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

Annual Report 2002-2003

Opening New Doors of Innovation

DEFENCE R&D DÉFENSE

Canada

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Message from the CEO

Over the past year – our third as a special operating agency – Defence R&D Canada has continued to grow and develop, broadening and deepening our interactions and collaborations with the Canadian Forces and with national security partners in other government departments and agencies.

Our growth was especially remarkable this year. The highly successful Technology Demonstration Program (TDP) continued to expand through direct contributions from national partners and in-kind contributions from international partners. And new staff, new programs, and new elements added significantly to our capacity and confidence.

Nowhere was this more obvious than with the addition of the Operational Research Division (ORD) to our team. Little known outside defence circles, its reputation within those circles is no less a stellar one, formed through its ability to apply advanced scientific and analytical methods to practical challenges and situations. ORD has the added value of working in the heart of its client communities, providing strategic advice to senior Department of National Defence and Canadian Forces (DND/CF) decision-makers.

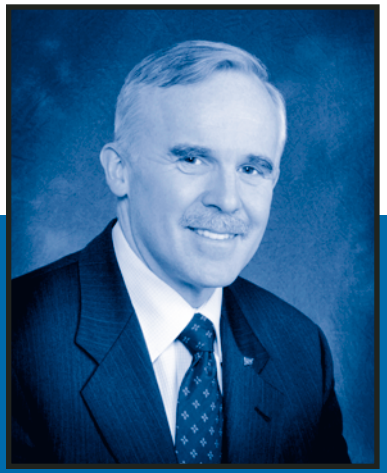
This year was also the setting for the beginning of operations of two groups involved in counter-terrorism efforts. The first, CRTI (CBRN Research and Technology Initiative), has been tasked with engaging the nation's innovation system in delivering multi-disciplinary science solutions on counter-terrorism and national security issues stemming from chemical, biological, radiological, and nuclear (CBRN) threats. The second, the Counter-Terrorism Technology Centre (CTTC), will be training first responders for a biological, chemical, or radiological incident, as well as providing forensic reference and analytic support for chemical warfare agents.

When the federal government committed itself to make Canada one of the most innovative countries, indeed to move into the top five R&D performers in the world, we were ready to meet the challenge. Our goal, as an organization, is to become known worldwide as the best in defence research and development.

This report provides an overview of how we are working to achieve this goal. In this report, we will outline our achievements in Defence R&D Canada's priority areas of enhancing service delivery, improving customer relations, growing our scientific and technological capacity, and promoting excellence.

These efforts, combined with the energy, dedication, and hard work of our people, will assist us in opening new doors of knowledge and innovation.

L.J. Leggat
Chief Executive Officer, Defence R&D Canada



Overview of Defence R&D Canada

OUR MISSION

Defence R&D Canada (DRDC) is Canada's leader in research and development for defence and national security. As an agency within the Department of National Defence, our mission is to ensure that the Canadian Forces are technologically prepared and relevant. We achieve this by:

- Facilitating and enhancing the ability of decision-makers to make informed decisions on defence policy, force generation, and procurement by providing expert science and technology (S&T) knowledge.
- Contributing to the success of military operations by pursuing research and development activities that provide improved support, knowledge, protection, and response to potential threats.
- Enhancing the preparedness of the Canadian Forces by assessing technology trends, threats and opportunities, and by exploiting emerging technologies.
- Contributing to the creation and maintenance of a Canadian industrial capability in defence-related science and technology that is internationally competitive, by contracting-out to industry, by transferring technology to industry, and by entering into contractual relationships in which cost and risk are shared.
- Conducting science and technology projects for clients external to the Department of National Defence, in order to assist the agency in developing and maintaining its defence-related technological capabilities.

OUR VALUES AND VISION

Our core values – commitment, client focus, creativity and innovation, leadership, professionalism and integrity, teamwork, and trust and respect – support our vision to be known worldwide as the best in defence research and development.

OUR STRATEGY

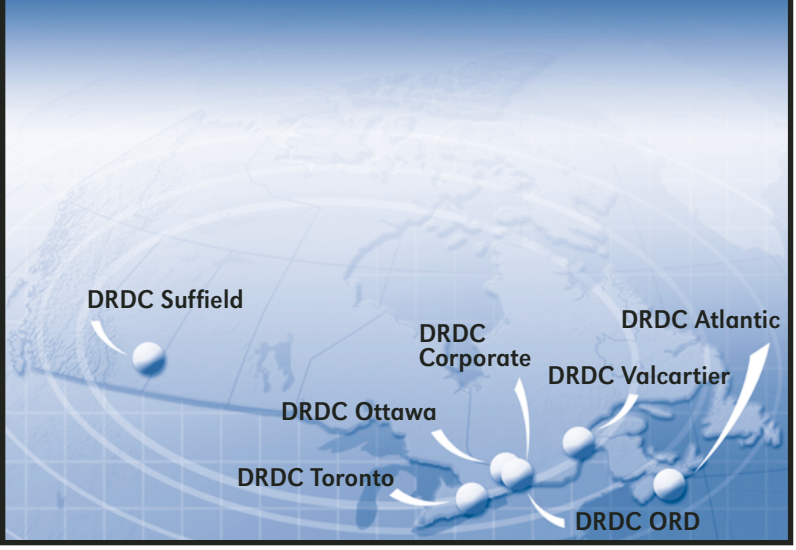
We exercise leadership both nationally and internationally by providing the Canadian Forces with relevant and timely advice and technologies, while at the same time offering attractive collaborative opportunities to other government departments, the private sector, academia, and international allies.

We have established a new series of strategic priorities to guide us toward realizing our vision:

- Enhancing service delivery;
- Improving customer relations;
- Growing our scientific and technological capacity; and
- Promoting excellence.

OUR CENTRES

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



Defence R&D Canada – Atlantic
DRDC Atlantic conducts research and development in underwater sensing and countermeasures, naval command and control information systems, naval platforms, air platforms, signature management, emerging materials, and modelling and simulation. Its main facilities are in Dartmouth, Nova Scotia, with dockyard laboratories at Canadian Forces Base (CFB) Halifax and CFB Esquimalt, and an air vehicle research section in Ottawa.

Defence R&D Canada – Valcartier
DRDC Valcartier is our most diversified research centre, and the main R&D facility for combat systems, optronics systems, and information systems. Scientists and technicians from all these disciplines cooperate closely in dealing with complex integration issues in order to support the current and future operations of the Canadian Forces.

Defence R&D Canada – Ottawa
DRDC Ottawa is the leader, across the country, in the exploitation of wireless and information technologies for defence and security applications (electromagnetic sciences applied to electronic warfare, information networks, navigation, radar, radiological effects, space systems, synthetic environments, and telecommunications). With more than 60 years of experience, its work covers the spectrum from concept and research work right through to deployment. Its technologies are in widespread use by the Canadian Forces and are widely licensed for both military and civilian applications.

Defence R&D Canada – Toronto
DRDC Toronto is this country's centre of defence R&D expertise in human performance and protection, human-systems integration, and operational medicine. Its mission is to enhance the effectiveness and ensure the health and safety of the human in any human-machine system or adverse environment.

Defence R&D Canada – Suffield
DRDC Suffield is Canada's centre of excellence in chemical and biological defence and countermine technology. Since its creation in 1941, its work has also expanded into shock and blast research, aerial targets, weather, vehicle mobility, and military engineering. DRDC Suffield hosts the largest experimental test range in Canada and supports the co-located Canadian Centre for Mine Action Technologies as well as the Counter-Terrorism Technology Centre. In addition, it has the only laboratories in Canada where chemical agents may be produced. These are used in the development of new protective materials and antidotes, and in research into the detection and identification of chemical agents and breakdown by-products.

Operational Research Division (ORD)
New to DRDC, the ORD's 140 scientists and technologists conduct research studies and analyses in support of DND/CF operations, working in the heart of their client communities. Their research is characterized by the practical application of advanced scientific and analytical methods to facilitate senior decision-making and problem solving. Issues tackled include resource optimization, operational effectiveness, human resources, strategic policy, equipment acquisition, and threat and risk assessment.

Defence R&D Canada – Programs
DRDC Programs provides central coordination and strategic planning for our science and technology programs through interfaces with our client groups in the Canadian Forces and with external partners. DRDC Programs is part of National Defence Headquarters, which is located in Ottawa, Ontario.

Defence R&D Canada – Corporate Services
DRDC Corporate Services provides functional direction and central management of our corporate services and is an interface between the Agency and the Department of National Defence and the Government of Canada. DRDC Corporate Services is also part of National Defence Headquarters.

OUR PROGRAM

Our program focuses on R&D in technology areas of critical importance to future CF operations. Its key objective is to ensure that the CF are technologically prepared and relevant in a defence environment that will see increased emphasis on interoperability with allies, technology driven warfare, and new forms of threats.

DRDC's Key Objectives

In DRDC's business plan for 2002-2003, we once again set ambitious targets corresponding with our strategic direction and the needs of our clients. These Key Objectives were outlined for 2002-2003 in *Looking Forward Staying Ahead* 2001. Throughout this report, sidebars like the one on this page will present our Key Objectives in the relevant context and outline the progress we have made toward achieving them.

The Technology Investment Strategy

The TIS is our strategy for positioning DRDC with the key competencies in the niche areas that will be critical to the CF over the next 10 to 15 years. It outlines the activities we will undertake in 22 areas (see Table 1 at the end of this report) to develop the science and technology (S&T) capacity needed for defence and national security. It takes into account the strategic direction provided by Defence Strategy 2020 and involves both the reallocation of existing resources and new investments. Operational Research and Analysis has been added to the TIS to reflect the work of our newest addition, the Operational Research Division.

Key Objectives related to the TIS

Objective: To develop a strategy to secure funding for R&D in order to progress to full implementation of the Technology Investment Strategy by 2004.

Result: A framework for the TIS was developed and approved by the DRDC Advisory Board. This document develops a strategy to secure the funding required to progress to full implementation of the TIS by 2004. The objective has been partially achieved with the cumulative addition of $7.8M to DRDC's budget for the 2003-2004 fiscal year to further support the TIS.

Objective: To recruit 85 new S&T workers by 2003.

Result: As of March 2003, 71 of the planned 85 new S&T workers have been recruited to satisfy the requirements of the TIS. Included in these numbers are the 20 new S&T workers that DRDC is hiring to support R&D in the area of chemical, biological, radiological, and nuclear (CBRN) defence.

Objective: To develop and implement detailed facilities plan for infrastructure renewal.

Result: This effort was approximately 50 per cent complete by March 2003. A ten-year plan will be integrated into our business plan beginning in 2004-2005.

Research and Development Program
Our R&D Program is carried out through a number of interconnected research mechanisms that include:

- The Technology Investigation and Technology Application Program (TI/TA)
- The Technology Demonstration Program
- The Technology Investment Fund
- The Defence Industrial Research Program

The Technology Investigation and Application Program (TI/TA)
Our technical program is delivered through Thrusts – delivery "packages" of R&D activities – that are developed in consultation with CF clients. Each thrust addresses both technology investigation and technology application and involves a team of R&D staff and external partners, including academia, industry and allies. Typical projects last five years and range between $3M and $6M. About 600 of our science and technology professionals in the research centres work on more than 80 TI/TA projects. This program element is supported by about $43M in contract funds and represents, in total, about 40% of our overall expenditures in 2002-2003.

The Technology Demonstration Program (TDP)
The TDP was initiated in 1999 to demonstrate technologies fostered by DRDC and Canadian industry within the context of real and potential future CF capabilities, concepts, doctrine, operations and equipment. TDP projects can be proposed by organizations within DND/CF, other government departments, and Canadian industry.

The value of DRDC's 31 active TDP projects for 2002-2003 was about $61M, which included $37M of contracted R&D and $9M from external cash and in-kind contributions. The balance comes from the efforts of some 150 of DRDC's science workers at an estimated total cost of approximately $15M. For more on the TDP, please see Table 2 at the end of this report.

Key Objectives related to the TDP

Objective: To develop a strategy to obtain external funding to add a Canada/U.S. collaboration element to the TDP by March 2003.

Result: The strategy is being applied. The program is funded in part through direct contributions from national partners and through in-kind contributions from collaborations with international partners. Approximately 75% of the 31 active TDP projects are engaged with defence agencies in the U.S.

Objective: To partner with industry on five international projects.

Result: Exceeded. Here are five examples:

- Force Protection against Enhanced Blast Weapons.
- Common Operating Picture 21
- CB Combat Duty Uniform (CB Plus)
- Advanced Distributed Mission Trainer – to develop and demonstrate a new generation of cost-effective, distributed air combat simulation.
- Coalition Aerial Surveillance and Reconnaissance – which integrates different forms of surveillance information and processes to provide an improved coalition operational picture to the war fighter and ensure interoperability among allied nations.

The Technology Investment Fund (TIF)

Initiated in 1998, the TIF funds projects – high-risk, high-payoff research – with potential for significant impact on military applications. External reviewers from universities and other research organizations assess each proposal based on scientific merit, technical methodology, project team capability, and novelty. Proposals are also evaluated for potential military impact and for contribution to the TIS. The TIF currently sponsors 28 R&D projects (see Table 3 at the end of this report for more information). The TIF provides $6M in annual nominal funding for R&D contracts, with our research centres expected to add at least another 25 per cent in contributions from internal and/or external sources. The total value of this element of our program was about $10M in 2002-2003. Typical projects are three years in duration with a total value of about $1M. The results of successful TIF projects are absorbed within our on-going R&D Program, thereby ensuring effective impact and uptake of this ground-breaking research.

The Defence Industrial Research (DIR) Program

The DIR program is our approach to working with small and medium-sized enterprises to identify and exploit emerging technologies with potential defence applications.

The past year saw the DIR program continue to enjoy success within Canadian industry and among the CF and our own scientists. There is obviously an outstanding supply of projects meeting the DIR program's mandate. Consequently, efforts to expand the program's funding have been ongoing. We have also been working to grow the DIR program through linkages with similar programs in Canada and the U.S. One such initiative involved co-sponsorship with the U.S. Air Force (USAF) Dual Use Science & Technology (DUST) program. To examine potential projects, we organized a major event hosting the USAF in Toronto. More than 100 Canadian technology companies participated.

In fiscal year 2002-2003, there were 34 active projects with a total value of approximately $40M, $15M of which was provided by DRDC as contracted R&D. Over the course of 2002-2003, 13 new projects were sponsored under the program, for a total of $10M (with DRDC providing half). Please see Table 4 at the end of this report for additional details on the DIR program.

S&T Policy and Advice

DRDC provides strategic and operational advice on S&T related products and services to DND/CF. This includes S&T related policy advice, strategic studies, operational research and analysis, and support for scientific and technical intelligence. Also included are technology watch and outreach activities.

We continuously need to assess technologies available worldwide. Most notably, this means assessing the risks posed by the proliferation of Soviet technologies. These technologies, as well as broader innovations in areas such as communications and computers, biotechnology and nanotechnology, may have significant impacts on military operations.

Moreover, technologies are evolving at such a dynamic rate that thorough analysis is required to understand where they are going, where the next breakthroughs are likely to occur, and what impacts those breakthroughs will have on defence.

Aware of the high cost of doing such assessments effectively, DRDC continues to diversify its relationships. We do this not only with the defence industry but also with industries in various sectors. This enables us to benefit from the many sources that are engaged in assessing, as we are, where R&D is likely to take us in the years to come.

Service Delivery and Customer Relations

Service delivery and customer relations: are these catchwords that make the eyes glaze over or fundamental values that really mean something? As corporate priorities, they would be meaningless without the hard work of our staff. We owe our success to the quality of the service and innovative solutions we provide to our customers. To successfully apply R&D involves thousands upon thousands of daily actions, small successes that fit together, often in unexpected ways, to form a larger whole.

To accomplish our work requires successful networking and effective client support.

Top: NATO ICT (International Cooperative Testing) of DAGR (Defence Advanced GPS Receivers) involves working with Canadian Forces personnel and U.S. Armed Forces personnel.

Right: DRDC Ottawa and NRC Flight Research Lab personnel work together to install the antenna of the SPOTSAR radar in the nose of the NRC's CONVAIR 580 aircraft.

Networking

We have worked hard at enhancing our partnerships across the Canadian and international S&T infrastructure. We have strong links with other government departments and agencies, most notably the Communications Research Centre, the National Research Council of Canada (NRC), Health Canada's laboratories, Environment Canada, and Agriculture Canada. We maintain strong links with Canadian industry, and we are one of the key players in NATO's research and technology efforts. We work closely with the U.S., the U.K., Australia, and New Zealand through The Technical Cooperation Program (TTCP), and we have bilateral relationships (see Table 6) with seven principal countries: the U.S., the U.K., Germany, France, the Netherlands, Sweden, and Australia.

Our organization is highly networked. We bring value to that network through the expertise of our scientists and through our world-class capability in the niche areas where we conduct R&D.

Client support

We ask for and act on feedback from our clients through a variety of mechanisms, set up in the last five years. These include the DRDC Advisory Board, the R&D Program Review Board, Client R&D Overview Groups, Thrust (packages of R&D projects) Advisory Groups, and formal and informal client satisfaction surveys.

Improving customer relations

DRDC commits considerable time and energy to understanding its customers and their needs. Our Customer Relations Group has been examining how to enhance the services we deliver, covering an extensive range of issues with the aim of ensuring that:

- The best S&T advice is provided on time.
- The R&D carried out is shared in a timely fashion.
- DRDC's potential in supporting operations is known and exploited.
- We can meet the growing demand for technology watch and trends analysis.
- We can more successfully transfer technology to industry.
- Broader national security issues are routinely included in DRDC's day-to-day activities.

These are ongoing challenges not unique to DRDC. We expect our solutions, however, to reflect our commitment to excellence and act as a beacon for other similar organizations around the world.

Helping our clients meet their objectives

DND/CF are called upon for assistance in a wide range of missions and activities. To respond promptly to domestic and foreign crises and to participate in joint and combined operations requires a great deal of planning. DND/CF delivers its services through five core capability programs.

- Command and Control
- Conducting Operations
- Sustaining Forces
- Generating Forces
- Corporate Policy and Strategy

CF personnel using Athene system during EX Resolute Warrior at CFB Wainright. Athene is part of the Command and Control system.

COMMAND AND CONTROL

In a world in which innovation is so rapid that even specialists find it difficult to keep up, Defence R&D Canada has demonstrated leadership weaving its many research efforts into effective, integrated results. International cost-sharing agreements are a key part of this integration; Command and Control projects are a prime example of why these take place.

Command and Control Information Systems

As part of multilateral and bilateral arrangements, we collaborate with many allied defence organizations. This allows us to build diverse partnerships and provide the CF with access to advanced defence technology, information, and expertise from around the world. Such an approach greatly enhances interoperability with our allies, a huge asset as we continue to enhance Command and Control functions.

Providing situational knowledge to all members of a coalition force requires the right infrastructure, including Geospatial Information (GI) that can serve as a common frame of reference for a shared view of the battle space. But the reality of military operations means that a crisis can develop anywhere in the world and leave insufficient time to generate the prerequisite geospatial information. Moreover, maintaining detailed global records, just in case, is an expensive proposition for any one country.

DRDC's GI expertise was put to the test by the U.S. National Imaging and Mapping Agency when it requested, as part of multilateral collaboration, that we determine how to build and maintain the necessary GI digital databases (involving the military, civil, and commercial sectors), as well as assess the optimal configuration of the Geomatics Division responsible for the data bank's management.

As part of this work, we developed a methodology to investigate workflow during crises (including sudden surges in demand and production) to determine how to handle extra workloads. The methodology and tools developed are being used to help guide Canada's future GI development and to form the basis of collaborative work with the U.S. and the U.K.

Command and Control refers to DND/CF's activity of collecting, analyzing, and communicating information; planning and coordinating operations; and providing the capabilities necessary to direct forces to achieve assigned missions.

Source: the Defence Plan

NORAD, CLEAR SKIES, and DRDC

Since 2001, extensive efforts have been directed at enhancing the security of North America's airspace. NORAD's CLEAR SKIES is one key result.

CLEAR SKIES

As part of this development, DRDC examined the utility of Air Defence Artillery (ADA) units. ADA units (Sentinal radars and ground-based Avenger missiles) are used to complement fighters as part of a layered air defence system.

First, DRDC undertook an operational analysis to determine the value added by ADA units. Next, we suggested a better engagement sequence. Then we recommended improved allocations. The result: substantial improvements to the layered defence used for CLEAR SKIES.

High Earth Orbit space surveillance

This project – a partnership between DRDC, DARPA (United States Defense Advanced Research Projects Agency), and Dynacon Inc. – aimed to provide a space-based test bed to facilitate R&D in satellite tracking, imagery, and data analysis.

Microsatellite requirements in high-earth orbit have already been studied, including radiation tolerance, power, communications, and altitude control. The results have confirmed the feasibility of placing a microsatellite into high earth orbit and have led to a TDP project that will build on the partnership already established.

Secure identity and access management

As the CF becomes increasingly involved in coalition operations with non-traditional partners, the question of how to share information securely among partners, while protecting sovereign Canadian information, has become a topic of considerable interest.

DRDC has been addressing the problem in two ways. First, in cooperation with the U.S., we have been investigating custom software and hardware technologies to support various levels of security requirements. Second, we have looked at integrating best-of-breed commercial software to accomplish those same objectives. A secure access management structure has now been developed combining both approaches and which has drawn the interest of information security engineers with the DND/CF. In collaboration with them, we are planning a larger-scale demonstration to be conducted using the Defence Information Network's infrastructure.

DRDC personnel work in the Secure Mobile Networking Wireless Lab

CONDUCTING OPERATIONS

Part of DRDC's mission is to directly contribute to the success of military operations by pursuing R&D activities that provide improved support, knowledge, protection, and response to potential threats. New warfare requires new defence, and we are developing and testing wide ranges of defensive and offensive military tools to meet the challenges of tomorrow's multi-dimensional battlefield.

Reducing interval times for divers

Safety also flows from innovation. DRDC's scientists have proven that the intervals between dives using rebreathers can be safely reduced from 18 hours to a mere 6 hours or less. This operational gain has drawn enormous attention both here in Canada and in navies around the world.

The work was done at DRDC's Experimental Diving Unit (EDU) in Toronto. Armed with tables that gave the safe decompression profiles for dives using the Canadian Underwater Mine-Countermeasures Apparatus, and a sophisticated ultra-sound device capable of detecting bubbles in a diver's blood, the EDU began work. Their aim was to determine the shortest interval between dives that a rebreather diver could safely observe and still follow the established decompression profiles.

The result – tripled effectiveness for a mine-countermeasures diving team – impressed even the most stalwart team members. It was determined that, in certain circumstances, an interval of three hours was all that was needed for a safe return to the water.

Reducing interval times for divers

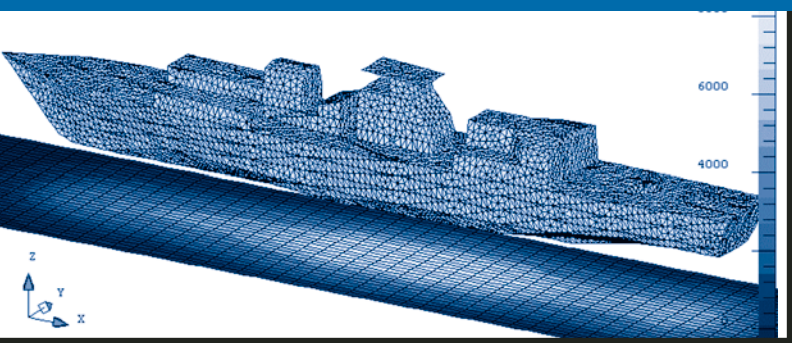
Neutralizing voice distortion

For diving operations in deep water – such as those made by the Navy as part of drug recovery missions in 1993 and 1995 or when assisting after the 1999 Swiss Air tragedy – a mix of helium and oxygen is used to escape the disabling effects of nitrogen under pressure. The problem with using helium is voice distortion, making communications with the surface difficult.

DRDC has been working with the Communications Research Centre (CRC) in Ottawa to counter this problem with a small system that can remove the distortion in the diver's voice. Extensive trials have proven the system successful. DRDC and CRC have now entered into a licensing agreement with Aqualung Canada to produce voice "unscramblers" through their manufacturing partner Offshore Technology Systems, for the Navy and the commercial diving community.

Conduct Operations refers to the ability of DND/CF to employ the range of military capabilities required to achieve its assigned missions, when and where directed.

Source: the Defence Plan



Reducing ship signatures

Ships and their crews stand a greater chance of survival if they can avoid being detected by weapons activated by a ship's electromagnetic field. DRDC has proposed a new methodology – based on ship degaussing – which decomposes the ship's total magnetization into components, each one related to the orientation of the degaussing coils. From the effect produced by each one of these components, the method then calculates the corresponding currents as an inverse problem using a regularization algorithm. The result is a magnetic stealth operation that greatly reduces a ship's electromagnetic output. DRDC has demonstrated that an optimum signature reduction throughout the ship's voyage can be obtained using this approach.

Light Armoured Vehicles – Turning complex notions into successful defence

A good example of our work in a complex area of conducting operations is our research on the Light Armoured Vehicle (LAV) Defensive Aids Suite (DAS) depicted on this page. To best illustrate a very complex set of activities – aimed at building a state-of-the-art multi-mission vehicle for the army – we have itemized the various stages of the project, and assigned them to an appropriate timeline.

DRDC RESEARCH ON THE LIGHT ARMOURED VEHICLE (LAV) DEFENSIVE AIDS SUITE (DAS)

Evaluating Protection Systems

- Phase I – Basic DAS Demonstrator (completed)
- Phase II – Enhanced DAS Demonstrator (under way)
- Phase II – Research (under way)
- Phase III – Active Protection Testing (proposed)

- Laser beam rider weapons detection
- Dazzlers
- Missile approach warning systems
- Jammers
- Decoys

- Shaped charges
- Flying plates and rods
- Fragmentation and blast warheads
- Explosively-formed projectiles

- Manœuvres
- Counterfire
- Deployment of multi-spectral smoke
- Laser Warning Receiver (HARLID™)

- Improved information processing
- Wireless contact with detection systems aboard other LAVs
- Better threat identification
- Improved human-machine interface
- Improved contact with ground-based applications
- Extended protection against rocket-propelled grenades and anti-tank guided missiles
- Adaptive camouflage

During Phase I, now completed, we tested the various components of the basic DAS. In Phase II, now under way, we are testing a number of enhancements to the DAS and undertaking research in some key communications and defensive areas. For Phase III, we have proposed work on some active protection measures (shaped charges, flying plates and rods, fragmentation and blast warheads, explosively formed projectiles) potentially very effective against kinetic-energy rounds (at velocities of 800 to 1,800 metres per second) and chemical-energy munitions (200 to 500 metres per second).

Urban operations

Operations in urban environments are an ever-growing reality for the Army and, as part of ongoing preparations for such operations, DRDC was asked to help define the operational-level capabilities needed. This work set the framework for Urban Challenge, an evaluation conducted in May 2002.

Twelve advanced concepts derived from a NATO study on Urban Ops 2020 were proposed, including the use of uninhabited air vehicles (UAVs) capable of flying over rooftops and along streets, as well as inside buildings, tunnels, and sewers; precision-guided munitions able to fly into a window or door; and fully integrated, enhanced situational awareness systems for soldiers.

Urban Challenge showed that operations in urban terrain would prove extremely difficult for any army, no matter how well it is equipped or organized. It also pointed to a number of key factors that will assist us in further enhancing soldier performance, protection, and survival in urban circumstances.

DRDC and Counter-Terrorism

After the terrorist attacks of 2001, DRDC added several important initiatives to its counter-terrorism R&D work. The new initiatives are funded from the $7.7B national security program announced in the 2001 federal budget and enhanced in the 2002 budget.

The CBRN Research & Technology Initiative (CRTI)

The lead element of the plan to further Canada's national security capabilities is a five-year program called the CRTI, managed by DRDC on behalf of the federal government. This initiative represents a key element in DND/CF's Conducting Operations goal to enhance its "overall capability to respond to chemical, biological, radiological, and nuclear (CBRN) threats." The aim of the CRTI is to improve Canada's capacity in these areas by encouraging and strengthening leading-edge research and partnerships.

Working with a budget of $170M over five years, the CRTI coordinates research, allocates funding, and attracts the best talent and ideas from wherever they are to be found, including institutions and companies that may have never previously worked on a government project.

About a dozen federal departments and agencies participate in the CRTI. Among the CRTI's 2002-2003 activities were:

- Symposia/workshops on emerging issues
- Support to federal lab cluster operations
- Assessment of emerging CBRN Technologies Threats & Hazards
- Knowledge management tools, methods and approaches for the CBRN sector
- Cooperative activities with international partners

To achieve results of this kind takes some of the best minds of our organization and our partners, public and private, as well as military experts and a variety of specific subject-matter specialists. These partnerships are the surest way to move the limits of knowledge.

The Counter-Terrorism Technology Centre (CTTC)

The CTTC is another important component in DRDC's counter-terrorism efforts. The CTTC's tasks include training first responders to handle a biological, chemical or radiological incident (detection, identification, handling, and decontamination of live agents). This training consists of practical work in controlled settings. The CTTC also assesses and evaluates equipment for use by first responders, and provides an evaluation site for similar testing by industry.

A key component of the CTTC is the modular chemical/biological forensic reference laboratory designed to provide all the capabilities necessary to identify unknown chemical and biological agents, ranging from classic microbiological techniques to cutting-edge genetic and immunological techniques. A $1.3M modular lab was delivered in mid-November 2002, with the facility scheduled to be operational in late 2003; other laboratories are in the design phase. The facility will hold reference samples of known agents, most of which are already in the DRDC collection. Others will be transferred from existing facilities or imported from other countries. With the assistance of the RCMP, all laboratory protocols and forensic methods will conform to the standards needed to allow the RCMP to use laboratory results as evidence in the prosecution of terrorists using chemical/biological agents. The facility will be unique in Canada – the sole lab with the expertise and facilities to safely work with and unambiguously identify chemical agents.

Radiation detection exercise

SUSTAINING FORCES

DRDC's work also covers this very crucial DND/CF operational requirement.

Providing scientific support for the VICTORIA Class submarines

Since cracking was first observed in January 2002 on the diesel exhaust hull and back-up valves of VICTORIA Class submarines, DRDC has worked closely with DND/CF to provide considerable scientific support.

Temper embrittlement, a form of metallurgical damage, was identified and the impact of that damage studied. We also assisted in the definition and conduct of acceptance trials, and reviewed and signed off on safety justification documents produced by the U.K. and DND/CF for submarine operations.

Developing advanced structural analysis tools for HMCS VICTORIA Class

DRDC has developed modern, rapid methods of calculating the risks of structural collapse. These tools were called into play during the past year to support operational decisions for the VICTORIA Class of submarines. They helped to determine the effects of dent deformation from collision.

Wounds treated with medicated dressing

Treating wounds during battle is a challenge. Many types of wounds can be encountered, untrained individuals may be called upon to administer care in some circumstances, and injured soldiers who are still able can be required to return to battle almost immediately.

DRDC's research has led to the development of medicated dressings that represent a major breakthrough in combat wound care in two key areas: burns and deep-penetrating hemorrhagic blast injuries.

Based on these designs, three patents have been filed. One of the technologies developed was licensed to industry. In addition, DRDC has signed a collaborative agreement with Avitar Inc. to develop a new generation of composite wound dressings.

Hercules life expectancy – A new look

When periodic inspections revealed evidence of structural fatigue on the aging Hercules fleet, DRDC was asked by the Air Force to conduct revised fatigue life calculations. Comparing fleet inspection results with known bench-test trial results enabled us to establish new fatigue expectancies for the fleet.

Partnerships to sustain forces

The partnership between DRDC, the NRC, and DND/CF has continued to provide valuable S&T applications in air equipment life-cycle management. Here are a few examples:

- The multi-national full-scale fatigue test of the CF-18 Hornet structure.
- Completion of development and evaluation work in the Hard Chrome Alternative Technologies initiative, producing initial qualification data of two potential replacement coatings for electrolytic hard chromium currently in use on CF aircraft landing gear.
- Significant improvements toward the reduction of stress-corrosion cracking of aluminum alloy used on many aircraft structures, especially the CC-130 Hercules, notably thanks to a reliable heat treatment process known as retrogression and re-aging, which can be applied to a limited region of large components either before or after installation of the aircraft.
- Successful demonstration of lower-temperature performance of batteries to meet CF requirements, including Li-Ion rechargeable military batteries.

Sustaining Forces refers to DND/CF's repairing and maintaining of equipment, sheltering and sustaining of personnel, and producing the infrastructure and capabilities necessary to support military operations.

Source: the Defence Plan

The Canadian Centre for Mine Action Technologies (CCMAT)

In early 2003, the CCMAT's funding was renewed for another three years. Its focus over this period will be the pursuit of short-term projects with an emphasis on bringing technologies to the field. Five products have so far reached application, and more are expected to follow. This will be consistent with the CCMAT's mandate to develop low-cost, sustainable technologies for mine action and to work towards their successful deployment.

GENERATING FORCES

This capability is the driver for success in all other areas. Recruitment, training, and improvement of existing capabilities to meet expected or actual challenges will have a broad and significant impact. Failure to generate the necessary resources will mean failure to fulfill operations capabilities.

CapDEM – Procurement to meet the need for rapid deployment

The current Defence procurement process can take several years to complete. With what is now, on average, a 15 year concept-to-deployment time frame, changes in technology that occur on a three to five year cycle often render the acquisition obsolete.

Through its introduction of CapDEM (**C**ollaborative C**ap**ability **D**efinition, **E**ngineering and **M**anagement), DRDC is aiming, along with a variety of representatives from across DND, to address this issue in a two-pronged manner: enhancing long-term capability-based planning by aligning strategic requirements with anticipated funding levels over a 25-year period; and reducing the acquisition cycle for approved projects by 30 per cent.

To achieve these goals, CapDEM uses modelling and simulation and a rigorous process to determine what capabilities will be required, what gaps exist, and what technologies could be used to fill those capability gaps.

Training and retaining pilots

When the Air Force challenged DRDC to turn its attention to pilot training and retention and issues such as flying hours, we produced a model of the Pilot Military Occupational Community (MOC).

We did this, in cooperation with subject matter experts from each flying community, by acquiring an in-depth understanding of the Pilot MOC and turning it into the Pilot Production/Absorption/Retention Simulation (PARSim) model.

The model was used extensively in 2002-2003 for the preparation of papers on the CF-18 Hornet and CP-140 Aurora communities, as well as for a consolidated assessment of pilot training and retention that was delivered to the Chief of the Air Staff.

Selecting members for the Military Police Branch

When the CF's Provost Marshal approached us with another challenge, this one to overhaul Military Police staffing, we turned an outdated procedure into a state-of-the-art process. What was once a file review, an interview, and a written test has become a culmination of "best practices" from civilian police forces. Today, candidates participate in a series of

Generating Forces refers to DND/CF's recruiting and training of personnel; researching, testing, and procuring of equipment; and designing the force structure needed to produce multi-purpose combat-capable military forces.

Source: the Defence Plan

Cormorant helicopter pilots from CFB Gander

group dynamics exercises, role plays, interviews, and skills tests that evaluate not only writing skills but also memory and observation, all designed to reflect the competencies required to be an effective member of the Military Police.

Surveys as tools for relevant change

Surveys play a key role in bringing about needed organizational change, including new policies and programs. Following two years of development, two surveys developed by DRDC have been administered and are now being analyzed. They are expected to reveal some key data on the impacts of deployment frequency and intensity, time away, and workload, on CF members, their loved ones, and the organization.

CORPORATE POLICY AND STRATEGY

DRDC's work also assists DND/CF activities in this important, trend-setting area. Here are a few of the Corporate Policy and Strategy projects we are working on.

A role for civil aircraft and uninhabited vehicles in maritime surveillance

Ensuring the maritime security of Canada, with its vast expanses, is a daunting task. The CP-140 Aurora is the primary CF asset employed to provide maritime intelligence, surveillance, and reconnaissance (ISR). But commanders continue to face cuts in the resources available for this purpose, as the Aurora is also used on contingency operations, continental maritime security, and, potentially, Arctic surveillance.

In light of these numerous demands, DRDC investigated the capability of civil aircraft to complement the Aurora for maritime surveillance. An analysis and computer simulation concluded that the supplementary capability could increase the probability of detection of surface targets in a cost-effective manner. Results are being used to support decisions at senior levels within DND/CF.

Corporate Policy and Strategy refers to DND/CF's producing and implementing corporate policies and strategies to achieve broad government objectives, manage departmental activities, and provide defence and security advice.

Source: the Defence Plan

Equally relevant testing, but under a broader mandate, was carried out this year by DRDC and DND/CF to assess three Uninhabited Surveillance Vehicles (USVs) currently offered by industry. USVs show great promise for a vast number of military and civil tasks, including maritime surveillance. Testing results have been analyzed and have provided key operational data on the potential use of USVs by DND/CF.

Future Forces Synthetic Environment Simulation of flying a UAV

Advising DND/CF on the U.S. Army's evolution to the Objective Force

In April 2002, DRDC and the U.S. Army reached agreement on 24 action items, ranging from specific technical follow-ups and meetings to the pursuit of new collaborative arrangements. Several arrangements were negotiated and put in place:

- A project arrangement on soldier ballistic protection
- Data exchange annexes on defensive aids suites and mine blast protection
- Working group terms of reference on soldier system technologies and future fire control
- A joint experimental plan on networked situational awareness

War gaming for long-term planning

In 2002-2003, DRDC and the CF completed a combat capabilities study (force development, force structuring, equipment acquisition, and doctrine and tactics development) of the Main Contingency Force Brigade Group.

Code-named BRONZE ZIZKA, this was the first brigade-level operational research study conducted in the CF since 1984, and one of the largest simulation war games ever conducted in Canada. The study provided insights into the strengths and weaknesses of the deployable group envisioned for the 2005-2006 timeframe.

Among other applications, study results will be used by the Army to better define the Army of Tomorrow structures and capabilities required beyond the year 2010.

How small is too small?

DRDC was asked to investigate how small the various Air Force fleets could become before they would be unable to conduct operations. We developed a model involving key fleet utilization factors such as flying rates and performance expected of aircraft and personnel. The results provided the Air Force with key data needed for future structure decisions.

With an eye toward the long term

DRDC conducted an analysis to find out what systems could meet or exceed the generic capabilities currently embodied in the CF-18 Hornet. The analysis evaluated a series of aircraft and technologies to provide these capabilities in the context of homeland security and expeditionary operations.

This study will provide the foundation for further analysis and decision by the CF with an eye to the 2015-2020 horizon.

Scientific and Technological Capacity

DRDC's business is to ensure that the Canadian Forces are technologically prepared and relevant. We dedicate our more than 60 years of leading-edge S&T experience to the service of the CF and Canada's allies. We deliver advice and innovations that support and enhance our defence and national security.

The pace of defence S&T has been remarkable. Termed by some the Revolution in Military Affairs, or RMA, the advances in question – both tools and methods – have meant that, to remain relevant and interoperable with its allies, Canada has had to embrace technology-driven warfare. We are taking part in a major transformation of combat capabilities.

The national security environment is also changing, as the safety and security risks facing modern societies expand. There are new health hazards, climate change, bio- and cyber-terrorism, and vulnerability of critical infrastructure. Defensive measures and counters to such attacks will also be found through the technological innovations that are energizing the RMA.

MOVING THE BOUNDARIES OF SCIENCE AND TECHNOLOGY

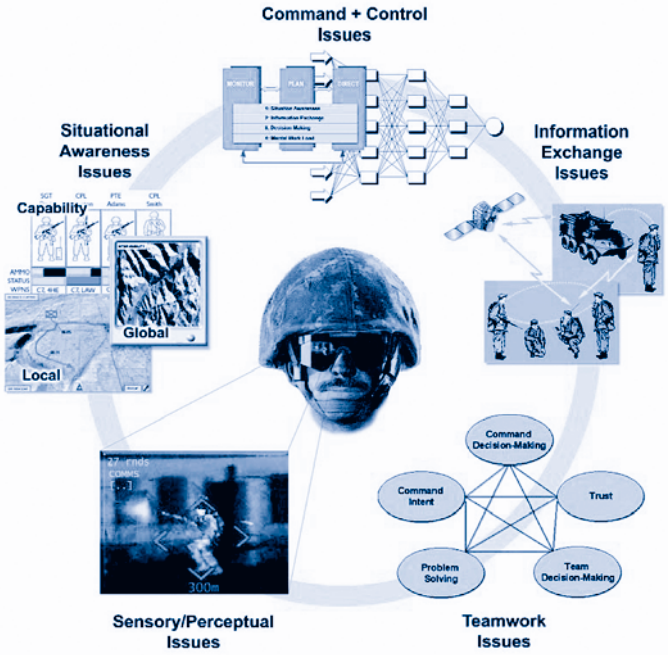
The following snapshots illustrate DRDC's work in a few of the niche sectors that we have identified as providing opportunities to excel and innovate.

DRDC and commercial naval architecture software

Over the past few years, DRDC has been building an extensive library of software being used and re-used in the development of a number of applications by in-house and industry programmers. A good example of the applications possible are the software tools being developed for DND/CF that are aimed at ship and submarine structural and hydrodynamic analyses.

The soldier of the future

What will the soldier of the future look like? Equipped with state-of-the-art sensors, aids for aiming weapons, and computers with visual, auditory, and vibro-tactile displays, the soldier of the future will look more like something out of science fiction than a warrior of the past. Developed with the assistance of modelling and simulation tools created by DRDC, these technologies will be delivered to Canadian soldiers in an intuitive, easy-to-use package that will optimize their effectiveness and survivability on the battlefield.



Soldier Information Requirements identified through Cognitive Task Analysis.

Modelling and simulation tools provide safe, cost-effective opportunities to train soldiers, rehearse missions, and assess equipment before buying it. These tools are crucial to the success of the Soldier Information Requirements project, which has now completed three years of activity. A total of 51 separate experiments have been conducted, including some that were instrumental in the acquisition of night vision, illumination, and aiming equipment for Operation Apollo, and of Personal Role Radios for Operation Athena personnel.

Defending against Enhanced Blast Weapons (EBWs)

EBWs such as thermobaric and fuel-air munitions are a comparatively new threat that is spreading rapidly. One example, the RPO-A thermobaric system, is already in service in at least 26 countries, and the list of user countries will only lengthen over the next few years.

But what accounts for the popularity of EBWs? Simply stated, EBWs are very, very lethal. They produce higher temperatures and longer shock waves than conventional, high-explosive fragmenting weapons. The blast they produce can also propagate around, into, under, and over objects in the open (such as walls, trenches, holes), which would protect a person from the blast

and from fragments produced by conventional munitions. Blast propagation greatly increases lethality in confined spaces such as buildings, tunnels, vehicles, and field defence structures.

DRDC is working on countering EBWs by determining their limits (e.g., range, strength) and their effects on the human body and on structures such as fortifications, camp installations, and typical city buildings. Although this research will focus on support to deployed operations through increased protection and effective countermeasures, it is also expected to enhance national security policy and the ability of the CF to respond in domestic emergencies. Broader protection standards for law-enforcement officials are also a likely result.

Through the wall sensing

Any innovation that allows for increased *and* safer detection of potential threats will garner a great deal of attention. Through-the-wall technologies offer such benefits, using radar technology to reveal, from a distance, the main contents of another room or space. It is a promising field for DRDC, with current research focusing on the development of different types of capabilities. Stand-off sensors, mobile radars on robots or drone vehicles, and multi-static configurations that also permit covert listening are being tested. Efforts are also being made to bring improvements to radar imaging. A 3-D imaging version of through-the-wall technology should make it possible to identify a dog or a cat, to distinguish a child from an adult, and to tell if a person is carrying a weapon such as a rifle.

Although still in its infancy, through-the-wall surveillance technology could be applied in counter-terrorism activities, military operations in urban terrain, and police activities.

BioSteel – A partnership with industry for superior soft body armour

The properties of spider webs are legendary – especially webs produced to trap fast-moving heavy insects. These same mechanical properties make "spider dragline silk" ideal for the construction of soft body armour offering superior protection and comfort, with increased flexibility and reduced weight.

This is the aim of NEXIA Biotechnologies Inc., the company that makes BioSteel, a light and extremely strong spider-silk fibre produced by a patented process using the milk of transgenic goats.

As part of its R&D work, NEXIA (with support from our DIR program) has called on DRDC for expertise in the design and evaluation of ballistic fabric. Along with three other partners, we have been working on selecting the DNA sequences that show good mechanical properties to produce an optimal fibre with ballistic applications.

Key Objectives related to S&T innovations

Objective: To produce at least 10 new defence S&T innovations that are internationally recognized.

Result: Exceeded. The following are 10 examples for 2002-2003.

1. The Seabed Penetrometer, which includes know-how & data processing software to identify the density of seabed struck by the javelin type device; licensed to A.G.O. Environmental Ltd & Jasco Research Ltd (Vancouver, B.C.).
2. ShipMO software, which is used to understand the motions of ships in water; licensed to QinetiQ Ltd., a U.K. company.
3. The High Frequency Surface Wave Radar (HFSWR), which was co-developed with Raytheon Canada. The HFSWR is gaining recognition internationally for tracking targets on the surface of seawater.
4. SHINCOM II (Shipboard Integrated Communication System), a technology which was developed with DRS Ltd.; used by the U.S. Navy on selected CVN aircraft carriers and Aegis class Frigates.
5. Advanced Distributed Mission Training, a system developed in collaboration with CAE Inc. and the U.S. Air Force Research Laboratory, and designed to reduce significant shortfalls in Air Force advanced combat training capabilities by developing and demonstrating a new generation of cost-effective simulation systems.
6. The Tactical Aviation Mission System Simulation (TAMSS) TD, carried out with the CF, Carleton University, XWave, HFE and the U.S. Army, led to the conceptualization and development of the Canadian Aerospace Synthetic Environment project.
7. Urban Dispersion Modelling (UDM) is a Canada, U.S., U.K. and Australia project developed to assess dispersion patterns of chemical and biological agents in urban areas. UDM was validated in laboratory and field trials, and used operationally during the 2002 Salt Lake City Winter Olympics.
8. Force Protection Against Enhanced Blast Weapons is a series of initiatives aimed at hardening the CF and other forces against blast weapons and terrorist improvised explosive threats. Participants include the CF, RCMP, Solicitor General and PWGSC.
9. CB^{plus} Combat Uniform is a whole-body protection system being designed to protect soldiers against warfare agents and high-risk industrial chemicals. Participants include the Netherlands TNO Laboratory and the Swedish Defence Research Agency (FOI). Please see pages 19-20 for more on the Soldier of the Future.
10. DRDC and a number of partners are designing the prototype of a semi-submersible-based Remote Minehunting System (RMS). A joint marketing/production agreement has already been reached between Canadian industry and DCN International (of France) to develop the RMS for operational purposes.

Objective: To initiate R&D in at least three new areas that address national security issues by 2003.

Results: Joint Forces Decision Support in Collective Responses to Asymmetric Threats; Joint Forces Defence and Management Systems; High Earth Orbit Space Surveillance.

Objective: To have at least three concepts based on emerging technologies accepted for experimentation by September 2003.

Results: Design of magnetic shape memory alloys; ultra-thin polymer coating technology for nanoscale powders; smart materials system development and test for aircraft structures.

Wind Chill Calculation Chart

where T air = Air temperature in °C and V_{10} = Observed wind speed at 10m elevation, in km/h.

T air	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
V_{10}												
5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	-58
10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57	-63
15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	-60	-66
20	1	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62	-68
25	1	-6	-12	-19	-25	-32	-38	-44	-51	-57	-64	-70
30	0	-6	-13	-20	-26	-33	-39	-46	-52	-59	-65	-72
35	0	-7	-14	-20	-27	-33	-40	-47	-53	-60	-66	-73
40	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68	-74
45	-1	-8	-15	-21	-28	-35	-42	-48	-55	-62	-69	-75
50	-1	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69	-76
55	-2	-8	-15	-22	-29	-36	-43	-50	-57	-63	-70	-77
60	-2	-9	-16	-23	-30	-36	-43	-50	-57	-64	-71	-78
65	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79
70	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-80
75	-3	-10	-17	-24	-31	-38	-45	-52	-59	-66	-73	-80
80	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81

Frostbite Guide

- Low risk of frostbite for most people
- Increasing risk of frostbite for most people in 10 to 30 minutes of exposure
- High risk for most people in 5 to 10 minutes of exposure
- High risk for most people in 2 to 5 minutes of exposure
- High risk for most people in 2 minutes of exposure or less

°C	-30	-25	-20	-15	-10	-5	-0	°C
°F	-22	-13	-4	5	14	23	32	°F

Revising the wind chill using human data

Scientists knew that the wind chill index was not perfect. But following an international workshop on the subject, in which DRDC played a critical role, Environment Canada and the U.S. Office of the Federal Coordinator of Meteorology decided to develop a Wind Chill Revision Program to update and correct the index using human data. Because of our expertise and involvement with a similar program supported by the CF, scientists from DRDC were invited to take the lead. Using modelling, mannequins, and human testing, a new Wind Chill Index and Frostbite Guide were developed, validated, and launched across Canada and the U.S., attracting much attention from the scientific community, the media, and the public.

LEVERAGING AND REVENUE GENERATION

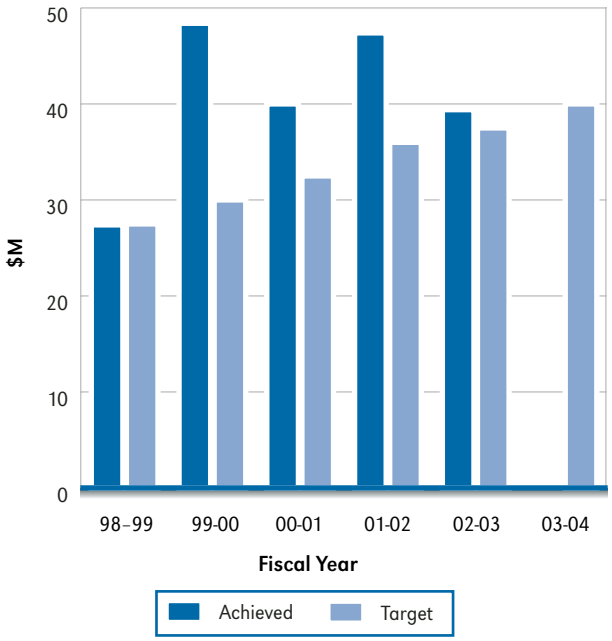
Objective: To annually leverage $40M from allies and $30M from national partners, and generate $10M in revenue from external sources by 2004. The targets for 2002-2003 are $38M, $28M, and $8.5M, respectively.

Results: Please see the following three charts for a multi-year perspective on our performance in these areas.

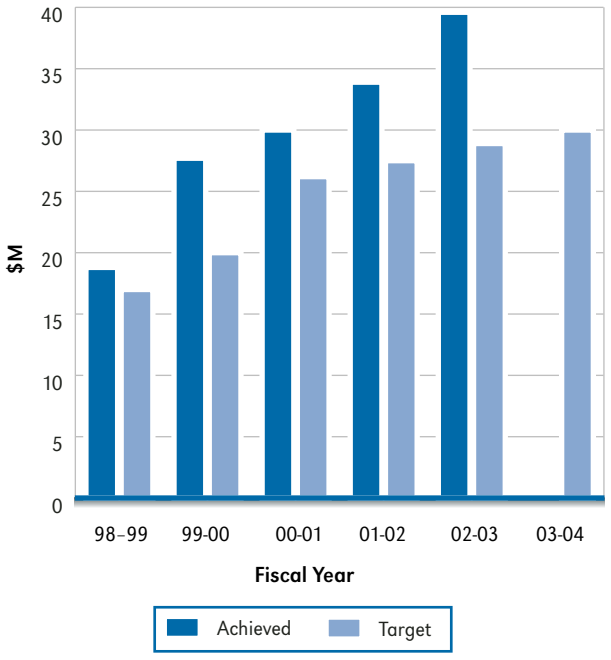
Leveraging from international and national collaborations

The first two charts show the achieved and target value of international and national collaborations for fiscal years 1998-1999 to 2003-2004. We have met our target of $40M for international collaborations and have surpassed our goal of $30M for national collaborations.

Leveraging from international collaborations



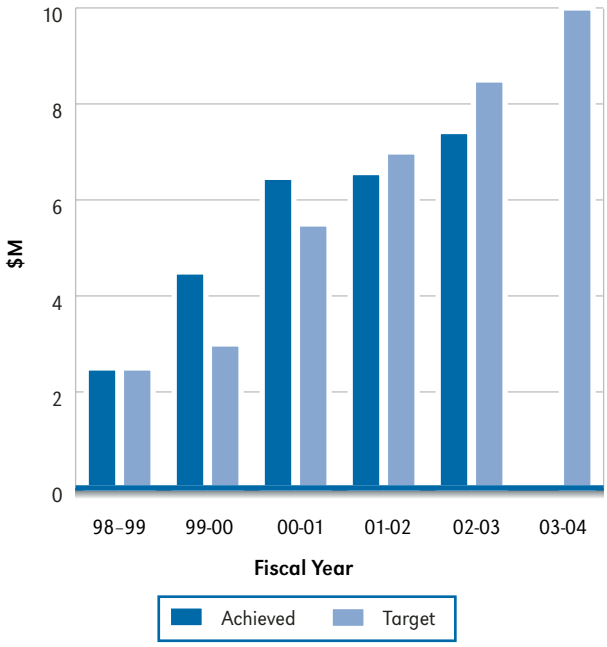
Leveraging from national collaborations



Revenues from external sources

This third chart shows our achieved and target revenue from external sources for fiscal years 1998-1999 to 2003-2004. While we fell short of our target for fiscal year 2002-2003 by about $1M, we are still well on the way to meeting our goal of $10M in revenue from external sources by 2004.

Revenues from external sources



DRDC AND THE ENVIRONMENT

Explosives ecology – Managing an untidy business

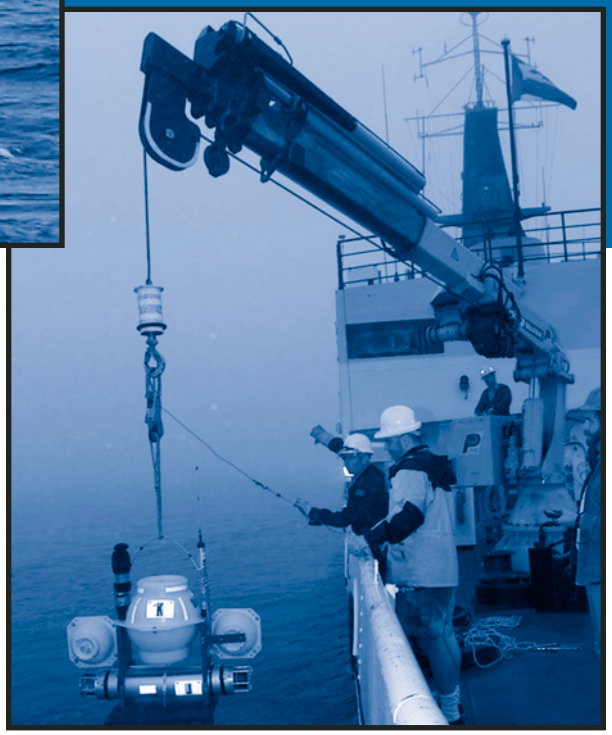
Soldiering can be messy, and hard on the environment. An R&D program conducted in association with a number of national and international partners (see below) seeks to improve our understanding of the complex fate of explosives and other contaminants in soils and ground water and to propose solutions or mitigation methods whenever appropriate.

Knowledge gained in this program will help DND/CF and other departments that use munitions and explosives to develop appropriate corrective actions and mitigation methods. This work is expected to produce significant environmental benefits, not only for Canada, but for all countries where live-fire training is conducted, and where the occasional unexploded ordnance must be destroyed.

DRDC partners in live-fire testing

- INRS-Georessources
- Institute of Biotechnology, NRC
- U.S. Army R&D Centres

Collecting blast data



Protecting the Right Whale

The concern that underwater acoustic signals could harm marine mammals has increased over the past few years, mainly with regard to military active sonars and seismic surveys. Whether in support of mitigation measures or in the larger context of marine mammal studies, there has been significant research on detecting, locating, and tracking whales.

This is where a joint project between DRDC and Dalhousie University comes in: finding the best method of tracking Right Whales in the Bay of Fundy near Grand Manaan Island – an area that happens to be the endangered Right Whales' preferred habitat as well as a principal shipping lane – and developing collision avoidance techniques and equipment.

Excellence in Science and Technology

We have the responsibility to demonstrate that the R&D we perform meets international standards of excellence. In accordance with the recommendations of the Council of Science and Technology Advisors, we track a number of qualitative and quantitative elements of excellence, which include quality, productivity, relevance, and the functional health of our organization.

This section outlines how we believe each of these is related to our achievements of the past year.

QUALITY

DRDC is committed to ensuring that its S&T is of high quality at all stages. Peer reviews are an effective means of assessing such quality.

Peer Reviews

Peer reviews are based on the collective view of experts with respect to the veracity and merit of the methodology and results of a given project. Peer reviews provide management with an objective and critical assessment of technological proficiency, program management, and program relevance.

Carried out by a team of three or four experts in a given field, reviews cover three specific areas: research, people, and infrastructure. The teams are provided with background material which, in concert with a three-day site visit, allows them to prepare reports for management.

In 2002-2003, we conducted a peer review of the Air Vehicles technology program, operated by the Air Vehicles Research Section (AVRS) located at the NRC's Montreal Road campus in Ottawa.

The review team found high-quality personnel, a high degree of relevance in the work being done, and some very innovative projects. However, the team expressed the need for the development of a strategic plan and for better coordination with the NRC's Institute of Aerospace Research.

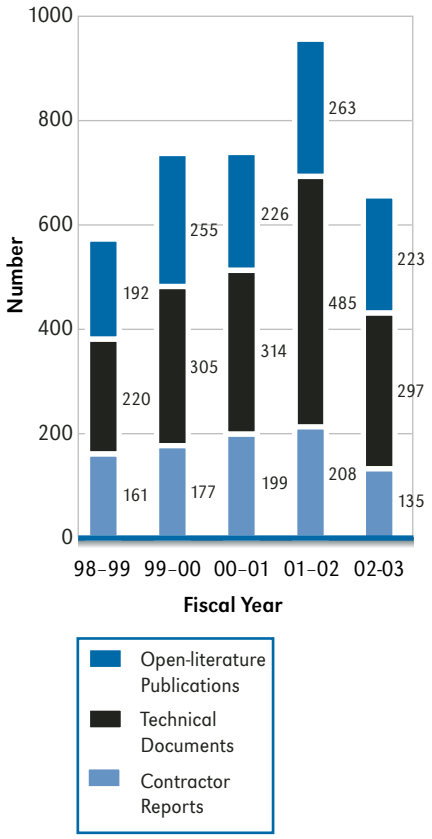
The review of the Air Vehicles program marked the completion of the first round of peer reviews. We are now restructuring the review process to make it consistent with our TIS.

PRODUCTIVITY

Tracking our productivity in publications and presentations is a means of evaluating the degree to which we are contributing to the transfer of knowledge to counterparts in industry, academia, and government who share our interest in this knowledge. It is also a means of assessing the up-trends and down-trends in specific areas of our work.

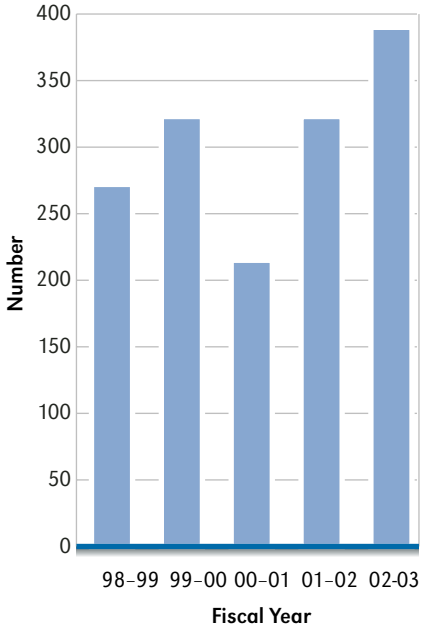
Publications

This first chart tracks the number of DRDC contributions to publications for the fiscal years 1998-1999 to 2002-2003.



Presentations

Presentations help us keep an existing audience – client, partner, media or public – up to date. They also give us the opportunity to further broaden our audience, and to have a better sense of how we are perceived. This second chart tracks the number of formal scientific presentations made by DRDC employees at national and international conferences during the fiscal years 1998-1999 to 2002-2003.



Key Objective related to productivity

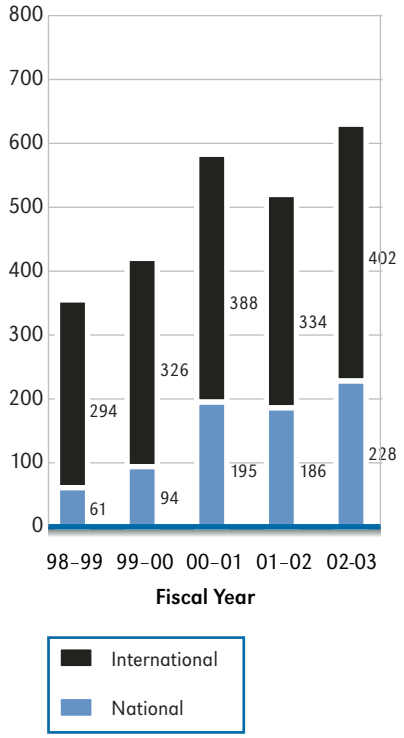
Objective: We set the objective of increasing the in-house effort devoted to R&D by 20 per cent from the 1999 baseline by 2004. The target for 2003 is a 15 per cent increase from the baseline.

Result: DRDC is developing a project activity reporting system to measure the productivity of employees, including the in-house effort devoted to R&D.

National and international activities

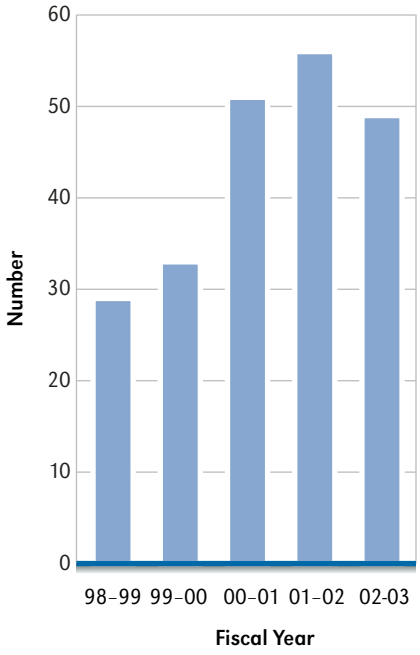
National and international activities are also indicators of productivity. They provide immense opportunities to network, to exchange scientific knowledge, to better observe technological change, and to analyze the trends that will have an impact on our operations and those of our clients in the years to come.

The following chart shows the number of national and international activities in which our staff participated from 1998-1999 to 2002-2003. These activities include membership on councils and technical panels, and participation on collaborative projects, working groups, and information exchanges.



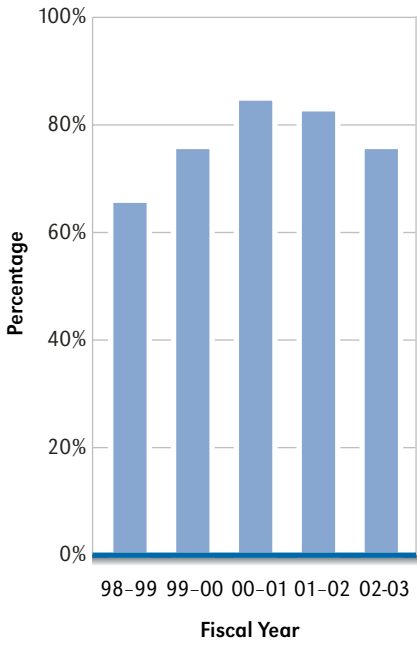
Patents and Reports of Invention

Patents and Reports of Invention are two other indicators of productivity, this time pointing to the originality of achievements. The following chart shows the number of patents granted and reports of invention filed by our staff over the last five years.



Milestone Achievement

We track the progress of projects by assigning anticipated completion dates to project milestones. A total of 355 milestones were used for this analysis for fiscal year 2002-2003. Of this number, 203 milestones were completed fully; the remaining 152 milestones were completed partially. The following chart shows the weighted-average completion of milestones for fiscal years 1998-1999 to 2002-2003. It should be noted that the decreases of the last two years were not unexpected, as we continue to improve our project management methods and processes, as well as their oversight.



RELEVANCE

We constantly ensure, through our work with partners inside and outside government, that we use our resources in the most effective manner possible, and that the results are well aligned with government mandates, missions, and priorities. The recognition we receive through awards and honours, as well as from commercial licenses, is an indication that our S&T activities are indeed relevant to the needs of our clients and partners.

Awards and Honours

Order of Canada

Prakash Bhartia, former Director General of DRDC Ottawa, was appointed a Member of the Order of Canada. He spearheaded major developments in integrated navigation systems that are presently utilized by the CF, and he has been instrumental in the Department of National Defence's R&D programs.

Jacques Beaulieu, a retired DRDC researcher and inventor of the TEA C02 laser, was appointed to the Order of Canada in recognition of his " … decisive influence on the development of lasers and their application in the fields of defence and medicine. In particular, he was responsible for the discovery of the high-power-pulsed carbon dioxide laser, recognized around the globe as a technological revolution."

TTCP Achievement Awards

Excellence in S&T requires individual as well as team leadership. We make every effort to foster leadership at every level of our agency. DRDC scientists and their colleagues at DND/CF and the NRC have been recognized, once again, by The Technical Cooperation Program (TTCP) for their exceptional contributions to increasing the technological strength of military forces in Canada, the U.S., the U.K., Australia, and New Zealand.

- **Eugene Yee** for the development of an urban hazard modelling capability for chemical, biological, and radiological hazard assessment to support military counter-proliferation, force protection, domestic preparedness, and emergency response.
- **Daniel Bourget** and **Denis Bergeron** (with Colonel Ian Anderson of DND/CF) for significant contributions to the advancement of understanding about the mechanisms of lower leg injury caused by blast-type anti-personnel landmines and the generation of the means to identify the best possible landmine personal protective equipment.

- **Éric Fournier, François Lesage**, and **Alain Dupuis** for significant contributions to the first detailed understanding of the physics of lattice control surfaces.

- **Pierre Yansouni** for work leading a collaborative effort that pioneered the exploitation of an interoperable Radar Electronic Support Measures specific emitter identification capability in military systems.

Federal Partners in Technology Transfer (FPTT)

For the fifth time in four years, DRDC has won awards from the FPTT.

- **Paul Brière** and **Bruno Gilbert** (with Michel St-Onge, a consultant) were awarded a Technology Transfer Award for their part in the successful development and transfer of liquid pyrophoric infrared decoy flare technology to provide maximum protection of aircrews against infrared-guided missiles.

- **Andrew Burczyk, Claude Chenier**, and **J. Garfield Purdon** also received a Technology Transfer Award, for their work aimed at the successful development and transfer of foam-based bomb mitigation and decontamination systems.

Departmental Awards

Robert Walker was awarded the Deputy Minister's Commendation for leading an interdepartmental team to address the S&T issues related to CBRN attacks. Through his negotiation, communications, and interpersonal skills, he led the way to the creation of a framework (the CRTI) that will help enhance the capacity and capability of federal laboratories, and make early responders and other communities more effective against terrorist attacks in Canada.

Ann Bradfield was awarded the Deputy Minister/Chief of the Defence Staff Renewal Award for her imagination, vision, and unique approaches to staffing in order to transform and rejuvenate ORD. Once demoralized by severe budget and personnel cuts, this group is now a vibrant, focussed team respected for its ability to provide objective timely research, analysis, and advice. In addition to this achievement, she has developed unique knowledge and influence in matters of defence that are continually sought out to help guide the senior officials of the Department of National Defence.

The following awards were presented to members of the DRDC Toronto Experimental Diving Unit (EDU) in recognition of the quality of their response when a fire broke out in the EDU's Deep Diving Chamber in November 2001:

- The **EDU**, as a team, received the ADM (S&T) Unit Commendation for its cohesive response to the chamber fire.

- The Medal of Bravery was awarded to **Lt. (N) Jay Frew**, Head of Diving operations, for his actions.

- **Leading Seaman Kevin Grant**, EDU diver, received the Chief of the Defence Staff Commendation for his actions.

- The Maritime Commander's Commendation was presented to **LtCdr (RN) Darroch Woodward** for his actions following the fire.

Sonia Latchman was presented the 1 Canadian Air Division Commander's Commendation for her work with **Norm Corbett** as part of their outstanding effort toward the development of PARSim (note: see "Training and Retaining Pilots" on page 16).

Paul Desmier was awarded the Director General Air Force Development Certificate of Service, in recognition of his " ... extraordinary contribution to the Canadian Air Force over the past 16 years, where [his] studies have had a major impact on too many studies to list."

Vice Admiral Ron Buck presented a Chief of Maritime Staff Commendation to the staff of **DRDC Atlantic** for its contribution to Operation Apollo, notably in the area of reducing underwater electromagnetic signatures to increase the safety margin of ships operating in mined waters.

DRDC's Recognition Awards

DRDC's Outstanding Achievement Awards for 2002 were given out to **Ingar Moen** for his sustained and outstanding work on the extensive revamping and refocusing of DND's S&T capabilities and programs, and to the team of **Guy Ampleman** and **Sonia Thiboutot**, who are heading a world-recognized project on the environmental aspects in energetic materials.

DRDC's Award of Public Distinction was handed out to the team of **Randall Osczevski, Michel Ducharme, Peter Tikuisis, Robert Limmer**, and **Debbie Kerrigan-Brown** for their very successful inter-departmental collaboration that has resulted in a revised wind chill index implemented throughout Canada and the U.S. last year.

Other Awards

Prakash Bhartia was presented with the prestigious A.G. McNaughton Medal by the Institute of Electrical and Electronics Engineers for his "exceptional creativity, innovation, and leadership in the R&D of microwave and millimetre wave transmission lines, devices, components, antennas, and systems."

Guy Ampleman and **Sonia Thiboutot** received an award from the Strategic Environmental Research and Development Program for their work on explosives ecology.

Robert Dickson was awarded a NATO commendation and the U.S. Department of Defense Joint Civilian Service Commendation Award.

Licences

Licences are another indicator of relevance, this time pointing to the technologies that may lead to opportunities for business. The following companies were licensed by DRDC in 2002-2003:

- Raytheon Canada for the High-Frequency Surface-Wave Radar which exploits "surface waves," and can detect low-flying aircraft and surface vessels below the radar horizon.
- A.G.O. Environmental Ltd. and JASCO Research Ltd. (Vancouver, B.C.) for the "Seabed Penetrometer," which includes know-how and data processing software to identify the density of seabed struck by a javelin type of device.
- QinetiQ Ltd (U.K.) for the ShipMO software that is used to understand the motions of ships in water.

HUMAN RESOURCES

Building on the activities and accomplishments of last year, DRDC continued to strive toward its goal of excellence in human resources (HR) management, and to develop a workplace that is driven by values, results, and respect for our diversity. Our major initiatives of the past year are presented below under four key results areas: leadership, a productive workforce, an enabling work environment, and a sustainable workforce. These areas are the four pillars on which the Public Service's Human Resources Management Framework is anchored.

Leadership

Defence Scientist Salary Administration System

The continuing evolution of the business environment of DRDC and the need to keep our mission and values current have led us to the modernization of the Defence Scientist (DS) Salary Administration System (SAS).

In-depth consultation and brainstorming, conducted at all of our centres over the past fiscal year, generated information and many ideas for redeveloping the DS SAS. Upon approval from executive management to proceed with the initiative, a DS SAS Development Team was established, which includes representatives from all of our centres, the Professional Institute of the Public Service of Canada, and the Treasury Board Secretariat.

The team will address issues such as revenue generation, management and group leader issues, mobility, personnel assessment, appeals, publications, performance management and measurement, reward mechanisms, and career and salary progression.

A productive workforce

Operational Research Division (ORD)

On April 1, 2002, the ORD officially amalgamated with DRDC, becoming the Agency's sixth research centre. This action ensured a cohesive and common approach in managing S&T workers within DND, and enhanced "synergy" in the Defence Science community. It also ensured that all scientific employees in DND are managed in a consistent manner, as a direct benefit of the HR flexibilities that we enjoy as a Special Operating Agency.

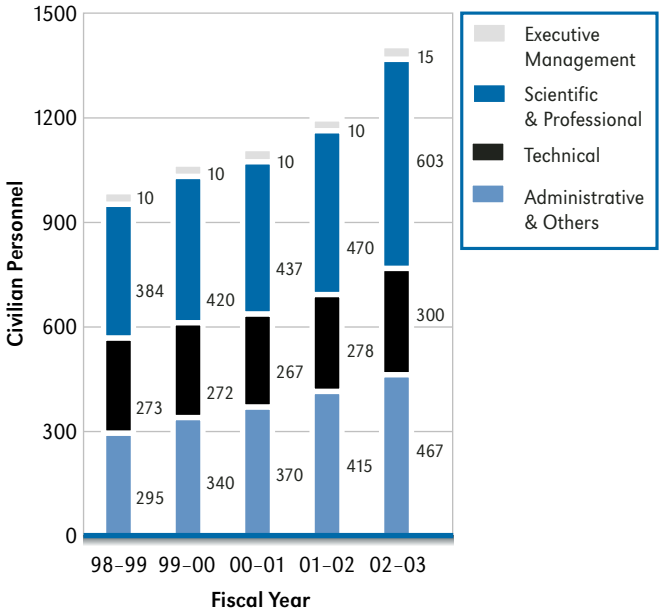
DRDC's demographics

As a result of the amalgamation of ORD with DRDC, our civilian population increased by 18 per cent. The following table shows DRDC's civilian population, by occupational category, as of March 31, 2003.

DRDC's Civilian Personnel by Occupational Category

Occupational Category	Number of Employees
Executive Management	15
Scientific & Professional	603
Technical	300
Operational, Administrative & Foreign Services and Other	467
Total	**1,385**

The next chart provides a five-year picture of DRDC's staffing levels, putting the previous numbers into broader perspective. Please note that a significant portion of our staffing levels increase for fiscal year 2002-2003 is related to the addition of ORD.



An enabling work environment

Orientation Program

With the aim of effectively welcoming new employees into DRDC and familiarizing them with their work environment, we have established a standard, agency-wide approach to employee orientation and developed a comprehensive Orientation Program. Designed and developed through the discussions and collaboration of working groups across DRDC, the program is closely aligned with that of DND and is further complemented by initiatives at the local level. For example, all centres have developed, or are currently developing, welcome packages and orientation sessions for new employees.

To be launched in phases during the 2003-2004 fiscal year, the DRDC Orientation Program is tailored to suit the needs of each new employee, to help each individual adjust to his/her workplace, and to equip and support her/him so that the employee may quickly begin to contribute to the achievement of the Agency's objectives. A useful tool for the identification and planning of the employee's current and future learning needs, the program also fosters commitment and collaboration between managers and employees and strengthens the relationship between them.

Employment equity

Improving our working environment involves continuous effort. Results can only be achieved through the collective commitment of all DRDC personnel.

DRDC participated in a departmental compliance audit begun during the 2002-2003 fiscal year. The audit, a requirement legislated under the Employment Equity Act, is conducted by the Canadian Human Rights Commission.

The findings of the audit will be incorporated into our Employment Equity Plan and measures will be identified to demonstrate our commitment to Employment Equity and to becoming a workplace of choice that is representative of Canadian society.

The following table compares our representation of designated group members for fiscal years 2001-2002 and 2002-2003 and demonstrates an increase in representation for each employment equity group.

Official languages

DRDC supports Canada's vision as a nation that respects linguistic, cultural, and regional diversity. We believe in the linguistic duality of our employees and promote the effective use of both official languages in our offices, both in the National Capital Region and in the regional research centres.

DRDC has adopted a values-based approach to official languages and aims to develop an organization committed to inclusiveness, tolerance and respect for others. In support of this new approach to official languages, we have undertaken a review of the language designation of positions and the extent to which incumbents meet the linguistic requirements of their position. Through this review, a process has been developed to ensure the integrity of data related to official languages.

This new approach to official languages will create a significant cultural shift and set in place a new system of values within the organization, thereby demonstrating DRDC's aim to embrace the spirit of the Official Languages Act.

A sustainable workforce

Learning and development

A qualified workforce with the right skills contributes greatly to the success of an organization. DRDC recognizes the importance of the continuous learning and development of its employees. In support of the Treasury Board Policy for Continuous Learning in the Public Service, which allows for all permanent employees to have a personal learning plan by March 31, 2004, DRDC has initiated the practice of discussions between managers and their employees on employees' learning needs and career aspirations. These discussions are to conclude

Representation of Employment Equity Groups as a Percentage of the Total DRDC Population

WOMEN		VISIBLE MINORITIES		PERSONS WITH DISABILITIES		ABORIGINAL PEOPLES	
2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
22.3%	23.5%	5.4%	7.5%	2.2%	2.4%	0.5%	0.8%

with the development of a learning plan that is to be integrated into the employee's annual Performance Review Report.

This initiative demonstrates our commitment to continuous learning for our employees, supports the development of a learning strategy for the Agency, facilitates the application of core competencies in learning and development, and contributes to effective succession planning.

Key Objectives related to Human Resources

Objective: To institute an annual innovation recognition event for significant achievements.

Result: In 2001, DRDC instituted an annual recognition event at which the DRDC Recognition Awards are presented. Awards for outstanding achievement and for public distinction were presented for the second year in 2002. In addition, each centre recognizes local achievements through their own annual awards program.

Objective: To implement career management for all staff by December 2002.

Result: Each of DRDC's employees belong to one of four career streams: management, science, technology, and corporate services. The careers of employees in the management and science streams career management are addressed at DRDC's Human Resources Management Committee. A similar approach has begun for the corporate services streams through the Corporate Service Management Committee. Career management for the technology stream is addressed by the directors general of DRDC's research centres.

Objective: To implement the management and leadership development and succession strategy by December 2002.

Result: Management and leadership development and succession planning are addressed in the context of career management, as described above.

CORPORATE SERVICES

When DRDC became an agency, we made a commitment to increase the efficiency and effectiveness of our Corporate Services. To this end, we undertook a thorough review of all our processes. The following three activities illustrate how we went about this work.

- A study of various activities allowed us to merge two administrative functions – procurement and finance – and proceed with the cross training of the officers involved. Real dollar savings and increased productivity have been the result.

- A successful records/document management pilot project, based at DRDC Ottawa, will soon be expanded to DRDC's other centres. Billed as the first step to a full e-document process, the pilot project features a database that stores full text unclassified documents and their images. Much of its content is of DRDC origin, but relevant external pieces are stored in the system as well. As part of a one-stop-reference effort, titles of classified documents are also displayed in the index. As an added feature, documents can be sent to multiple recipients simultaneously, meaning significant time saved on larger R&D projects.

- "Process Maps On-Line" (PMOL) is another administrative measure expected to result in significant efficiencies for DRDC. PMOL's aim is to document the Agency's internal processes – from leave forms and requests for translation to more complex management tools – and display these methods and practices on DRDC's intranet site. There, DRDC staff can find out what correct steps to follow for each task displayed. Section-by-section detailing, as well as task-by-task indexing, makes PMOL easy-to-use. Reaction to these documents-of-record has been very favorable.

Financial Statements

EXPENDITURES

The expenditures reported here do not include ORD, which was not fully integrated into DRDC until the end of fiscal year 2002-2003.

Expenditures by Business Line

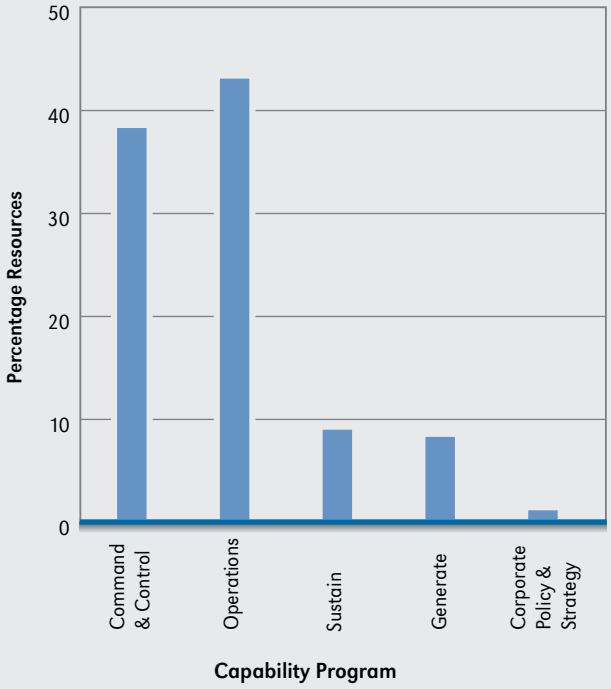
We fulfill our role as part of Canada's Defence Team through four lines of business.

1. **R&D for the CF and DND** through five environmental client groups: Maritime, Land, Air, Command and Control Information Systems, and Human Performance. Common objectives related to a client's needs are set and adjusted regularly through a comprehensive client consultation process.
2. **Strategic S&T advice and support to the CF and DND.**
3. **Strategic S&T advice and support to National Security Partners**, including Canadian industry and other government departments.
4. Our own **Corporate Management** as an agency of the Department of National Defence.

BUSINESS LINE	CIVILIAN FTEs	EXPENDITURES ($000)	CIVILIAN FTEs	EXPENDITURES ($000)
1. R&D for the CF and DND				
Client Groups:				
Maritime	139	$34,344		
Land	112	$31,042		
Air	73	$25,847		
Command and Control Information Systems	127	$24,731		
Human Performance	80	$18,045		
Sub-total for Business Line 1	531	$134,009	531	$134,009
2. Strategic S&T Policy and Advice			57	$6,235
3. S&T with National Security Partners			97	$21,831
4. Corporate Management			546	$61,073
Total			**1231**	**$223,148**

Expenditures by Capability Program for Business Lines 1 and 2

Each project in Business Lines 1 and 2 is associated with one of the five Capability Programs. This chart shows the percentage of resources in Business Lines 1 and 2 that were expended in fiscal year 2002-2003 by these projects.



Expenditures by fund type and centre

This table shows how each of our centres expended their resources. CRTI and CCMAT (Canadian Centre for Mine Action Technologies) have been shown as separate line items to enhance clarity.

CENTRE	SALARY	OPERATIONS & MAINTENANCE	R&D CONTRACTS	EQUIPMENT	ENVIRONMENT	TOTAL ($000)
DRDC Atlantic	$14,676	$3,430	$8,196	$1,091	$13	$27,406
DRDC Valcartier	$22,240	$9,654	$9,770	$3,155	$402	$45,221
DRDC Ottawa	$11,569	$4,462	$14,710	$2,440	$116	$33,297
DRDC Toronto	$8,743	$4,145	$6,732	$370	-	$19,990
DRDC Suffield	$10,327	$2,966	$6,064	$1,582	$107	$21,046
DRDC Corporate	$9,056	$5,829	$43,787	$91	$10	$58,773
CRTI	$353	$717	$3,332	$11,028	-	$15,430
CCMAT	$569	$1,416	-	-	-	$1,985
Total ($000)	**$77,533**	**$32,619**	**$92,591**	**$19,757**	**$648**	**$223,148**

REVENUES

Appropriations by fund type

This table summarizes the funds that DRDC received in fiscal year 2002-2003 to carry out its program.

FUND TYPE	TOTAL ($000)
Salary and Wages	$69,903
Operations and Maintenance	$27,947
R&D Major and Minor Projects	$88,914
Capital & Minor Requirements	$7,905
Environment	$644
Corporate	$4,090
CCMAT	$1,867
CRTI	$29,797
Local Revenues	$5,678
Revenues from Collaborative Agreements	$1,748
Transfers from Other Government Departments	$0
Total	**$238,493**

Sources of revenue by centre

This table shows the revenues our centres earned from various sources for conducting R&D activities above and beyond the Service Level Agreements we have established with our CF clients.

CENTRE	PRIVATE SECTOR SOURCES	REVENUES FROM COLLABORATIVE AGREEMENTS	DND/CF CLIENTS	TOTAL ($000)
DRDC Atlantic	$376	-	$740	$1,116
DRDC Valcartier	$2,689	-	$5,781	$8,470
DRDC Ottawa	$1,356	-	$223	$1,579
DRDC Toronto	$136	$803	$1,175	$2,114
DRDC Suffield	$1,097	$945	-	$2,042
DRDC Corporate	$24	-	-	$24
Total ($000)	**$5,678**	**$1,748**	**$7,919**	**$15,345**

FINANCIAL SAVINGS

When DRDC became a Special Operating Agency, it committed itself to reducing costs by $3.5M by 2004. Numbers compiled so far put savings at over $4.1M, or 117 per cent of the goal. The following table outlines where DRDC generated savings for fiscal year 2001-2002.

CENTRE	TARGET ($000)	SAVINGS ACHIEVED IN FY 2001-02 ($000)				PERCENTAGE OF TARGET
		Recurring	Non-recurring	Cost Avoidance	Total	
DRDC Atlantic	$465	$0	$0	$140	$140	30%
DRDC Valcartier	$1,570	$500	$135	$1,350	$1,985	126%
DRDC Ottawa	$170	$93	$0	$40	$133	78%
DRDC Toronto	$220	$250	$25	$1,020	$1,295	589%
DRDC Suffield	$920	$192	$0	$260	$452	49%
DRDC Corporate	$195	$41	$0	$102	$143	73%
Total	**$3,540**	**$1,076**	**$160**	**$2,912**	**$4,148**	**117%**

Note: Where use of resources has been optimized, further cost reductions may not be possible in years ahead.

Summary

Defence R&D Canada's mission is to ensure that the Canadian Forces are technologically prepared and relevant. To achieve this, we stay in close touch with our clients and seek out their feedback regularly.

To do a better job every day, every year, we act on this feedback through a variety of mechanisms initiated over the last five years. These include the DRDC Advisory Board, the R&D Program Board, Service Level Agreements, Thrust Advisory Groups, and formal and informal client satisfaction surveys.

With the Operational Research Division (ORD) joining our ranks, the level of service we provide to our clients and the quality of customer relations we nurture have already increased. The integration of R&D and decision-making through closer ties between the Operational Commands and ourselves has also significantly improved our level of service.

We have long been leaders in establishing and promoting partnerships, especially with allies, through the TTCP, NATO, and bilateral and trilateral agreements. The unique relationship that Canada shares with the U.S. has benefited the Canadian defence R&D program and has led to the successful development, commercialization, and exploitation of many technologies and systems. It has also led to favourable conditions for Canadian industry to access U.S. defence programs.

We manage the CRTI, mentioned earlier in this report, the lead element of the federal plan to further Canada's national security capabilities to deal with threats of a chemical, biological, radiological or nuclear nature. The initiative is strengthening the nation's preparedness for a CBRN terrorist attack by investing in new capabilities aimed at both preparation and response. To this effect, DRDC has collaborative projects with a number of Canadian federal organizations, including Health Canada, Environment Canada, and the Canadian Food Inspection Agency.

Our scientists are recognized internationally as world leaders in niche areas of defence technology. We are committed to expanding on this expertise and on developing innovative areas of knowledge. Ultimately, the most important results of defence R&D are better training, new and improved equipment, and more innovative tactics and processes, all of which underlie increased excellence in the technological policy advice we can provide for the greater safety of the Canadian Forces and of all Canadians wherever they are.

We are proud of the legacy we have established. We are proud of the legacy we are building. We look forward to meeting the challenges that will be put before us in the years to come. We look forward to opening new doors of innovation, as we strive to become known as the best in defence R&D.

Tables

TABLE 1 R&D ACTIVITIES IN THE RESEARCH CENTRES

R&D ACTIVITY	RESEARCH CENTRE					
	DRDC Atlantic	DRDC Valcartier	DRDC Ottawa	DRDC Toronto	DRDC Suffield	Operational Research Division
Autonomous Intelligent Systems					■	
Chemical/Biological/Radiological Hazard Assessment, Identification and Protection			■		■	
Command & Control Information Systems Performance and Experimentation	■	■				
Communications			■			
Electro-Optical Warfare		■				
Emerging Materials & Bio-Technology	■				■	
Human Factors Engineering & Decision Support Systems	■	■		■		
Information and Knowledge Management	■	■				
Multi-Environment Life Support Technologies				■		
Network Information Operations		■	■			
Operational Medicine				■	■	
Platform Performance & Life Cycle Management	■					
Precision Weapons		■				
Command Effectiveness & Behaviour				■		
Radio-Frequency Electronic Warfare			■			
Sensing (Air & Surface)		■	■		■	
Underwater Sensing and Countermeasures	■					
Signature Management	■					
Simulation & Modelling for Acquisition, Requirements, Rehearsal, and Training	■	■	■	■		
Space Systems		■	■			
Weapons Performance and Countermeasures		■			■	
Operational Research and Analysis						■

TABLE 2 TECHNOLOGY DEMONSTRATION PROGRAM (TDP) PROJECTS

CLIENT GROUP	PROJECT NAME	DATES		TOTAL VALUE (000$)	CONTRACTED R&D	
		Start	End		Total (000$)	FY 02/03 (000$)
Maritime	Canadian Naval Electronic Warfare Set	1990	2002	$32,055	$27,604	$600
	SHINCOM Upgrade	1996	2003	$16,477	$10,100	$1,669
	Improved Ship Structural Maintenance Management	1996	2004	$4,985	$4,290	$521
	Towed Integrated Active/Passive Sonar	1997	2005	$19,882	$16,172	$3,900
	Remote Minehunting System	1997	2003	$9,784	$9,004	$2,865
	Command Decision Aids Technology	2000	2004	$7,164	$5,600	$1,685
	Shipboard Integration of Sensor and Weapon Systems	2000	2006	$7,266	$6,000	$963
	Rapidly Deployable Underwater Acoustic Surveillance System	2000	2005	$11,005	$7,500	$560
	Networked Underwater Warfare	2001	2006	$10,087	$6,200	$600
	Multi-Sensor Integration within Common Operating Environment	2002	2006	$6,897	$6,000	$200
	Force TEWA -Force Threat Evaluation Weapons Assignment	2003	2008	$8,636	$7,600	New
Land	Soldier Information Requirements	1996	2004	$13,087	$16,398	$2,400
	Land Intelligence and Electronic Warfare Automation	1998	2003	$5,847	$6,374	$777
	Intelligence, Surveillance, Target Acquisition and Reconnaissance	2000	2004	$9,738	$6,400	$1,945
	High Energy Missiles for Light Combat Vehicle	2000	2005	$16,655	$7,100	$1,900
	Future Armoured Vehicle Systems	2000	2005	$12,077	$8,000	$2,900
	Tactical High Capacity Communication Links	2000	2006	$8,845	$5,600	$1,550
	Soldier Integrated Headwear System	2002	2006	$7,349	$5,800	$150
	Integrated Communications EW Analysis and RF Sensor	2002	2007	$9,206	$5,700	$200
	Force Protection against Enhanced Blast Weapons	2002	2007	$13,847	$5,930	$0
	Multi-Mission Effects Vehicle	2003	2006	$8,873	$7,255	New
	Advanced Linked Extended Reconnaissance & Targeting	2003	2008	$8,861	$5,950	New
Air	Tactical Aviation Mission System Simulation	1999	2004	$7,436	$6,140	$2,080
	Hyperspectral Imagery for Improved Airborne ISR	2000	2005	$6,824	$5,900	$1,500
	Maritime Air Littoral Operations	2000	2006	$9,661	$6,200	$400
	Uninhabited Surveillance Vehicle	2001	2004	$3,454	$685	$435
CCIS	High Frequency Surface Wave Radar for Coastal Surveillance	1995	2003	$8,734	$6,352	$200
	Radarsat 2 GMTI	1999	2008	$24,605	$7,290	$1,184
	Common Operating Picture 21	1999	2005	$11,320	$6,120	$1,060
	Coalition Aerial Surveillance and Reconnaissance	2001	2005	$3,046	$1,151	$302
	Advanced SATCOM Terminal	2001	2006	$8,613	$2,650	$0
	Collaborative Capability Definition Engineering & Management	2002	2007	$12,588	$7,411	$670
	Joint Network Defence and Management Systems	2003	2006	$5,949	$5,250	New
	Joint Forces Decision Support in Collective Responses to Asymmetric Threats	2003	2007	$6,626	$6,000	New
	High Earth Orbit Space Surveillance	2003	2007	$7,090	$6,500	New
HP	Vaccine Development Initiative	1998	2005	$5,977	$4,200	$500
	Advanced Distributed Mission Training	1999	2004	$7,331	$7,000	$1,800
	CB Combat Duty Uniform (CB Plus)	2001	2006	$10,080	$5,900	$800
	Aerosol Inhalors for Field Prophylaxis and Therapy (Cipro Plus)	2001	2006	$4,633	$4,000	$650
	Advanced Deployable Day/Night Simulation (definition only)	2003	2007	$1,311	$300	New
	Total			**$393,899**	**$275,625**	**$36,966**

TABLE 3 TECHNOLOGY INVESTMENT FUND (TIF) PROJECTS

CLIENT GROUP	PROJECT NAME	DATES		CONTRACTED R&D	
		Start	End	Total (000$)	FY 02/03 (000$)
Maritime	Ocean Environmental Conditions by Remote Sensing	2000	2003	$680	$210
	Adaptive Learning Techniques for Future Radar and Communications	2001	2004	$750	$250
	Fabrication of Organic Radar Absorbing Material	2001	2004	$750	$250
	Synthetic Target Signature Generation for Non-cooperative Target Recognition	2001	2004	$750	$240
	Design of Magnetic Shape Memory Alloys	2002	2005	$750	$220
	Dielectric Actuators for Active/Passive Vibration Isolation	2002	2005	$750	$270
	Application of Evolutionary Algorithms to the Optimization of an Adaptive Control System for Closed-Loop Systems	2003	2006	$750	New
	Aural Discrimination of True Targets from Geological Clutter	2003	2006	$750	New
	Decision Centred Evaluation Capability of Decision Support Systems from a Net Decision-Making and an Operational Perspective	2003	2006	$750	New
Land	Hydrogen Storage in Carbon Nanotubes	2000	2003	$955	$270
	Small Cross Section Imagers	2000	2003	$660	$350
	Super-Compressed Detonation	2000	2003	$1,000	$300
	Development of Polymer Coating	2002	2005	$625	$225
	Advanced Electrochromic Polymer Technologies for Adaptive Camouflage Applications	2003	2006	$545	New
	Volumetric Sensing of Complex Environments for Control of Complex Vehicles	2003	2005	$700	New
Air	Active Identification System for Unresolved Airborne Targets	2001	2004	$750	$240
	Modelling Single Crystal Superalloy Properties from First Principles	2001	2004	$300	$100
	Novel Imaging Sensors	2002	2005	$510	$151
	Critiquing System for the Improvement of the Military Estimate Process	2002	2004	$750	$220
	Smart Materials System Development and Test	2002	2005	$283	$90
	Low Probability of Intercept Synthetic Aperture Radar	2003	2006	$650	New
	Supersonic Missile Flight Control	2003	2006	$750	New
CCIS	Miniaturization of Modules for Phased Arrays	2001	2003	$350	$175
	Advanced RF Tag for SAR	2002	2004	$740	$320
	Bistatic STAP Signal Processing for Space Based Radar	2001	2004	$175	$125
	Nanotechnologies in Military Systems	2001	2004	$745	$375
	Polarimetric InSAR	2001	2004	$725	$400
	Remote Detection of Radiological Threats	2002	2003	$600	$200
HP	Drug Design of Peptide Mimetics	2000	2003	$760	$270
	Nanotechnology-Based Platform for Genetic Analysis of Biological Agents	2000	2003	$1,000	$300
	Ultrasonic Sensing and Imaging Technology Applied to Field Medicine Diagnostics	2000	2003	$950	$250
	Display Techniques for Improving Battlespace Visualization	2001	2004	$750	$157
	Molecular Target Identification for Novel Antimicrobial Development	2001	2004	$950	$330
	Nanostructured Metal-Organic Polymers for Chemical and Biological Protective Barriers	2001	2004	$564	$188
	Adaptive and Creative Decision Making Under Stress	2003	2006	$750	New
	Emerging Material Technologies for Applications in Battlefield Wound Care	2003	2005	$750	New
	Nucleic Acid-Based Drugs against Biological Weapons Agents	2003	2006	$750	New
	Total			**$25,717**	**$6,476**

TABLE 4 DEFENCE INDUSTRIAL RESEARCH (DIR) PROGRAM PROJECTS

PROJECT NAME	DATES		CONTRACTED R&D	
	Start	End	Total (000$)	FY 02/03 (000$)
Development of Advanced Navier-Stokes Methods for Vortical and Separated Flows	1999	2004	$500	$121
Proof-of-Concept for a Hand-Held Real Time Biodetector and Sampler	1999	2003	$500	$23
Development of a Prototype Alternating Current Potential Difference (ACPD) System to measure Compressive Residual Stresses in metallic components	1999	2004	$363	$89
Integrated Ship Defence Simulation Research and Development	1999	2003	$353	$59
Hemoglobin-Starch Conjugates for Blood Volume Replacement and Oxygen Delivery	2000	2003	$500	$85
Energetic Materials Technology for Large Calibre Ammunition	2000	2003	$500	$138
Display Assessment and Enabling Technology Research for new Military Displays	2000	2004	$500	$156
In-Situ Coating of Plasma Synthesized Ultra-Fine Nanosized Metallic Powders	2000	2003	$357	$31
Development of Advanced Ceramic Armour System for Personal Protection	2001	2002	$500	$144
Bio-Alloy Smart Materials for Biosensing: Detection and Identification of Chemical and Biological Warfare Agents (Phase II)	2001	2003	$500	$196
Immune Modulator Strategy, Phase III	2001	2003	$496	$252
Improved Oil Debris Monitor	2001	2004	$266	$130
Multi-Platform Data Fusion between Halifax Class Frigate and an Airborne Collaborating Platform	2001	2003	$500	$227
Single-Chip MEMS Switch Networks	2001	2004	$500	$195
Defence Learning Object Project	2001	2005	$1,001	$153
Improved Tactical Rocket Motor	2001	2003	$500	$239
Fuze Setting Technologies Assessment and Analysis	2001	2004	$500	$80
Advanced Packetized Oxidizers for High Performance Missiles	2001	2003	$127	$75
Hydro-Reactive Gas Generator Hybrid (HyPerG)	2001	2003	$199	$90
Integrated IPME/SAFEWORK Graphical Human Task Environment (INSIGHT)	2002	2004	$474	$98
Advanced Underwater Energy System	2002	2004	$343	$100
Algorithms for HS Target Detection	2002	2003	$491	$251
Processing of Biased PZT Material for Use in High-Power Sonar Transducers and High-Strain Actuators	2002	2004	$500	$169
Tri-Dimensional Automatic Target Recognition	2002	2004	$325	$193
CASE-based reasoning on aircraft technician fault diagnostic learning and learning retention	2002	2005	$472	$106
Uninhabited Armoured Vehicle Engineering Study	2002	2003	$500	$485
Development of Gas Turbine Life Prediction software	2002	2006	$500	$113
Secure Internet Communication using 7Net Technology	2002	2003	$500	$269
Near Earth Space Surveillance	2002	2003	$110	$15
Data Mining for Decision Support Systems	2002	2004	$500	$142
Launch and Flight Characteristics of Kinetic Energy Projectiles	2002	2006	$401	$4
Ultra light CERAMOR Bullet Resistant Plates for plate Protection	2003	2004	$400	$96
Phage Therapy: An Innovative Approach for the Management of Anthrax and Brucella Infections	2003	2005	$495	$25
Recombinant Spider Silk-Based Advanced Performance Fibre	2003	2005	$500	$25
Total			**$15,174**	**$4,575**

TABLE 5 PATENTS GRANTED

- Bacterial and Synthetic Polysaccharide Immunomodulators that Enhance General Immunity
- Circuit for LPI Signal Detection and Suppression of Conventional Pulsed Signals
- Emergency Exit System
- Formulation for Decontaminating Chemical Warfare Agents
- Glycidyl Azide Polymer Copolyurethane Thermoplastic Elastomers
- High Resolution 3D Ultra Sound Imaging System Deploying a Multi-Dimensional Array of Sensors And Method For Multi-Dimensional Beamforming Sensor Signals
- Insensitive Propellant Formulations Containing Energetic Thermoplastic Elastomers
- Liposome-Encapsulated Poly ICLC
- Method for Evaluating Similarity of Signals having a Carrier Frequency Offset
- Method of Detecting A Pathogen Using a Virus
- Process for Making CuO Semiconductors
- Synthesis of Energetic Polyester Thermoplastic Homopolymers and Energetic Thermoplastic Elastomers formed Therefrom

TABLE 6 MAJOR INTERNATIONAL AGREEMENTS

AGREEMENT	AREA OF ACTIVITY
The Technical Cooperation Program	Aerospace Systems
	Command, Control, Communications, and Information Systems
	Chemical, Biological, and Radiological Defence
	Electronic Warfare Systems
	Human Resources and Performance
	Maritime Systems
	Materials and Processing Technology
	Sensors
	Conventional Weapons Technology
North Atlantic Treaty Organization (NATO) Research and Technology Organization	Applied Vehicle Technology
	Human Factors and Medicine
	Information Systems Technology
	Modelling and Simulation Group
	Studies, Analysis and Simulation
	Systems Concepts and Integration
	Sensors and Electronics Technology
Bilateral Agreements with the U.S.	Master Data Exchange Arrangement
	Technology Research and Development Projects
	North American Technology Industrial Base Organization
Trilateral Agreements with the U.S. and the U.K.	Trilateral Technology Research and Development Projects
	Chemical, Biological, and Radiological Memorandum of Understanding
Other Multilateral Agreements	Multilateral Master Information Exchange Memoranda of Understanding (MMIEM), also known as ABCANZ, with the U.S., Australia, the U.K., and New Zealand
	Technical Support Working Group, with the U.S., the U.K., and Israel
Other International Partners	France, Germany, Sweden, and the Netherlands.

Contact Information

Defence R&D Canada publishes this report annually to describe its operations for the previous fiscal year, including information about Defence R&D Canada's performance with respect to the objectives established in its business plan, its financial statements, and any other information that the Deputy Minister of National Defence may require to be included.

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