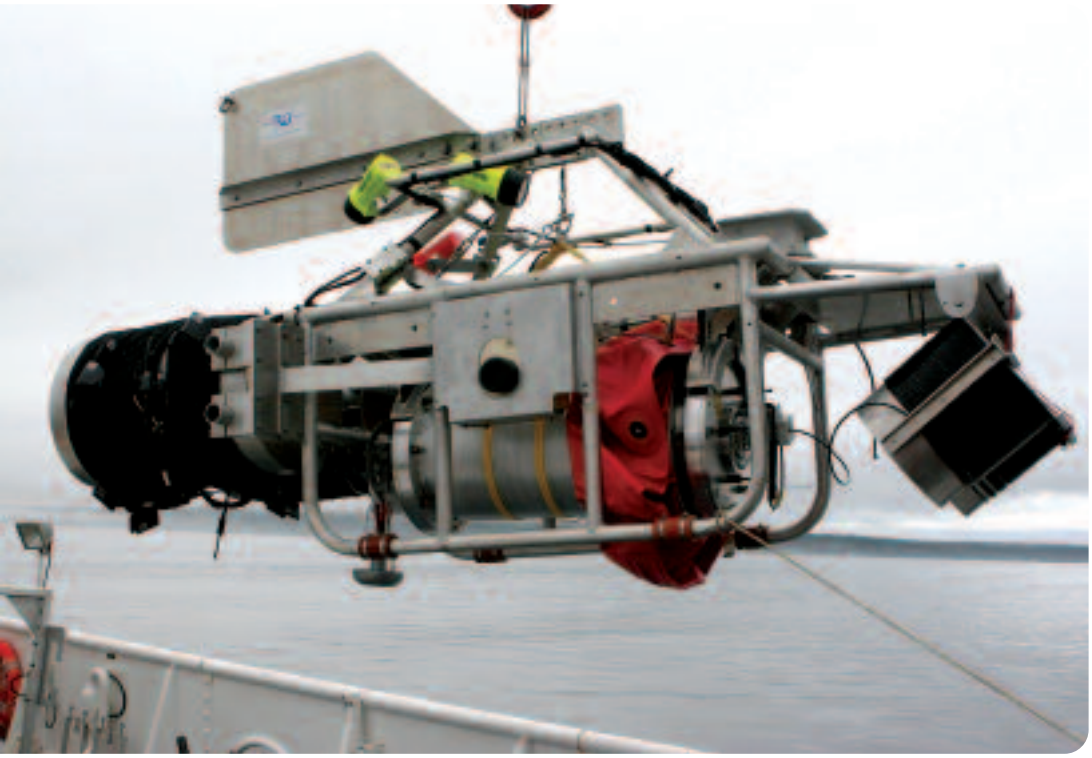

Examples of our collaboration with national organizations follow.

## RAPID DEPLOYMENT OF UNDERWATER SENSOR SYSTEMS

The Rapidly Deployable Systems (RDS) technology demonstration project, a collaborative effort between DRDC and several private sector organizations, with contributions from the University of Victoria, drew to a close in July 2006. The RDS project developed a highly flexible, very light-weight and low-power digital array system that can support a wide variety of acoustic and electromagnetic sensors along with temperature, pressure and orientation sensing devices. These light-weight arrays can be deployed in coastal waters in less than 30 minutes using a small boat. The long-lived, self-powered, digital arrays have an internal processing capability that currently provides automatic vessel detection, on-board localization and tracking of the source of sounds, and remote control of a network of deployed surveillance systems. They have the ability to generate and compress sonar images that are transmitted to a remote operator. The operator can then direct the deployed systems to undertake other processing options or missions.



**Graphic image of two arrays on the seafloor with a pair of boats passing over them**



**The Rapidly Deployable Systems digital array deployment sled**

The RDS is significant in that it is a viable technology with many immediate applications in surveillance, ranging, security and oceanography. Australia has purchased six RDS arrays for use in their own deployable system research. Other countries have also shown interest in the technology. The RDS project has provided a wealth of technical knowledge that is allowing DRDC to create a specification for a deployable sensing system with significant capabilities that can be provided at low cost compared with other underwater array systems.

## IMPROVING ISR CAPABILITIES OF THE AURORA

In collaboration with the private sector, DRDC's Air-to-Surface Sensors project developed airborne radar imaging and surveillance capabilities in support of intelligence, surveillance and reconnaissance (ISR) for Canada's current fleet of surveillance aircraft, the CP-140 *Aurora*, as well as for future manned and unmanned air platforms. The DRDC component of the research project capitalized on our expertise in synthetic aperture radar (SAR) and further developed a state-of-the-art ground moving target indication (GMTI) capability. We then transferred these technologies to MacDonald, Dettwiler and Associates Ltd. and oversaw the development and evaluation of a real-time radar signal processor funded by the *Aurora* Incremental Modernization Program (AIMP).

The AIMP subsequently adopted the SAR and GMTI technologies as the foundation for its new radar. These new ISR functions allow the *Aurora* to transition from its traditional role as a maritime surveillance platform to its burgeoning role in land surveillance. The AN/APS-508 radar still maintains its maritime surveillance capability, making it a unique multi-mission sensor, whose performance in its class is considered to be the best in the world.

**The CP-140 *Aurora***

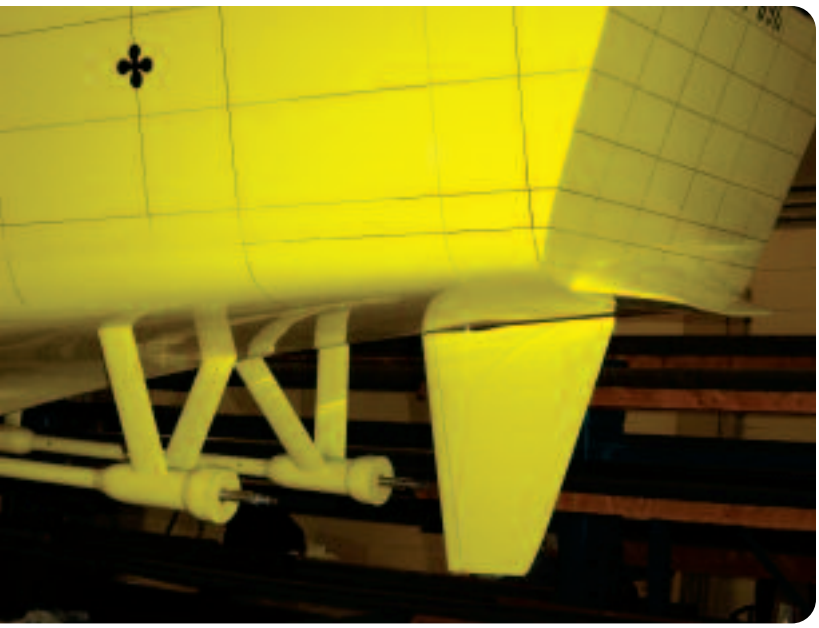
## COST SAVINGS FOR THE HALIFAX CLASS FRIGATES

Stern flaps can reduce a ship's resistance by modifying the pressure field near the stern. This reduction in resistance translates into fuel savings that are becoming increasingly important as fuel costs rise and operational budgets remain under pressure.

DRDC and the National Research Council's Institute for Ocean Technology (NRC-IOT), in collaboration with the Department of National Defence, Directorate of Maritime Ship Support, embarked upon a program of computational fluid dynamics modelling and physical model tests to develop a stern flap for the HALIFAX Class frigates. The objective of the program was to determine the most efficient design and to quantify the gains in its performance.

The study aimed to determine the optimal length and angle of the stern flap for the HALIFAX Class hull form and speed profile. The DRDC/NRC-IOT team evaluated a series of flap geometries through computer simulations to narrow the field of potential candidates. The team built a nine-metre model of the HALIFAX Class with a removable stern extension and several flaps. The resistance of the model was measured over a speed range for each of the flaps. The fuel savings for the fleet were estimated for each flap by using the measured resistance and the average speed-time profile of the ships.

As a result of this work, cost savings in the order of $1 million per ship are projected over a 15-year period at current fuel prices, and further increases are expected as fuel prices rise. A significant additional benefit of



**Model of the HALIFAX Class frigate with stern flap**

this installation will be an improvement in ship stability, saving about 35 tonnes of required ballast and allowing for future growth.

## Networking

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

- Sponsored by the Canadian Association of Defence and Security Industries (CADSI), CANSEC 2006 brought together defence and national security practitioners and their supporting industry counterparts with a view to potential collaboration. The event provided an excellent opportunity for DRDC to demonstrate its capabilities in both the defence and the national security fields.

- In conjunction with CADSI, DRDC presented its Technology Opportunities Day, which focussed on "Strengthening Science and Technology Impact." The presentation made by the DRDC Chief Executive Officer, entitled "Delivering Science and Technology for Impact," provided the first public introduction of the *Defence S&T Strategy*, and the roles of DRDC and Canadian industry in the strategy. There were also presentations outlining opportunities for industry in science and technology in the intelligence, public security, surveillance, force protection, maritime and human factors domains. In addition, DRDC took the opportunity to announce the next phase of its science and technology initiative on countering improvised explosive devices, which will provide a formal mechanism for industry to propose their ideas to the program.

- The Farnborough International Airshow is a globally renowned showcase of aerospace equipment and technology. It offers a superb business platform and is an excellent environment in which to take advantage of the opportunities presented by the global aerospace market. For 2006, as in previous years, DRDC engaged the Aerospace Engineering Test Establishment (AETE) and focussed its presentation on the combined research, development, test and evaluation capabilities of the Department of National Defence, as well as the civilian capabilities of the National Research Council Institute of Aerospace Research, AETE and DRDC.

- DRDC presented two exhibits at the 25th U.S. Army Science Conference which had for its theme "Transformational Army Science and Technology – Charting the Future of Science and Technology for the Soldier." The conference was sponsored by the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology and featured presentations of papers and posters judged as best among those submitted by scientists and engineers from government, industry and academia. A DRDC scientist received a Best Paper Award, and Canada was acknowledged, along with several other nations, by the International Collaboration Award.

# Boosting Impact through a Strong Foundation

*At DRDC, we recognize that the success we achieve is underpinned by the quality and relevance of the science we conduct, the excellence of our operations, the skills of our workforce, and the effectiveness of our work environment. The way we approach our activities reflects our commitment to continuous improvement to achieve the best results possible. We celebrate our success by recognizing and rewarding our achievements.*

# Expedition 07 Moves Forward

In 2005, DRDC embarked upon Expedition 07, a two-year strategic action plan to ensure that science and technology, under our leadership, is a key contributor to the transformation of the Canadian Forces, to the alignment of the defence institution and to the broader public security needs of Canada. The plan outlined three strategic objectives: (1) to lead the development of a defence science and technology (S&T) strategy for the Canadian Forces and the Department of National Defence, and to position DRDC to respond to this strategy; (2) to solidify DRDC's role in support of public security; and (3) to strengthen the enablers of success, with a particular focus on the capacity of our management and corporate services.

In the past year, Expedition 07 has made great strides forward. DRDC led the development of the departmental *Defence S&T Strategy* which was endorsed and approved by the Deputy Minister and the Chief of the Defence Staff in autumn 2006. DRDC began the alignment of the Research, Technology and Analysis Program, established to manage the departmental science and technology investment, with the objectives laid out in the *Strategy* and, in doing so, will provide a more coherent and integrated management framework. We strengthened our contribution to public security by providing direct support to, and cementing our cooperative ties with, Public Safety Canada (PS). In collaboration with PS, we are currently developing a public security science and technology strategic framework that will guide science and technology investments in supporting capability needs, not only those of the Canadian Forces but also those of more than 21 federal government departments and agencies operating in the public security arena.

Although Expedition 07 achieved most of its objectives, work remains to be done, particularly on the enablers of success. This work will form the basis of a new two-year plan to be launched in autumn 2007. The plan will also include the next steps in the implementation of the *Defence S&T Strategy*, particularly in the area of governance and in the development of strategic partnerships, both within and external to the Department of National Defence.

# Enabling a Supportive Workplace

In 2006–2007, DRDC built on the successes of former years by providing a work environment reflective of its ongoing commitment to respect employee well-being, so that all employees could make their best contribution at work.

DRDC focussed the staffing of its human resources on the premise of hiring the right people for the right jobs while still respecting the need for fairness, transparency and access, in accordance with the *Public Service Employment Act*. In addition, by providing timely training sessions for all managers and executives, DRDC ensured that employees in management roles were suitably equipped to exercise their delegated authorities. DRDC also set in place corporate initiatives, such as the DRDC Mentoring Program, and provided access to departmental and federal initiatives, such as the Scientists as Leaders Pilot Program, to better equip managers and executives and to address succession planning needs.

The following examples demonstrate some of our efforts to create a supportive workplace.

## INCREASING THE DIVERSITY OF OUR WORKFORCE

DRDC strives to create and maintain a workforce that reflects modern Canadian society. Moreover, DRDC has set clear employment goals to increase representation in the four designated employment equity groups: women, Aboriginal peoples, persons with disabilities and visible minorities.

DRDC participated in a federal science and technology student Aboriginal working group

that strongly supports the Canadian Aboriginal Science and Technology Society, a national, non-profit corporation created to increase the representation of Aboriginal people in science and technology careers. DRDC also participated in a working group on women in federal science and technology established under the Science and Technology Human Resources Senior Steering Committee. This working group strongly supports the creation of a work environment that encourages women to participate and remain in the federal science and technology community, and the statistics regarding the representation of women at DRDC reflect our success in this area.

In order to monitor our progress in achieving our employment goals, we continue to compile demographic statistics. More details on our employment equity representation can be found in Appendix 5.

## FOSTERING A BILINGUAL CULTURE

With the intent to foster the development and retention of a culture of bilingualism in the workplace, DRDC provided training opportunities to staff members who were seeking to improve or maintain second language competencies by participating in non-statutory full-time and part-time language training. DRDC also provided opportunities to those who identified second language training as a requirement for future career growth. The development of these competencies was addressed in individual learning plans, and DRDC supported this training through considerable funding. By providing such training, DRDC is positioning itself to meet both current and future linguistic needs.

## NURTURING OUR LEADERS OF TOMORROW THROUGH MENTORING

Building on the successes of the Mentoring Pilot Project of 2003–2005, DRDC implemented its Mentoring Program and focussed its efforts in three areas: skills development, career development and organizational/cultural development. The program also intended that mentoring relationships should provide opportunities to look at other work-related issues, such as coping with stress in the workplace, effective self-management in a multi-tasking work environment and work-life balance.

The Mentoring Implementation Team (MIT), composed of representatives from each research centre and supported by Human Resources staff, aimed to respond to DRDC's present and future needs by developing a cadre of excellent managers, as outlined in the goals of Expedition 07. The MIT successfully matched 42 mentoring pairs, targeting new managers and employees aspiring to become managers as mentees, and senior executives and managers as mentors.

## LEARNING, TRAINING AND PROFESSIONAL DEVELOPMENT FOR DRDC MANAGERS

The Treasury Board Policy on Learning, Training and Development came into effect in January 2006 with the objectives of building a skilled, well-trained and professional workforce; of strengthening organizational leadership; and of adopting leading-edge management practices to encourage innovation and continuous improvements in performance. As a result of this policy, all DRDC civilian managers, executives and military senior officers at the rank of Lieutenant-Colonel and Commander and above completed a mandatory online knowledge assessment, an exercise to ascertain that they possessed the knowledge necessary to effectively exercise their delegated authorities.

In addition, four representatives from DRDC took part in the Scientists as Leaders Pilot Program that aims to prepare science and technology professionals for executive level positions. This program addresses a pressing challenge as we face an environment that is more horizontal, multidisciplinary and characterized by partnerships that cross organizational and national borders.

## FACILITATING COLLABORATION

In order to facilitate teamwork and collaboration among employees at our offices across Canada, DRDC implemented ORBIT, an online collaboration workspace. ORBIT provides a secure

Web-based environment for project teams, committees, working groups and professional interest groups, such as communities of practice, to share information and work together. It is multi-functional and customizable, and training for users is not required.

ORBIT presents many desirable features, such as its seamless integration with desk-top tools and an instant secure authorization access. In addition to assisting teams and committees in tracking the progress of tasks and sharing information, ORBIT also provides a virtual environment for fostering collaboration and innovation.

While this year's focus is on internal collaboration, there are plans to extend ORBIT to DRDC's external partners in the future. ORBIT will help the defence science and technology communities to grow and expand as a result of its effective collaborative capabilities. ORBIT will evolve and improve to further assist DRDC teams and communities in managing operational challenges and developing innovative science and technology solutions.

# 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 12 DRDC employees:

**Éloi Bossé**, **Catherine Daigle** and **Jean Roy**, for their significant contribution to the development of a scientific book on *Concepts, Models and Tools for Information Fusion* which was submitted for publication to Artech House. Information Fusion is of paramount importance in supporting coalition operations in both peace and wartime, and has been recognized as a fundamental requirement for future military and national security operations;

**Bruno Gilbert**, for his significant contribution to the evaluation of the performance of missile warning sensors and systems through participation in live missile firings at MANPADS Week 2006. The results of this collaboration have led to algorithm modifications in at least two operational systems, facilitated validation of a crucial hardware-in-the-loop facility, and added immensely to existing threat missile databases;

**Paul Comeau**, **Paul Labbé**, **Sophie Villeneuve** and **Kendall Wheaton**, for their significant contribution to the theory and practice of defence experimentation. *The Guide for Understanding and Implementing Defence Experimentation* has provided a vehicle by which the international defence experimentation community has come together, and the quality of the product is reflected in its significant impact on TTCP national programs as well as on NATO nations;

**Neil Carson**, **Michael Crawford** and **Paul Saunders**, for excellence in developing novel ship-based maritime force protection models and methodologies in a coherent framework that includes technical, procedural and legal aspects, and applying these methodologies to quantify current, near- and longer-term operational capability gaps and to identify promising solutions; and

**Franklin Wong**, for his significant contribution to the development and application of prognostic modelling capabilities and embedded sensor technologies, which improve the understanding and prediction of solid rocket motor failures due to mechanical damage.

## NATO AWARDS

**David Connell** was awarded the NATO Non Article 5 Medal in recognition of his service to NATO in relation to international Security Assistance Force operations.

**John Fawcett** received the NATO Underwater Research Centre international Maritime Advanced Research Excellence Award for his significant and lasting contributions to the Centre's scientific and technical reputation, the Centre's Scientific Program of work and/or NATO Operating Forces.

**Jacques Dubois**, **Jean Dumas**, **Stéphane Giroux** and **Maj** (retired) **Pierre Lapierre** received the NATO Research and Technology Organisation (RTO) Scientific Achievement Award for their contributions to NATO's Joint Serial Communications Interface / Sensors and Electronics Technology Task Group on sensors and sensor denial by camouflage, concealment and deception.

**Yaw Asiedu**, **Tony Ghoman**, **Stuart Grant**, **Jack Landolt**, **Michael Lepard**, **Lochlan Magee**, **Don Turner** and **Robert Wolfe** received the NATO RTO Scientific Achievement Award for the exceptional team effort in significant RTO activities, excellence and originality in the scientific and technical content of these activities, and outstanding results in terms of military benefit. The award was given in recognition of team activities conducted in Exercise First WAVE (Warfighter Alliance in a Virtual Environment).

## INTERNATIONAL AND NATIONAL AWARDS

**Debbie Blakeney** received the Best Paper Award from the Australian Defence Science and Technology Organisation for her paper entitled "Operational Research Tools Supporting the Force Development Process for the Canadian Forces."

**Amal Bouamoul** received the Rosalind and Pei Chi Chou Award for Young Authors at the 23rd Symposium on Ballistics held in Tarragona, Spain, for her paper entitled "Experimental and Numerical Modelling of a Mannequin for the Assessment of Blast Incapacitation and Lethality Under Blast Loading."

**David Chapman** received the Acoustical Society of America Silver Certificate in honour of his 25 years of participation with the Society.

**Bob Cheung** received the Aerospace Medical Association's 2007 Professional Excellence Award in recognition of his long-term research and development efforts in the areas of vestibular physiology and spatial disorientation.

**John Evans** received the Best Paper Award at the 23rd International Symposium on Military Operational Research for his paper entitled "Military Impact of Canadian Operational Research and Analysis." The paper was co-authored by Bob Dickinson and Maria Rey.

**Capt Gary K. Johnston** received the Anne-Liis Ots-Goodman Prize for 2006 from the Department of Public Health at the University of Toronto. This award is presented to the graduating student who achieves the highest grades in the Master of Health Sciences program in Occupational and Environmental Health.

**Allison Nolting** received the Henry O. Fuchs award at the 2007 Society of Automotive Engineers World Congress Meeting in Detroit, Michigan. This award recognizes a graduate or recently graduated student working in the field of fatigue research and applications. Its purpose is to promote the education of engineering students in the area of fatigue technology.

**Chris Purcell**, along with **Bruce Armstrong** of GeoSpectrum Technologies Inc. and **James Crawford** of Ultra Electronics Maritime Systems, received the Best Paper Award at the Undersea Defence Technology conference in Hamburg, Germany, for their paper entitled "A Modular Projector System, Modelled versus Measured Performance."

**Sreeraman Rajan** received the Institute of Electrical and Electronics Engineers Award of Recognition for

his valuable contribution to the 2006 Conference on Electrical and Computer Engineering.

**Peter Tikuisis** received the Best Paper Award at the 25th U.S. Army Science Conference for his paper entitled "Target Detection, Identification and Marksmanship under Various Types of Physiological Stress."

**Mark Trevorrow** was elected a Fellow of the Acoustical Society of America for his contribution to high-frequency underwater acoustics and acoustical oceanography.

**Paris Vachon** was appointed the title of Institute of Electrical and Electronics Engineers Fellow for his contributions to operational marine applications of imaging radar.

**Heather E. Wright** received the 2007 Graduate Student Research Award from the American College of Sports Medicine's Environmental Physiology Interest Group for her abstract entitled "Acute Neuroendocrine Response to Uncompensable Heat Stress in Endurance-Trained versus Untrained Males."

**François Bouffard** and **Jean-Marc Thériault** received a Best Paper Presentation Award in the Land and Surface Monitoring category at the International Symposium on Spectral Sensing Research 2006 for their presentation entitled "Background Contributions in Direct and Differential Fourier Transform Long Wave Infrared (LWIR) Measurements: A Comparative Analysis."

**John Fawcett**, **Dave Hopkin** and **Bao Nguyen** received the 3rd place, National Practice Prize from the Canadian Operational Research Society for their work on the concept of exploratory operations for the side scan sonar autonomous underwater vehicles developed at DRDC Atlantic.

**François Bouffard**, **Hugo Lavoie**, **Eldon Puckrin** and **Jean-Marc Thériault** received a Best Paper Presentation Award in the Surface Sensing and Monitoring category at the International Symposium on Spectral Sensing Research 2006 for their presentation entitled "Passive Standoff Detection of Surface Contaminants: A Novel Approach by Differential Polarization Fourier Transform Infrared (FTIR) Spectrometry."

**Sylvie Buteau**, **Bernard Dery**, **Jim Ho**, **Pierre Lahaie**, **Vincent Larochelle**, **Pierre Mathieu**, **John McFee**, **Gilles Roy** and **Jean-Robert Simard** received a Best Paper Presentation Award in the Air Sensing and Monitoring category at the International Symposium on Spectral Sensing Research 2006 for their presentation entitled "Wide Area Spectrometric Bioaerosol Monitoring in Canada: From Sinbahd to Biosense."

**DRDC Valcartier** won the *Coups de cœur* prize for the 2006 *Centraide Québec* fundraising campaign in the federal Public Service category.

**DRDC** received the Best Booth Award in the 100 square foot category at the 43rd annual Association of Old Crows' International Symposium and Convention.

## DEPARTMENTAL AWARDS

**Paul Comeau** received the Deputy Chief of the Defence Staff Commendation in recognition of his leadership and exemplary devotion during the planning, management and analysis of experiments at the Canadian Forces Experimentation Centre (CFEC). His exceptional performance during the planning and execution of the largest and most complex joint experimentation campaign undertaken by the Canadian Forces largely contributed to enhancing the national reputation of the CFEC and DRDC as well as internationally within the concept development and experimentation community.

**Dave Eaton** received a Commanding Officer Canadian Forces Environmental Medicine Establishment (CFEME) Commendation for his outstanding personal dedication towards the development of critical life support Canadian Forces diving equipment and operating procedures. He provided the technical expertise behind virtually every operational item of Canadian Forces diving equipment that has passed through DRDC, CFEME, and the Experimental Diving Unit. His leadership and dedication as the Head of the Science and Engineering Group of the

Aerospace and Undersea Medical Science Centre has resulted in a revitalization of the Diving Research Facility.

**Yvan Gauthier** received the Canadian Navy Maritime Forces Pacific (MARPAC) Headquarters Commanding Officer's Certificate for the work he did during his tour at MARPAC / Joint Task Force Pacific from August 2003 to August 2006.

**WO Steve James** received the South-West Asia Service Medal in recognition of his outstanding service with the Coalition Task Force Headquarters in Kabul, Afghanistan.

**Bob Michas** received a Commanding Officer Canadian Forces Environmental Medicine Establishment (CFEME) Commendation for outstanding engineering support to CFEME and the Canadian Forces by leading the re-design, implementation and man-rating of "Man-in-the-Loop" in the Human Centrifuge. This capability is essential to enhanced high-G training and motion research within the Canadian Forces.

**LCdr Wynn Polnicky** received a Commander's Commendation for his contribution to the Joint Task Force Afghanistan. He was recognized for his specific efforts on framework operational plans and effects measurement.

**Elizabeth Speed** received the South-West Asia Service Medal in recognition of her deployment with the Strategic Advisory Team in Kabul, Afghanistan.

**Ken Ueno** received the 406 Maritime Operational Training Squadron, Commanding Officer's Commendation in recognition of his contributions as Project Manager for the 12 Wing Helicopter Maritime Environment Trainer (HelMET) Enhancement Project.

**Maj John Valade** received a Commanding Officer Canadian Forces Environmental Medicine Establishment (CFEME) Commendation for outstanding leadership in the development of the current DRDC Toronto / CFEME human factors accident investigation and future high-G spatial disorientation programs. Maj Valade's dedication to these two areas has resulted in the relevant and responsive redirection of the Aerospace Group's support to the Canadian Forces.

## DRDC ORGANIZATIONAL AWARDS

**Elizabeth Speed** received the DRDC Performance Excellence Award in recognition of her work in Afghanistan where she was deployed with the Strategic Advisory Team between August 2005 and August 2006. During her deployment, she provided direct operational research and analysis support to the Canadian Forces.

**Jack Cornett**, of Health Canada, and **Ted Sykes** received the DRDC Performance Excellence Award for building and maintaining a highly effective cross-government team of radiological/nuclear experts.

The **DRDC Valcartier *Bouclier froid* Scientific Team** received the DRDC Performance Excellence Award for the completion of crucial scientific testing that helped in providing the Canadian Forces with a cooperative program for protecting vehicle passengers against blast effects and fragmentation damage. Team members included **Yves Baillargeon**, **Amal Bouamoul**, **Robert Durocher**, **Claude Fortier**, **Michel Girard**, **Karl Goulet**, **Marc Grondin**, **Denis Leclerc**, **Josée Manseau**, **Yves Payette**, **Alexandra Sirois** and **Benoît St-Jean**.

The **DRDC Valcartier *Bouclier froid* Technical Trial Team** received the Assistant Deputy Minister (Science and Technology) Commendation for its exceptional contribution to the program with the goal of improving the protection of Canadian Forces vehicles in Afghanistan against new threats caused by improvised explosive devices. The team included members of the following groups: **Trial Coordination Group**, **Metrology Group**, **Imagery Group**, **Mechanical Installations Group**, **Armament Group**, **Munitions Group** and **Manoeuvres Group** of the Munitions Evaluation and Test Centre; **Prototype Service**; **Corporate Services (Communications)**; **Corporate Services (Infrastructure and Environment)** and **Corporate Services (Resource Administration)**.

## DRDC RESEARCH CENTRE AWARDS

**Darren Baker** received the DRDC Ottawa Outstanding Performance Recognition Award for his significant dedication and perseverance as acting Section Head for the Communications, Navigation and Electronic Warfare Section.

**Alyre Brideau** received the DRDC Corporate Office Outstanding Performance Award for his dedication and commitment to maintaining uninterrupted service to DRDC.

**Ray Burrill** received the DRDC Ottawa Outstanding Contribution Award in recognition of his excellence in developing the apprentice electronics technologists.

**Mary Ellen Campbell** received the DRDC CORA Achievement Award and Commendation for over 28 years of exemplary performance and client service.

**Pierre Cossette** received the Outstanding Performance Award in recognition of his contribution to the promotion of DRDC Valcartier values through his professional commitment and perseverance displayed in the management of the information network.

**Kathy Craig** received the DRDC Ottawa Outstanding Performance Award in recognition of her high-quality work and dedication.

**Derek Elsaesser** received the DRDC Ottawa Outstanding Contribution Award in recognition of his significant efforts supporting the KLONDIKE and ICEWARS technology demonstration projects.

**Éric Fournier** received the DRDC Corporate Office Leadership and Creative Management Award for his exceptional leadership and commitment to the Air Research and Development Program.

**Edna Fraser** received the DRDC Toronto Commendation in recognition of her inspiring, supportive and dedicated leadership of DRDC Toronto's administrative officers.

**Marc Grenier** received the Outstanding Performance Award in recognition of his contribution to the promotion of DRDC Valcartier values through his untiring dedication and his essential and undeniable contribution to the development of numerous projects in optronics.

**Dawn Gardham** received the DRDC Toronto Leadership Award in recognition of her dedicated and effective leadership as Manager of Corporate Services.

**Fawzi Hassaine** received the DRDC Ottawa Outstanding Contribution Award in recognition of his significant efforts leading the MALO technology demonstration project.

**Susan Hughes** received the DRDC Corporate Office Outstanding Performance Award for her professionalism and commitment in coordinating and supporting the Canadian participation in the June 2006 Canada/Russia Colloquium on Atmospheric Dispersion of CBR Weapon Agents held in Moscow.

**Julie Lefebvre** received the DRDC Ottawa Leadership and Creative Management Award in recognition of her strong leadership and creative management in promoting and developing the Network Information Operations Team.

**Peter Mason** received the DRDC Ottawa Outstanding Contribution Award in recognition of his contributions in promoting an inclusive and healthy workplace.

**Sgt Michelle Mueller-Neuhaus** received the DRDC Ottawa Safety Recognition Award for her tremendous efforts as a key member of the DRDC Ottawa Fire Emergency Organization.

**Bob Noyes** received the DRDC Ottawa Safety Recognition Award for his outstanding leadership as the leader of the DRDC Ottawa Workplace Inspection Team.

**Mark O'Connor** received the DRDC Atlantic Stockhausen Award 2006 for his consistently excellent contribution of technical support to

DRDC Atlantic's scientific program and his positive contribution to staff activities which greatly improve staff morale, both at home and in field condition environments.

**Joe Templin** received the DRDC Corporate Office Outstanding Performance Award for his exceptional leadership and guidance in the development of the first ever pan-departmental *Defence S&T Strategy*.

**Caroline Wilcox** received the DRDC Corporate Office Outstanding Performance Award for her professionalism and commitment to her role as the Canadian member of the Executive Sub-Group under the Square Dance international Memorandum of Understanding.

**Stan Isbrandt** and **Antony Zegers** received the ORBITA Award for their technical report entitled *Arena Career Modelling Environment (ACME) Individual Training and Education (IT&E) Projection Tool*. ORBITA is an association of former DRDC CORA employees.

**Don Day**, **Melvin Duran**, **Wing Fong** and **Robert Miles** received the DRDC Toronto Teamwork Award, in recognition of their dedicated, efficient and highly productive performance as members of the Impact Studies (HyGe) Team.

**Paul Fourny**, **Ahmed Ghanmi**, **Lani Haque**, **Bohdan Kaluzny**, **Antonio Sanchez** and **David Shaw** received the DRDC CORA Teamwork Award for the development of the GALAHAD model used for modelling and analysis of deployment airlift.

The **Modern Communications Electronic Warfare (MCEW) Operation ATHENA Support Team** received the DRDC Ottawa Outstanding Performance Recognition Award for its outstanding performance in Communication Electronic Warfare for increased Canadian Forces force protection. Team members included **Heather Fitzgerald**, **Bruce Hiscock**, **Alain Joyal**, **Loc Mai**, **Maria Missios**, **Bill Moreland**, **Andrew Mudry**, **Pietro Reitano**, **Larry Ryan** and **Sean Stamplecoskie**.

The **Submarine Nickel Aluminum Bronze Valve Evaluation Project Team** received the DRDC Atlantic Outstanding Achievement Award. Team members included **Lesley Eckstrand**, **Gary Fisher**, **James Huang**, **Steve Kavanaugh**, **Paul Martin**, **Danny Morehouse**, **John Porter** and **Yueping Wang**.

**Yves Baillargeon**, **Amal Bouamoul**, **Robert Durocher**, **Claude Fortier**, **Michel Girard**, **Karl Goulet**, **Marc Grondin**, **Denis Leclerc**, **Josée Manseau**, **Capt Yves Payette**, **Alexandra Sirois** and **Benoît St-Jean** received the Outstanding Performance Award in recognition of their contribution to the promotion of DRDC Valcartier values through the development of a unique program of trial and experimentation of vehicles that has had an impact not only on Canadian Forces troops deployed in Afghanistan but also on the national and international defence science community.

The **Project REBECCA Team** received the DRDC Atlantic Teamwork Award. Team members included **Nancy Allen**, **Roger Arsenault**, **Chris Browne**, **David Chapman**, **Dale Ellis**, **Dave Hazen**, **Brian Maranda**, **Don Mosher**, **Cheryl Munroe**, **Tim Murphy**, **Sean Pecknold**, **Charles Reithmeier**, **Cary Risley**, **Grant Stocker**, **Jim Theriault** and **Lloyd Whitehorne**.

The DRDC Toronto **Organizational Alignment Program Team**, **Organizational Design (Initiative 2) Team**, **Human Resources Group**, **Information Services Group**, and **Management Committee** received the Organizational Achievement of the Year Award, in recognition of their combined contributions to the successful alignment of DRDC Toronto with the departmental transformation.

# Financial Statement

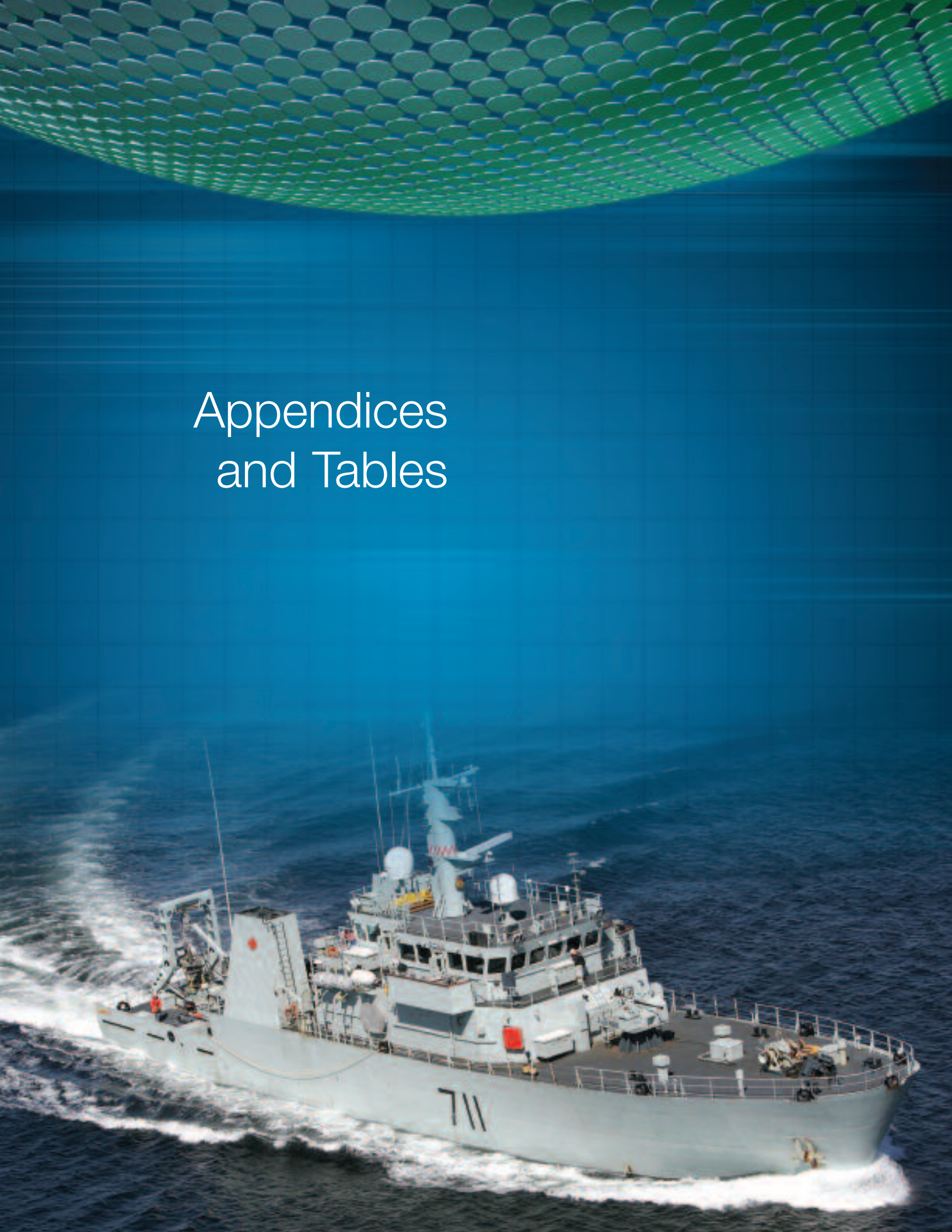
This table summarizes the funds DRDC received and expended in fiscal year 2006–2007 to carry out its program. The values shown are in thousands of dollars, with negative variances shown in parentheses.

| Fund type | Revenues ($000) | Expenditures ($000) | Variance ($000) |
|---|---|---|---|
| Salary and Wages | 108,986 | 107,389 | 1,597 |
| Operations and Maintenance | 37,781 | 37,508 | 273 |
| R&D Contracting | 84,741 | 86,379 | (1,638) |
| Capital – R&D Equipment, Construction | 28,100 | 27,755 | 345 |
| Environment | 1,900 | 1,836 | 64 |
| CCMAT – Salary & Wages, Operations & Maintenance | 1,000 | 1,000 | - |
| DRDC CSS – Salary & Wages, Operations & Maintenance, R&D Contracting | 25,000 | 23,002 | 1,998 |
| DRDC CSS – Capital Equipment | 3,000 | 3,000 | - |
| CTTC – Capital | 4,000 | 4,000 | - |
| Revenue | - | (3,214) | 3,214 |
| **Total** | **294,508** | **288,655** | **5,853** |

**Notes:**

- CCMAT is the Canadian Centre for Mine Action Technologies.
- DRDC CSS is the DRDC Centre for Security Science.
- CTTC is the Counter Terrorism Technology Centre.

# Appendices and Tables



# Appendix 1

## Defence R&D Centres

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

### DEFENCE R&D CANADA – ATLANTIC

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

### DEFENCE R&D CANADA – VALCARTIER

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

### DEFENCE R&D CANADA – OTTAWA

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

### DEFENCE R&D CANADA – TORONTO

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

### DEFENCE R&D CANADA – SUFFIELD

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

### DEFENCE R&D CANADA – CENTRE FOR OPERATIONAL RESEARCH AND ANALYSIS (CORA)

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

### DEFENCE R&D CANADA – CENTRE FOR SECURITY SCIENCE

DRDC Centre for Security Science provides support to Public Safety Canada and contributes to and supports the capability needs of the Canadian Forces in the area of public security. The Centre also manages the Chemical, Biological, Radiological, Nuclear and Explosives Research and Technology Initiative and the Public Security Technical Program.

### DEFENCE R&D CANADA – CHIEF OF STAFF

The Chief of Staff – Assistant Deputy Minister (Science and Technology) organization is accountable 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 client groups in the Canadian Forces and with external partners.

## DEFENCE R&D CANADA – CORPORATE SERVICES

DRDC Corporate Services provides functional direction and central management of 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 composed of our Research and Development Program and the provision of scientific analysis and advice to the Canadian Forces and the Department of National Defence. The Research and Development Program is developed in consultation with our client groups in the following areas: Maritime; Land; Air; Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance; and Human Performance.

The Science and Technology Program is delivered through *thrusts* – packages of scientific and technical activities. Each thrust addresses a broad spectrum of issues and involves a team of our staff working with external partners, including academia, industry and allies. In fiscal year 2006–2007, the total value of our Science and Technology Program was approximately $309 million. This figure includes internal costs, such as salaries and overhead, research and development contracts, and external and in-kind contributions. Please refer to the tables at the end of this report for additional details on our Science and Technology Program.

### MARITIME

The Maritime research and development program identifies specific objectives and activities to be pursued, and outputs to be produced, for the Maritime client group. It also identifies the resources required to meet the research and development priorities established by the client for ships, submarines and maritime aircraft, and their systems. The program is arranged in five thrusts: Maritime Integrated Above-Water Warfare; Maritime Command and Control; Maritime Underwater Warfare; Naval Platform Technology; and Maritime Intelligence, Surveillance and Reconnaissance.

### LAND

The Land Force research and development program provides scientific and technological leadership and expertise to the army so that it can implement its transformation agenda as effectively and efficiently as possible. The program is organized along five thrusts: Command, Sense, Act, Shield and Sustain. These thrusts parallel the army's operational functions.

### AIR

The Air Force research and development program supports the air force's scientific and technological needs in order to maintain a combat capable, multi-purpose air force while introducing new capabilities in the areas of weapon and sensor systems and human performance. The program is delivered through five thrusts: Air Force Command, Control, Intelligence, Surveillance and Reconnaissance; Air Force Protection and Projection; Air Vehicle Systems; The Human in Air Systems; and Air Mission Systems.

### COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE (C4ISR)

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

### HUMAN PERFORMANCE

The Human Performance research and development program 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 human performance, and is achieved through the efforts of DRDC, scientists, contractors, military personnel, and our national and international collaborators. The program is packaged into five thrusts: Simulator Training Technologies; Military Operational Medicine; Diving and Underwater Intervention; Human Factors in Military Systems; and Defence against Chemical, Biological and Radiological Hazards.

### PROVIDING SCIENTIFIC ANALYSIS AND ADVICE

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

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

### APPLIED RESEARCH PROGRAM

The Applied Research Program is DRDC's main research and development program and is made up of projects distributed among the five client 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 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 through patents, copyrights, trademarks and licences. Over the course of the year, we were granted 14 patents and filed 15 new patents.

The following patents were granted during fiscal year 2006–2007:

- Method for Detecting Antibodies to and Antigens of Fungal and Yeast Exposures
- Portable Instrument to Determine Concentration of Aqueous Film Forming Foam (AFFF) in Fresh and Sea Water
- Stretchable Chemical Vapour Protective Garment Worn Next-to-Skin
- Adaptive Multi-Channel, Multi-Function Digital Intercept Receiver
- Simplified Biofidelic Lower Leg Surrogate
- Insensitive Melt Case Explosive Compositions Containing Energetic Thermoplastic Elastomers
- Process for Preparing Carbon Nanotubes
- Compact Methanol Steam Reformer with Integrated Hydrogen Separation
- Computer Interfaced Video Positioning System Module (United States)
- Computer Interfaced Video Positioning System Module (Canada)
- Beam Laser Atmospheric Scattering Trajectory Guidance
- Flextensional Pipe Projector
- An Automatic Gain Control for Digital Radar Intercept Receivers
- Missile Steering Using Laser Scattering by Atmosphere

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

- Xwave Solutions Inc., for COP 21
- Queen's University, for the Human Load Carriage Simulator
- Brooke Ocean Technology Ltd., for the Free Fall Cone Penetrometer Test (FFCPT)
- Smart Open Systems Products Inc., for LOCATE
- Cartenav Solutions Inc., for the Automatic Identification System Relay Station HUB
- Smart Open Systems Products Inc., for the Systemic Error and Risk Analysis (SERA)

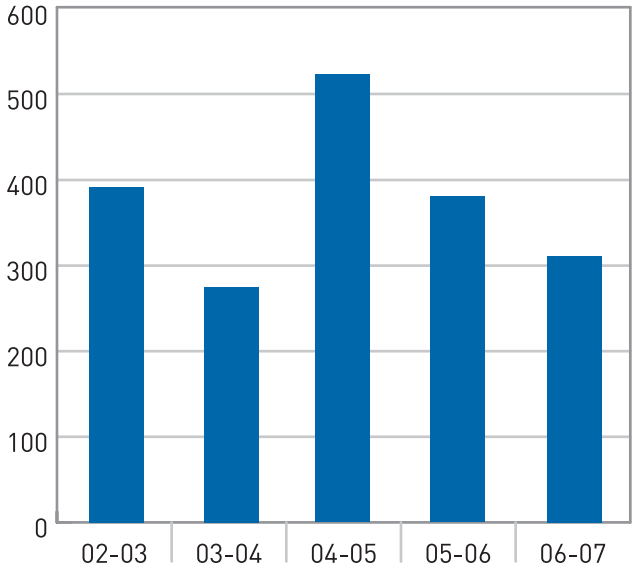
We received $1.1 million in royalties; of this amount $326,000 went to our inventors.

# Appendix 4

## Publications and Conference Presentations

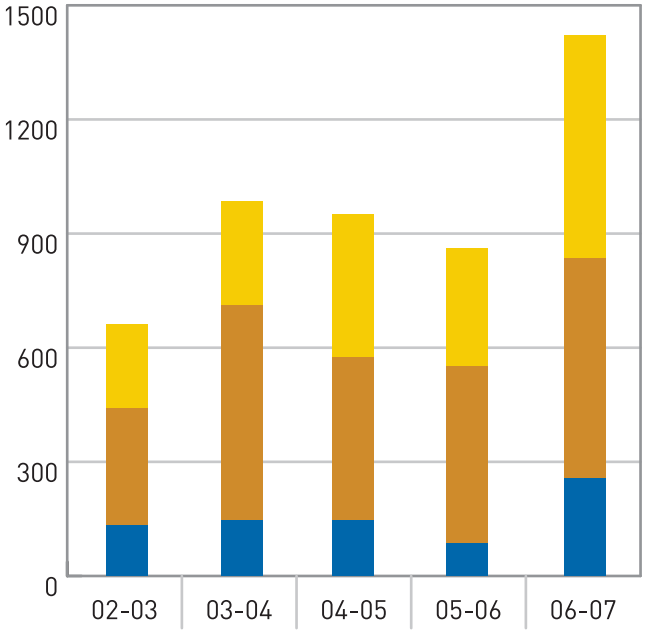
By promoting the results of our research and development activities, either through publication or conference presentation, DRDC transfers knowledge to clients in the Canadian Forces and the Department of National Defence and to colleagues in industry, academia and government. This dissemination is a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

**Number of conference presentations**




Fiscal year

**Number of publications**




Fiscal year

**Open literature** **Technical documents** **Contractor reports**

# Appendix 5

## Employment Equity Representation

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

In 2007, DRDC surpassed its goal with respect to the representation of women, showing a positive gap of seven between the number of women employed by DRDC and the external workforce availability.

Last year, our goal was to increase the representation of the other designated groups, with a particular emphasis on visible minorities. The chart shows an increase in the representation of visible minorities, progressing from a shortfall of 15 to 11. DRDC plans to continue its efforts to increase the representation of visible minorities as well as the other designated groups while maintaining its positive representation of women.

# 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 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 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 participates and the number of projects associated with each agreement in fiscal year 2006–2007.

| Agreement | No. of projects |
|---|---|
| Bilateral with Australia | 9 |
| Bilateral with France | 16 |
| Bilateral with Germany | 1 |
| Bilateral with The Netherlands | 6 |
| Bilateral with the United Kingdom | 10 |
| Bilateral with the United States | 49 |
| Bilateral with other countries | 1 |
| Trilateral with The Netherlands and Sweden | 13 |
| Multilateral on chemical, biological and radiological defence | 13 |
| Multilateral Master Information Exchange MOU | 5 |
| Multilateral with other countries | 21 |
| Trilateral Technology Research and Development Projects | 1 |
| North Atlantic Treaty Organisation (NATO) | 16 |
| NATO Research and Technology Organisation | 102 |
| Other agreements | 9 |
| Public Security Technical Program | 8 |
| The Technical Cooperation Program | 104 |

# Table 1

## Value of DRDC S&T Program[1] by client group

| Client Group | Internal Costs[2] ($000) | R&D Contracts ($000) | External Contributions[3] ($000) | Total Value ($000) |
|---|---|---|---|---|
| Maritime | 23,610 | 22,305 | 13,835 | 59,749 |
| Land | 23,262 | 20,450 | 12,406 | 56,118 |
| Air | 12,024 | 15,736 | 12,619 | 40,380 |
| Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance | 20,020 | 17,104 | 18,825 | 55,949 |
| Human Performance | 15,555 | 13,615 | 11,684 | 40,854 |
| **Sub-total R&D Program** | **94,470** | **89,211** | **69,369** | **253,050** |
| Provide Scientific Analysis and Advice | 48,216 | 2,630 | 5,510 | 56,356 |
| **Total S&T Program** | **142,686** | **91,842** | **74,879** | **309,406** |

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

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

[3] 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 | 4,589 | 31,010 | 16,109 | 51,708 |
| Information and Intelligence | 23,544 | 13,130 | 16,962 | 53,636 |
| Operations: Conduct | 2,511 | 57,425 | 28,602 | 88,538 |
| Operations: Mobility | 1,354 | 622 | - | 1,976 |
| Operations: Protect | - | 27,548 | 35,724 | 63,272 |
| Sustain | 1,037 | 21,735 | 752 | 23,524 |
| Generate | 11,405 | 8,780 | 5,432 | 25,617 |
| Corporate | 1,135 | - | - | 1,135 |
| **Total S&T Program** | **45,575** | **160,250** | **103,581** | **309,406** |

[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

| Client Group | Time Horizon I[1] ($000) | Time Horizon II[2] ($000) | Time Horizon III[3] ($000) | Total Value ($000) |
|---|---|---|---|---|
| Maritime | 20,519 | 24,888 | 14,342 | 59,749 |
| Land | 15,952 | 20,343 | 19,824 | 56,118 |
| Air | 15,749 | 15,447 | 9,183 | 40,380 |
| Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance | 16,102 | 23,178 | 16,669 | 55,949 |
| Human Performance | 8,304 | 18,241 | 14,309 | 40,854 |
| **Sub-total R&D Program** | **76,626** | **102,097** | **74,327** | **253,050** |
| Provide Scientific Analysis and Advice | 51,061 | 2,484 | 2,810 | 56,356 |
| **Total S&T Program** | **127,687** | **104,581** | **77,137** | **309,406** |

[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.

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