



Defence R&D  
Canada

R & D pour la défense  
Canada



Scientific Excellence for  
Canada's Defence  
**Annual Report**  
**2000-2001**

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Canada

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# Message from the CEO

Welcome to the third Annual Report of Defence R&D Canada. This report, our first as a Special Operating Agency, highlights the delivery of our services to our clients in the Canadian Forces and the Department of National Defence for the fiscal year 2000-01. It also shows how well we have performed relative to the targets set out in our business plan.

As an agency, we have gained new opportunities that are improving our ability to respond to the immediate and future needs of our clients. New business processes and innovative approaches to management of science and technology are helping us to create centres of excellence in niche areas of defence research and development. We are continuing to evolve our new structure to enhance our core competencies, develop new technologies, enter into diverse partnerships, and increase the efficiencies of our operations. All of these improvements will help us achieve our goal of improved service delivery to our clients.

The success of a research and development organization depends fundamentally on the competence, dedication and diligence of its people. I commend the staff of Defence R&D Canada for their excellent performance during the past year.

I also extend my sincere appreciation to our clients for their active involvement in guiding our programs. We have set ambitious targets for the first five years of our new agency, including aligning our programs with the Defence vision articulated in *Shaping the Future of Canadian Defence: Strategy 2020* and increasing our capacity and productivity. We are taking the initiatives needed to meet these targets, and we are confident that we will achieve our goals.

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

## Our Vision

As Canada's lead defence science and technology organization, our vision is to provide science and technology leadership to the Department of National Defence, the Canadian Forces, and Canadian industry.

## Our Mission

Our mission, which is articulated in *Looking Forward Staying Ahead... as a New Agency, Defence R&D Canada 2000* and which supports the vision of the Department of National Defence as stated in *Shaping the Future of Canadian Defence: Strategy 2020*, is to:

- Facilitate and enhance the ability of decision-makers in the Department of National Defence and the Canadian Forces to make informed decisions on defence policy, force generation, and procurement by providing expert knowledge in science and technology.
- Contribute to the success of military operations by pursuing research and development activities that provide improved support, knowledge, protection, and response to potential threats.
- Enhance the preparedness of the Canadian Forces by assessing technology trends, threats and opportunities, and by exploiting emerging technologies.
- Contribute to the creation and maintenance of a Canadian defence industrial capability that is internationally competitive by contracting-out to industry, by transferring technology to industry, and by entering into partnerships in which cost and risk are shared.
- Conduct projects in science and technology for clients that are external to the Department of National Defence to assist us in developing and maintaining our defence-related technological capabilities.

## Our Values

Our values are articulated in *Looking Forward Staying Ahead... as a new Agency, Defence R&D Canada 2000*. Our primary focus is our clients in the Department of National Defence and the Canadian Forces, for whom we are committed to delivering excellent research and development in support of current and future needs. The following principles and values are reflected in all aspects of our operations:

- Scientific excellence, creativity, innovation and quality are the foundation values of our culture. We are committed to maintaining these attributes as we serve as leaders in defence, national, and international science and technology communities.
- As members of the defence team, we are committed to providing our clients with responsive, relevant, and cost efficient products and services.
- We are committed to building a scientific centre of excellence with an atmosphere of trust and respect, accountability, teamwork, and strong leadership.
- We are committed to the well being of our employees, building their skills and expertise, recognizing and rewarding their contributions, and to building a workforce dedicated to excellence.



**Agency  
Overview**

# 1 Agency Overview

Defence Research and Development (R&D) Canada plays an important role in the defence of Canada by supporting its military forces with cutting-edge technologies and by providing information on the threats they face. The importance of this role is borne out by *Defence Planning Guidance 2000*, which states that technology will play an increasingly important role in equipping, organizing and training armed forces.

Our primary focus is our client base in the Canadian Forces (CF) and the Department of National Defence (DND). To improve the economy, efficiency and effectiveness of conducting our activities, Defence R&D Canada became a Special Operating Agency in fiscal year 2000-01. As an agency, we fulfil our role through four business lines:

## ■ BUSINESS LINE 1 – R&D for the Canadian Forces and DND:

We conduct research and development activities for our clients in the Canadian Forces and the Department of National Defence.

## ■ BUSINESS LINE 2 – Strategic S&T Policy and Advice to the Canadian Forces and DND:

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.

## ■ BUSINESS LINE 3 – S&T 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.

## ■ BUSINESS LINE 4 – Corporate Management:

We manage our corporate affairs in areas that include human resources, communications, knowledge and information management, infrastructure, and business planning.

Defence R&D Canada consists of a headquarters in Ottawa and five Defence Research Establishments:

- Defence Research Establishment Atlantic (DREA), in Halifax;
- Defence Research Establishment Valcartier (DREV), near Quebec City;
- Defence Research Establishment Ottawa (DREO), in Ottawa;
- Defence and Civil Institute of Environmental Medicine (DCIEM), in Toronto;
- Defence Research Establishment Suffield (DRES), near Medicine Hat.

The scientific capabilities of the research establishments are listed on page 54.

Our research and development program – Business Line 1 – is structured along five environmental client groups: Maritime, Land, Air, Command and Control Information Systems (CCIS), and Human Performance (HP). A comprehensive client consultation process maintains a close working relationship with all aspects of the Canadian Forces and the Department of National Defence.



**Highlights of Service Delivery  
to the Canadian Forces**

## 2 Highlights of Service Delivery to the Canadian Forces

The majority of our resources are directed towards delivering research and development services to support the requirements of the Canadian Forces. This chapter highlights our service delivery to the Canadian Forces for fiscal year 2000-01.

### Navy

#### Mine-Detection Modifications for Active Sonar

We have developed new transmission modes and algorithms for the AN/SQS-510 sonar to provide improved mine detection capability and to reduce the operator load. The improved capabilities remove the effects of changing geometry due to ship motion and help the operator look for small stationary targets.

#### Ship Signature Assessment

We continue to provide the navy with assessments of mine vulnerability for warships going to sea for strategic operations. These assessments use the Total Mine Simulation System with data gathered on our degaussing ranges.

#### Single-Pass MAD Localization

In collaboration with CAE Ltd., we have developed a new tactic for Magnetic Anomaly Detection (MAD) that can locate a target within about one hundred metres. This is a considerable improvement over traditional techniques. The feasibility of the new tactic, which requires the aircraft to follow a curved trajectory over the target area, has been demonstrated in trials with a small surface target and a submarine.

*A new tactic for Magnetic Anomaly Detection (MAD) can locate a target within about one hundred metres.*

#### Sensor Fusion Testbed

A key element in managing information on naval platforms is the ability to fuse data from multiple sources to exploit the unique combinations of information that may be available. An effective way to evaluate data fusion techniques is through a computer-based simulation such as the Concept Analysis and Simulation Environment for Automatic Target Tracking and Identification (CASE\_ATTII). CASE\_ATTII is a high-fidelity simulation that emulates the behaviour of real targets, sensor systems, and the meteorological environment in an Anti-Air Warfare (AAW) context.

#### Prediction of Low-Frequency Target Strength

We have adapted the AVAST software, a mixed finite element/boundary element program, to predict the target strength associated with low-frequency active sonar systems. This capability has been validated and has been used to predict the target strength of a typical diesel electric submarine.

#### Analysis and Resolution of Bridge Window Failures

The bridge windows of the navy's frigates have been subject to repeated failures that generally result in spontaneous cracking and shattering. More serious failures can produce arcing and sparking, and can be a danger for the bridge crew. Our scientists examined the history of these failures and were able to determine the failure mechanisms and damage thresholds. Remedial action has been initiated to correct the problem.



## Army

### **Advanced Land Fire Control System**

The Advanced Land Fire Control System improves anti-armour direct fire engagements. An integrated architecture and a well-designed operator interface improve the ease, speed, and accuracy with which the crew can fire the main armament. Technology from the project may be applied to future armoured vehicles or to the mid-life upgrade of in-service vehicles.

### **Evaluation of Handheld Mine Detectors**

In conjunction with foreign participants in the International Pilot Project for Technical Cooperation, we have evaluated a number of different mine detectors to support the plan to replace the current Schiebel AN19/2 Mine Detectors with an interim fleet of commercially available metal detectors.

### **Electronic Battle Box**

The architecture for version three of the Electronic Battle Box was successfully tested for compatibility with the army's Tactical Command Control and Communications System. This validates a major element of the Electronic Battle Box project and places it one step closer to implementation and fielding. When fielded, the Electronic Battle Box V3 will provide the army with an integrated planning tool set to allow collaborative planning.

### **Protection against Anti-Vehicular Blast Landmines**

We conducted experimental and simulation studies on the vulnerability of the light armoured vehicle (LAV-III) when subjected to anti-vehicular blast landmines. The studies addressed personnel vulnerability, injury mechanisms to the occupants, and the development of simulation models to address local deformation and motion.

We also performed structural and dynamics analysis of the GM Brute design concept when subjected to a mine strike under a wheel.

### **New Rucksacks**

In collaboration with Queens University, Humansystems Inc, and Ostrom Outdoors, we conceived a new military rucksack that is far superior to the previous design. A group of field soldiers assisted the design team in determining the strengths and limitations of a number of commercial and foreign military rucksacks. The team has tried to reduce pressures on the skin, which can cause damage to underlying tissues. Production of the new rucksack is slated to be under way by 2003.

### **Environmental Characterization of CFB Shilo**

Following the closure of the German Army Training Establishment Shilo at Canadian Forces Base Shilo, we conducted an environmental characterization of the site to assess the potential contamination related to explosives and heavy metals. Since the site is located on a major regional aquifer, it was critical to ensure that no contamination had migrated off the range.

### **Energetic Polymer Explosives**

We are developing a new family of explosives with our own recently invented energetic polymer. The new materials should reduce the vulnerability of munitions to external threats, such as a fire in a magazine or a bullet attack, while maintaining adequate performance.



*New Army Rucksack*



*High Energy Missile Concept*

### **High Energy Missile Preliminary Concept**

We have completed the initial concept definition for a new high-energy missile. The definition involved studying the components, identifying the technical challenges, evaluating the technical risks, and determining the in-house and industrial capabilities essential for the success of the project.

### **Evaluation of Rocket Motors Using Computer Tomography**

We have demonstrated a non-destructive method to detect defects in solid rocket motors using ultrasonic signals. The technique holds the promise of determining the suitability for service of rocket motors without having to resort to destructive sampling and testing.

## **Airforce**

### **Advanced IR Decoy Flare**

Under our leadership, Bristol Aerospace completed the development of two variants of an advanced infrared (IR) decoy flare based on liquid pyrophoric technology. The new flares are designed to protect the CC-130 Hercules and

CF-18 Hornet aircraft from modern IR-seeking missiles. In addition, we have successfully tested prototypes of a flare that is suitable to protect the CH-146 Griffon helicopter.

### **Safety of Helicopter Deck Landings on CF Frigates**

As part of our research and development program, the National Research Council of Canada's Institute of Aerospace Research completed a study to examine the safety of helicopter deck landings on the navy's frigates. The work defined standardized manoeuvres that quantify the types of handling manoeuvres a helicopter must be able to perform to land on a heaving deck in a wind. These criteria and the associated experimental facility provide a means of assessing the suitability of candidate ship-borne helicopters for deployment at sea.



*Pyrophoric IR decoy flares for the CC-130 and CF-18*

### **Future Short-Range Air-to-Air Missiles**

We provided technical assistance regarding future short-range air-to-air missiles to support participation in the IRIS-T development program with Europe. We led a three-year examination of the performance of contender missiles for the CF-18 short-range requirement. The analysis produced envelopes of maximum and minimum range of each contender missile based upon detailed derived knowledge of the motor, seeker, and airframe. We are now assisting the airforce to analyse other combat scenarios for this kind of weapon system.

### **Aerodynamics Characteristics of Bombs**

We have completed a series of experimental flights of models of the conventional bombs used with the CF-18 to determine their aerodynamics characteristics. The Software Engineering Support Centre is now using these results to modify the ballistic integrator algorithms.

### **Ground-Based Seeker Test Facility**

We have developed the HARFANG ground-based seeker test facility in response to a national deficiency to measure vulnerability of air assets to infrared threats. The HARFANG facility is equipped

to perform ground-to-air or ground-to-surface effectiveness measurements of infrared countermeasures.



*HARFANG test facility*

## **Joint**

### **Canadian Integrated Biochemical Agent Detection System**

The Canadian Integrated Biochemical Agent Detection System (CIBADS) project was completed with the delivery of two Chemical/ Biological (CB) Sentry technology demonstrators. CIBADS is intended as a point detection system. It is the first completely integrated autonomous system that can automatically detect and identify chemical or biological agent threats. CB Sentry is now being marketed internationally by Computing Devices of Canada under the name 4-Warn.

### **Lightweight Chemical/ Biological Operational Suit**

We have developed a lightweight Chemical/ Biological (CB) Operational Suit that reduces the heat load associated with the older CB combat uniform. The new one-piece suit was developed using high-performance lightweight carbon barriers and an outer shell that repels liquids; it offers soldiers functional fit and improved operational performance.

### **Hydrogel-Based Wound Dressing**

We have completed the development of a novel hydrogel-based wound dressing. Tests have demonstrated the efficacy of the medicated dressing in providing a sustained drug-delivery effect, a non-adhesive feature to facilitate dressing removal, and a moist and cool environment to promote healing.



*CB Sentry*

### Advanced Radiation Detectors

The Canadian Forces have deployed several of our spectroscopic and dosimetric systems in-theatre to detect and identify radiological hazards. The *Virtual Expertise Nuclear (VEN)* system allows technicians in the field to send pictures, energy spectra and voice in near real-time to our staff who can provide advice on potential hazards. The VEN system was deployed



*Virtual Expertise Nuclear (VEN) in Bosnia*

by the Canadian Forces in Eritrea and in Bosnia, and was also used by the Netherlands to re-survey some areas that had anomalous high radiation readings.

### Light Weight Surface-Supplied Diving System

Until recently, the ability to conduct surface-supplied diving operations away from a surface support vessel was very rudimentary and was

insufficient for CF requirements. We have developed a small lightweight air supply panel with the ability to supply two divers with breathing air for use in diving operations where space limits the diver wearing diving cylinders or for missions with extended bottom times. A number of panels have been manufactured and distributed for testing, team training, and implementation by designated diving teams.

*The Virtual Expertise Nuclear (VEN) system allows technicians in the field to send pictures, energy spectra and voice in near real-time.*

### Medical Countermeasures

We have made a number of advances in medical countermeasures including the discovery of new antiviral compounds and the successful synthesis of a next generation DNA-based vaccine. An animal model of Chemical Casualty Management, developed as a research and a training tool, has provided unique information to improve both surgical and medical management of individuals exposed to nerve or blister agents.

### Chemical and Biological Hazards

We have responded to the increasing focus of the Canadian Forces on Force Health Protection, on the operational and health effects of Toxic Industrial Materials (TIMs), and on endemic diseases. We have identified a portable mass-spectrometer that has been adopted by CF units tasked to assess TIM hazards in contingency operations, and we have established a research effort in malaria and tuberculosis, two endemic diseases identified as serious threats to the CF.

### **Entrust Public Key Infrastructure in NATO**

Our *Entrust* Public Key Infrastructure (PKI) supports a wide variety of clients, including international partners and the entire TTCP community. We have been instrumental in arranging a trial of the *Entrust* PKI in NATO. *Entrust* will provide the software and technical support for the trial and NATO will provide the certificate authority. Most NATO nations will participate in the trial, which will allow them to become familiar with the operation of a full-featured PKI.

### **RADARSAT-2 Ground Moving Target Indication**

We have contributed to the design and construction of the RADARSAT-2 satellite payload to ensure that it has the capability to transmit and receive in the RADARSAT-2 Ground Moving Target Indication (GMTI) mode. An airborne GMTI experiment showed that the radar could detect moving targets on the ground and that our signal processing algorithms were able to differentiate the targets from the clutter. A simulation has shown that the experimental airborne results can be extrapolated to the higher velocities and geometries of the space-based platform.



*RADARSAT-2  
(Image from the Canadian Space Agency.)*

### **Asynchronous Transfer Mode to Wireless**

We have designed and tested a system to support the extension of military voice from the fixed Asynchronous Transfer Mode (ATM) networks into the wireless environment. The successful transport of ATM over wireless links has been achieved through analysis and simulation studies and testbed experiments conducted in collaboration with the Communications Research Centre.



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## 3 National Collaborations

Defence R&D Canada collaborates with other Canadian organizations – including other government departments, defence industries, and the universities – to enhance our support to the Canadian Forces and the Department of National Defence. This chapter highlights our national collaborations for fiscal year 2000-01.

### Intergovernmental Alliances

#### DRDC – NRC Strategic Alliance

Defence R&D Canada and the National Research Council have joined in a strategic alliance to promote increased collaborative research and development between the two organizations. This will result in an enhanced knowledge base and increased research and development capabilities accessible to Canadian private sector partners, with whom the agreement encourages collaboration. A major benefit of the agreement will be to help avoid duplication and reduce overall research costs, by building on the existing strengths and unique facilities of the organizations, and by using innovative approaches. Three technology areas have been identified as potential candidates for collaboration: vehicle technology, information technology, and biological sciences.

#### DRDC – CIHR Agreement to Fund Health Research

Defence R&D Canada and the Canadian Institutes of Health Research signed an agreement to jointly support up to two Postdoctoral Fellowship Awards and two New Investigator Awards annually. The awards are part of the Health Research Partnership Fund. The partnership will fund health-related research into areas such as casualty management and diagnostics, toxicology and pharmacology, and the prevention and treatment of diseases. Collaboration between Defence R&D Canada and CIHR will increase the medical and health sciences expertise in Canada. This will benefit national defence interests and contribute to Canada's knowledge-based economy.

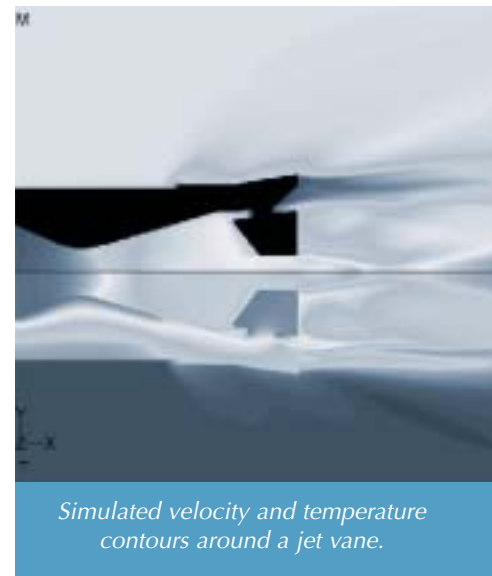
### Collaborations with Industry and Universities

#### Uncooled Sensor Imagers

In collaboration with the National Optics Institute, we used micro-electric mechanical systems and advanced sensor technologies to produce an uncooled infrared camera with no moving parts. This makes the camera a low cost, lightweight, silent and rugged handheld device that can see through dust, fog, smoke, and battlefield obscurants 24 hours a day.

#### Jet Vane Thrust Vector Control

The Jet Vane Thrust Vector Control project is a collaboration with the Natural Sciences and Engineering Research Council (NSERC), Honeywell, and Laval University. The project addresses the electro-mechanical control feedback for the use of jet vanes in nozzle rocket flow. Data from this project are being used to validate erosion models for applications in computational fluid dynamics.



*Simulated velocity and temperature contours around a jet vane.*

*Monitoring the presence of marine mammals prior to the use of low-frequency active sonar systems could help minimize the exposure of the animals to acoustical hazards.*

#### **BeamLink**

As part of a co-operative venture with COM DEV International Ltd., an advanced development model of a Military BeamLink has been successfully tested at the US Army Communication and Electronics Command. The use of similar technology in commercial satellites has demonstrated increases in capacity of up to thirty per cent.

#### **Common User Interface for Sonar Models**

We collaborated with Computing Devices Canada to consolidate a variety of active and passive sonar models under a common user interface. Both Computing Devices Canada and Defence R&D Canada are interested in having a comprehensive but easy to use suite of acoustic models available for sonar development and performance evaluation.

#### **Acoustic Methods to Locate and Identify Marine Mammals**

We collaborated with Dalhousie University on using acoustic methods to locate and identify marine mammals. If successful, the methods could provide a simple and cost-effective means of monitoring for the presence of marine mammals prior to the use of low-frequency active sonar systems and could help minimize the exposure of the animals to acoustical hazards.



*Right whale in the Bay of Fundy, from CFAV QUEST  
(Photo courtesy of Dalhousie University)*



A blue-tinted image of Earth from space, showing the Western Hemisphere with North and South America visible. The Earth is centered in the frame, surrounded by a field of stars of varying brightness against a dark background.

**ations**

## 4 International Collaborations

Defence R&D Canada collaborates with other nations in a diverse mixture of multi-lateral and bilateral arrangements to provide the Canadian Forces and the Department of National Defence with global access to advanced defence technology, information, and expertise, and to facilitate interoperability with Canada's allies. The two most important areas of international collaboration 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 2000-01.

### The Technical Cooperation Program

#### Global Hawk

We participated in multinational trials of the USAF Global Hawk High Altitude Endurance (HAE) Unmanned Aerial Vehicle (UAV). The involvement of a broad spectrum of departmental staff sensitized the Canadian Forces to the practicality and importance of high altitude, long endurance UAV technology to Canada. The Joint Unmanned Surveillance and Target Acquisition System (JUSTAS) Project is a direct spin-off from this initiative and is serving as a pilot for joint experimentation in the new Canadian Forces Experimentation Centre.

#### Chemical/Biological Hazard Assessment Modelling System

We are currently developing the Chemical/Biological Hazard Assessment Modelling System in collaboration with the United States, the

United Kingdom and Australia. It is designed to integrate warning, reporting, and modelling information to provide a knowledge-based system that can be used by the field commander.

#### Multi-Sensor Trial (MUST) 2000

We participated with other TTCP members in the MUST 2000 Trials in Australia. The objectives of the trials were to collect and analyze data to assess the military utility – in a tropical climate – of multi-sensor systems for the detection and identification of ground targets employing deep-hide techniques.

#### Coalition CINC 21

We are participating in a collaborative program – entitled Coalition CINC 21 – with the United States, the United Kingdom and Australia. The program will focus on novel technologies and architectures in support of coalition operations.

#### GeoGateway Technologies and ToMaDi

We collaborated with the US National Imagery and Mapping Agency (NIMA) and Defence Geomatics in experiments to demonstrate the use of web-based geospatial services. Our ToMaDi display was deployed at NIMA and was used to display large digital maps.



Defence R&D Canada at MUST 2000

*Defence R&D Canada collaborates with other nations to provide the Canadian Forces and the Department of National Defence with global access to advanced defence technology, information, and expertise.*



*The ToMaDi Mk II Display*

## NATO

### **NATO Standard for High-Rate HF Communications**

The NATO High-Frequency (HF) Communications Working Group has selected a waveform developed by the Communication Research Centre as the new standard for HF data communications. This technology is a key element in planned Canadian and allied naval networking activities.

### **Space-Based Sensing of the Ocean Acoustic Environment**

We collaborated with Royal Military College, the Bedford Institute of Oceanography, Dalhousie University, and NATO SACLANTCEN in exploiting space-based sensing of the ocean acoustic environment. This project is investigating the use of space-based imagery of sea surface features and oceanographic models to determine inputs of relevance to acoustic models. The techniques will greatly enhance the density and speed with which environmental measurements can be made in new areas.

### **Human Performance Problems Correlated to Ship Motions**

We developed the NATO Performance Assessment Questionnaire to examine the effects of ship motions on fatigue, motion sickness and naval task performance. The resulting database will help to establish priorities for future research, and enables the development of new modelling and simulation tools.

## **Other International Collaborations**

### **Seismic-Acoustic Waves in Soft Marine Sediments**

We collaborated with the National Oceanic and Atmospheric Administration's Environmental Technology Laboratory on a combined experimental and theoretical investigation of seismic-acoustic wave phenomena in soft marine sediments.

### **Missile Performance Computer Model**

We collaborated with the Netherlands to develop a new missile-performance computer model, capable of modelling ramjet and solid rocket powered missiles.

### **Fusion Algorithms and Concepts Exploration Testbed**

The Fusion Algorithms and Concepts Exploration Testbed (FACET) is a collaborative effort with the TNO Physics and Electronics Laboratory (TNO-FEL) in the Netherlands for analyzing multi-source data fusion systems. By joining their efforts, Canada and the Netherlands are mutually increasing their potential for exploring a wider range of design philosophies as well as giving each other the opportunity to benefit from previous experiences and lessons learned.

### **Sleep Deprivation**

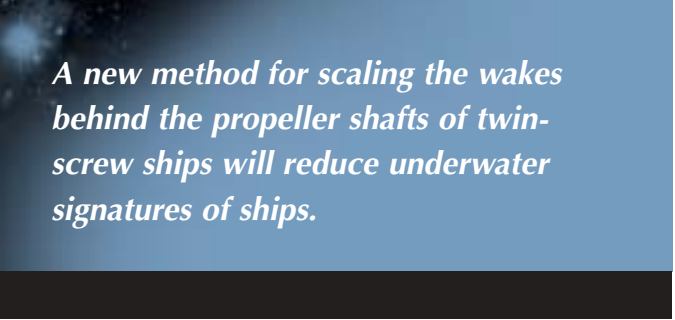
In collaboration with France, we conducted a comprehensive series of studies to examine the potential effect of the drug *modafinil* on cognitive performance, thermoregulation, and immunomodulation during 40 hours of sleep deprivation. This drug has been used by Canada's allies to promote alertness during sustained operations and was recently approved by Health Canada for use in Canada.

### **Cooperative Research Ships**

As a participant in the Cooperative Research Ships project on propeller inflow prediction, we developed a new method for scaling the wakes behind the propeller shafts of twin-screw ships. This method, which has been validated against experimental data provided by the French Navy, will allow for reduced underwater signatures of ships.

### **International Chemical/Biological Counter-Terrorism Preparedness**

We have assumed an increasingly important role in international chemical/biological counter-terrorism preparedness in Canada by providing access to specialized training and test facilities, including live agent training for national and international first responders.



*A new method for scaling the wakes behind the propeller shafts of twin-screw ships will reduce underwater signatures of ships.*

### **Vaccine Development**

Under the terms of the new memorandum of understanding on Chemical, Biological and Radiological Defence, signed with the UK and the US, we are negotiating Project Arrangements that will result in the shared development of vaccines required by the Canadian Forces.



## Performance Review

## 5 Performance Review

Each year, the Chief Executive Officer of Defence R&D Canada is required to submit to the Deputy Minister of National Defence and the Chief of the Defence Staff a business plan that states our objectives for the next fiscal year. The business plan for fiscal year 2000-01 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 the Business Plan for fiscal year 2000-01. The review addresses each business line separately.

### BUSINESS LINE 1: R&D for the Canadian Forces and DND

*Research and Development for the Canadian Forces and DND* is our first business line. The majority of our resources are directed to this business line, which is where most of the research and development activities take place. These activities are defined annually by service level agreements with each of five client groups. Elements of this business line comprise research and development projects that are funded from various sources, including funds from the client groups, and various special programs including the Technology Demonstration Program, the Technology Investment Fund, the Defence Industrial Research Program, the DND/ NSERC Research Program, and the Defence Communications Program.

*The Technology Investment Strategy (TIS) articulates 21 research and development areas aligned with the National Defence vision.*

### Performance on Key Defence Objectives

This section reviews our performance against the Key Defence Objectives for Business Line 1, Research and Development for the Canadian Forces and DND, as stated in our business plan for fiscal year 2000-01.

#### Defence Objective ST01: Defence Research and Development Activities

##### Objective

To undertake twenty-one research and development activities with support from allies and partners in Canadian industry and universities to address CF requirements in 2020 and identify the most promising research and development activities for delivering on the CF's future technology needs.



*We have found that wearing a headset over communications earplugs provides an effective low-cost alternative to active noise control systems.*

### Performance

We have developed a Technology Investment Strategy (TIS) to meet the future needs of the Canadian Forces. The TIS articulates twenty-one research and development areas that are aligned with the National Defence vision contained in *Shaping the Future of Canadian Defence: Strategy 2020*. The TIS reflects a Canadian approach to technology improvements that

are inherent in the recent approaches to the Revolution in Military Affairs and the Defence Capabilities Initiatives.

The research and development areas in the TIS are listed in the table below. For each area, the table gives an estimate of the percentage of the work that is in aligned with the goals of the TIS.

Research and Development Areas in the Technology Investment Strategy	
Research and Development Area	Percent Aligned
Autonomous Intelligent Systems	50%
Chemical/Biological/Radiological Threat Assessment and Detection	70%
Command Control Information Systems Performance and Experimentation	30%
Command Effectiveness and Behaviour	30%
Communications	60%
Electro-Optic Warfare	100%
Emerging Materials and Biotechnology	50%
Human Factors and Decision Support Systems	60%
Information and Knowledge Management	85%
Multi-Environment Life Support Technologies	90%
Network Information Operations	40%
Operational Medicine	65%
Platform Performance and Life Cycle Management	80%
Precision Weapons	90%
Radio-Frequency Electronic Warfare	50%
Sensing (Air and Surface)	50%
Signature Management	50%
Simulation and Modelling for Acquisition, Rehearsal and Training	50%
Space Systems	30%
Underwater Sensing and Countermeasures	70%
Weapons Effects	50%

**Defence Objective ST02: Technology Demonstration Program**

*Objective*

To initiate approximately five Technology Demonstration projects per year.

*Performance*

The objective of the Technology Demonstration Program is to demonstrate technologies fostered by Defence R&D Canada and Canadian Industry

in the context of real and potential future CF capabilities, concepts, doctrine, operations and equipment.

We initiated eight new Technology Demonstration projects in fiscal year 2000-01. These projects are listed in the following table, sorted according to client group. A complete list of Technology Demonstration projects is given on page 55.

New Technology Demonstration Projects for 2000-01		
Client Group	Technology Demonstration Project	Budget
Maritime	Shipboard Integration of Sensor and Weapon Systems	\$6.0M
	Command Decision Aids Technology	\$5.6M
Land	Tactical High Capacity Communications Links	\$5.6M
	Intelligence, Surveillance, Target Acquisition and Reconnaissance	\$6.0M
	High Energy Missile for Light Combat Vehicle	\$4.5M
Air	Hyperspectral Imagery for Improved Airborne ISR	\$5.9M
CCIS	Rapidly Deployable Underwater Acoustic Surveillance System	\$7.5M
	Optical Inter-Satellite Links	\$4.8M



### Defence Objective ST03: Technology Investment Fund

#### Objective

To provide funding for forward-looking, high-risk, but potentially high pay-off, research projects.

#### Performance

The Technology Investment Fund (TIF) program supports forward-looking, high-risk, but potentially high-payoff, research projects that are

consistent with the Technology Investment Strategy. The TIF was approved at \$4M in fiscal year 1999-2000 and \$6M in subsequent years.

We funded twenty-six projects through the TIF program in fiscal year 2000-01. The list of all active TIF projects is given on page 57. In addition, we approved eleven new TIF projects to start in fiscal year 2001-02. These projects are listed in the following table, sorted according to client group.

New Technology Investment Fund Projects		
Client Group	Technology Investment Fund Project	Budget
Maritime	Synthetic Target Signature Generation for Non-Co-operative Target Recognition	\$750K
	Adaptive Learning Techniques for Future Radar and Communications ESM	\$750K
	Fabrication of Organic Radar Absorbing Material	\$750K
Air	Active Identification System for Unresolved Airborne Targets	\$750K
	Modelling Single Crystal Superalloy Properties From First Principles	\$300K
CCIS	Space-based Interferometric SAR Development and Exploitation	\$300K
	Space-based Polarimetric SAR Studies	\$725K
	Space Survivability of Electronics and Photonics	\$745K
Human Performance	Display Techniques for Improving Battlespace Visualization	\$750K
	Molecular Target Identification for Novel Antimicrobial Development	\$950K
	Nanostructured Metal-Organic Polymers for CB Protective Barriers	\$564K

## **Defence Objective ST04: Client Group Agreements**

### *Objective*

To provide scientific and technological expertise to Defence R&D Canada's five major client groups through the establishment of Service Level Agreements.



*An eye tracking system records eye movements to help our scientists determine how motion affects visual acuity and object acquisition.*

### *Performance*

We established Service Level Agreements with each of our five client groups – Maritime, Land, Air, Command and Control Information Systems (CCIS) and Human Performance (HP) – as part of the annual business planning cycle. Each Service Level Agreement identified specific objectives and activities to be pursued, and outputs to be produced for each client group.

## **Defence Objective ST05: Expanded Defence Industrial Research Program**

### *Objective*

To further assist small and medium-sized enterprises to exploit emerging technologies in partnership with our science and technology workers.

### *Performance*

We have entered into discussions with other government departments to fund the expansion of the Defence Industrial Research (DIR) program to further assist small and medium-sized

enterprises. In the meanwhile, the DIR program is very active and highly successful. The complete list of DIR projects is given on page 58.

## **Defence Objective ST06: Canada's Response to the Revolution in Military Affairs**

### *Objective*

To review the recommendations from the concept paper *Canadian Defence Beyond 2010: The Way Ahead* to determine their applicability to the future defence needs of DND and the CF.

### *Performance*

We have developed detailed plans to implement the *Technology Investment Strategy* (TIS) to address requirements of the Canadian Forces for 2020. An updated TIS, which will be published in the summer of 2001, will have the detail and refinement to serve as a high-fidelity road map to the future for science and technology in the Department of National Defence. This effort was part of a larger process to refocus our science capacity and to determine which technology areas should be stressed in order to apply this capacity most effectively.

## **Defence Objective ST07: Technology Adopted by Clients**

### *Objective*

To have at least ten initiatives or products developed and adopted for implementation by the Canadian Forces.

### *Performance*

The Canadian Forces have adopted for implementation a number of our initiatives and products, for example:

- Advanced IR Decoy Flares
- ATM to Wireless
- Canadian Integrated Biochemical Agent Detection System
- CF-18 Radar Simulator (SAFIRE)
- Detection and identification of radiological hazards
- Electronic Battle Box Version 3
- Evaluation of Head Up Display for the Griffon Helicopter Night Vision Goggle
- Ground-Based Seeker Test Facility (HARFANG)
- Integration of *Human Systems Integration* (HSI) process for CF materiel acquisition
- Lightweight Surface-Supplied Diving System
- Mine detection modifications for the AN/SQS-510 active sonar
- New diving tables for mine countermeasures diving using re-breathers
- Recommendations for remedial action to correct manufacturing defects that resulted in repeated failures of bridge windows on the Halifax-class frigates
- Vestibular Influence on G-Tolerance

### **Defence Objective ST08: Solutions to Asymmetric Threats**

#### *Objective*

To be involved in the development of timely, accurate asymmetric threat assessments and effective countermeasures.

#### *Performance*

We are involved in a number of initiatives that could be used effectively to combat asymmetric threats. These initiatives include:

- Secure Management of Access Privileges through Electronic Visas and Fingerprint Recognition;
- Malicious Code Detection in COTS (MaliCOTS) software;
- Canadian Integrated Biochemical Agent Detection System; and
- Modelling, hazard avoidance, and medical countermeasures aspects of Nuclear, Biological, and Chemical Defence.



*The small arms training simulator is used to study the effects of various environmental stressors on marksmanship.*

### **Defence Objective ST09: Concept Development and Experimentation**

#### *Objective*

To participate in the coordination of joint doctrine and joint requirements into joint experimentation in order to maximize the effectiveness of new doctrines and systems.

#### *Performance*

Through our Technical Demonstration project *Common Operating Picture 21 (COP 21)*, we have established a collaboration with the United States, Australia and the United Kingdom to demonstrate advanced technologies for building and using the Common Operational Picture. The project will influence the concepts, doctrine, and capabilities of the future CF Common Operational Picture, and will leverage the allied initiatives through joint experimentation.

## Defence Objective ST10: Enhanced Support to DND and CF Clients

### Objective

To enhance our support to DND and CF clients outside the Service Level Agreements by taking on an active role with our national research and development collaborative organizations.

### Performance

We have entered into new agreements with the National Research Council (NRC) and with the Canadian Institutes of Health Research (CIHR) to enhance our support to our clients in the Canadian Forces and the Department of National Defence outside the Service Level Agreements. More information about these agreements can be found on page 13.

## Defence Objective ST11: Contribution of International Collaborators to Research and Development Program

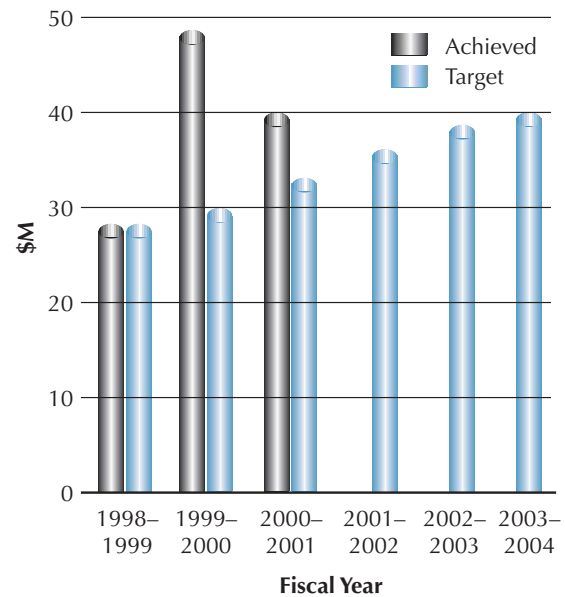
### Objective

To enter into more strategic collaboration with allies. Our strategic goal is to increase internationally leveraged in-kind science and technology to \$40M annually in five years. The goal for 2000-01 was \$32.5M.

### Performance

We collaborate with a number of allied countries, including the United States, the United Kingdom, Australia, New Zealand, France, the Netherlands, Norway, and Sweden. We are very active in The Technical Cooperation Program (TTCP)

## Target and Achieved International Collaboration Leveraging



with the US, the UK, Australia, and New Zealand, and with the NATO Research and Technology Organization (NATO RTO). A list of significant international collaborative partnerships is given on page 62.

The above figure shows our target and achieved international collaboration leveraging for fiscal years from 1998-99 to 2003-04. It is worth noting that we have already met our goal of \$40M in internationally leveraged in-kind science and technology.

### **Performance on Key Change Objectives**

This section reviews our performance against the Key Change Objectives for Business Line 1, Research and Development for the Canadian Forces and the Department of National Defence, as stated in our business plan for fiscal year 2000-01.

#### **Change Objective ST22: Research and Development Program for the Future**

##### *Objective*

To be forward-looking both in forecasting and assessing the future technological landscape.

##### *Performance*

We have established the Technology Investment Strategy (TIS) and the Technology Investment Fund (TIF) to address the research and development program for the future.

We developed the TIS in response to a projected set of new capabilities that the Canadian Forces will need in 2010 and beyond. The TIS will continue to be refined as the future requirements of the Canadian Forces change with time. Our base funding has been augmented to address workforce rejuvenation and personnel shortfalls in support of the TIS. Starting at \$3 million in fiscal year 2001-02, the funding augmentation increases by \$1 million per year to \$6 million for fiscal year 2004-05 and beyond.

We established the TIF to fund forward-looking, high-risk, but potentially high-payoff, research projects that are consistent with the defence technology investment strategy. The funding level is about \$6M each fiscal year. Approximately one-third of the funds is available for new project starts each year. Individual projects typically last less than three years and have a total value less than \$750K.

*The Technology Investment Fund (TIF) funds forward-looking, high-risk, but potentially high-payoff, research projects that are consistent with the defence technology investment strategy.*

#### **Change Objective ST23: Increased International Collaboration**

##### *Objective*

To leverage \$40M of in-kind science and technology from international allies over a five-year period.

##### *Performance*

We are proactive in fostering international collaboration. For example, we held a Technology Showcase in June 2000 at the Canadian Embassy in Washington to increase visibility and understanding of Canadian defence capabilities and to spotlight our Agency and our programs. The showcase also aimed to advance US-Canada collaboration in science and technology, thereby furthering interoperability, coalition operations, and burden sharing.

Our associations with The Technical Cooperation Program (TTCP) and the NATO Research and Technology Organization (RTO) promote co-operative research and information exchanges with Canada's allies that support the development and effective use of national defence research and technology to meet the military needs of Canada and its allies.

Within the Chemical, Biological and Radiological memorandum of understanding, negotiations are continuing to permit us to participate with the Canadian Forces Medical Group in the US Joint Vaccine Acquisition Program to develop three militarily-significant vaccines.

In addition, negotiations are underway on several memoranda of understanding, including:

- Coalition Aerial Surveillance and Reconnaissance (CAESAR),
- A quadripartite arrangement with the Netherlands, Sweden and the UK on countermine and de-mining technologies,
- A trilateral arrangement with the Netherlands and UK for co-operative science and technology;
- A bilateral arrangement with Sweden on co-operative science and technology;
- A memorandum of understanding with the UK and the US on Chemical, Biological, and Radiological Defence.

*Defence R&D Canada played a major role in the creation and staffing of the Canadian Forces Experimentation Centre (CFEC).*

## **Change Objective ST24: Concept Development and Experimentation**

### *Objective*

To work with experts in the development and testing of new concepts.

### *Performance*

We have played a major role in the creation and staffing of the Canadian Forces Experimentation Centre (CFEC), which will be co-located with the Defence Research Establishment Ottawa. CFEC will lead exploration and evaluation of emerging concepts to determine future capabilities required by the Canadian Forces. It will do this systematically, through use of a structured process of concept development and experimentation by a multi-disciplinary team using state-of-the-art technology.

## **BUSINESS LINE 2: Strategic S&T Policy and Advice to the CF and DND**

*Strategic Science and Technology Policy and Advice to the CF and DND* is our second business line. This business line 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, and technology investment strategy.

### **Performance on Key Defence Objectives**

This section reviews our performance against the Key Defence Objectives for Business Line 2, Strategic Science and Technology Policy and Advice to the CF and DND, as stated in our business plan for fiscal year 2000-01.



Networked simulation devices allow researchers to develop joint training scenarios for dismounted combatants.

### **Defence Objective ST12: Advice to Policy Makers**

#### *Objective*

To provide science and technology advice and expertise to DND policy makers.

#### *Performance*

We have worked with other government departments on interdepartmental initiatives to ensure that the best advice possible is provided concerning strategic science and technology policy development and application in the Canadian context. We also provided DND with expert advice concerning a variety of defence initiatives, including the provision of input into the Capabilities Initiative and the development of the Canadian Universal Joint Task List, the Asymmetric Threat study, the Strategic Capability Plan Working Group, and NATO's Defence Capabilities Initiative. We continue to develop and formulate detailed plans to implement the Technology Investment Strategy to address Canadian Forces requirements for 2020.

### **Defence Objective ST13: Advice to Force Development Community**

#### *Objective*

To provide science and technology advice and expertise to the DND force development community.

#### *Performance*

We participated in a trial Joint Capability Assessment Team (JCAT) on Command Control, Information, and Intelligence. The JCAT was intended to develop capability goals, review functional plans, assess gaps and propose remedial options in relation to strategic capability based planning and force development processes. However, the process was very labour intensive and only partially successful. The prime avenues for providing scientific advice to the DND force development community remain the Defence R&D Canada Advisory Board, the client-based overview groups, and case-by-case counsel relating to specific projects.

### **Defence Objective ST14: Advice to Intelligence Community**

#### *Objective*

To provide science and technology advice and expertise to the DND intelligence community.

#### *Performance*

We continue to provide timely and high quality advice and expertise to the DND intelligence community through an activity entitled *Scientific and Technical Intelligence Support and Advice*.

### **Defence Objective ST15: University Partnerships**

#### *Objective*

To expand our technology outreach with Canadian universities and sponsor two more chairs in other technology areas as part of the Technology Outlook Program.

#### *Performance*

We contributed to the Chair in Ocean Mapping at the University of New Brunswick and to the DREA-SATLANTIC Chair at Dalhousie University. In addition, our agreement with the Canadian Institutes of Health Research will jointly support up to two Postdoctoral Fellowship Awards and two New Investigator Awards annually.

#### **Performance on Key Change Objectives**

This section reviews our performance against the Key Change Objectives for Business Line 2, Strategic Science and Technology Policy and Advice to the CF and DND, as stated in our business plan for fiscal year 2000-01.



*Our climatic and physiological monitoring facilities at DCIEM are used to assess the protective capabilities of technical clothing for the Canadian Forces.*

### **Change Objective ST25: Strategic Advice – Defence 2020 Strategy**

#### *Objective*

To focus on strategic defence decision-making that is aligned with Defence 2020 Strategy.

#### *Performance*

We developed detailed plans to implement the Technology Investment Strategy to address requirements for 2020. Work was initiated to map our projects onto the Department's new framework for *Capability Based Planning*. A concept paper entitled *Creating the CF of 2020: Concept Development and Experimentation and Modelling & Simulation* was published following a major symposium that was jointly sponsored by the Vice and Deputy Chiefs of the Defence Staff and our Chief Executive Officer.

### **Business Line 3: S&T with National Security Partners**

*Science and Technology with National Security Partners* is our third business line. This business line enables us to exploit our science and technology base to serve the needs of clients outside DND, including Canadian industry and other government departments. Also under this business line, we conduct projects for DND clients not covered by Business Lines 1 and 2. Under this business line, we can collect and retain revenues to assist the development and maintenance of our technological capabilities.

#### **Performance on Key Defence Objectives**

This section reviews our performance against the Key Defence Objectives for Business Line 3, Science and Technology with National Security Partners, as stated in our business plan for fiscal year 2000-01.



## Defence Objective ST16: Contribution of National Collaborators to Research and Development Program

### Objective

To enter into more strategic collaboration with national science and technology partners. It is anticipated that partnerships with industry, other government departments, and universities will help to leverage up to \$30M of in-kind science and technology over a five-year period. The goal for 2000-01 is \$25M.

### Performance

We have continued to seek opportunities to collaborate with our national science and technology partners. With new agreements to promote increased collaborative research and development, such as the strategic alliance with the National Research Council, the level of collaboration is expected to grow.

The following figure shows the target and achieved national collaboration leveraging for fiscal years from 1998-99 to 2003-04. It is worth noting that we have already met our goal of \$30M in nationally leveraged science and technology.

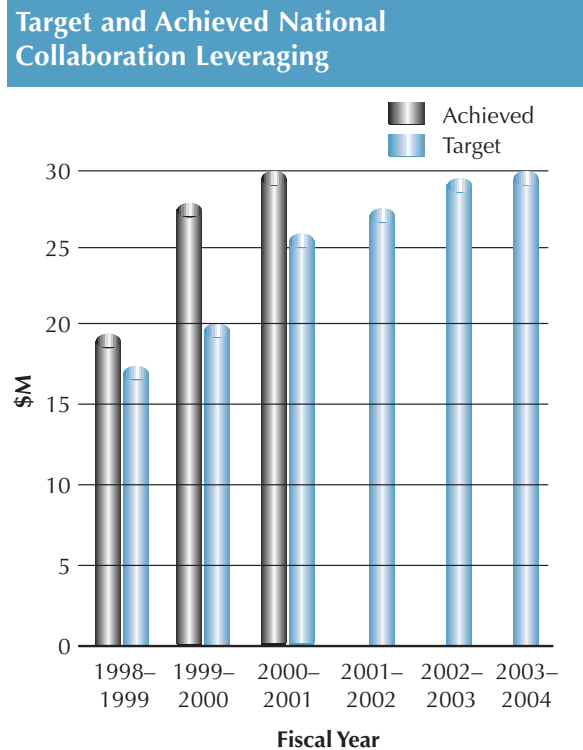
## Defence Objective ST17: Revenue Generation

### Objective

To generate approximately \$10M in revenue from external sources by 2004. The goal for 2000-01 is \$5.5M.

### Performance

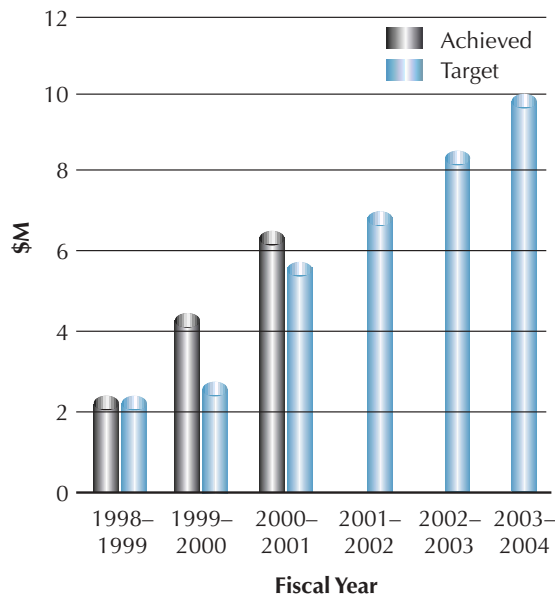
We have begun to implement a new revenue generation and retention model. Under this model, we will continue to provide superior services to our traditional clients in the Canadian Forces and the Department of National Defence



while looking for ways to leverage our annual appropriations to expand our capability in our core competencies. In effect, this new way of operating will help us provide our clients with an effective research and development function while expanding our depth.

The figure on the following page shows our target and achieved revenue from external sources for fiscal years from 1998-99 to 2003-04. We are well on the way to meeting our goal of \$10M in revenue from external sources. Note that “external sources” include clients outside the Department of National Defence as well as clients inside the Department but outside our Service Level Agreements.

### Target and Achieved Revenue from External Sources



### Defence Objective ST18: Technology Transfer to Canadian Industry

#### Objective

To license five technology concepts to industry for further development.

#### Performance

In fiscal year 2000-01, we licensed nineteen technologies to industry for further development, with eleven additional licenses pending. The tables on the next page list the licensing agreements that were completed and those agreements that are pending. A list of all patents and reports of invention are listed on page 60.

### Performance on Key Change Objectives

This section reviews our performance against the Key Change Objectives for Business Line 3, Science and Technology with National Security Partners, as stated in our business plan for fiscal year 2000-01.

### Change Objective ST26: Increased National Collaboration

#### Objective

To develop strategic leveraging through collaborative arrangements with industry to influence industry to produce research and development products required by DND and the CF.

#### Performance

We continue to search for new collaboration opportunities. For example, we signed an agreement with the National Research Council (NRC) to promote increased collaborative research and development between the two organizations. The agreement will strengthen and complement core competencies in both organizations.

We continue to work with other government departments and contribute to several interdepartmental initiatives on science and technology, including the Interdepartmental Committee on Science and Technology and the Sub-Committee on Science Advice. We also provided input to the Council of Science and Technology Advisors for their report on Excellence in Federally Performed Research and Development and their Review of Science Advisory Bodies.

## Licensing Agreements Completed

Technology	Company
A multimedia book: fracture control of metals	TISEC Inc
Antibodies against Venezuelan Equine Encephalitis (VEE)	Cytobiotechnics
Auto Context Image Database Exploitation (ACIDE) System	DMS Technologies
Barrel stave flextensional projector technology	Sensor Tech
Cold Water Survival Model	EMS Technologies
Corrosion Detection	Tektrend International
Electro-Optic equipment for FAVS and SAPS	Thomson CSF Systems
Folded shell projector	Edge Technologies
Geographic Information System	Global Géomatique
Helicopter Deck Landing Simulator	Atlantis Systems International
HF Channel Simulator	IP Unwired
Improved Landmine Detection System	CDL Systems Ltd.
Intelligent Clothing & Equipment Sizing System	VisImage Inc
MAVART software	Sensor Technologies
Pulmonary Delivery of Liposomes	Delex
Resolved Directional Sensor	Northrup Grumman
Structural analysis software	Martec
Survival Time Prediction software	Digital Space Systems
Thin Film Thermopile Detectors	Gentec Électro-Optique

## Licensing Agreements Pending

Technology	Company
Aircrew Cooling Vest	Mustang Survival
Cell Lines for Production of Antibodies	DERA
Electronic Battle Box software	Saab Systems
HF Adaptive Antenna Receiver Algorithm	SED Systems
HF Block Equalization Technology	Thales
High Frequency Surface Wave Radar	Raytheon Canada
LOCATE Software	AIM Corp
Mechanical Reproduction Mines	Amtech
Mobile Communications Simulator Toolbox	Norwegian Defence Research Establishment
SEB Antibodies	Hycult BV
Wideband HF Digital Receiver	IP Unwired

## Change Objective ST27: Strategic Partnering

### *Objective*

To establish and maintain strong national and international networks.

### *Performance*

Our strategic alliance with the National Research Council (NRC) promotes increased collaborative research and development between the two organizations and allows us to purchase services from each other. More information about this alliance can be found on page 13.

We continue to strengthen and maintain our international networks through membership and participation in the activities of international organizations such as The Technical Cooperation Program (TTCP) and the NATO Research and Technology Organization (NATO RTO). We also participate with other countries under a number of bilateral and multilateral agreements.

## BUSINESS LINE 4: Corporate Management

*Corporate Management* is our fourth business line. This business line includes central administration, infrastructure, human resources, performance measurement, communications, knowledge and information management, and management overhead. It also includes business planning, management, and co-ordination of international activities.

### **Performance on Key Defence Objectives**

This section reviews our performance against the Key Defence Objectives for Business Line 4, Corporate Management, as stated in our business plan for fiscal year 2000-01.

## Defence Objective ST19: Management of the Agency

### *Objective*

To finalize and implement a performance measurement system, and to complete the Activity Based Management Study that will allow us to use our resources more efficiently.

### *Performance*

A draft of our performance measurement framework has been completed. It will be finalized, validated, and implemented in the coming year.

The objectives of the study on Activity Based Management were to reduce the involvement of technical personnel in non-technical activities and to deliver internal support services more efficiently and effectively. Based on the results of this study, the Functional Direction project was established to define a method of operating whereby strategic and operational issues affecting corporate management could be coordinated across the normal vertical lines of authority. Functional Direction will align all corporate management activities under the new Corporate Service Managers in the Defence Research Establishments. We expect the benefits from Functional Direction to include greater efficiency and more effective service in corporate management, a more entrepreneurial approach to activities,



*A talking mannequin is used to study speech reception in noisy environments such as ship operations rooms.*

sharing of best practices among the Defence Research Establishments and headquarters, and freeing up resources for the research and development program.

### **Defence Objective ST20: Management of the Research and Development Program**

#### *Objective*

To manage the research and development program using effective management practices.

#### *Performance*

We are developing the Collaborative Planning and Management Environment (CPME) as an electronic planning and management tool that will be used for business planning and program monitoring. CPME was sufficiently advanced by spring 2000 to be used in preparing the Service Level Agreements. It should provide an excellent database for performance measurement and, when fully implemented, is intended to reduce the administrative burden on our managers.

The National Council for Ethics in Human Research (NCEHR) performed an external review of practices used by the Human Subject Research Ethics Committee at DCIEM. The review found the policies and procedures to be highly consistent with prevailing standards for the use of human subjects in experimental research.

### **Defence Objective ST21: Management of International Activities**

#### *Objective*

To manage the international research and development activities using effective management practices.

#### *Performance*

We manage our international research and development activities through collaborative organizations such as The Technical Cooperation Program (TTCP) – with the United States, the United Kingdom, Australia, and New Zealand – and the NATO Research and Technology Organization (RTO). In addition, we participate in a number of multilateral and bilateral arrangements with Canada's allies.

#### **Performance on Key Change Objectives**

This section reviews our performance against the Key Change Objectives for Business Line 4, Corporate Management, as stated in our business plan for fiscal year 2000-01.

### **Change Objective ST28: Research and Development Program for the Future**

#### *Objective*

To become a much stronger and more capable organization that will deliver significantly greater return on DND's research and development investment by making use of best practices in science and technology.

#### *Performance*

Under the auspices of The Technical Cooperation Program (TTCP) and with inputs from the member nations of TTCP, we published a report entitled *Winning Techniques in Science and Technology Management: A Compendium of Best Practices*. This compendium is a collection of the management practices employed by each nation.

*The “sense of belonging” of DREV personnel now exceeds 77 percent.*

### **Change Objective ST29: Information and Knowledge Management**

#### *Objective*

To increase the capacity of DND and CF decision-makers to absorb, understand and integrate science and technology knowledge into planning and operations, to build the innovation and decision-making capacity of DND, and to leverage knowledge through the Defence Science and Technology Network.

#### *Performance*

We conducted a Knowledge Management Audit to find out how well we manage knowledge and information. A complete analysis of the data will be undertaken in the coming year.

We published a paper entitled *The Knowledge Revolution: A Literature Review* as an overview of the application and implementation of knowledge management initiatives within organizations. Another paper, *Why do We Need Knowledge Management*, examines our challenges of knowledge management. In addition, we participated in two one-day workshops – *Data Mining Tools and Techniques* and *Knowledge Management Strategies* – that were held to explore knowledge management tools and practices.

When we achieved agency status, two new directorates – Directorate Research and Development Communications (DRD Comm) and Directorate Research and Development Knowledge and Information Management (DRDKIM) – were formed from a single previous directorate. This separation of responsibilities gives increased focus to each new directorate. DRDKIM now has the capacity for applications development and will develop a strategic plan to chart our way ahead for information management.

### **Highlights of Administration and Infrastructure**

This section gives some highlights of our activities regarding administration and infrastructure.

#### **Odysée 2000**

We have taken major strides towards improving organizational economy, efficiency and effectiveness with the completion of the Odysée 2000 organizational development project. The objective of this initiative was to enhance performance by improving the organizational climate and fostering the client-culture of all personnel. An employee's survey, carried out in March 2001 at DREV, demonstrated that the sense of belonging of the personnel now exceeds 77%. This score falls between good organizations, which normally score 70%, and excellent enterprises, which score 80%.

#### **Improved Operational Efficiency (ALEOP)**

As an element of our Business Administration Efficiency Working Group, we have initiated the Improved Operational Efficiency (ALEOP) project at DREV. The aim of the project is to improve the operational efficiency of materiel management, information technology, and site support functions.

### **Peer Review of Support Services**

We conducted a peer review of support services at DREV. The review team compared the procedures, processes, costs and resources used at DREV with those of similar organizations. The reviewers found that DREV has a positive work atmosphere and a remarkable client culture. They also identified areas for improvement in site support, materiel management, and transport.



*Canadian Forces Auxiliary Vessel Quest*

### **Refit of CFAV Quest**

The Canadian Forces Auxiliary Vessel (CFAV) *Quest* became fully operational this year following the completion of its mid-life refit in November 1999. DND's Assistant Deputy Minister for Materiel funded the refit. CFAV *Quest* gives us an excellent facility for conducting acoustics research at sea.

### **New Facilities at DCIEM**

The addition of two facilities at the Defence and Civilian Institute of Environmental Medicine (DCIEM) will further advance our capabilities. We have initiated the construction of a new Synthetic Environment Research Facility, which will provide an affordable means for human participation and representation in modelling and simulation applications. It will be the focus for human experimentation with virtual reality training technologies, for distributed mission training experiments, and for human-systems modelling.

We are also undertaking the design, manufacture, and procurement of new human centrifuge arm and gondola. This facility will significantly enhance research and development capabilities related to human performance and protection of aircrew, in addition to providing a state-of-the-art vehicle for training combat aircraft personnel.



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## 6 Human Resources

We are committed to building the skills and expertise of our employees and to building a workforce that is dedicated to excellence. In support of this commitment, the top priority for Human Resources in fiscal year 2000-01 was to begin implementing a new framework based on the Treasury Board's *Framework for Good Human Resource Management in the Public Service*. This framework will provide a structure for managing our human resources; it is based on:

- leadership
- a workforce built on values
- a productive workforce
- an enabling work environment
- a sustainable workforce

Efforts were concentrated on developing our Human Resources Framework, establishing the human resources structure and staffing the human resource offices in all of our workplaces, and in preparing for delegations of authorities from the Deputy Minister of National Defence to our Chief Executive Officer. The Deputy Minister's conditions for delegation were met and, at the end of the year, the Chief Executive Officer was ready to assume the delegated authorities. In a move toward greater management flexibility and accountability, many of these authorities – including staffing – will be sub-delegated to our managers. In anticipation of assuming staffing authorities, managers have been trained to ensure effective and appropriate application of their new responsibilities.

We have begun the development of a Career Management policy and related management tools – including competency profiles – for all job streams. This development will remain a priority in the next fiscal year and beyond. We also implemented a succession planning framework and review process for all key corporate positions.

As the prime user of the Defence Science (DS) occupation group, we are responsible on behalf of the public service for the management of the DS group. Therefore, we have a continuing responsibility to maintain an effective and efficient classification standard, pay plan, and strategies for recruitment, retention, and career management of knowledge workers and leaders in defence science.

Consistent with other government initiatives and to further support our management of human resources, we held workshops to consult employees to further define our corporate values and culture. The objective was to develop a solid consensus on values throughout the Agency to establish trust, information sharing, and receptiveness to change, upon which an organizational culture could be built.

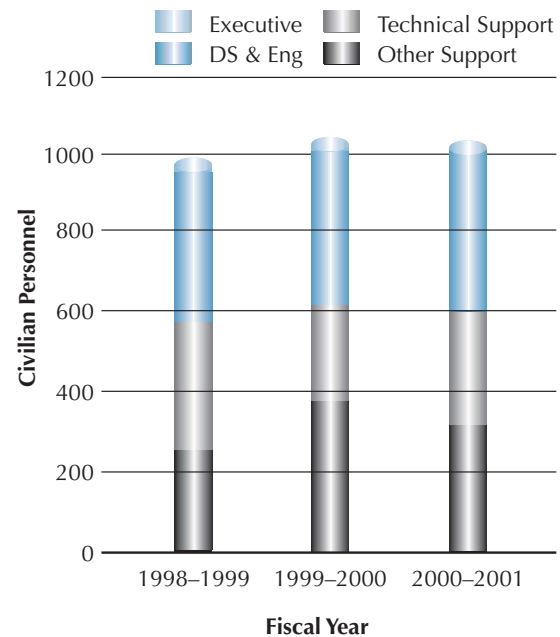
The positive relationship with the unions representing our employees continued as we reached agreement with union representatives on the terms of reference for national and local level consultation committees. Our Chief Executive Officer will chair the first agency-level union/management meetings in the coming year.

## Staffing Trends

The following table shows the number of civilian employees in Defence R&D Canada, as of 31 March 2001, sorted according to job group: executive, defence science and engineer, technical support, and other support. The table also shows the number of employees who have been hired and have departed, as well as the percent change for the year.

The figure to the right shows the trend in staffing levels for all of our civilian employees for fiscal years 1998-99 to 2000-01. Over this three-year period, the population of executives has remained constant, the population of defence scientists and engineers has increased by 30 (8%), the population of the technical support staff has increased by 21 (8%), and the population of other support staff has increased by 6 (2%).

### Staffing Trends for all Civilian Personnel



### Civilian Personnel by Job Group

Job Group	Number of Employees	Hired	Departed	Change
Executive <sup>1</sup>	10	–	–	–
Defence Science & Engineer	414	28	19	+2%
Technical Support <sup>2</sup>	294	18	25	-2%
Other Support <sup>3</sup>	301	24	36	-4%
<b>TOTALS</b>	<b>1019</b>	<b>70</b>	<b>80</b>	<b>-1%</b>

<sup>1</sup> "Executive" includes the occupational groups EX, DS 7a, DS 7b, and DS 8.

<sup>2</sup> "Technical Support" includes the occupational groups EG, EL, CS, CH, VM, GT, and SI.

<sup>3</sup> "Other Support" includes all other administrative and operational personnel.



Excellence in  
Science

# 7 Excellence in Science

Our vision is to provide leadership in science and technology to our clients. 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.

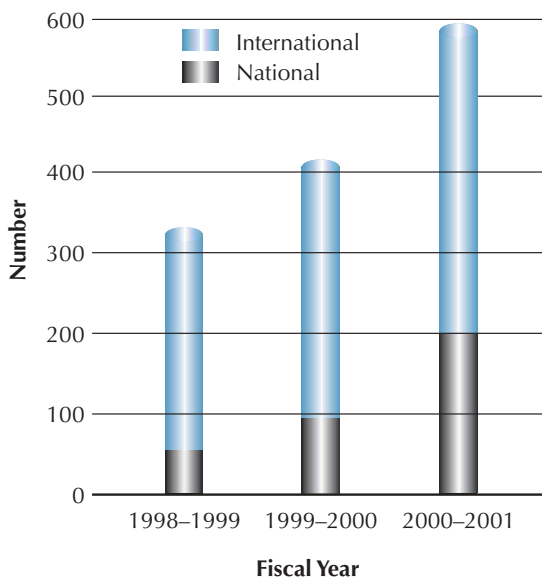
## Scientific Indicators

We track a number of indicators that serve as useful benchmarks of our standing in the international scientific community. These indicators include participation in national and international activities, patents and reports of inventions, publications, milestone achievement, and awards and honours.

### National and International Activities

The figure below shows the number of national and international activities in which our staff participated for the three fiscal years from 1998-99 to 2000-01. These activities include membership on councils, participation on collaborative projects, working groups, and information exchanges.

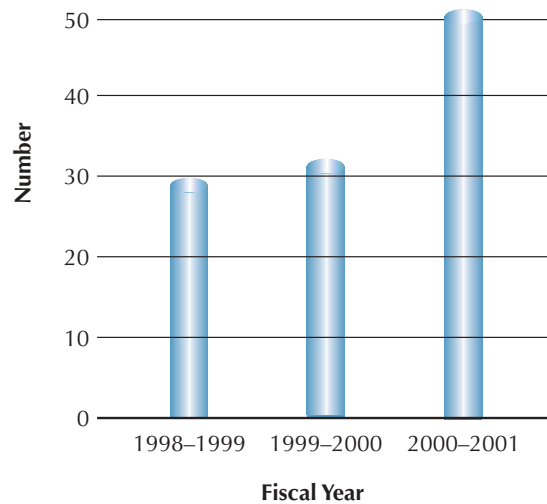
Three-year trend for national and international activities



## Patents and Reports of Inventions

The figure below shows the number of patents and reports of invention filed by our staff for the three fiscal years from 1998-99 to 2000-01. The complete list of patents and reports of invention is given on page 48.

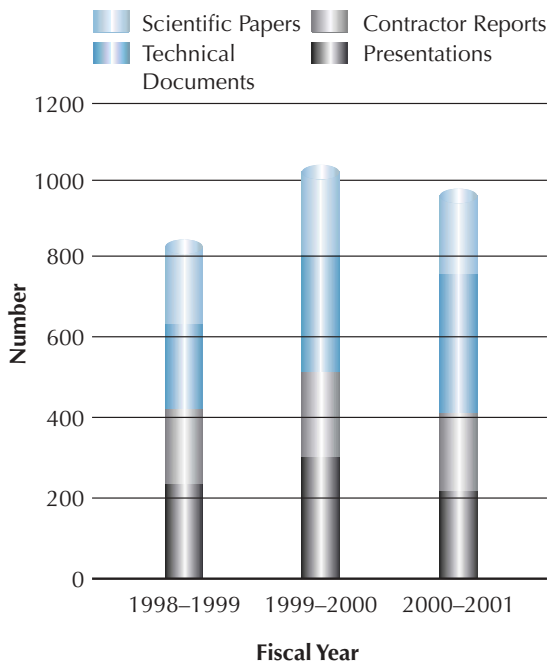
Three-year trend for patents and reports of inventions



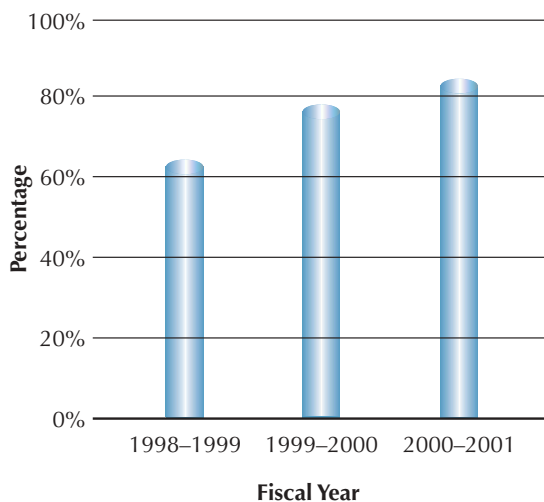
## Publications

The figure above left on the next page shows the number of reports published and presentations made by our staff for the three fiscal years from 1998-99 to 2000-01. The reports include papers published in the scientific literature, technical documents published by the Defence Research Establishments, and reports resulting from research contracts funded by our research and development program.

### Three-year trend for publications and presentations



### Three-year trend for milestone achievement



### Milestone Achievement

The figure at left below shows the percentage of milestones that we achieved in delivering our research and development program for the three fiscal years from 1998-99 to 2000-01.

### Awards and Honours

The number of awards and honours that are bestowed upon our staff by external organizations is an indication of their impact and recognition in the scientific community.

### Achievement Awards

- **Lyle Wagner** and **Caroline Tom** of DREO and Barry Felstead of the Communications Research Centre received a TTCP Achievement Award for their work on the military use of civil satellite-communications systems.
- **John Preston** and **Roland Poeckert** of DREA received a TTCP Achievement Award for developing techniques to measure the characteristics of the seabed sediment relevant to mine burial and sonar prediction models.
- **Jacques Dubois** of DREV, as part of an international team, received a TTCP Achievement Award for demonstrating the ability of maritime platforms to detect and counter laser and infrared imaging threats.
- **Bill Fraser** of DCIEM received the Research and Development Innovation Award from the Life Sciences and Biomedical Engineering Branch of the Aerospace Medicine Association.
- **Tom Cousins, Trevor Jones, and Jean-Roch Brisson** of DREO and **John McFee** of DRES received the John S. Hewitt Achievement Award by the Canadian Nuclear Society for developing a thermal neutron activation system for non-metallic land mine detection.



Winners of the TTCP Achievement Awards:  
 Left to right: John Leggat (CEO of Defence R&D Canada), Jacques Dubois (DREV), Lyle Wagner (DREO), Caroline Tom (DREO), The Honourable Art Eggleton (Minister of National Defence), John Preston (formerly DREA), Roland Poeckert (formerly DREA), and Barry Felstead (Communications Research Centre)

### Publication Awards

- **Satish Kashyap** of DREO received a best paper award from the IEEE Electromagnetic Compatibility Society for his joint publication entitled *Shielding Effectiveness Estimation of Enclosures with Apertures*.
- **James Cruickshank** and **Denis Vincent** of DREV received an outstanding paper award from the Journal of Defence Science for their paper on laser-induced eye injuries.
- **Bob Cheung** of DCIEM received the Sidney Leverett Award from the Aerospace Medicine Association for a significant contribution to environmental medicine and science through a publication in *Aviation, Space and Environmental Medicine*.

### Fellows of Learned Societies

- **Dennis Jones** of DREA was elected a Fellow of the Acoustical Society of America for his contributions to the development of flexensional transducers.
- **Paul Hines** of DREA was elected a Fellow of the Acoustical Society of America for his contributions to acoustic scattering at ocean boundaries.
- **Doug Laurie-Lean** of Defence R&D Canada Headquarters was elected a Fellow of the Canadian Aeronautics and Space Institute.

### Leadership in Societies and Committees

- **Ira Jacobs** of DCIEM was elected President of the Canadian Society for Exercise Physiology.
- **Justin Hollands** of DCIEM was elected Chair of the Human Factors and Ergonomics Society Visual Performance Technical Group.
- **Sharon McFadden** of DCIEM was elected President of the Canadian National Committee to Commission Internationale d'Eclairage (CIE).

### Other Awards

- **Robert Charpentier** and **Martin Salois** of DREV received the TechnoFed 2000 Gold Medal Award in the partnership category for their work on the Malicious Code Detection in COTS (MaliCOTS) software project.
- **André Cantin** and **Jacques Dubois** of DREV with Tom Doyle and Paul Webb of Perkin Elmer Optoelectronics Canada received an award from Federal Partners in Technology Transfer for the successful development, transfer, and commercialization of the High Angular Resolution Laser Irradiation Detector.

### Government Awards

- **Prakash Bhartia** of DREO received the Public Service Award in the Excellence in Service Delivery category for “sustained and exceptional service in developing and delivering research and development programs and projects”.
- **Eric Fresque**, as part of a team of 14 PWGSC recipients, received a Silver Medal of Distinction at the Technology in Government Tradeshow.
- DREV won an award in the Excellence in Public Administration category from the Institut de l’administration publique de Québec (IAPQ) for the creation of its Business Development Office.

### Canadian Peacekeeping Service Medals

- **Ken Johnson** of Defence R&D Canada Headquarters received the Canadian Peacekeeping Service Medal for serving on fourteen missions for the identification, verification, and destruction of Iraq’s capability to produce biological weapons.
- **Gary Soucey** and **Dean Verpy** of DRES received the Canadian Peacekeeping Service Medal for their service in Iraq as part of a team charged with the destruction of chemical weapons.
- **Jack Toews** of DRES received the Canadian Peacekeeping Service Medal for his work in Cambodia, Afghanistan, and Bosnia-Herzegovina in metal detector trials for de-mining.
- **Ira Jacobs** of DCIEM received the Canadian Peacekeeping Service Medal for his three missions to Iraq as a weapons inspector.

- **Peter Lockwood** of DREO received the Canadian Peacekeeping Service Medal for his work as a safety officer with the United Nations Special Commission in Iraq.

- The following military personnel associated with Defence R&D Canada also received Canadian Peacekeeping Service Medals: LCol J Dick and Maj H Burke (Defence R&D Canada Headquarters); LCdr RB MacLennan, Lt(N) AD Foster, Lt(N) GD White, and MS DA Drummond (DREA); Maj JPM Gareau, Maj JP La Pierre, Capt JJLR Durocher, Sgt JM Grenier, and Sgt JM Hénault (DREV); Maj F Pinkney (DREO); Maj A Carruthers, Maj K Hocevar, and Capt M Haché (DRES); and Col DA Salisbury (DCIEM).

### Academic Awards

- **Malcolm Vant** of DREO received the Commandant’s Award from the US Industrial College of the Armed Forces for the best paper in Grand Strategy.
- **Malcolm Vant** of DREO was named a Distinguished Graduate by the US Industrial College of the Armed Forces.

### Peer Reviews

Our peer reviews are objective and critical evaluations of technology areas within our research and development program. These evaluations address 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-best standards in Defence R&D Canada, and to identify areas for improvement.

Two peer reviews of technical areas were conducted in fiscal year 2000-01: the Electronic Warfare Technology at DREO and the Military Engineering Technology at DRES.

### **Electronic Warfare at DREO**

The review committee found the Electronic Warfare (EW) programs at DREO to be cohesive, well grouped, and in general, of high quality. Some elements of the program are truly world class and provide status for Canada in the international arena. The review committee found that the technical staff was highly qualified and positively motivated. The review committee identified three problem areas:

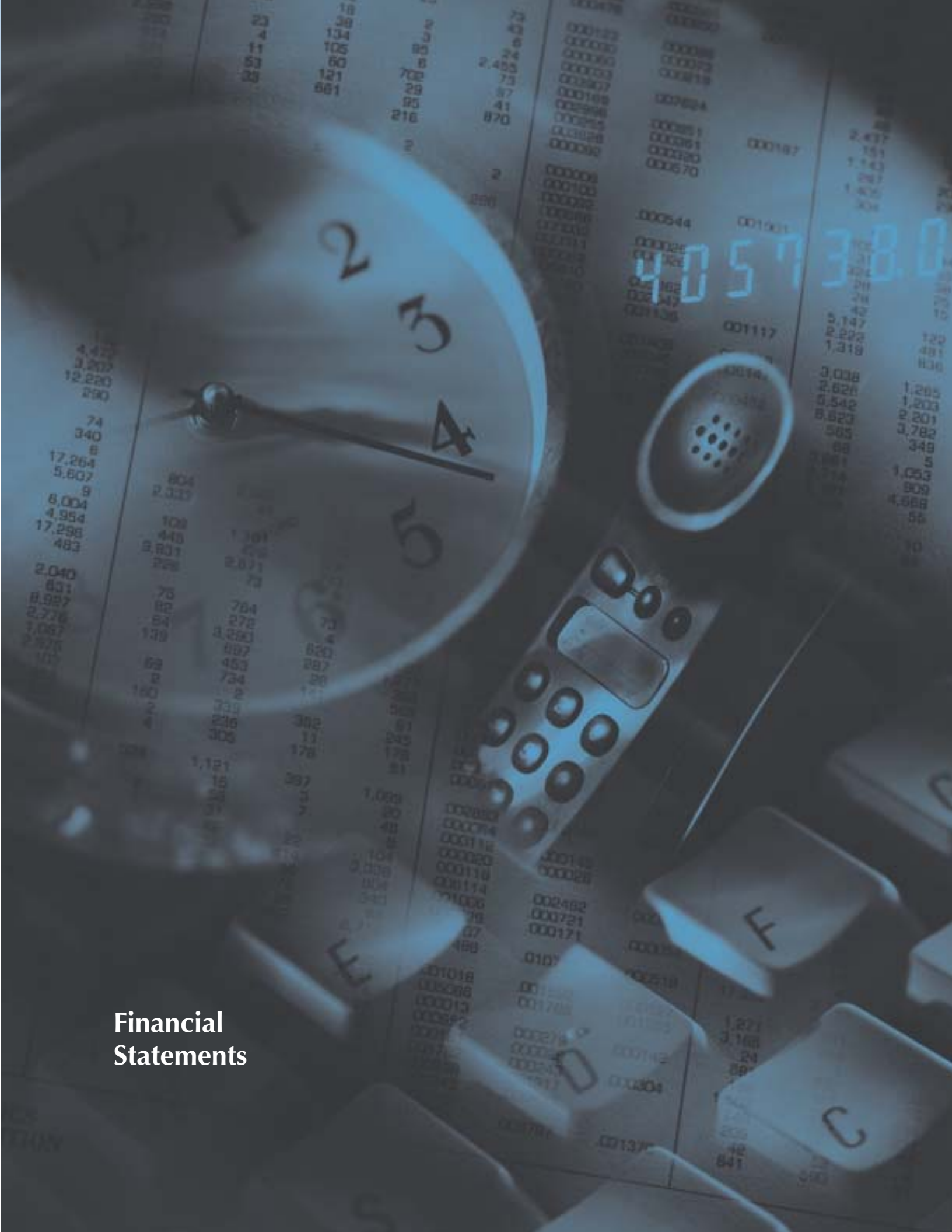
- The recent need to generate revenues from external sources requires staff to undertake roles for which they not suited, and for which they were not initially employed. This can place them in a position where they do not have the skills or the background to succeed.
- We are experiencing some difficulty in providing competitive career opportunities and economic incentives to recruit and retain technical professionals. Consequently, many research programs are being maintained with insufficient technical resources.
- There is no customer pull from within the Department of National Defence for Electronic Warfare products.

### **Military Engineering at DRES**

The review committee found the Military Engineering Program to be overall very strong and positive. The program is generally well organized, and is executed to serve the needs of clients. Most of the scientists have strong scientific backgrounds, and they use their abilities to meet the needs of their clients. The review committee made three recommendations:

- Defence R&D Canada should consider bolstering the work on ground penetrating radar.
- The mandate for the Canadian Centre for Mine Action Technologies (CCMAT) should be renewed when it ends in 2003.
- Facilities should not be allowed to degenerate, despite the high cost of maintenance.





**Financial  
Statements**

## 8 Financial Statements

	Civilian FTEs <sup>1</sup>	Total Expenditure
<b>Business Line 1</b>		
<i>Maritime</i>		
Maritime Integrated Above Water Warfare	25	7,143
Maritime Command, Control, Communications and Intelligence	16	4,829
Maritime Underwater Warfare	54	10,053
Maritime Mine Countermeasures Systems	13	3,043
Naval Platform Technology	33	5,805
<b>Total Maritime</b>	<b>141</b>	<b>30,872</b>
<i>Land</i>		
Soldier Systems	18	5,598
Tactical Vehicle Systems	33	5,512
Information Operations	28	6,895
Military Engineering	10	2,468
Munitions and Firepower	22	4,454
<b>Total Land</b>	<b>117</b>	<b>24,927</b>
<i>Air</i>		
Air Electronic Warfare	14	3,919
Airborne Surveillance	32	8,510
Air Weapons Systems	19	2,549
Air Vehicles	5	4,576
Aircraft Crewsystems Technologies	15	4,187
<b>Total Air</b>	<b>85</b>	<b>23,741</b>
<i>Command Control Information Systems</i>		
National Level Command and Surveillance	26	4,955
Information Operations	26	5,268
Military Information Technology Infrastructure	10	3,895
Space Systems and Technologies for Defence Applications	27	10,372
<b>Total CCIS</b>	<b>89</b>	<b>24,490</b>

<sup>1</sup> FTE stands for Full-Time Equivalent.

	Civilian FTEs	Total Expenditure
<b>Business Line 1 (cont'd)</b>		
<i>Human Performance</i>		
Simulator Training Technologies	7	4,385
Military Operational Medicine	12	2,159
Diving and Underwater Intervention	7	957
Human Factors in Military Systems	19	1,844
Defence against Chemical, Biological and Radiation Hazards	55	11,192
<b>Total HP</b>	<b>100</b>	<b>20,537</b>
<b>Total Business Line 1</b>	<b>526</b>	<b>124,567</b>
<b>Business Line 2</b>	<b>32</b>	<b>3,151</b>
<b>Business Line 3</b>	<b>24</b>	<b>1,717</b>
<b>Business Line 4</b>	<b>430</b>	<b>51,376</b>
Departmental and Interdepartmental Initiatives	7	4,274
Opportunity Funds	–	5,196
<b>Total for all Business Lines</b>	<b>1,019</b>	<b>190,281</b>

## Resource Summary

Resources By Fund Type and Site (\$K)					
	Salary	O&M <sup>1</sup>	R&D Contracts	Equipment	Total
DREA	12,205	2,627	4,595	886	20,313
DREV	19,309	6,519	12,418	979	39,225
DREO	9,914	2,611	15,050	681	28,256
DCIEM	8,330	2,244	8,773	648	19,995
DRES	9,146	5,803 <sup>†</sup>	7,122	674	22,745
HQ	6,474	4,657	40,198	8,418	59,747
<b>Total</b>	<b>65,378</b>	<b>24,461</b>	<b>88,156</b>	<b>12,286</b>	<b>190,281</b>

<sup>†</sup> The DRES O&M allocation was \$2,344K. The balance shown above also funds the Canadian Centre for Mine Action Technologies (CCMAT), which is located at DRES.

Sources of Revenue by Site					
	Private Sector Sources (Local Revenues)	Specified Purpose Accounts	Other Government Departments	FE <sup>2</sup> Savings	Total
DREA	124	–	–	–	124
DREV	603	–	–	788	1,391
DREO	402	–	–	440	842
DCIEM	967	517	305	–	1,789
DRES	473	1,491	–	–	1,964
HQ	631	–	–	–	631
<b>Total</b>	<b>3,200</b>	<b>2,008</b>	<b>305</b>	<b>1,228</b>	<b>6,741</b>

### Notes on Resource Summary

<sup>1</sup> O&M stands for *Operations and Maintenance*.

<sup>2</sup> FE stands for *Financial Encumbrance*.



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## 9 Summary

As a Special Operating Agency, Defence R&D Canada has gained greater autonomy to shape our future, but at the same time has taken on greater responsibilities within the Department of National Defence. The fundamental reason for our existence remains, however, the provision of leadership in science and technology to the Canadian Forces, DND, and Canadian industry.

We were successful this year in delivering services to our clients by enhancing the capabilities of the Canadian Forces, by providing expert advice on science and technology and policy, by forging strong national and international partnerships, and by transferring our technologies to industry for commercial exploitation. The provision of services to the Canadian Forces through the Service Level Agreements helps us to develop and maintain a client-oriented culture within Defence R&D Canada.

The Peer Reviews of Electronic Warfare at DREO and Military Engineering at DRES found the programs to be of high quality, with motivated staff and excellent facilities. The review teams warned of potential problems with staff retention and the dangers of not maintaining some of the unique facilities found in the Defence Research Establishments.

In terms of technical achievement, our scientists produced more technical documents and were responsible for an increased number of contractor reports compared to previous years. Several of our scientists were honoured with awards from external organizations.

We have already met our long-range targets for collaborative leveraging from our national and international partners. In addition, we are well on our way to meeting our long-range targets for generating revenues from external sources.

As an agency, we have accepted new delegations of responsibility to manage our Human Resources. We continue to develop and implement our Human Resources Framework as part of our corporate commitment to build a skilled workforce that is dedicated to competence and excellence. Corporate support services are being reviewed, with the intention of redirecting more effort into science by providing more efficient and effective services. These initiatives, combined with the Technology Investment Strategy and the Technology Investment Fund, have set in place a strong foundation upon which we can build for the future.

## Tables



# 10 Tables

**Table 1 Scientific Capabilities of Defence Research Establishments**

DREA	■ Air vehicles (as of 1 April 2001)
	■ Electromagnetics
	■ Marine materials
	■ Mine and torpedo countermeasures
	■ Naval and airborne sonar technologies
	■ Naval command and control
	■ Ship operability, safety and signatures
	■ Sonar sensors and undersea environmental acoustics
DREV	■ Acoustic surveillance systems
	■ Advanced electro-optical systems
	■ Electromagnetic sensor performance prediction
	■ Energetic materials
	■ Information systems technology
	■ Military laser technology and systems
	■ Remote sensing technology and systems
	■ Weapon delivery systems
DREO	■ Aerospace radar and navigation
	■ Electronic warfare – electronic countermeasures
	■ Electronic warfare – electronic support measures
	■ Information operations
	■ Military communications
	■ Radiation biology and radiation detection
	■ Space systems technology
	■ Surface radar
DCIEM	■ Aerospace life support
	■ Behavioural and cognitive sciences
	■ Biomedical sciences
	■ Experimental diving
	■ Human factors engineering
	■ Human protection and performance
	■ Human-computer interaction
DRES	■ Simulation and training technologies
	■ Casualty management
	■ Countermine technology
	■ Detection and identification of chemical and biological (CB) hazards
	■ Medical countermeasures against CB agents
	■ Novel energetic materials
	■ Physical protection against CB agents
	■ Tactical vehicle mobility and robotics
■ Threat assessment and explosive effects	



**Table 2 Technology Demonstration Projects**

Project Name	Start	End	Total K <sup>1</sup>	00/01 K
Canadian Naval Electronic Warfare Set (CANNEWS)	1990	2002	27,604.0	1,100.0
Artillery Regimental Data System	1992	2001	22,561.0	126.2
SpotMode Synthetic Aperture Radar	1993	2004	6,654.0	653.0
Towed Array Sensor Development	1993	2004	10,792.0	847.0
Submarine AIP	1994	2000	9,138.0	79.9
Advanced Land Fire Control System Major Project	1995	2001	9,842.0	465.0
Advanced Shipboard Command And Control Technology (ASCACT)	1995	2000	6,350.0	75.0
High Frequency Surface Wave Radar for Coastal Surveillance	1995	2002	6,352.0	407.0
Canadian Integrated Biological Agent Detection System	1996	2000	9,203.0	1,330.0
Improved Ship Structural Maintenance Management	1996	2004	4,290.0	858.8
SHINCOM Upgrade	1996	2002	9,596.7	1,166.0
Soldier Information Requirements	1996	2004	16,398.0	2,300.0
Next Generation Signal Processor Advanced Development Model	1997	2001	7,909.0	2,609.0
Remote Minehunting System	1997	2004	8,677.0	1,675.0
Towed Integrated Active/Passive Sonar (TIAPS)	1997	2004	12,140.0	2,164.0
Electronic Warfare Technology Demonstrator	1998	2001	5,931.0	400.0
Enhanced Synthetic Vision System	1998	2001	3,100.0	858.0
Land Intelligence And Electronic Warfare Automation	1998	2003	6,374.0	1,536.0
MILSATCOM Performance Enhancement	1998	2001	9,342.0	475.0
Pyrophoric IR Decoy/Dispenser	1998	2001	7,015.0	399.0
Vaccine Development Initiative (VDI)	1998	2004	4,200.0	300.0
Advanced Distributed Mission Training (ADMT)	1999	2003	7,000.0	3,059.0
CF-18 Radar Modernization	1999	2002	2,861.0	1,315.0
Common Operating Picture 21	1999	2004	6,120.0	557.4
RADARSAT-2 GMTI	1999	2004	7,000.0	2,147.0

<sup>1</sup> Contract Funds only.

### Technology Demonstration Projects (continued)

Project Name	Start	End	Total K	00/01 K
Tactical Aviation Mission System Simulation	1999	2004	6,100.0	800.0
Command Decision Aids Technology (COMDAT)	2000	2003	5,600.0	1,052.0
Future Armoured Fighting Vehicle Systems (FAVS)	2000	2004	8,000.0	1,259.9
High Energy Missiles for Light Combat Vehicle	2000	2005	4,500.0	370.0
Hyperspectral Imagery for Improved Airborne ISR	2000	2005	5,900.0	300.0
Intelligence, Surveillance, Target Acquisition and Reconnaissance	2000	2004	6,000.0	14.0
Optical Inter-Satellite Links	2000	2005	4,800.0	100.0
Rapidly Deployable Underwater Acoustic Surveillance System	2000	2005	7,500.0	160.0
Shipboard Integration of Sensor and Weapon Systems	2000	2004	6,000.0	100.0
Tactical High Capacity Communication Links	2000	2004	5,600.0	162.0
<b>Total</b>				<b>31,220.2</b>

**Table 3 Technology Investment Fund Projects**

Project Name	Start	End	Total K	00/01 K
Detection of Malicious Codes in COTS Software	1998	2002	520.0	229.0
DNA Immunization to BW Agents	1998	2001	1,000.0	350.0
Electromagnetic Radiation Munitions	1998	2002	1,000.0	350.0
FOREX – DRES	1998	2001	1,000.0	362.0
FOREX – DREV (Ultradispersed Particles)	1998	2002	850.0	250.0
Integrated Physiological Modelling	1998	2001	360.0	125.0
JMCIS-Based Sonar Information Management	1998	2002	810.0	279.0
Laser Beamrider Detection System	1998	2001	650.0	231.0
Mobile Communications EW Countermeasures	1998	2002	900.0	373.0
Rapid Production of Genetic Engineered Human Antibodies for Immunotherapy and Diagnostics	1998	2001	920.0	345.0
Self-Organized, Goal Drive, Adaptive Learning	1998	2002	560.0	170.0
An Intelligent Recognition System for Sensor Surveillance	1999	2002	280.0	100.0
Helmet Mounted Fused IR/II for Enhanced Night Vision	1999	2003	875.0	50.0
Intelligent Recognition System for Sensor Surveillance	1999	2001	280	125.0
Mid-Infrared Active Imaging MAWS/Dazzler	1999	2002	690.0	260.0
Space-Time Adaptive Processing: Algorithm Design and Implementation for Airborne Radars	1999	2002	450.0	293.0
Stand-Off Biodetection	1999	2002	725.0	120.0
Detection of Radiological Threats from Airborne and/or Space-Based Platforms	2000	2003	1,000.0	400.0
Drug Design of Peptide Mimetics	2000	2003	760.0	235.0
Hydrogen Storage in Carbon Nanotubes	2000	2003	955.0	274.4
Nanotechnology-Based Platform for Generic Analysis of Biological Agents	2000	2003	1,000.0	320.0
Ocean Environmental Conditions by Remote Sensing	2000	2003	680.0	200.0
Pulse-Detonation Engines for Missile Propulsion	2000	2003	850.0	350.0
Small Cross Section Imagers	2000	2003	660.0	80.0
Super-Compressed Detonation	2000	2003	1,000.0	400.0
Ultrasonic Sensing and Imaging Technology Applied to Field Medicine Diagnostics	2000	2003	950.0	280.0
<b>Total</b>				<b>6,256.4</b>

Table 4 Defence Industrial Research Projects				
Project Name	Start	End	Total K	00/01 K
Inorganic Intumescent Coating Technology for Improved Firesafety on Naval Vessels/Submarines	1995	2001	347.3	27.6
CFD Prediction of the Flow Around Ships	1996	2003	202.0	80.0
Direct View Thin Film Electroluminescent (TFEL) Enabling Technology for Military Display Applications	1998	2001	449.6	92.9
HVOF Process Development, Evaluation and Qualification	1998	2002	500.0	153.6
Hyperspectral Land Mine Detection	1998	2001	498.1	112.7
Image Analysis And Object Recognition Decision Aids for Airborne Surveillance	1998	2000	500.0	127.4
Immune Modulator Strategy Phase II	1998	2001	466.6	90.1
Magneto-Inductive Duplex Communication System	1998	2001	310.2	120.3
Mine Boot Protection System	1998	2001	360.8	54.6
Seabed Classification for Multibeam Sonars	1998	2001	499.4	134.5
Tools for the Generation of Advanced Scansar Data Products with RADARSAT	1998	2001	500.0	219.6
Cultured Human Skin for Burn and Wound Therapy	1999	2003	498.9	79.7
Development of a Prototype Alternating Current Potential Difference (ACPD) System to Measure Compressive Residual Stresses in Metallic Components	1999	2002	363.4	78.5
Development of Advanced Navier-Stokes Methods for Vortical and Separated Flows	1999	2002	500.0	135.9
HBT Power Cell Development	1999	2001	485.7	77.4
Identification of Chemical and Biological Warfare Agents	1999	2001	500.0	175.0
Integrated Ship Defence Simulation Research and Development	1999	2002	353.5	158.2
ISED – Instructional Systems Engineering and Delivery	1999	2001	487.5	43.5
Low Frequency Acoustic Transducers	1999	2002	500.0	345.1
Proof-of-Concept for a Hand-Held Real Time Biodetector and Sampler	1999	2001	500.0	260.0
Satellite Monitoring through Model Based Vision	1999	2001	301.9	149.9
Signal Image and Data Processing Algorithms	1999	2001	482.5	175.0
Tactical Multimedia over Wireless and Wired LANs	1999	2001	500.0	165.2

### Defence Industrial Research Projects (continued)

Project Name	Start	End	Total K	00/01 K
Technology Development for the Gyrowheel Spacecraft Attitude Control Device	1999	2001	500.0	439.4
X-Band Multifunction MMIC	1999	2001	449.2	256.1
An Enzyme-Based Bioreactor for Carbon Dioxide Management in Submarines	2000	2001	262.1	200.4
Display Assessment and Enabling Technology Research for new Military Displays	2000	2003	493.2	66.7
Distributed Parallel and Parallel Simulation Server Batch Run Interface	2000	2001	139.3	139.3
Electro-Optical Remote Sensing Software	2000	2003	489.1	59.1
Energetic Materials Technology for Large Calibre Ammunition	2000	2002	459.1	100.0
Hemoglobin-Starch Conjugates for Blood Volume Replacement and Oxygen Delivery	2000	2003	500.0	298.2
In-Situ Coating of Plasma Synthesized Ultra-Fine Nanosized Metallic Powders	2000	2001	357.2	90.0
Development of Advanced Ceramic Armour System for Personal Protection	2001	2003	500.0	60.0
<b>Total</b>				<b>4,765.8</b>

**Table 5 Patents and Reports of Inventions**

- A centrifugal reverse osmosis unit incorporating an annual membrane cartridge
- A circuit for LPI signal detection and suppression of conventional pulsed signals
- A method for estimating systolic and diastolic blood pressure and heart rate
- A multimedia book: Fracture Control of Metals
- A parametric control device
- Adaptive beamforming processing for integrated passive and active sonar and radar systems
- Adaptive multi-function and multi-channel digital receiver architecture
- Analog high angular resolution laser irradiation detector (HARLID)
- Automatic gain control for digital radar intercept receivers
- Biological aerosol detection with laser diode
- C4 landmine surrogate containers
- Combination vaccine for enhancing immunity against brucellosis
- Comfort liners for chemical protective and other impermeable gloves
- Delivery of liposomal antioxidants for therapeutic applications
- Device for determining the change in density of a medium
- Digital sonobuoy demultiplexor
- Emergency exit system
- Field-deployable forced-air warming system
- Flow through device for the ultrasonic destruction of microorganisms in fluids
- Gel-based marking system
- Glycidyl azide polymer copolyurethane thermoplastic elastomers
- Horizontal projector array of pressure-compensated barrel stove projectors
- Hydrogel wound dressing containing liposome-encapsulated therapeutic agents
- Insensitive gun propellant formulations
- Insensitive melt cast explosive compositions
- In-service detection of corrosion in multi-layer structure using the lift-off point of intersection
- Landmine destroying and disabling system
- LOCATE: A computer-aided approach to optimizing communication effectiveness through workspace layout
- Mechanical reproduction training landmines
- Method for detecting antibodies to and antigens of fungal and yeast exposures
- Method for removing the effects of particulate matter from sequences of images
- Modulation recognition and parameter estimation of radar pulses
- Multifunction receiver architecture for simultaneous intrapulse analysis
- Multiple scattering technique (must) LIDAR
- Multi-sensor vehicle-mounted mine detector
- Non-invasive 3-D intracranial thermography system

### Patents and Reports of Inventions (continued)

- Non-invasive diagnostic device monitoring brain abnormalities caused by density and/or temperature fluctuations
- Novel application of liposome-encapsulated ciprofloxacin as an immunotherapeutic
- Novel DNA-based vaccine against the encephalitic alphaviruses
- Novel monoclonal antibodies for the detection and identification of Western Equine Encephalitis
- Novel recombinant antibody for detection and identification of Venezuelan Equine Encephalitis (VEE) virus and prophylaxis against/treatment of VEE infections
- Organic amine impregnated activated carbon
- Pulmonary delivery of liposome-entrapped d9-tetrahydrocannabinol
- Solar infrared ground clutter suppressor
- Stretchable protective fabric and protective apparel made therefrom
- Sun optical limitation illumination detector (solid)
- Synthesis process of nanotubes and nanofibers by directly heating the catalytic site
- Therapy of respiratory influenza virus infection using free and liposome-encapsulated ribonucleotides
- Thermoplastic chemically resistant polymer
- Treatment of intra-abdominal sepsis by liposome-associated cefoxitin
- Very high angular resolution laser beam rider detector

**Table 6 Significant International Partnerships**

**The Technical Cooperation Program (TTCP)**

Group	Technical Panels & Action Groups
Aerospace Systems	■ Uninhabited Air Systems
Command, Control, Communications & Information	■ Space & UAV Communication Technology ■ Space & UAV Communication Technology Information Assurance & Defensive Information Warfare ■ IO Symposium Committee
Chemical and Biological Defence	■ Medical Countermeasures against Biological Warfare Agents ■ Hazard Assessment ■ Detection of Biological Warfare Agents ■ Low Burden CB Individual Protective Equipment ■ Chemical Toxicology ■ Radiological Hazards ■ Passive Stand-Off Chemical Detection ■ BTWC-Related Analytical Methodologies
Electronic Warfare Systems	■ Countermeasures to Advanced and Coherent Threats to Air Platforms ■ Countermeasures to Surveillance & Targeting Radars ■ Electronic Support Systems ■ Anti-Ship Missile Countermeasures
Human Resources and Performance	■ Training Technology ■ Physiological and Psychological Aspects of Using Protective Clothing & Personal Equipment ■ Human Factors in Aircraft Environments ■ Physical & Cognitive Performance Enhancement for Conventional & Special Operations ■ Human Factors Integration for Naval Systems ■ Survival Psychology ■ Human Aspects of Command
Joint Systems and Analysis	■ Land Systems ■ Modelling & Simulation ■ Joint Concepts & Analysis ■ Systems Engineering for Defence Modernization ■ Small Unit Land Operations ■ Unmanned Aerial Vehicle Concepts ■ Defence Science & Technology Management ■ Technology for Effects-based Operations



## The Technical Cooperation Program (continued)

Group	Technical Panels & Action Groups
Maritime Systems	<ul style="list-style-type: none"> <li>■ Maritime Command, Control and Information Management</li> <li>■ Maritime Systems Studies</li> <li>■ Sonar Technology</li> <li>■ Maritime Air Systems</li> <li>■ Mine Warfare and High Frequency Acoustics</li> </ul>
Materials and Processing Technology Group	<ul style="list-style-type: none"> <li>■ Metals Technology and Performance</li> <li>■ Non-destructive Evaluation for Aging Military Platforms</li> <li>■ Polymers, Adhesives and Coatings</li> <li>■ Composites Technology and Performance</li> <li>■ Technologies for Enhancing Individual Combatant Protection</li> </ul>
Sensors	<ul style="list-style-type: none"> <li>■ Multi-Sensor Integration</li> <li>■ Signal and Image Processing</li> <li>■ Radar Systems and Technology</li> <li>■ Radar Detection of Small Targets in Clutter</li> <li>■ HF Surface Wave and Line-of-Sight Radar</li> <li>■ Surveillance from Space-Based and High-Altitude Platforms</li> </ul>
Conventional Weapons Technology	<ul style="list-style-type: none"> <li>■ Energetic Materials &amp; Propulsion Technology</li> </ul>

## NATO Research and Technology Organization

Panel	Technical Teams
Human Factors & Medicine	<ul style="list-style-type: none"> <li>Therapy and Prophylaxis of Chemical Warfare Agents</li> <li>Toxicity of Non-CW Chemicals in Military Environments</li> <li>Test Methodology to Assess PPE Performance against AP Mine Blast</li> <li>Radiation Injury &amp; Medical Countermeasures</li> </ul>
Information Systems Technology	<ul style="list-style-type: none"> <li>Information Assurance</li> <li>Visualization of Massive Multimedia Data Sets</li> </ul>
System Concepts and Integration	<ul style="list-style-type: none"> <li>Countermeasures to Imaging Radars</li> <li>Tactical Implications of High Power Microwaves</li> <li>Force EW Command and Control in the Context of Anti-Ship Missile Defence (ASMD)</li> <li>Susceptibility of Mobile Tactical Radio Systems</li> <li>Systems Concepts and Integration Panel</li> </ul>
Sensors & Electronics Technology	<ul style="list-style-type: none"> <li>Radar Signatures in Littoral Environment</li> <li>Integration of Radar and Infrared for Ship Self Defence</li> <li>Impact of Emerging Technologies on Air Defence Radars</li> <li>Generation of Synthetic Data Bases for NCTR by Radar</li> <li>Electromagnetic Compatibility in the Defence Systems of Future Years</li> </ul>

## Bilateral and Multilateral Agreements

- US TRDP PA on Distributed Mission Training
- US Information Exchange on Ballistic Missile Defence
- US Information Exchange on Integrated Command Environment, Smart Ship Technologies, and Capital Investment for Labor Technologies
- US NICOP: Navy's International Collaborative Opportunity Program
- UK Memorandum of Understanding: Chinook
- US/UK Memorandum of Understanding on Research, Development and Acquisition of Chemical, Biological and Radiological Defensive Materiel
- UK/Netherlands Memorandum of Understanding on Human Factors
- European Commission ESPRIT Project on Medical Tomographic Imaging