



Rising to the Challenge



Annual Report

01|02



Defence Research and Development Canada

Recherche et développement pour la défense Canada

Canada

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Message from the CEO



Rising to the Challenge

When the Centers for Disease Control and Prevention (CDC) in Atlanta last year requested urgent assistance to perform highly specialized tests at the Brentwood mail facility in Washington, where anthrax contamination had been found, they could have asked any organization in the western world for help. Perhaps not surprisingly, they chose us. They were well aware of our international reputation in chemical and biological defence and see our people as among the very best in the world.

With a wider range of security challenges at hand, our work has never been more relevant, nor our efforts more needed. As the Canadian Forces are reshaped, both at home and abroad, we are tapping into a number of elements in our impressive science and technology portfolio. Understandably, this comes with certain costs and additional effort.

For example, there have been adjustments in some of our research activities. These adjustments involve tighter deadlines to help us expedite the work of getting new technology into the hands of the Canadian Forces as quickly as possible. We continue to re-evaluate our program to ensure that it matches national priorities and we are ensuring that our investments are consistent with the needs of the Department of National Defence.

This Annual Report outlines just some of our contributions in the post-September 11th environment. It also describes our ambitious research and development program, as well as our pursuit of innovative approaches

to managing our organization. These qualities are vital to any responsive and forward-looking organization. One of the lessons I took from September 11th was the need to work very well together to maximize our strengths. This report shows how partnerships with industry, academia, and other government departments have become even more important. Through such collaboration, we have greater access to technology and expertise, and are able to improve our service to the Canadian Forces.

Science and technology play a vital role in the current geopolitical and military context. Our advice, our know-how, and our technology will continue to make important contributions to Canada's efforts. We are rising to the challenge.

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

Our Vision

To be known worldwide as the best in defence research and development.

Our Mission

To ensure that the Canadian Forces remain technologically prepared and relevant 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 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; and
- 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

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



Agency Overview



Defence R&D Canada, an agency of the Department of National Defence, provides the department with leading-edge products and services in defence-related science and technology. We have more than 50 years of success in providing scientific excellence to the Canadian Forces in areas such as biological and chemical defence, radar, communications, sonar systems, lasers, rocket systems, electro-optics, life support systems, marine vehicle systems, and mine countermeasures.

As the Canadian Forces prepare for operations in the 21st century, our role in supporting military strategies will continue to expand. Technology will play an increasingly important role in equipping, organizing, and training our armed forces. To this end, we work closely with strategic planners in the Department of National Defence to ensure that the Canadian Forces remain technologically prepared and relevant in a future defence environment that will see increased focus on interoperability with allies, technology-driven warfare, and new asymmetric threats.

Our Business Lines

We fulfill our role as part of the Defence Team through four business lines:

- **Research and Development for the Canadian Forces and the Department of National Defence**

We conduct research and development activities for our clients in the Canadian Forces and the Department of National Defence. Our program is structured along five environmental client groups: Maritime, Land, Air, Command and Control Information Systems, and Human Performance. The program is managed in collections of projects – known as *Thrusts* – that

share a common objective related to a client's needs. A comprehensive client consultation process maintains a close working relationship with the Canadian Forces and the Department of National Defence.

- **Strategic Science and Technology Policy and Advice to the Canadian Forces and the Department of National Defence**

We provide strategic advice on science and technology to departmental policy makers and provide science and technology services to support the capabilities of the Canadian Forces and the Department of National Defence.

- **Science and Technology with National Security Partners**

We exploit our base in science and technology to serve the needs of clients outside the Department of National Defence. These clients include Canadian industry and other government departments.

- **Corporate Management**

We manage our corporate affairs and provide corporate services as an agency of the Department of National Defence.

Our Centres

As of 31 March 2002, Defence R&D Canada consisted of seven centres: five research centres spread across Canada and two corporate centres located in Ottawa.



Defence R&D Canada's Centres

The five research centres are:

- Defence R&D Canada – Suffield, formerly known as the Defence Research Establishment Suffield (DRES), near Medicine Hat, Alberta;
- Defence R&D Canada – Toronto, formerly known as the Defence and Civilian Institute of Environmental Medicine (DCIEM), in Toronto, Ontario;
- Defence R&D Canada – Ottawa, formerly known as the Defence Research Establishment Ottawa (DREO), in Ottawa, Ontario;

- Defence R&D Canada – Valcartier, formerly known as the Defence Research Establishment Valcartier (DREV), near Quebec City, Quebec; and
- Defence R&D Canada – Atlantic, formerly known as the Defence Research Establishment Atlantic (DREA), in Dartmouth, Nova Scotia, with outstations in Ottawa, Ontario, and Esquimalt, British Columbia.

The capability areas of the research centres are listed on page 60.

The two corporate centres in Ottawa are:

- Defence R&D Canada – Programs; and
- Defence R&D Canada – Corporate Services.

Defence R&D Canada – Programs provides central coordination and strategic planning for our research and development program through interfaces with our client groups in the Canadian Forces and external partners, while Defence R&D Canada – Corporate Services provides central management of our corporate services.

The goal of Defence R&D Canada is to build upon its success by strengthening its role as a defence science and technology centre of excellence for the Canadian Forces, industry, and academia.

Highlights of Service Delivery to the Canadian Forces



Highlights of Service Delivery to the Canadian Forces

Defence R&D Canada exists to support the Canadian Forces. Our mission includes providing expert knowledge and advice to decision makers in the Department of National Defence to enhance their ability to make informed decisions, pursuing research and development activities that contribute to the success of military operations, and assessing and exploiting technologies that enhance the capabilities of the Canadian Forces.

The majority of our resources are directed towards delivering research and development services to respond to the requirements, present and future, of the Canadian Forces. This chapter highlights our contributions to the Canadian Forces during fiscal year 2001-02. Our direct contributions to *Operation APOLLO*, Canada's military contribution to the international campaign against terrorism, are highlighted in the following chapter, *Rising to the Challenge*, starting on page 13.

Navy

Joint Warrior Interoperability Demonstrations 2001

We assisted the Navy in the Joint Warrior Interoperability Demonstrations 2001, where we demonstrated advanced communications technologies. These technologies will influence the design and architecture of the Navy's next generation tactical communications system, to be deployed as part of the Mobile Interoperable Secure Networks project.

Modelling & Simulation for Information Fusion and Decision Support

We have enhanced the Navy's modelling and simulation capabilities through the development of two new systems. The Simulation Environment for the Analysis of the Tactical Situation is a modelling and simulation facility for measuring situation-analysis capabilities. The Command Decision Support Interface System is an "operational-like" user-interface prototype that can be used to study the enhancement of situational awareness.

Universal Non-Destructive Inspection Tool

We helped develop an automated universal non-destructive inspection tool that uses ultrasonic technology and advanced three-dimensional imaging techniques to visualize the size, shape, and type of flaws imbedded in steel plate and welds. The high speed of the instrument will allow this technique to be used for the rapid inspection of welds on naval vessels such as the Victoria Class submarines.

Sonar Information Management System

Using infrastructure based on various software components, we developed a Sonar Information Management System that provides a flexible architecture to test candidate combat system algorithms. This technology will give the Navy the ability to combine information from a variety of sensors and platforms, resulting in an improved view of the underwater tactical picture.

High Seas Capability for the Maritime Coastal Defence Vessels

We conducted a comprehensive investigation of the performance of the Kingston-class Maritime Coastal Defence Vessels in high seas. The study included full-scale sea trials, model tests, and numerical modelling. The findings will be used to determine safe operational envelopes for these vessels in severe sea conditions.

Army

Enhanced Surveillance Demonstration

We conducted an exercise in which a Coyote light armoured reconnaissance vehicle was linked to an advanced All Source Intelligence System using a combination of the Tactical Command Control Communications System and the Near Term Digital Radio. We demonstrated the improvements in situational awareness in terms of timeliness, quality, level of detail, and relevance that result from the synergy of advanced sensing, increased bandwidth, and advanced intelligence processing.



The Coyote light armoured reconnaissance vehicle



Blast landmine test on a light armoured vehicle

Anti-Vehicular Mine Protection

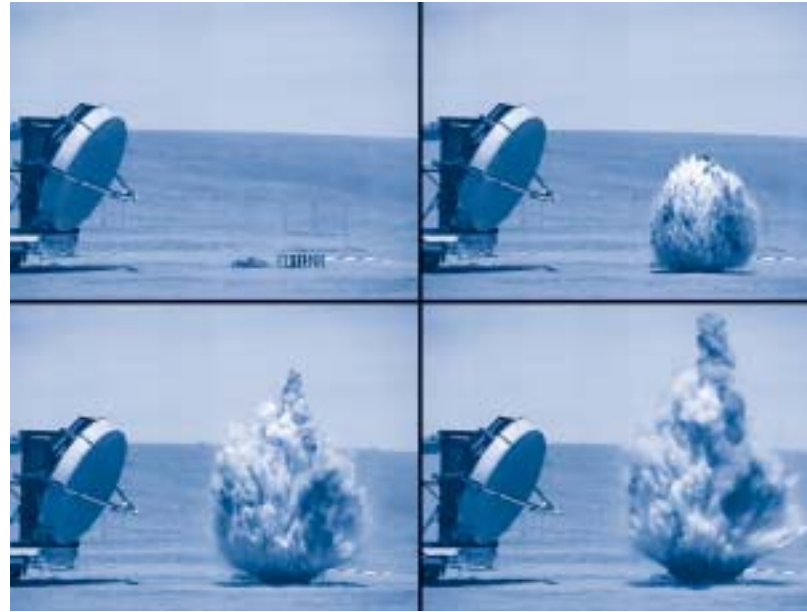
Our knowledge of protection against anti-vehicular landmines has led us to become the technical advisor in support of future acquisition programs for light armoured vehicles. We assist in identifying the protection level required, share experimental results that can assist the development of new protection systems, and make recommendations for the testing and evaluation of proposed mine protection systems. Our involvement allows for better understanding of the technology and will ultimately result in fielding more efficient mine protection systems for our troops.

Investigation of Anti-Vehicular Mine Strikes

In March 2001, two Canadian vehicles struck landmines while carrying out routine duties in Eritrea. We sent a scientific investigation team to gather first-hand information to determine the precise nature of the damage and to assess the risk of injury to the crews. The investigation resulted in new findings that we have applied to the development of a mine protection system for the light armoured vehicle.

Investigation of Eryx Missile Accident

An accident occurred in November 1999 when the rocket motor of an Eryx missile exploded, injuring the gunner and loader and resulting in the suspension of live-fire training and operations. After a detailed investigation involving extensive experimentation and analysis, we determined the likely cause of the explosion and suggested modifications to the equipment and procedures that would dramatically reduce the risk of injury. Our findings and recommendations were instrumental in lifting the firing restrictions on the missile and returning it to use for training and operations.



Neutralizing landmines using high-power microwaves

Neutralizing Landmines Using High-Powered Microwaves

We demonstrated in an experimental setting the feasibility of neutralizing landmines using high-powered microwaves. The landmines, which are commonly found on deployments, were all neutralized when exposed to the high-powered microwaves at a distance of six metres. Our findings make this a technology that the Canadian Forces could potentially employ in conjunction with the newly delivered Improved Landmine Detection System – FORESIGHT.

The Improved Landmine Detection System, developed by Defence R&D Canada and marketed as FORESIGHT by General Dynamics Canada, is a multi-sensor system that detects landmines with a success rate better than 95 percent.

Robotic Vehicles in the Urban Ram Exercise

In what could be described as the ultimate field test, some of our robotics technologies, including the combat caterpillar, were used in an exercise with the Princess Patricia's Canadian Light Infantry to ensure that forces from across the Land Force Western Area are effectively trained to fight in urban settings. Our robotic vehicles were part of an assault on a building. While the technologies are still at their early stage, introducing robotics into urban combat settings holds promise for reducing casualties.



Our combat caterpillar with soldiers from Princess Patricia's Canadian Light Infantry

Air Force

Rechargeable Military Battery

We sponsored a demonstration of a prototype rechargeable lithium ion battery for use in military applications. The demonstration showed that the new battery exceeds the requirements, at least at ambient temperatures. The low-temperature performance, which is reported to be outstanding, remains to be confirmed.

Modified Ballistic Integrator Algorithms on the CF-18 Hornet

Reliable weapon performance characteristics are required to ensure successful bombing missions. Our experimental characterization of conventional bombs has resulted in the modification of the ballistic integrator algorithms used by the operational flight program on the CF-18 *Hornet*. Our work has been extended to include trajectory modelling and simulation for both guided and unguided weapons.

HARFANG

The Chief of the Air Staff inaugurated the new mobile laboratory, HARFANG, a field-testing facility that measures the effectiveness of the Canadian Forces' infrared self-protection systems for air, land, and maritime platforms. Operational trials have shown that HARFANG can improve our understanding of how to increase aircraft survivability and should lead to improvements in aircraft defence electronic warfare systems.

Radar Simulator for the CF-18 Hornet

SAPHIRE, a simulator for the intercept radar on the CF-18 *Hornet*, provides a state-of-the-art synthetic environment for air-to-air combat. A new version of the simulator can be used to determine the effects of improving the radar's memory and processor. It includes a high-level link to a CF-18 cockpit simulator at CMC Electronics in Kanata, Ontario. The crew-in-the-loop system can now be used to assess human factors issues and familiarize air requirements staff with the operation of an advanced air-to-air radar weapon system.

Joint

High Frequency Surface Wave Radar

Under the High Frequency Surface Wave Radar project, we successfully demonstrated the ability to detect and track ships and low-flying aircraft at long ranges over salt water. We also demonstrated techniques to mitigate heavy external clutter interference. A subsequent acquisition project, sponsored by the Chief of the Maritime Staff, will result in two fully operational systems that can be used in testing. The systems are expected to provide continuous wide-area surveillance of the coastal waters for ships and low-flying aircraft.

Detection and Characterization of Biological Agents

Despite treaties that constrain the use of chemical and biological weapons, some countries still pose a threat to deploy these weapons. The process of monitoring biological weapons is therefore a major concern to the

Defence R&D Canada provides the Canadian Forces with advice and equipment needed to counter the hazard from the use of chemical and biological weapons.

Canadian Forces and to the defence community in general. In order to address this threat, we have developed a system to assess the potential to detect and characterize threatening biological clouds from a safe distance. We tested a prototype system using an open-air release of bioaerosol simulants and were able to demonstrate a sensitivity of a few living organisms per litre of air over multi-kilometre distances.

Passive Chemical Detection

The Compact Atmospheric Sounding Interferometer is a passive infrared system designed to detect chemical threats from safe distances and to remotely probe chemical plumes. Its differential detection capability provides two unique features for a field-deployable instrument. First, it maintains a constant calibration, thereby providing reliable measurements over a long period. Second, it can compensate for the background signal without the need for extensive calculations. This is an advanced instrument with strong potential for use on moving-platforms, such as aircraft. Recent field experiments have demonstrated its ability to detect low concentrations of chemical vapours at ranges up to 1.5 kilometres.



Detection and characterization of biological agents

Rising to the Challenge

03



The terrorist attacks in the United States on September 11th, 2001, moved the issues of counter-terrorism and national security to the top of the nation's agenda. Science and technology has a vital role to play in the evolving geopolitical and military context. This chapter highlights our contributions to the campaign against terrorism in fiscal year 2001-02.

Support for Operation APOLLO

Operation APOLLO is Canada's military contribution to the international campaign against terrorism. The contribution of the Canadian Forces to the campaign includes the Canadian Naval Task Group, which is on station in the Arabian Sea.

Subsequent to the deployment of Canadian warships as part of *Operation APOLLO*, we were asked to determine their vulnerability to mines. This work involved examining the static magnetic, static electric, and alternating electromagnetic fields of each ship and minimizing their electromagnetic emissions. We provided significant reductions to the vulnerability of the vessels involved.

We applied our expertise in modelling underwater explosions and their effects on ship structures to determine safe standoff distances for various levels of threats against naval vessels. This information was used to help establish exclusion zones for Canadian ports and seaways and for Canada's naval vessels in foreign ports and seaways.

We also addressed urgent operational concerns about the vulnerability of the ships and their crews to blast and fragmentation devices, and we measured the radar cross sections of the ships to assess their vulnerability to detection. We provided critical technical support to ensure the continued operation of vital satellite communications and data-link service to HMCS *Iroquois*.

As a result of our efforts, the ships that participated in *Operation APOLLO* were more prepared to deal with potential threats than ever before.

In preparation for the deployment of Sea King helicopters for *Operation APOLLO*, we worked with the Canadian Forces Electronic Warfare Centre to optimize the performance of the helicopter's infrared jammers. The work was successfully conducted using the HARFANG field-testing facility (*see page 10*) at Canadian Forces Base Valcartier.

Training First Responders

We undertook a major national training initiative for first responders (fire, police, and ambulance personnel) to chemical, biological, radiological, and nuclear (CBRN) attacks. Courses were offered in Vancouver, Calgary, Toronto, Ottawa, and Montreal in November and December 2001, and in Regina, Winnipeg, Fredericton, and St. John's in February and March 2002. The courses were offered with support from Health Canada, the Solicitor General's office, and the Office of Critical Infrastructure Protection and Emergency Preparedness. Each course was a two-day CBRN awareness training session for first responders, their supervisors, and medical professionals. Participants were briefed on the nature of CBRN hazards, as well as methods to detect, identify, and counter these threats.

Anthrax Decontamination in Washington

In November 2001, the Centers for Disease Control and Prevention (CDC) in the United States requested urgent assistance to perform highly specialized tests at the Brentwood mail facility in Washington D.C. Anthrax spores had been found at the site, killing two workers and infecting two others. Ours was the only international team asked to help. We responded by sending a team from Defence R&D Canada – Suffield, all experts in chemical and biological defence. Our Fluorescent Aerodynamic Particle Sizer and slit samplers were used to determine the presence and quantity of anthrax in the building, information key to safely decontaminating the facility.



Anthrax decontamination in Washington

CBRN Research and Technology Initiative

Because of our knowledge and expertise, we are responsible for administering the new fund for chemical, biological, radiological, and nuclear (CBRN) research and technology development that was announced in the federal budget of December 2001, with a budget of \$170M over five years. The CBRN Research and

Unique facilities allow Defence R&D Canada to provide live-agent training, such as equipment decontamination exercises and emergency response exercises for simulated terrorist attacks.

Technology Initiative will improve Canada's ability to respond to CBRN incidents by closing gaps in our capability and capacity in related science and technology areas. The approach will be interdepartmental, creating clusters of laboratories as parts of a greater federal response network. Projects will be funded through a competitive process that will encourage collaboration and leveraging. Support will be available for three kinds of projects: Technology Acquisition (equipment and infrastructure), Technology Acceleration (fielding technology now under development), and Research and Technology Development (research to close capability gaps).

Counter Terrorism Technology Centre

The Counter Terrorism Technology Centre will be constructed at Defence R&D Canada – Suffield over the next two years. This facility will be used to train first responders from across Canada to react to incidents involving biological or chemical warfare agents. Several theatres and mock-up sites will be built to provide hands-on training scenarios for emergency crews. The centre will also assess and evaluate equipment proposed for use within the first responder community to determine its effectiveness and suitability. It will provide a technology evaluation site for industries that are looking to develop products for the first responder, emergency-medical, and military communities. Additionally, the centre will facilitate access by first responders to the expertise of our scientists in the field of chemical and biological defence.



National Collaborations

National Collaborations

The strength of Defence R&D Canada depends partly on our ability to establish and maintain strong national networks. We collaborate with other national organizations – including other government departments, defence industries, and universities – to enhance our support to the Canadian Forces. Such collaborations ensure the sharing and exchange of knowledge and technology, improve our access to a broader technology base, and increase the return on our investment. Promoting national collaborations and expanding existing arrangements contributes to wealth generation for Canada.

This chapter highlights our national collaborations for fiscal year 2001-02.

Collaborations with Other Government Departments

New Models of Federal Partnerships

We have worked with other federal departments and agencies to develop new models – such as the Federal Innovation Networks of Excellence – for science and technology in Canada. The Chemical, Biological, Radiological, Nuclear (CBRN) Research and Technology Initiative (*see page 14*) that we are now leading to respond to the CBRN terrorist threat is an example of new methods of collaboration: the approach will be interdepartmental and will be part of a greater federal response network

Research Agreement with Institute of Aerospace Research

We signed a memorandum of understanding with the National Research Council's Institute of Aerospace Research in Ottawa on the "development of a capability to predict heat load on projectiles under hypersonic flow conditions, and controls of flow fields around non-axisymmetric missiles". Over the next three years, a total of \$660,000 will be jointly invested in this partnership to generate information and share expertise, results, and techniques in this technology.

Enhanced Synthetic Vision System

In response to our commitment to improving the safety of members of the Canadian Forces, we partnered with the National Search and Rescue Secretariat and Canadian industry to demonstrate the capabilities of an Enhanced Synthetic Vision System. The system provides a computer-enhanced visual scene to the pilot on a helmet-mounted display. The consensus among evaluation pilots is that the system has tremendous potential.



A scene from the Enhanced Synthetic Vision System

High-Power Microwave Devices

We worked with the National Research Council on the development of pulsers for high-power microwave devices to investigate their effects on electronic circuits and systems. This work will allow us to advise the Canadian Forces on how to protect its equipment from attacks from this potential terrorist threat.

Interdepartmental Committee on Northern Science and Technology

Efforts are continuing to develop a horizontal multi-departmental initiative aimed at increasing the portfolio of science and technology activities in support of Canada's north. The initiative is looking at all aspects of support for the north, but it is the issue of northern sovereignty that is of particular interest to the Department of National Defence.

Collaborations with Industry and Universities

Memorandum of Understanding with General Dynamics Canada

A strong working relationship between two growing organizations became even stronger with the signing of a memorandum of understanding with General Dynamics Canada, formerly known as Computing Devices Canada. The agreement is an important component in our overall strategy for collaborating with national industrial partners. General Dynamics is one of Canada's premier defence companies, with a global reputation for delivering leading-edge technology.

Partnership Agreement with Laval University

We signed a memorandum of understanding with Laval University that will see \$750,000 invested in joint projects with the university over the next three years. The agreement reinforces an already strong partnership and will establish Defence R&D Canada – Valcartier as a placement of choice for Laval's graduate and postgraduate students. In addition, the agreement enables our scientists to work as associate professors at Laval University, participate in joint projects, and direct students towards activities in defence-related research and development.

Materials and Manufacturing Ontario

We joined two collaborative projects with Materials and Manufacturing Ontario. The two projects involve the development of concepts for thoracic protection against bullets and lower-limb protection against anti-personnel mines. Our participation in these initiatives has allowed us to optimize our investment through collaboration with the Canada Centre for Mine Action Technologies, the University of Waterloo, ACERAM Technologies, Barrday, Med-Eng Systems, Dew Engineering and Development, Biokinetics and Associates, and the Canadian Police Research Centre.

Security During the Summit of the Americas

We collaborated with Harris Corporation to demonstrate the use of next-generation three-dimensional visualization tools to agencies responsible for security at the Summit of the Americas in April 2001. The sophisticated suite of tools, which included realistic visualizations of Quebec City for situational awareness, facilitates planning and other tasks critical to the safeguarding of resources in an urban environment. Situational awareness is critical to operational success, and the security-related events that occurred during the summit illustrated the problematic nature of conducting operations in a complex urban environment.

Second Voyage to Study Endangered Whales

For the second year in a row, our researchers and colleagues from Dalhousie University headed to the Bay of Fundy on Canadian Forces Auxiliary Vessel *Quest* to conduct research to protect the endangered North Atlantic Right Whale. The team used hydrophones and sonobuoys to record whale vocalizations, researching technology that will allow them to locate the whales acoustically and track their movements. Researchers hope to develop a permanent system to detect Right Whales in near real-time, thereby warning ships of their presence and preventing collisions. The exercise also contributed to the on-going development of techniques for submarine detection and sonar operations.

International Collaborations



Engaging international partners in cost-shared collaborative projects is a vital component of our research and development program. Defence R&D Canada collaborates with allied defence organizations in a diverse mixture of multi-lateral and bilateral arrangements to provide the Canadian Forces with global access to advanced defence technology, information, and expertise, and to facilitate interoperability with our allies.

The two most important organizations regarding our international collaborations are The Technical Cooperation Program (TTCP) – with the United States, the United Kingdom, Australia, and New Zealand – and the NATO Research and Technology Organization (RTO).

This chapter highlights our international collaborations for fiscal year 2001-02.

The Technical Cooperation Program (TTCP)

Distributed Simulation

We participated in a collaborative program involving an international network of flight simulators located in Canada, the United Kingdom, and the United States. The program is part of a multi-year project to resolve behavioural issues of coalition mission training within a secure synthetic environment. The first exercise involved an air-to-ground operation in southwest Asia to identify and solve the problems of international networking, security, and interactivity among a large number of simulated entities.

Common Operating Picture 21

The Common Operating Picture 21 (COP21) project, conducted in collaboration with the United States, the United Kingdom, and Australia, is investigating issues related to the conceptual operational architecture and knowledge environment for the common operating picture, global battlespace visualization, commander's decision support, geospatial and imagery information

services, and interoperability. Integration of the COP21 components, which will be completed by the end of March 2005, is expected to have a significant impact on the capabilities of the Canadian Forces Command System.

Low Solar-Absorbance Coatings

A collaborative project on Low Solar-Absorbance Coatings has produced for the exteriors of ships a coating that reflects a large portion of incident solar energy. The coating will reduce heat build-up, increase crew comfort and efficiency, and diminish the amount of infrared energy that is re-radiated and could be used to detect the ship. The coatings have been introduced into the navies of the United States and Australia.

Advanced Radar System Modelling and Simulation

Through a collaborative project with the United States and Australia to evaluate, enhance, and validate the modelling capabilities of a high-fidelity radar simulation tool, we now have access to a multi-channel radar system model that includes an accurate representation of complex real-world environments and threats. Such a simulation asset can play a significant role in characterizing the performance of advanced radar systems prior to development and acquisition, thereby mitigating development risk and reducing the dependence on expensive field trials to verify performance requirements.

North Atlantic Treaty Organization (NATO)

Multi-spectral Camouflage for the Coyote

The Integrated Multi-spectral Camouflage for Vehicle System, specially designed for the Coyote reconnaissance vehicle, represents the latest technologies in modern camouflage systems. The system consists of three separate but highly integrated kits that are efficient at reducing the signature of the vehicle in the ultraviolet, visible, and infrared spectral bands.



Integrated Multi-spectral Camouflage for Vehicle System on a Coyote reconnaissance vehicle

Interoperable Networks for Secure Communications

As part of the NATO-sponsored project Interoperable Networks for Secure Communications, we have joined a consortium of research laboratories from eight nations to design, implement, test, and demonstrate a common technical architecture for interoperable, secure communications. We are contributing expertise in network management and security, mobile networking, high-frequency communications, and internet-protocol networking.

Entrust Public Key Infrastructure

Thirteen NATO nations participated in a one-year trial of Entrust Public Key Infrastructure software that demonstrated the utility and ease of using an integrated information security solution, as well as the resources and skills required to operate it. The experience illustrated some of the challenges that lie ahead in security policy and international cooperation as the requirement grows for secure information sharing in dynamic international coalitions.

Canadian Advanced Radar Deception System

We tested the Canadian Advanced Radar Deception System, our radar jamming technology, in Germany last year. A high-resolution synthetic aperture radar was installed in a van and driven along the autobahn and over a bridge while imaging the valley below. Radar jammers were set up in a parking lot with their antennas pointed towards the bridge. The trial provided insights into the use of electronic countermeasures against high-resolution radar systems.

Joint Sea Trials

In collaboration with NATO scientists aboard the Research Vessel *Alliance*, we conducted innovative experiments in mine hunting and seabed acoustics in Halifax Harbour and St. Margaret's Bay, Nova Scotia. High-frequency sonar systems were used to determine characteristics of the ocean bottom and to perform mine detection tests. The ultimate goal of the work is

Collaborative sea trials significantly advanced the on-going work of both Defence R&D Canada and NATO in mine hunting and seabed acoustics.



Canadian Forces Auxiliary Vessel Quest (foreground) and the NATO Research Vessel Alliance (background)

Photo: Formation Imaging Services Halifax

to allow tactical commanders to optimize the performance of active sonar systems by exploiting our knowledge of the undersea environment.

Measuring and Modelling Maritime Infrared Signatures

Canada hosted the first NATO trial entirely dedicated to the validation of Infrared Ship Signature models. The Ship Infrared Model Validation Experiment collected a rich data set that includes images of ships in two wavebands, measured from land and air platforms. The data set will greatly contribute to improving the reliability of the current model, since all NATO members will be contributing to its further validation.

Brush De-miner System in Thailand

The Canadian Centre for Mine Action Technologies, in collaboration with the Thailand Mine Action Center, undertook a technical assessment of a novel Canadian de-mining system in a region that is being demilitarized by members of the Royal Thai Army. We were part of the Canadian group that tested Promac Manufacturing's brush de-mining system. Because the results of the test were very positive, the Department of Foreign Affairs and International Trade is contributing the trial system to support the on-going de-mining operations.



The Promac brush de-miner in operation



Performance Review



Each year, the Chief Executive Officer of Defence R&D Canada is required to submit a business plan to the Deputy Minister of National Defence and the Chief of the Defence Staff stating our objectives for the next fiscal year. The business plan for fiscal year 2001-02 set ambitious targets to respond to strategic direction and to the needs of our clients. In accordance with *Defence Plan 2001*, our business plan included two kinds of objectives: defence objectives and change objectives. Defence objectives sustain and support the on-going activities of the department, while change objectives modify our activities to align them with the vision of *Defence Strategy 2020*.

This chapter reviews our performance with respect to the defence objectives and the change objectives that were stated in our business plan for fiscal year 2001-02. The review addresses each business line separately.

Research and Development for the Canadian Forces and the Department of National Defence

Research and Development for the Canadian Forces and the Department of National Defence is our first business line. The majority of our resources are directed to this function, which is where most of the research and development activities take place. These activities are defined annually by Service Level Agreements with each of our five client groups: Maritime, Land, Air, Command and Control Information Systems, and Human Performance. Elements of this business line are funded from various sources, including the Technology Demonstration Program, the Technology Investment Fund, the Defence Industrial Research Program, the DND/NSERC Research Partnership Program, and the Defence Communications Program. The client groups can also fund additional activities that do not fall within the scope of the Service Level Agreements.

The following sections review the performance of Defence R&D Canada against the objectives for this business line.

Defence Objectives

Defence Research and Development Activities

We conduct, sponsor, and collaborate on a wide range of research and development activities of relevance to the Canadian Forces and the Department of National Defence. In doing so, we are governed by our clients' requirements and by our Technology Investment Strategy. The Technology Investment Strategy describes 21 research and development activities that span the defence technology spectrum and take into account the strategic direction provided by *Defence Strategy 2020* and by the new approach of *Strategic Capability Planning*.

Objective

To implement the Technology Investment Strategy, which defines the research and development activities that Defence R&D Canada will pursue to meet the future needs of the Canadian Forces.

Performance

Implementing the Technology Investment Strategy will require new people. To date, we have hired twenty-nine highly qualified employees with expertise and skills in new areas to support the strategy.

Implementing the Technology Investment Strategy will also require enhanced facilities. We have begun a review of the state of our facilities and have identified a number of requirements. Using these requirements, we have confirmed a first wave of major recapitalization projects aimed at updating some of our older facilities to state-of-the-art. Detailed designs, plans, and specifications have been completed for the Dockyard Laboratory (Atlantic) facility and the French Cable Building, both at Defence R&D Canada – Atlantic. Construction options have been analyzed and costed for four other major projects at the other research centres.

Expanded Use of Technology Demonstration

The Technology Demonstration Program demonstrates technologies fostered by Defence R&D Canada and Canadian industry in the context of real and potential future capabilities, concepts, doctrine, operations, and equipment for the Canadian Forces. Proposals are assessed in terms of military utility, technical merit, project implementation concept, and overall value.

Objective

As part of the Technology Demonstration Program, to initiate approximately five technology-demonstration projects per year to demonstrate and validate technological solutions to the operational requirements of the Canadian Forces.

Performance

We approved six new Technology Demonstration projects, listed in the following table, for funding in fiscal year 2001-02. All the projects in the Technology Demonstration Program are listed in the table on page 61.

New Technology Demonstration Projects

CLIENT GROUP	TECHNOLOGY DEMONSTRATION PROJECT	BUDGET
Land	Soldier Integrated Headwear System	\$5.80M
Land	Integrated Communications Electronic Warfare Analysis and Radio Frequency Sensors	\$5.70M
Land	Force Protection Against Enhanced Blast Weapons	\$5.93M
Air	Unmanned Airborne Surveillance	\$1.51M ¹
CCIS	Multi-sensor Integration with the Common Operating Environment	\$6.00M
CCIS	Advanced SatCom Terminal	\$2.65M

¹ The budget shown for the Unmanned Airborne Surveillance project is our contribution to the total cost of \$3.6M for the project.

New Technology Investment Projects

CLIENT GROUP	TECHNOLOGY INVESTMENT PROJECT	BUDGET
Maritime	Design of Magnetic Shape Memory Alloys	\$750K
Maritime	Dielectric Actuators for Active / Passive Vibration Isolation	\$750K
Land	MEMS Transducers for Direct Thermal Viewer	\$470K
Land	Ultra-thin Polymer Coating Technology for Nanoscale Powders	\$625K
Air	A Critiquing System for the Improvement of the Military Estimate Process	\$750K
Air	NIR Imaging Sensors	\$510K
Air	Smart Materials System Development and Test	\$283K
CCIS	Advanced RF Tag for Radar Satellites	\$740K

Strong Technology Base

The Technology Investment Fund supports forward-looking, high-risk, but potentially high-payoff, research projects consistent with the Technology Investment Strategy. 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 Technology Investment Strategy.

Objective

Through the Technology Investment Fund, to support research projects consistent with the defence Technology Investment Strategy.

Performance

We approved the eight projects listed in the table above for initiation in fiscal year 2001-02. All the projects supported by the Technology Investment Fund are listed in the table on page 62.

Client Group Agreements

We develop Service Level Agreements with each of our five client groups – Maritime, Land, Air, Command and Control Information Systems and Human Performance – as part of our annual business planning cycle. The Service Level Agreements identify specific objectives

and activities to be pursued, and outputs to be produced for the client group. The Service Level Agreements are key elements in our relationship with our clients in the Canadian Forces.

Objective

To complete Service Level Agreements with the five Client Groups: Maritime, Land Force, Air Force, Command and Control Information Systems, and Human Performance.

Performance

We established Service Level Agreements with our five client groups. The representatives of the client groups are listed in the table on the next page.

Expanded Defence Industrial Research Program

The Defence Industrial Research Program provides assistance to small and medium sized enterprises to exploit emerging technologies in partnership with Defence R&D Canada.

Objective

To seek assistance to expand the Defence Industrial Research Program by \$5M in fiscal year 2001-02, \$7.5M in fiscal year 2002-03, and by \$10M for fiscal year 2003-04 and beyond.

Client Representatives

CLIENT GROUP

Maritime

Land

Air

Command and Control Information Systems

Human Performance

CLIENT REPRESENTATIVE

Director General Maritime Force Development

Director General Maritime Equipment Program Management

Director General Land Staff

Director General Air Force Development

Director General Joint Force Development

Director General Information Management Strategic Direction

Chief of Staff, Deputy Chief of the Defence Staff

Director General Health Services

Director Nuclear, Biological and Chemical Defence

Performance

We developed a proposal (not yet approved) to increase funding for the Defence Industrial Program from \$5 M to \$15 M. Nonetheless, funding for the program was augmented by \$1M from the Department of National Defence's Training and Education Policy Directorate for a project to support their activities. Altogether, the program funded 25 projects in fiscal year 2001-02 with a total expenditure of \$4.3M. All the projects in the Defence Industrial Research Program are listed in the table on page 63.

Technology Adopted by Clients

Part of our mandate is to help the Canadian Forces modernize its equipment. We do this, in part, by transferring our technologies to Canadian industry and by introducing our technologies directly to our clients in the Canadian Forces.

Objective

To develop at least ten initiatives or products for implementation by the Canadian Forces.

Performance

The Canadian Forces and the Department of National Defence have adopted a number of our initiatives or products for implementation, including the following:

- Countermeasure program for the CF118 *Hornet* and the C130B *Hercules*
- Countermeasure program for the CH124 *Sea King*
- Detection of malicious codes in commercial-off-the-shelf software
- Dynamic Scheduling System
- High Frequency Surface Wave Radar
- Modelling and simulation software for guided weapon engagements

- Operational Planning Environment and Reference Application
- Operational Stimulator for the AAR-47 missile-approach warning system
- Protection against mines for heavy engineer-support vehicles
- Protective shield for the Eryx missile system
- Testing standards for personnel protection equipment
- Topographical Map Display
- Wing and Squadron Planner

Solutions to Asymmetric Threats

Asymmetric threats are an attempt by a smaller, less powerful entity to inflict injury on a more powerful adversary by using surprise and deception to strike at targets that are difficult to defend by conventional means. Rogue or criminal elements, such as terrorists, employ asymmetric methods as a means to strike at the infrastructure, economic interests, and even the civilian populations of states in an effort to undermine both their physical security and their way of life.

Objective

To increase the capacity to deal with emerging asymmetric threats to information systems and national security, and to develop defence against terrorism and weapons of mass destruction.

Performance

We are working with the Communications Security Establishment, the Office of Critical Infrastructure Protection and Emergency Preparedness, and the Communications Research Centre to protect the critical

information infrastructure in response to cyber terrorism and to establish a community of practice on wireless security. In addition, we are in discussion with the United States on participating in their Content-based Information Security Project and their Coalition Information Assurance Common Operation Picture Project.

A memorandum of understanding signed with the Centers for Disease Control and Prevention (CDC) in August 2001 made Defence R&D Canada – Suffield one of only two accredited Canadian facilities in its Laboratory Response Network. The network was organized in response to the growing threat of a bio-terrorist attack in the United States. Membership in the network provides unique opportunities for our researchers, including access to protocols and materials. It will further expand our efforts in identifying agents used in bio-terrorism using antibody and gene-based techniques.

Concept Development and Experimentation

Concept Development and Experimentation is an essential tool for enabling the Revolution in Military Affairs and creating the future Canadian Forces.

Objective

In partnership with the Deputy and Vice Chiefs of the Defence Staff, to implement a Concept Development and Experimentation capability by March 2002.

Performance

Five of our scientists have joined the Canadian Forces Experimentation Centre since the summer of 2001. The Centre, which is co-located with Defence R&D Canada – Ottawa, is a direct outcome of the Department of National Defence's recent efforts to improve its methodology for force development by using the approach of Concept Development and Experimentation that is being pursued increasingly by Canada's allies. The Canadian Forces Experimentation Centre will complement our own capabilities in Concept Development and Experimentation by focusing on joint and combined capabilities.

Enhanced Support to Clients

While most of our work is performed under the Service Level Agreements negotiated each year with our client groups, the need arises from time to time to undertake projects beyond the scope of those agreements.

Objective

To carry out research and development projects for the Canadian Forces and the Department of National Defence outside of Service Level Agreements.

Performance

Some examples of projects undertaken outside of the Service Level Agreements follow:

- **Protected Military Satellite Communications:** We analysed the expected performance of various command and control scenarios using advanced satellite communications systems. We identified areas of inefficiency and recommended potential solutions.
- **Low-Profile Planar Antenna Systems:** We designed specialized antenna technologies, such as hologram antennas and dielectric Fresnel lenses, to provide defined capabilities for special communications applications.
- **Trends in Information Technology:** We analyzed technology trends in the areas of networks, wireless, and knowledge management to identify technologies likely to have the greatest impact over the next five years.
- **Clothe the Soldier Project:** We provided assistance to the Clothe the Soldier project, concentrating our efforts on the definition and implementation of test procedures, standards, and the quality control of equipment for ballistic protection.

Contribution of International Collaborators

We collaborate with a number of allied countries, including the United States, the United Kingdom, Australia, New Zealand, France, the Netherlands,

Norway, and Sweden. In particular, we are very active in The Technical Cooperation Program and with the NATO Research and Technology Organization.

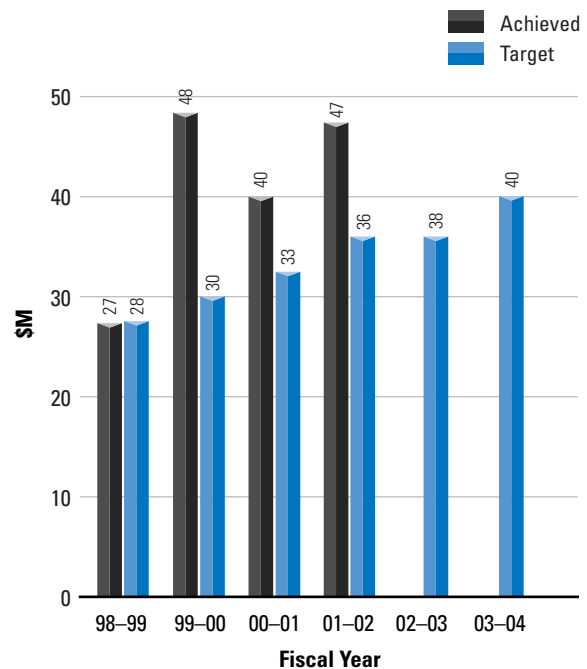
Objective

To leverage \$40M of in-kind science and technology from international allies by 2004; to initiate three new collaborative Technology Demonstration Projects with international partners; and to seek funding to institute a Canada / United States cooperative program to enhance interoperability.

Performance

The following chart shows the achieved and target value of international collaborations for fiscal years 1998-99 to 2003-04. The achieved values reported in the chart are estimates only; a more rigorous derivation

Leveraging from International Collaborations




of the value of collaborative activities will be developed and used in future reports. About 35% of our international leveraging takes place under the auspices of The Technical Cooperation Program, about 20% is in conjunction with NATO, and the balance is through other arrangements, chiefly bilateral arrangements with the United States. Note that we have already surpassed our goal of \$40M. Our major international collaborative agreements are listed in the table on page 65.

We initiated three new collaborative Technology Demonstration Projects with international partners:

- **Unmanned Airborne Surveillance:** The United States Air Force will provide access to Global Hawk, a high-altitude long-endurance unmanned aerial vehicle. The United States Army will assist in planning the flights.
- **Soldier Integrated Headwear System:** International collaboration for the Soldier Integrated Headwear System can take place under a number of arrangements, including NATO Topical Group 1, a trilateral agreement between Canada, the Netherlands and Sweden, and a bilateral agreement between Canada and the United States.
- **Force Protection Against Enhanced Blast:** The United Kingdom will provide data on blast injuries and assessments of the protection offered by the protective equipment currently used by the Canadian Forces.

The special relationships that exist between Canada and the United States have seen the successful development, commercialization, and exploitation of many technologies and systems. The unique position that Canada enjoys in defence science creates favourable conditions for Canadian industry to access defence programs in the United States. To exploit this relationship



Two-thirds of the Technology Demonstration Projects include some form of international collaboration.

more fully, we developed a proposal to expand the Technology Demonstration Program with new funds of \$30 M annually to target collaboration with the United States, thereby enhancing interoperability. The proposal has not yet been funded.

Change Objectives

Research and Development Program for the Future

The original implementation plan for the Technology Investment Strategy, which was first published in 1999, defined nine growth activities and twelve evolving activities that we have to pursue to meet the future requirements of the Canadian Forces and the Department of National Defence.

Objective

To refocus the research and development in the growth areas by September 2001 and to transform the twelve evolving research and development activities by 2002.

Performance

We have refocused our work in the growth activities, but have been able to hire only twenty-nine of the fifty new employees that were planned for fiscal year 2001-02. The table on the next page shows the allocated staffing level of each growth activity as a percentage of the target allocation as specified by the Technology Investment Strategy.

Staffing Levels for Growth Activities

RESEARCH AND DEVELOPMENT GROWTH ACTIVITY	STAFFING LEVEL
Autonomous Intelligent Systems	30%
Command Effectiveness & Behaviour	24%
Emerging Materials and Biotechnology	76%
Human Factors and Decision Support Systems	29%
Information and Knowledge Management	49%
Network Information Operations	55%
Signature Management	19%
Simulation & Modelling for Acquisition, Requirements, Rehearsal and Training	32%
Space Systems	57%

We have transformed our work in the evolving activities to meet the requirements of the Technology Investment Strategy as planned for fiscal year 2001-02. The following table shows the allocated staffing level of each evolving activity as a percentage of the target allocation.

Staffing Levels for Evolving Activities

RESEARCH AND DEVELOPMENT EVOLVING ACTIVITY	STAFFING LEVEL
Chemical/Biological/Radiological Threat Assessment and Detection	90%
Command Control Information Systems Performance and Experimentation	22%
Communications	99%
Electro-Optical Warfare	104%
Multi-Environment Life Support Technologies	115%
Operational Medicine	96%
Platform Performance and Life Cycle Management	88%
Precision Weapons	73%
Radio-Frequency Electronic Warfare	99%
Sensing (Air & Surface)	86%
Underwater Sensing and Countermeasures	94%
Weapons Effects	103%

Increased International Collaboration

Objective

To complete the *CIBADS* Technology Demonstration Project by September 2001 and to enhance collaboration with the United States.

Performance

The *CIBADS* Technology Demonstration Project was successfully completed by September 2001, meeting all of its technical objectives. The technology, which is now available from General Dynamics Canada under the name 4-Warn, has been successfully deployed in support of Canadian Forces naval operations.

We participate in a number of activities that enhance our collaborations with the United States:

- **Coalition Aerial Surveillance and Reconnaissance:** With other members of the National Defence team, we are participating in the Coalition Aerial Surveillance and Reconnaissance project, a multi-national collaboration with the United States, the United Kingdom, France, Germany, Italy, and Norway. The project takes in many different forms of surveillance information and processes and fuses these inputs to provide an improved operational picture to the war fighter and to ensure interoperability between the nations involved.
- **Command Decision Support Interface System:** The development of the Command Decision Support Interface System, an “operational-like” interface for the study of the enhancement of situation awareness, is being used to access the Tactical Aids for Decision-Making Under Stress program in the United States.
- **Environmental Impact of Explosives on Military Training Sites:** The American Strategic Environmental Research and Development Program awarded us a grant to study the environmental impact of explosives on military training sites. The grant is part of a larger program to better

understand the relationships between detonations and the environment. Two laboratories operated by the American military will serve as research partners.

- **Future Combat Systems Symposium:** We took part in a symposium that was organized by the Association of the United States Army to identify opportunities for collaborating in projects related to Future Combat Systems.

Concept Development and Experimentation

Objective

Participate in the development of a program for joint experimentation and Concept Development and Experimentation with the Deputy and Vice Chiefs of the Defence Staff.

Performance

We have established an activity on the Future Force Synthetic Environment to link directly with the Concept Development and Experimentation program at the Canadian Forces Experimentation Centre. Additionally, we have initiated a number of projects under the Technology Demonstration Program that will collaborate with the Canadian Forces Experimentation Centre in support of its program. For example, the Unmanned Airborne Surveillance project will provide experimental data to validate activities to be carried out at the Canadian Forces Experimentation Centre.

Strategic Science and Technology Policy and Advice to the Canadian Forces and the Department of National Defence

Strategic Science and Technology Policy and Advice to the Canadian Forces and the Department of National Defence is our second business line. It includes the strategic studies, advice, and input to policy that we provide to senior decision-makers in the Canadian Forces and the Department of National Defence on issues related to science and technology. It also includes support of scientific and technical intelligence, technology watch

and outreach activities, developing the Technology Investment Strategy, and providing operational advice and expertise to the Canadian Forces.

The following sections review the performance of Defence R&D Canada against our defence and change objectives for this business line.

Defence Objectives

Advice to Policy Makers

As is clear from our Mission Statement, one of our primary functions is to provide advice to the Department of National Defence and the Canadian Forces.

Objective

To provide advice and expertise to policy makers on science and technology products and services required to effectively carry out the Department's assigned mission and tasks.

Performance

We provided policy makers in the Department of National Defence with expert advice concerning a variety of science and technology products and services:

- We worked with other government departments on interdepartmental science and technology initiatives to ensure that the best advice possible is available to support the development of strategic science and technology policy.
- We coordinated the development and update of the *Technology Investment Strategy* to address the requirements of the Canadian Forces and the Department of National Defence for 2020 and formulated detailed plans for its implementation.
- We helped address nationally significant emerging issues and economic opportunities through our participation with the Federal Innovation Networks of Excellence. The initiative brings



Defence R&D Canada takes an active role in the federal science and technology network and supports government objectives to stimulate economic growth, improve quality of life and advance knowledge through innovative activities in science and technology.

together partners within and outside Canada to create networks for innovation and integrates research and development with policy application and commercialization.

Advice to Force Development Community

Objective

To provide advice and expertise to the force development community on science and technology products and services required to effectively carry out the Department's assigned mission and tasks.

Performance

We provided the force development community in the Department of National Defence with expert advice concerning a variety of science and technology products and services:

- We convened a two-day symposium in conjunction with the Short Course Business Unit of the Royal Military College to familiarize senior executives and managers with the role of emerging technologies in shaping the future defence forces.
- We provided advice to the Capability Development Working Group.
- We provided advice to the Canadian Forces concerning a variety of defence initiatives, including the Asymmetric Threat study.

- We provided technical assistance concerning the development of future short-range air-to-air missiles, which helped the Department of National Defence decide to terminate its participation in a multi-national project to develop missiles.

Advice to Intelligence Community

Objective

To provide advice and expertise to the intelligence community on science and technology products and services required to effectively carry out the Department's assigned mission and tasks.

Performance

We continue to provide the Canadian Forces and the Department of National Defence with expert scientific, technical, and intelligence support and advice. During fiscal year 2001-02, we provided advice on land, air, and sea weapons, chemical and biological defence, and surveillance and counter surveillance. As a result of the terrorist attacks in the United States on September 11th, 2001, we increased our emphasis on asymmetric threats, including chemical and biological attacks and novel explosives.

Monitoring Global Technology Development

Objective

As part of the Technology Outlook Program, to watch emerging technologies, assess their relevance to Canadian defence, and produce a report on global technology developments.

Performance

We sponsored a report to identify and document best practices in industry to enhance our approach to monitoring developments in technology. This report provides a framework to better understand, position, and monitor emerging, surprise, and potentially disruptive defence technologies. In addition, we are collaborating with other science-based government departments and agencies to explore new technology foresight methodologies.

We published a report on the relationship between various new technologies and modern military logistics. We also completed a study on technology trends, threats, and opportunities in nanotechnology, and contributed a regular column to *Vanguard Magazine* looking at emerging technologies as they may be applied in a modern military context.

We published an "Issue Paper in Defence Science and Technology" to identify for our clients and other interested parties of emerging technology issues and recent advances in technology.

Change Objectives

Strategic Advice – Defence 2020 Strategy

Objective

To provide research and development advice that is closely integrated and aligned with Defence Strategy 2020.

Performance

Our updated Technology Investment Strategy outlines the research and development activities required to develop the capacity for future defence and national security, taking into account the strategic direction provided by *Defence Strategy 2020* and the new approach of Strategic Capability Planning. The new technology strategy better reflects technologies that are integral to the Revolution in Military Affairs and has added more emphasis to responding to terrorist threats.

Science and Technology with National Security Partners

Science and Technology with National Security Partners is our third business line. It allows us to exploit our science and technology base to serve the needs of partners outside the Department of National Defence, including Canadian industry and other government departments.

The following sections review the performance of Defence R&D Canada against our defence and change objectives for this business line.

Defence Objectives

Contribution of National Collaborators

Objective

To establish partnerships with industry, other government departments and agencies, and universities. The goal is to leverage \$30M of in-kind science and technology from national partners by 2004. The goal for 2001-02 was \$27.5M.

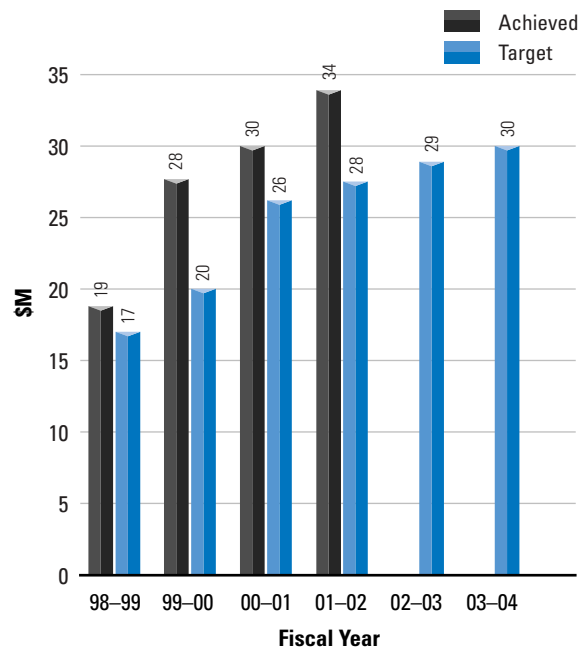
Performance

The chapter on National Collaborations on page 12 highlights our collaborations with other government departments and agencies, academia, and the private sector. Some of these collaborations include:

- A research agreement with the National Research Council's Institute for Aerospace Research
- Two collaborative projects through Materials and Manufacturing Ontario
- A partnership agreement with Laval University
- A memorandum of understanding with General Dynamics Canada for conducting collaborative research and development

Some of the possibilities fostered by the memorandum of understanding with General Dynamics Canada include information sharing and personnel exchange.

Leveraging from National Collaborations



The following chart shows the achieved and target value of national collaborations for fiscal years 1998-99 to 2003-04. The achieved values reported in the chart are estimates only; a more rigorous derivation of the value of collaborative activities will be developed and used in future reports. Note that we have already surpassed our final goal of \$30M.

Revenue Generation

Objective

To generate approximately \$10M in revenue from external sources by 2004. The goal for 2001-02 was \$7M.

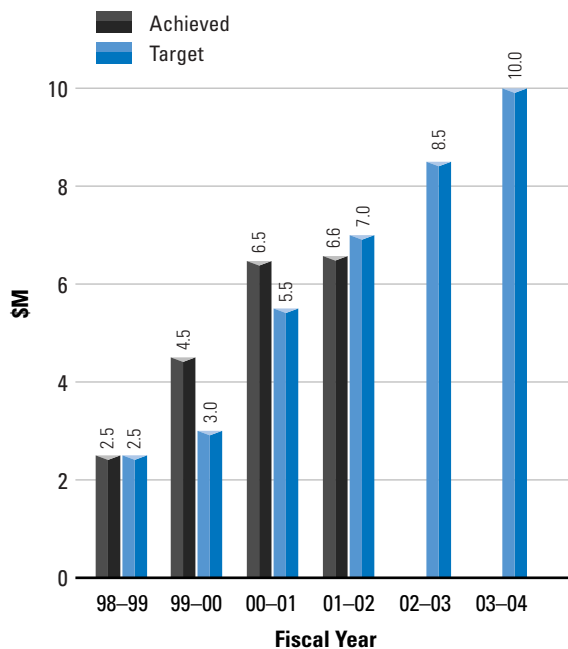
Performance

Under our revenue generation and retention model, we continue to provide superior science and technology services to our clients in the Canadian Forces and the Department of National Defence while leveraging our

annual appropriations to expand our capability in our core competencies.

The following chart shows our target and achieved revenue from external sources² for fiscal years 1998-99 to 2003-04. While we fell short of our target for fiscal year 2001-02 by about \$400K, we are still well on the way to meeting our goal of \$10M in revenue from external sources.

Revenues from External Sources



Technology Transfer to Canadian Industry

Objective

To promote the transfer of Defence R&D Canada's technology to Canadian industry, to manage and exploit the intellectual property generated by Defence R&D Canada, and to license at least five technology concepts to industry for further development.



Advanced knowledge management systems are vital to information-based warfare.

² "External sources" include clients outside the Department of National Defence as well as clients inside National Defence but outside our Service Level Agreements.

Licensing Agreements

TECHNOLOGY	COMPANY
Mechanical Reproduction Mines Technology	Amtech Aeronautical Limited
Pyrophoric Decoy Flare Technology	Bristol Aerospace Limited
Pulmonary Delivery of Liposome-Entrapped D9-Tetrahydrocannabinol	Delex Therapeutics Inc.
HLLFLO, SUBMO, ESSAM and DSSP20 Software Packages	International Submarine Engineering Ltd.
Hydrogel Wound Dressing Containing Liposome-Encapsulated Therapeutic Agents	Uroteq Incorporated
Intelligent Clothing And Equipment Sizing System Software	Visimage Systems Inc.

Performance

In fiscal year 2001-02, we licensed six technologies to industry for further development and exploitation; another nine license agreements are pending. The following table lists the license agreements that were completed.

Change Objectives

Strategic Partnerships and Increased National Collaboration

Objective

To enhance the participation of industry in the Technology Demonstration Program, and to initiate at least one technology demonstration project that addresses the asymmetric threat by September 2001.

Performance

We are exploring new models for partnership and collaboration to change the way we carry out and deliver our services. For example, our Business Development Office developed and launched our Strategic Marketing Plan, which focuses on ways to raise our profile with potential partners in both the public and private sector in Canada and internationally. We also hosted *Defence Innovation*, a three-day conference highlighting business opportunities offered by Defence R&D Canada –

Valcartier. The conference identified technologies, systems, and devices that are ready for military and civilian markets.

We initiated the following two Technology Demonstration projects that address asymmetric threats:

- Force Protection Against Enhanced Blast
- Soldier Integrated Headwear System

Corporate Management

Corporate Management is our fourth business line. It includes management of Defence R&D Canada as an agency of the Department of National Defence, management of the research and development program, and the provision of corporate services.

The following sections review the performance of Defence R&D Canada against our defence objectives for this business line.

Management of the Agency

Objective

To consolidate and complete the implementation of functions associated with the establishment of Defence R&D Canada as a Special Operating Agency.

Performance

We continued to develop our functional direction initiative, in which managers at Defence R&D Canada – Corporate Services provide functional direction for corporate services delivered in the research centres. As part of this initiative, we are streamlining our business processes by identifying best practices and implementing common solutions to shared problems. Any financial savings realized from increased efficiencies will be made available to support the research and development program.

We developed the *Road Map to Our Vision* to track the implementation of functions associated with the establishment of Defence R&D Canada as a Special Operating Agency. The following table summarizes the percentage completion of the implementation of these functions. Note that this is a five-year process that should be completed by 2004.

Completion of the Implementation of Functions

FUNCTION	% COMPLETION
Business Administration	
Set up agency-wide comptrollership	90%
Develop the Collaborative Planning and Management Environment	85%
Implement a knowledge management strategy and framework	80%
Streamline business administration practices	50%
Implement a true single operating budget	90%
Technology Investment	
Align the research and development program with National Defence strategic direction	95%
Harmonize the thrust program with the Technology Investment Strategy	100%
Identify and deal with science and technology capacity shortfalls	90%
Program Management	
Streamline program and project planning, tracking, and management	100%
Establish accountabilities and authorities and assume accorded flexibilities	80%
Human Resources	
Set up the human resources function	100%
Act on recommendations related to culture change	80%
Implement career management for all employees	50%
Implement a succession planning and management development program	60%
Implement a recognition and awards program	100%

Management of the Research and Development Program

Objective

To manage the research and development program effectively.

Performance

Our science managers have had extremely heavy workloads, and reducing their administrative burden to free up time for scientific program management is a priority. One area identified as especially time consuming and complex is program and project planning, tracking, and management. The advanced development of the Collaborative Planning and Management Environment should result in more efficient processes and tools to help program and project managers do their jobs.

Through our functional direction initiative (see *Management of the Agency*, pages 36 and 37), we are identifying administrative duties that could be transferred from our scientific and technical staff to our corporate services staff. Any time saved by reducing the administrative burden on our scientific and technical staff will free up time to support the research and development program.

Management of International Activities

Objective

To manage international research and development activities effectively.

Performance

We have developed a database linking our research and development activities to the overall Canadian involvement in The Technical Cooperation Program and with NATO. This database provides a catalogue of current activities and research initiatives as they pertain to our international involvement.



Human Resources



Within the environment of a special operating agency, our Human Resources activities were focused on implementing our human resources management framework. This framework, based on the Treasury Board model, outlines four key results areas: *Leadership*, *A Productive Workforce*, *An Enabling Work Environment*, and *A Sustainable Workforce*. Each key result area is described in the following sections.

Leadership

Competency and Career Management

To ensure that we are well positioned to achieve our vision, strategic goals, and initiatives, we initiated the Competency and Career Management Project to define the competencies required by our employees. Based upon our values, we have defined six core competencies:

- Client Focus
- Teamwork
- Creativity and Innovation
- Professional Integrity
- Results Orientation
- Leadership

The project will move forward with the definition of career-stream competencies for the job families of Science, Technology, Management, and Corporate Services. Once these competencies are defined, they will be incorporated into a competency-based human resource management system and will facilitate the development of a career management program for all our personnel. This will serve as the foundation for an integrated set of processes and tools to be used in recruitment, career management, learning and development, succession planning, and performance management.

Union – Management Consultations

The Union Management Consultative Committee is a forum for the exchange of ideas and information on policies, programs, procedures, and conditions of employment as they apply to all of our employees. The committee met for the first time in January 2002, with participation from our Chief Executive Officer, the Directors General, and national representatives of our employees' unions. The purpose of the meeting was to reinforce a spirit of openness and candour, to restate the commitment to our continued vitality, and to support the structure for labour-management relations. Discussions centred on the human resources aspects of the Technology Investment Strategy, our values and options for person-based (rather than position-based) promotion, apprenticeship and development programs, and the committee's terms of reference. This first meeting provided a venue for a positive exchange of ideas and supported our commitment to strengthen our relationships with the unions.

A Productive Workforce

Staffing Level

Our workforce increased by eight percent over the past year, mainly in the Scientific & Professional and the Administrative & Foreign Services categories. During the year, we also hired 46 students: 18 Defence Research Assistants through the Federal Student Work Experience Program and 28 co-op students.

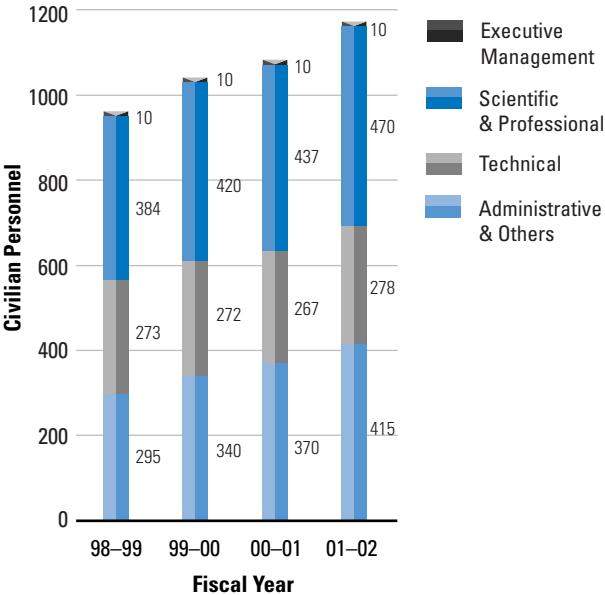
The following table shows the number of civilian employees in Defence R&D Canada, as of 31 March 2002, sorted according to occupational category. The table also shows the percent change in the number of employees in each category.

Civilian Personnel by Job Group

OCCUPATIONAL CATEGORY	NUMBER OF EMPLOYEES	% CHANGE
Executive Management (includes EX, DS 7, & DS 8)	10	0%
Scientific & Professional (includes DS, CH, & ENG)	470	8%
Technical	278	4%
Administrative & Foreign Services	415	12%
TOTAL	1173	8%

The chart below shows the trend in staffing levels for all of our civilian employees for fiscal years 1998-99 to 2001-02.

Staffing Trends for all Civilian Personnel



The precise measurement of colours used for electronic displays helps our scientists develop better methods of coding information.

Natural Science and Engineering Research Council Programs

We participate in two programs sponsored by the Natural Science and Engineering Research Council: the Visiting Fellowships Program and the Postgraduate Supplement Program. The Visiting Fellowships Program provides young Canadian scientists with an opportunity to work with researchers in a government laboratory and encourages them to embark on a scientific career. Last year, three new Visiting Fellowships were awarded: two at Defence R&D Canada – Toronto and one at Defence R&D Canada – Suffield. The Postgraduate Supplement Program encourages and supports graduate students to carry out research of interest to Defence R&D Canada, increases contacts between our researchers and Canadian universities, and fosters graduate training of potential candidates for future employment at Defence R&D Canada. Last year we awarded three new supplements at Defence R&D Canada – Valcartier.

Retirement and Recruitment

As a consequence of a projected high number of retirements over the next five to ten years and the resulting loss of specialized knowledge, particular recruitment needs, and the difficulty in recruiting to meet the expected demand, the science and technology community has been identified as being particularly at risk. Prompted by forecasted shortages in areas in the science and technology community, the twelve science-based departments and agencies that comprise the community recommended the development of the Graduate Opportunities Strategy Program. Designed to address key recruitment needs, this program provides continuity within the science and technology community through the recruitment of recent science and technology graduates in advance of the departures of senior personnel, thereby facilitating the transfer of specialized knowledge. A pilot program was implemented last year, enabling us to hire sixteen employees, including five at Defence R&D Canada – Atlantic, ten at Defence R&D Canada – Ottawa, and one at Defence R&D Canada – Suffield.

Learning

We maintain our commitment to becoming an organization where continuous learning and training is encouraged. During fiscal year 2001-02, our training activities and initiatives included military Out-Service Training, as well as other opportunities for both military and civilian personnel. They include Departmental Materiel Acquisition and Support Training, professional and personal development courses and workshops provided by the Departmental Learning and Career Centres and Training and Development Canada. We have also participated in various local, national, and international events that support and enhance our vision to be known worldwide as the best in defence research and development.

Other development opportunities for senior and middle management included the Defence Resources Management Course, the National Security Studies Course, the National Security Studies Seminar, and the Middle Management Leadership Development Course. Participants across Defence R&D Canada benefited from these ongoing initiatives, which are supported by senior management. These courses and seminars have been commonly identified as useful instruments to enhance career progression.

An Enabling Work Environment

Organizational Culture

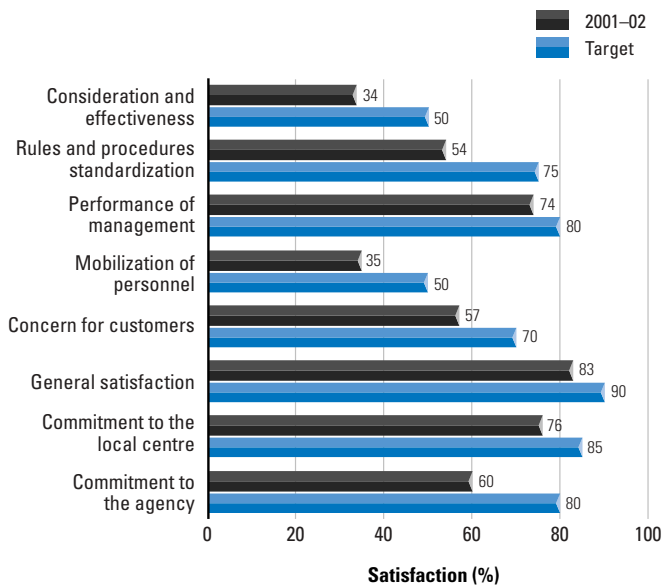
The exercise of evolving our organizational culture to one that will foster our vision continued with the development of our new core values:

- Commitment
- Client Focus
- Creativity and Innovation
- Leadership

- Professionalism and Integrity
- Teamwork
- Trust and Respect

The drive to move toward our vision was further strengthened with the establishment of a number of teams to identify and propose ways to address the areas targeted for improvement in a survey completed during the culture change exercise. The results of the survey, including our targets for employee satisfaction, are summarized in the chart below.

Employee Satisfaction with Organizational Culture



Defence R&D Canada is striving to evolve its organizational culture to one that will foster the vision to be known worldwide as the best in defence research and development.

Employment Equity

We are committed to ensuring employment equity and strive to increase the representation of designated groups within our organization, not only to reflect the makeup of the Canadian population but also to offer better service to our clients.

In accordance with the Employment Equity Act, we analysed our workforce to determine the degree of representation in each of the four designated groups – women, aboriginal peoples, persons with disabilities, and visible minorities – in each occupational group within our workforce. The results of the workforce analysis were instrumental in establishing the goals in our three-year Employment Equity plan to address specific areas of under-representation.

Women continue to be critically under-represented in the science and technology field. Our management has met to determine the barriers to women advancing in the science and technology community and what could be done to make science and technology a more attractive career option to women. The observations and suggestions made at this meeting have been incorporated into our Employment Equity Plan and action will be taken at each of our research centres to address the situation.

Employment Equity Analysis

OCCUPATIONAL CATEGORY	WOMEN		VISIBLE MINORITIES		PERSONS WITH DISABILITIES		ABORIGINAL PEOPLES	
	Labour market	Our workforce	Labour market	Our workforce	Labour market	Our workforce	Labour market	Our workforce
Scientific & Professional	20.8%	10.1%	14.6%	10.1%	4.0%	1.8%	0.5%	0.2%
Administrative & Foreign Service	38.3%	35.7%	5.3%	3.1%	3.2%	2.3%	0.6%	0.8%
Technical	40.3%	13.3%	7.2%	1.2%	5.7%	2.0%	0.8%	0.8%
Administrative Support	81.3%	87.2%	5.5%	1.7%	4.8%	2.6%	1.2%	0.0%
Operational	8.3%	5.2%	3.7%	3.1%	8.9%	4.1%	1.2%	1.0%

The table above shows our representation of designated group members compared to the Labour Market Availability in each occupational category. The Labour Market Availability is established by Treasury Board and is based on the 1996 Census.

Official Languages

We fully support the Official Languages Program. Work is currently under way to confirm the linguistic requirements of positions and employee profiles, to conduct tests of employees' linguistic abilities, and to develop Official Languages guidelines for human resource managers and for position identification.

Our workforce appears to be representative of the Canadian population: 67% of our employees identified English as their first language, whereas 33% identified French as such. Approximately 35% of our positions are classed as bilingual positions.

Recognition and Awards

We formally recognize the achievements and contributions of our employees through our Recognition and Awards Program. At our first annual Recognition and


Awards Ceremony, in September 2001, the Outstanding Achievement Award was presented to seven employees. Two others received the Public Distinction Award for meritorious service outside of the workplace. As part of the celebration of the International Year of Volunteers, two employees were recognized for their work in the Employee Assistance Program, a joint labour-management initiative.

A Sustainable Workforce

Succession Planning

Over the next five years, we expect that 28% of our scientists will be eligible for retirement, representing an unprecedented loss of knowledge and expertise. As events around the world place an increased demand on security-related research and development, we are committed to aggressively engage in various recruitment activities and programs to meet these challenges.

We have consistently employed a succession strategy for science managers through the Defence Science Career Management System and the Defence Science Merit Review. Currently, science managers can take advantage



Defence R&D Canada is committed to ensuring employment equity and strives to increase the representation of designated groups within its organization, not only to reflect the Canadian population, but also to offer better service to the people it serves.

of various assignment opportunities to develop their management potential. In addition, several initiatives have been undertaken to address issues with recruitment, retention, and anticipated shortages.

While we have been proactive in succession planning for science managers, we are now beginning to apply this concept to other job streams. In support of succession planning for all key corporate positions, we have identified anticipated departures over the next five years and their possible replacements.

Classification Reform

The Government of Canada recognizes that classification reform is essential to modernizing the manner in which work is described and valued within the Public

Service. After careful consideration of various perspectives, the Government has decided not to proceed with a single Universal Classification Standard, but will instead move ahead with classification reform, adopting an approach tailored to specific occupational groups.

This approach will build on work already done, which includes the development, writing, quality control, and evaluation of model work descriptions, as well as the mapping of our positions to the departmental model work descriptions. Efforts are being made to ensure that work descriptions for all positions are up-to-date.



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Excellence in Science & Technology





Excellence in Science & Technology

Our vision is to be known worldwide as the best in defence research and development. This vision can be achieved only with a staff that excels in its scientific and technical work. To assess our standing in the international scientific community, we track a number of indicators of excellence in science and conducts peer reviews of our defence technology areas.

Awards and Honours

The number and quality of awards and honours that are bestowed upon our staff is an indication of their scientific and technical impact.

Achievement Awards

On behalf of the Subcommittee on Non-Atomic Military Research and Development, the following employees were presented Achievement Awards for their contributions to our collaborative research program under The Technical Cooperation Program:

- **Brad Cain** of Defence R&D Canada – Toronto
- **Keith Hendy** of Defence R&D Canada – Toronto
- **John Evans** of the Operational Research Division
- **Paul Pace** of the Canadian Forces Experimentation Centre
- **Georges Fournier** of Defence R&D Canada – Valcartier
- **Garry Heard** of Defence R&D Canada – Atlantic
- **Terry Foster** of Defence R&D Canada – Atlantic (Dockyard Lab Esquimalt)
- **David DiFilippo** of Defence R&D Canada – Ottawa
- **Gary Geling** of Defence R&D Canada – Ottawa

- **Steven Hughes** of Defence R&D Canada – Corporate Services
- **Paul Chevrette** of Defence R&D Canada – Valcartier
- **Tracy Smithson** of Defence R&D Canada – Valcartier
- **Maria Rey** of Defence R&D Canada – Ottawa
- **Franklin Wong** of Defence R&D Canada – Valcartier
- **Jim P.Y. Lee** of Defence R&D Canada – Ottawa
- **Robert Walker** of Defence R&D Canada – Programs

Tracy Smithson of Defence R&D Canada – Valcartier received a Scientific Achievement Award from the NATO Research and Technology Organization recognizing his exceptional work and contributions to scientific and technological cooperation.

Fellows of Societies and Institutes

Prakash Bhartia of Defence R&D Canada – Ottawa was inducted as a fellow by both the Engineering Institute of Canada and the Canadian Academy of Engineers for his outstanding scientific creativity, productivity and leadership, as well as management skills.

Doug Laurie-Lean of Defence R&D Canada – Programs was among three professionals granted fellow status by the Canadian Aeronautics and Space Institute.

Gary Gray of Defence R&D Canada – Toronto was made a fellow of the Aerospace Medical Association.

Best Paper Awards

Paul Labbé of Defence R&D Canada – Valcartier received best paper honours from the Institute of Electrical and Electronics Engineers for “Assessing Shared Awareness of Wireless-mobile Units”, co-authored with university researchers in Morocco and United Arab Emirates.

Robert Stodilka of Defence R&D Canada – Ottawa won the 2001 Alavi-Mandell Prize for his paper about techniques to improve the accuracy of “single photon emission computed tomography” that would enable more accurate diagnosis of certain types of brain disease, such as Alzheimer’s disease.

Best Poster Awards

Pierre Lessard, France Beaupré, and Patrick Brousseau of Defence R&D Canada – Valcartier won an award for best poster from the 32nd International Conference on Energetic Materials of the *Fraunhofer Institut Chemische Technologie*.

Guy Ampleman of Defence R&D Canada – Valcartier won a best poster award at the Insensitive Munitions and Energetic Materials Technology Symposium.

Government Awards

Association of Professional Executives Leadership Award

In one of the most significant tributes ever accorded a defence scientist in Canada, **John Leggat**, CEO of Defence R&D Canada, was awarded the 2001 APEX Leadership Award, the top honour of the Association of Professional Executives (APEX) of the Public Service of Canada. The leadership award is given annually to a federal senior executive who demonstrates outstanding leadership of people, leads an organization recognized for provision of exemplary service to the public, or its contribution to substantially improving the internal workings of the public service, personifies the principles of APEX, and provides an example for other senior executives.



Simulators create environments to assess human capabilities.

Head of the Public Service Awards

The Clerk of the Privy Council presented Head of the Public Service awards, among the government’s most prestigious honours, to **Denis Faubert**, Director General of Defence R&D Canada – Valcartier, and the **Canadian Centre for Mine Action Technologies** team, which includes a number of employees from Defence R&D Canada – Suffield.

Federal Partners in Technology Transfer

For the fourth time in three years, Defence R&D Canada has won an award from the Federal Partners in Technology Transfer. Last year, **Garfield Purdon** and **Andrew Burczyk** of Defence R&D Canada – Suffield were winners for their contribution to the development and transfer to industry of a skin decontaminant lotion that protects the skin against chemical warfare agents.

Canadian Information Productivity Awards

Defence R&D Canada – Valcartier was honoured with three Canadian Information Productivity Awards (CIPA) of Excellence. The CIPA is Canada’s largest business awards program in the field of information management.

The **SARPlan** team received two CIPA awards: an award of excellence as well as best in category. SARPlan is a software tool to support search and rescue operations. It proposes search areas, assigns specific patterns and altitudes to search aircraft, and suggests deployment strategies for search units, all taking into account ground specifications and operational constraints.

The other CIPA went to the **MaliCOTS** team for Commercial Software Certification for Government Applications. The MaliCOTS project has made it possible to develop a full range of software certification tools suited for commercial off-the-shelf software integration into government information systems.

OCTAS Technological Innovation Award

The **SARPlan** team from Defence R&D Canada – Valcartier received the OCTAS award for Technological Innovation from the *Fédération de l'informatique du Québec* for their software.

Departmental Awards

Commendations from the Deputy Minister

The Department of National Defence recognized the important work of **Paul Pace** and **John Evans**, formerly of Defence R&D Canada – Programs, with a commendation from the Deputy Minister. The pair was selected for successfully demonstrating the potential utility and strategic benefit of unmanned aerial vehicles to Canada.

A Certificate of Commendation from the Deputy Minister was also awarded to individuals at Defence R&D Canada – Suffield for their assistance in the aftermath of the terrorist attacks in the United States on September 11th, 2001. The certificates were awarded to **Kent Harding, Joan Armour, Mel Spence, Jim Ogston, Cam Boulet, Clement Laforce, Bill Kournikakis, Jim Ho, Captain Megan McKenzie, Lawrence Schofield, and Jim Hancock.**

Defence R&D Canada Awards

The inaugural Defence R&D Canada Awards recognized three individuals and one team for their exemplary efforts.

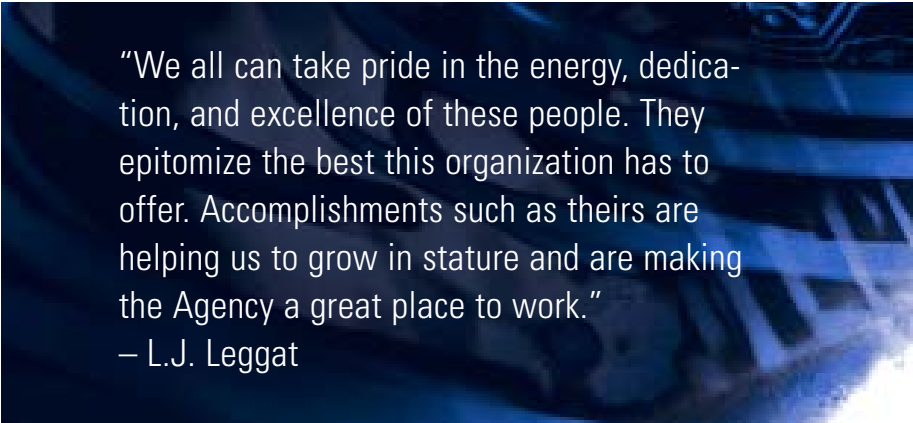
Outstanding Achievement Awards

Gordon Marwood of Defence R&D Canada – Ottawa received an Outstanding Achievement Award. The exceptional quality of his research and management is most clearly demonstrated by his creation of new research units and in his nurturing of international partnerships.

The team responsible for the development of the Canadian Integrated Biochemical Agent Detection System also received an Outstanding Achievement Award. The team is **Ken Johnson** and **Cam Boulet**, of Defence R&D Canada – Programs, and **Paul D'Agostino, Elaine Fulton, Jim Ho, and Mel Spence** of Defence R&D Canada – Suffield.

Awards of Public Distinction

Mary Anne O'Keefe, of the Department of National Defence Headquarters (formerly of Defence R&D Canada – Ottawa) and **Jean-Pierre Morency**, of Defence R&D Canada – Valcartier received Awards of Public Distinction for their involvement in the Employee Assistance Program and the Government of Canada Workplace Charitable Campaign.



“We all can take pride in the energy, dedication, and excellence of these people. They epitomize the best this organization has to offer. Accomplishments such as theirs are helping us to grow in stature and are making the Agency a great place to work.”
– L.J. Leggat

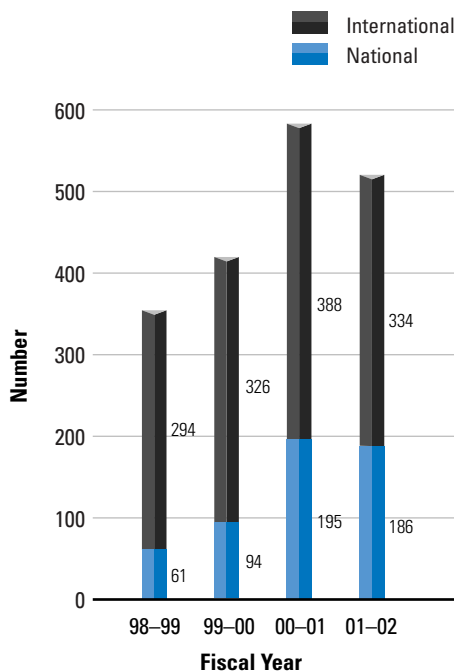
Scientific Indicators

In addition to awards and honours, we track a number of indicators that serve as useful measures of our standing in the international science and technology community. These indicators include participation in national and international activities, patents, reports of invention, publications, and achievement of project milestones.

National and International Activities

The chart below shows the number of national and international activities in which our staff participated in fiscal years 1998-99 to 2001-02. These activities include membership on councils and technical panels, and participation on collaborative projects, working groups, and information exchanges.

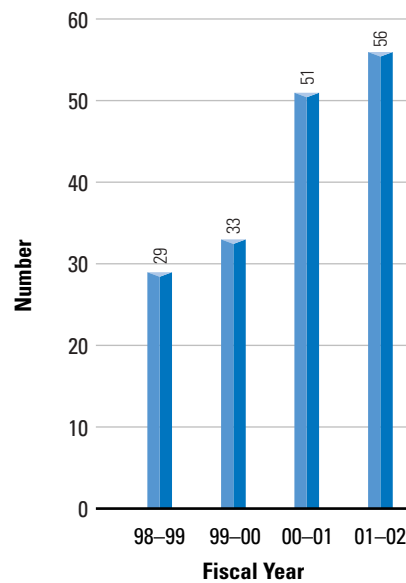
Four-year trend for the number of national and international activities



Patents and Reports of Inventions

The chart below shows the number of patents granted and reports of invention filed by our staff for fiscal years 1998-99 to 2001-02. The list of patents granted is given on page 64.

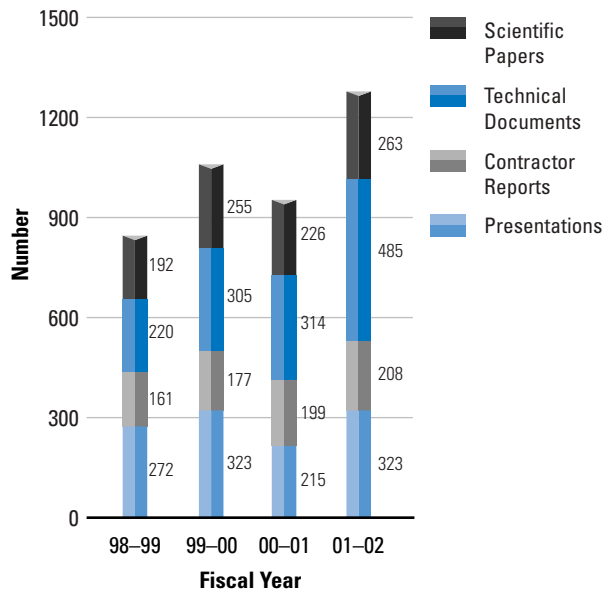
Four-year trend for the number of patents granted and reports of invention filed



Reports and Presentations

The chart below shows the number of reports and presentations for fiscal years 1998-99 to 2001-02. The reports include papers published in the scientific literature, technical documents published by our research centres, and reports resulting from research contracts funded by our research and development program.

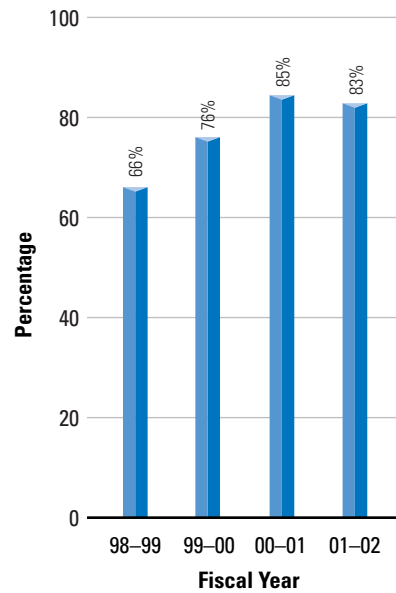
Four-year trend for the number of reports and presentations



Milestone Completion

We track the progress of projects by assigning anticipated completion dates to project milestones. A total of 401 milestones were used for this analysis for fiscal year 2001-02. Of the 401 milestones, 270 milestones were completed fully; the remaining 131 milestones were completed partially. Using a weighted average, the overall milestone completion for last year was 83.0%. The chart below shows the weighted average milestone completion for fiscal years 1998-99 to 2001-02.

Four-year trend for milestone completion



Peer Reviews

Our peer reviews are objective and critical evaluations of technology areas within our research and development program. These evaluations address the quality of the research, the people, the infrastructure, and the management of the program. The purpose of the peer reviews is to identify strengths and weaknesses in the program, to assess the extent of world-class science in Defence R&D Canada, and to identify areas for improvement.

We conducted three peer reviews in fiscal year 2001-02: Undersea Warfare at Defence R&D Canada – Atlantic, Communications at Defence R&D Canada – Ottawa (in conjunction with the Communications Research Centre), and Combat Systems at Defence R&D Canada – Valcartier. The following section highlights these peer reviews.

Undersea Warfare

The review team described the scientific personnel as “internationally recognized as experts in their areas of specialty”. Contributions from the undersea warfare program are readily identified in the international community. The review team noted that capital investment in facilities and equipment is needed for the long-term health of the program, and that a hiring strategy is needed to address the aging workforce.

Communications

The review team found that the research in the communications program is highly focused on client needs. There is a good level of international collaboration and the program has had some impressive accomplishments. The review team expressed concerns about the aging population of the researchers and the need for senior staff to mentor new scientists.

Combat Systems

The review team noted a very high level of dedication and enthusiasm with the technical staff and were impressed with the research being done. While reviewers were impressed with the facilities, they were not rated as world class. The review team submitted a number of recommendations designed to help the organization build on its strengths.



Financial Report



Expenditures by Business Line

	Civilian FTEs ³	Total Expenditure (\$K)
BUSINESS LINE 1		
Maritime		
Maritime Integrated Above Water Warfare	26	8,431
Maritime Command, Control, Communications and Intelligence	15	6,895
Maritime Underwater Warfare	54	11,581
Maritime Mine Countermeasures Systems	17	7,079
Naval Platform Technology	37	6,666
Total Maritime	148	40,652
Land		
Soldier Systems	23	7,791
Combat Vehicle Systems	38	8,097
Information Operations	20	7,950
Military Engineering	12	2,761
Munitions and Firepower	29	6,356
Total Land	123	32,955
Air		
Air Electronic Warfare	14	4,578
Airborne Surveillance	34	11,646
Air Weapons Systems	15	3,059
Air Vehicles	3	4,697
Aircraft Crewsystems Technologies	15	4,056
Total Air	82	28,036
Command Control Information Systems		
National Level Command and Surveillance	29	6,765
Information Operations	31	4,631
Military Information Technology Infrastructure	11	4,813
Space Systems and Technologies for Defence Applications	24	10,768
Total CCIS	95	26,977

³ FTE stands for Full-Time Equivalent

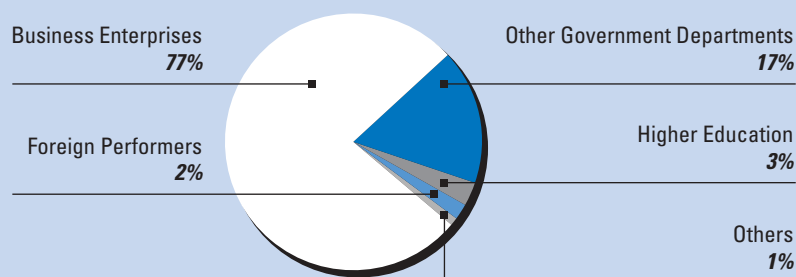
Expenditures by Business Line (continued)

	Civilian FTEs	Total Expenditure (\$K)
BUSINESS LINE 1		
Human Performance		
Simulator Training Technologies	7	2,516
Military Operational Medicine	15	2,944
Diving and Underwater Intervention	8	1,079
Human Factors in Military Systems	34	3,700
Defence against Chemical, Biological and Radiation Hazards	49	9,314
Total HP	113	19,552
Total Business Line 1	560	148,173
BUSINESS LINE 2	37	5,182
BUSINESS LINE 3	30	2,236
BUSINESS LINE 4	475	58,790
Departmental and Interdepartmental Initiatives	7	3,448
Total for all Business Lines	1,109⁴	217,830⁵

Expenditures by Performing Sector

The following chart shows the performing sectors in which we spent our research and development contracting funds in fiscal year 2001-02.

Contract expenditures by performing sector



⁴ The total *Civilian FTEs* number is not expected to agree with the *Number of Employees* in the table on page 41. The total *Civilian FTEs* is indicative of the total personnel resources that were available throughout the entire fiscal year. The *Number of Employees* is a "snapshot" of our staffing level as of 31 March 2002. During a period of moderate growth, the total *Civilian FTEs* would be expected to be smaller than the *Number of Employees*.

⁵ The *Total for all Business Lines* includes \$14,270K of Investment Opportunity Funds.

Resource Summary

Resource Summary by Fund and Site (\$K)

	SALARY	O&M ⁶	R&D CONTRACTS	EQUIPMENT	TOTAL
DRDC Atlantic	\$13,610	\$3,433	\$8,519	\$1,165	\$26,727
DRDC Valcartier	\$21,004	\$6,573	\$13,285	\$2,760	\$43,622
DRDC Ottawa	\$10,297	\$3,856	\$12,574	\$2,329	\$29,056
DRDC Toronto	\$8,609	\$4,354	\$6,521	\$2,301	\$21,785
DRDC Suffield	\$10,188	\$5,831 ⁷	\$6,415	\$2,834	\$25,268
DRDC Corporate	\$7,772	\$5,021	\$57,950	\$628	\$71,371
Total	\$71,480	\$29,068	\$105,264	\$12,017	\$217,829

Sources of Revenue by Site (\$K)

	PRIVATE SECTOR SOURCES	SPECIFIED PURPOSE ACCOUNTS	OTHER GOVERNMENT DEPARTMENTS	FE ⁸ SAVINGS	TOTAL
DRDC Atlantic	\$171	-	-	-	\$171
DRDC Valcartier	\$829	-	-	\$1,539	\$2,368
DRDC Ottawa	\$388	-	-	\$730	\$1,118
DRDC Toronto	\$89	\$585	\$209	-	\$883
DRDC Suffield	\$1,223	\$721	\$17	-	\$1,961
DRDC Corporate	\$70	-	-	-	\$70
Total	\$2,770	\$1,306	\$226	\$2,269	\$6,571

⁶ O&M stands for *Operations and Maintenance*

⁷ The DRDC Suffield O&M allocation was \$2,383K. The O&M allocation shown above also funds the Canadian Centre for Mine Action Technologies, which is located at DRDC Suffield.

⁸ FE stands for *Funds Earmarked*. This is the internal transfer of funds from one departmental account to another.



Summary



The terrorist attacks in the United States on September 11th, 2001, and the ensuing campaign against terrorism have given us new opportunities to apply our expertise to support the operations of the Canadian Forces and the goals of the Government of Canada.

We provided assistance to *Operation APOLLO*, Canada's military contribution to the international campaign against terrorism. Our support included reducing the vulnerability of our naval vessels to potential mine threats and blast and fragmentation devices, optimizing the performance of the infrared jammers on the Sea King helicopters, and ensuring the continued operation of vital satellite communications and data-link services.

We trained first responders across the country to deal with chemical, biological, radiological, and nuclear attacks. Because of our expertise in the area, the Government of Canada directed us to manage a federal collaboration with industry, academia, and first responder communities to provide new knowledge, technology, and research for chemical, biological, radiological, and nuclear response and preparedness.

Ensuring that the Canadian Forces remain technologically prepared and relevant is our mission and our top priority. In support of our mission and in recognition of the changing defence environment, we continued to evolve and implement our Technology Investment Strategy to meet the future needs of the Canadian Forces. We hired new science and technology workers and initiated projects to update our infrastructure and facilities.

We are striving to evolve our organizational culture to one that will foster our vision to be known worldwide as the best in defence research and development. We established teams of employees to identify and propose

ways to address the areas targeted for improvement in a survey completed during the culture change exercise. We developed core competencies and initiated a program of career management for all our employees.

Our science and technology workers are respected and recognized as experts in their fields, as evidenced by our peer reviews and by the quantity of awards bestowed upon them. While the number of national and international activities declined somewhat, there was an increase in the number of reports, presentations, patents granted, and reports of invention filed.

As the Canadian Forces are reshaped to deal with a wider range of future security challenges, our work has never been more relevant. Science and technology has a vital role to play in the current geopolitical and military context. Our advice, our know-how, and our technology will continue to make important contributions to the Canadian Forces. We are rising to the challenge.



Tables





Tables

Table 1 Capability Areas of the Research Centres

RESEARCH CENTRE	CAPABILITY AREAS	
DRDC Atlantic	<ul style="list-style-type: none"> ■ Air vehicles ■ Antisubmarine warfare ■ Emerging materials ■ Maritime information and knowledge management 	<ul style="list-style-type: none"> ■ Mine and torpedo defence ■ Naval platforms ■ Shipboard command and control ■ Signature management ■ Virtual platforms and combat systems
DRDC Valcartier	<ul style="list-style-type: none"> ■ Advanced electro-optical systems ■ Aero-acoustic surveillance systems ■ Chemical/Biological/Radiological threat assessment, identification and protection ■ Command and control information systems performance and experimentation ■ Electro-optical warfare and sensor performance modeling ■ Energetic materials and biotechnology ■ Human factors engineering and decision support 	<ul style="list-style-type: none"> ■ Information and knowledge management ■ Information systems technology ■ Military laser technology and systems ■ Precision weapon delivery systems ■ Remote sensing technology for EO systems performance prediction ■ Sensing (air and surface) ■ Space Systems ■ Weapon effects and protection ■ Weapons performance and countermeasures
DRDC Ottawa	<ul style="list-style-type: none"> ■ Authentication for Information Operations ■ Communication Electronic Attack / Support ■ Creation of Synthetic Environments ■ Decision Support for Common Information Operations Picture ■ Electromagnetic Protection ■ Imaging Radar Signal Processing ■ Integration of Synthetic Environments ■ Mobile Agents for Network Discovery ■ Mobile Network Security ■ Moving Target Signal Processing ■ NavWar 	<ul style="list-style-type: none"> ■ Networked Sensors / Sensor Fusion ■ Radar Systems and Data Exploitation ■ Radar Electronic Attack and Support ■ Radiation Biology and Spectroscopy / Dosimetry ■ Real Time Technology for Sophisticated Threats and Attacks ■ Signature Management ■ Software Radio Architecture ■ Space Systems (Surveillance of Space, MicroSat Technology)
DRDC Toronto	<ul style="list-style-type: none"> ■ Aerospace life support ■ Behavioural and cognitive sciences ■ Biomedical sciences ■ Experimental diving 	<ul style="list-style-type: none"> ■ Human factors engineering ■ Human protection and performance ■ Human-computer interaction ■ Simulation and training technologies
DRDC Suffield	<ul style="list-style-type: none"> ■ Casualty management ■ Countermine technology ■ Detection and identification of chemical and biological (CB) hazards ■ Medical countermeasures against CB agents 	<ul style="list-style-type: none"> ■ Novel energetic materials ■ Physical protection against CB agents ■ Robotics ■ Threat assessment and explosive effect

Table 2 Technology Demonstration Projects

PROJECT NAME	START	END	TOTAL (\$K)	01/02 (\$K)
Canadian Naval Electronic Warfare Set	1990	2002	\$27,604	\$1,800
Towed Array Sensor Development	1993	2002	\$10,792	\$200
Advanced Land Fire Control System	1995	2001	\$9,842	\$309
High Frequency Surface Wave Radar for Coastal Surveillance	1995	2002	\$6,352	\$1,091
SHINCOM Upgrade	1996	2002	\$9,596	\$1,900
Improved Ship Structural Maintenance Management	1996	2004	\$4,290	\$883
Soldier Information Requirements	1996	2004	\$16,398	\$3,400
Towed Integrated Active/Passive Sonar	1997	2004	\$12,140	\$4,360
Remote Minehunting System	1997	2004	\$8,677	\$3,943
Land Intelligence And Electronic Warfare Automation	1998	2003	\$6,374	\$1,555
Enhanced Synthetic Vision System	1998	2001	\$3,100	\$75
MILSATCOM Performance Enhancement	1998	2002	\$9,342	\$609
Vaccine Development Initiative	1998	2004	\$4,20	\$800
Radarsat 2 GMTI	1999	2004	\$7,290	\$2,139
Tactical Aviation Mission System Simulation	1999	2004	\$6,100	\$2,000
Advanced Distributed Mission Training	1999	2003	\$7,000	\$2,000
CF-18 Radar Modernization	1999	2002	\$2,861	\$411
Common Operating Picture 21	1999	2005	\$6,120	\$1,345
Shipboard Integration of Sensor and Weapon Systems	2000	2005	\$6,000	\$750
Command Decision Aids Technology	2000	2003	\$5,600	\$1,974
Future Armoured Vehicle Systems	2000	2005	\$8,000	\$2,542
Tactical High Capacity Communication Links	2000	2004	\$5,600	\$900
Intelligence, Surveillance, Target Acquisition and Reconnaissance	2000	2004	\$6,400	\$932
High Energy Missiles for Light Combat Vehicle	2000	2005	\$4,500	\$1,025
Maritime Air Littoral Operations Definition	2000	2006	\$200	\$200
Hyperspectral Imagery for Improved Airborne ISR	2000	2005	\$5,900	\$1,000
Rapidly Deployable Underwater Acoustic Surveillance System	2000	2005	\$7,500	\$408
Networked Underwater Warfare	2001	2006	\$6,200	\$160
Coalition Aerial Surveillance and Reconnaissance	2001	2005	\$950	\$489
CB Combat Duty Uniform	2001	2005	\$5,900	\$200
Aerosol Inhalors for Field Prophylaxis and Therapy	2001	2005	\$4,000	\$200
Total				\$39,600

Table 3 Technology Investment Fund Projects

PROJECT NAME	START	END	TOTAL (\$K)	01/02 (\$K)
FOREX - Valcartier (Ultradispersed Particles)	1998	2001	\$850	\$173
Detection of Malicious Codes in COTS Software	1998	2002	\$520	\$60
Mobile Communications EW Countermeasures	1998	2004	\$900	\$198
DNA Immunization to BW Agents	1998	2001	\$1,000	\$350
Rapid Production of Genetic Engineered Human Antibodies for Immunotherapy and Diagnostics	1998	2001	\$920	\$345
JMCIS-Based Sonar Information Management	1999	2002	\$810	\$182
Self-Organized, Goal-Driven, Adaptive Learning	1999	2002	\$560	\$220
Mid-Infrared Active Imaging MAWS/Dazzler	1999	2002	\$690	\$260
Space-Time Adaptive Processing: Algorithm Design and Implementation for Airborne Radars	1999	2002	\$450	\$100
Helmet Mounted Fused IR/II for Enhanced Night Vision	1999	2002	\$875	\$395
An Intelligent Recognition System For Sensor Surveillance	1999	2002	\$280	\$100
Stand-Off Biodetection	1999	2002	\$725	\$145
Ocean Environmental Conditions by Remote Sensing	2000	2003	\$680	\$270
Small Cross Section Imagers	2000	2003	\$660	\$230
Super-Compressed Detonation	2000	2003	\$1,000	\$300
Hydrogen Storage in Carbon Nanotubes	2000	2003	\$955	\$350
Electromagnetic Radiation Munitions (Valcartier)	2000	2003	\$489	\$22
Electromagnetic Radiation Munitions (Ottawa)	2000	2003	\$511	\$25
Remote Detection of Radiological Threats	2000	2002	\$800	\$400
Ultrasonic Sensing and Imaging Technology Applied to Field Medicine Diagnostics	2000	2003	\$950	\$420
Drug Design of Peptide Mimetics	2000	2003	\$760	\$255
Nanotechnology Platform for Genetic Analysis of Biological Agents	2000	2003	\$1,000	\$380
Synthetic Target Signature Generation for Non-cooperative Target Recognition	2001	2004	\$750	\$270
Adaptive Learning Techniques for Future Radar and Communications ESM	2001	2004	\$750	\$250
Fabrication of Organic Radar Absorbing Material	2001	2004	\$750	\$250
Active Identification System for Unresolved Airborne Targets	2001	2004	\$750	\$270
Modeling Single Crystal Superalloy Properties from First Principles	2001	2004	\$300	\$100
Miniaturization of EHF T/R Modules for Phased Arrays	2001	2003	\$350	\$175
Bi-static Space-Time Adaptive Processing (STAP) For SBR	2001	2002	\$125	\$125
Polarimetric Insar	2001	2002	\$175	\$175
Implications of Nanotechnologies on Military Systems	2001	2002	\$145	\$145
Display Techniques for Improving Battlespace Visualization	2001	2004	\$750	\$430
Molecular Target Identification for Novel Antimicrobial Development	2001	2004	\$950	\$280
Nanostructured Metal-Organic Polymers for CB Protective Barriers	2001	2004	\$564	\$188
Total				\$7,838

Table 4 Defence Industrial Research Projects

PROJECT NAME	START	END	TOTAL (\$K)	01/02 (\$K)
Development of Advanced Navier-Stokes Methods for Vortical and Separated Flows	1999	2003	\$500	\$146
Proof-of-Concept for a Hand-Held Real Time Biodetector and Sampler	1999	2001	\$500	\$23
Integrated Ship Defence Simulation Research and Development	1999	2002	\$354	\$59
Development of a Prototype Alternating Current Potential Difference System	1999	2003	\$363	\$133
Hemoglobin-Starch Conjugates for Blood Volume Replacement and Oxygen Delivery	2000	2003	\$500	\$194
Energetic Materials Technology for Large Calibre Ammunition	2000	2003	\$459	\$102
Display Assessment and Enabling Technology Research for new Military Displays	2000	2003	\$493	\$156
In-situ Coating of Plasma Synthesized Ultra-Fine Nanosized Metallic Powders	2000	2003	\$357	\$70
Development of Advanced Ceramic Armour System for Personal Protection	2001	2003	\$500	\$139
Multi-Platform Data Fusion between Halifax Class Frigate and an Airborne Collaborating Platform	2001	2003	\$500	\$214
Improved Oil Debris Monitor	2001	2004	\$266	\$170
Single-Chip MEMS Switch Networks	2001	2004	\$500	\$216
Satellite Monitoring through Model Based Vision	2001	2002	\$302	\$16
Immune Modulator Strategy, Phase III	2001	2003	\$496	\$215
Bio-Alloy Smart Materials for Biosensing: Detection and Identification of Chemical and Biological Warfare Agents (Phase II)	2001	2003	\$500	\$196
Improved Tactical Rocket Motor	2001	2003	\$500	\$223
Research Study for an Electronic Fuzes Remote Setting System on Chambered Ammunition	2001	2002	\$500	\$80
S/W Reconfigurable Omni-Band Radio	2001	2003	\$500	\$263
Processing of Biased PZT Material for Use in High-Power Sonar Transducers and High-Strain Actuators	2002	2004	\$500	\$265
Tri-Dimensional Automatic Target Recognition	2002	2004	\$325	\$206
EO Remote Sensing Software	2002	2003		\$159
Algorithms for HS Target Detection	2002	2003		\$245
Integrated IPME/SAFEWORK Graphical Human Task Environment	2002	2004	\$474	\$237
Advanced Underwater Energy System	2002	2004	\$343	\$283
Case Based Reasoning on Aircraft Technician Fault Diagnostic Learning and Learning Retention	2002	2005	\$472	\$275
Total				\$4,285

Table 5 Patents and Reports of Invention

Patents Granted	<ul style="list-style-type: none"> ■ A landmine detector with a high-power microwave illuminator and an infrared detector ■ Acoustic gel ■ Articulated robotic scanner for mine detection ■ Automated monitoring of digital communication channel conditions ■ Emergency exit system ■ Flame retardant foam material ■ Folded shell projector ■ Force generation device for simulation of shoulder-supported rocket launch ■ Fourier-transform spectrometer configuration optimized for self emission suppression ■ Glycidyl azide polymer copolyurethane thermoplastic elastomers ■ High-speed pulse pile-up rejection ■ In-service detection of corrosion in multi-layer structure using the lift-off point of intersection ■ Metal oximate/polyethylene glycols decontaminant system ■ Method of detecting a pathogen using a virus ■ Method of tracking organ motion & removing motion artifacts for computed tomography ■ Multifunction receiver architecture for simultaneous intrapulse analysis ■ Nozzles for pyrophoric infrared decoy flares ■ Optical tracker and dynamic pointing ■ The use of bacterial components to improve liposomal delivery of antibiotics ■ Wavelength-agile receiver with noise neutralization & angular localization capability 	
Patent Applications	27	<i>(disclosure regulations prevent us from listing our patent applications)</i>
Reports of Invention	33	<i>(disclosure regulations prevent us from listing our reports of invention)</i>

Table 6 Major International Agreements

The Technical Cooperation Program	<ul style="list-style-type: none"> ■ Aerospace Systems ■ Command, Control, Communications and Information Systems ■ Chemical, Biological, and Radiological Defence ■ Electronic Warfare Systems ■ Human Resources and Performance ■ Joint Systems and Analysis ■ Maritime Systems ■ Materials and Processing Technology ■ Sensors ■ Conventional Weapons Technology
North Atlantic Treaty Organization (NATO)	<ul style="list-style-type: none"> ■ NATO Underwater Diving Working Group ■ NATO Handheld Operator's Working Group
NATO Research and Technology Organization	<ul style="list-style-type: none"> ■ Applied Vehicle Technology ■ Human Factors & Medicine ■ Information Systems Technology ■ NATO Modeling and Simulation Group ■ Studies Analysis & Simulation ■ Systems Concepts & Integration ■ Sensors & Electronics Technology
Bilateral Agreements with the United States	<ul style="list-style-type: none"> ■ Master Data Exchange Arrangement ■ Technology Research and Development Projects ■ Exchange of Defence Personnel ■ North American Technology and Industrial Base Activities ■ Canada – US Test and Evaluation Program
Trilateral Agreements with the United States and the United Kingdom	<ul style="list-style-type: none"> ■ Chemical, Biological and Radiological Memorandum of Understanding ■ Trilateral Technology Research and Development Projects
Other International Partners	<ul style="list-style-type: none"> ■ Australia ■ France ■ Netherlands ■ Sweden

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