

DEFENCE



DÉFENSE



Looking Forward Staying Ahead

Into the Next Century



National
Defence

Défense
nationale

Canada

DEFENCE



DÉFENSE

Looking Forward Staying Ahead Into the Next Century



National
Defence

Défense
nationale

Canada

September 1999

Additional copies of this report are available from:

Director Science and Technology Policy
Defence Research and Development Branch
National Defence
Constitution Building, 8th floor
305 Rideau Street
Ottawa, Ontario
K1A 0K2

Tel.: (613) 995-2091

Fax: (613) 996-5177

Message from the Chief

As the events of the past few years have shown, the Canadian Forces (CF) must respond to an increasingly diverse set of challenges, including peacekeeping missions, disaster relief and coalition operations. As the battlespace becomes driven by high technology and the spectrum of conflict becomes broader, the Defence Research and Development (R&D) Branch is playing an increasing role in equipping, organizing and training a combat capable force as well as contributing to future defence policy.

In carrying out the defence R&D program, our strategy is to align our R&D activities with *Defence Strategy 2020* and establish key objectives relating to each of our four mission elements. This year we have set ambitious targets for moving into the next century. These targets reflect the impact that rapid technological advances are having on the nature and spectrum of conflict. As such, we need to begin work now on developing a science capacity capable of responding to military requirements in the 2020 timeframe.

Over the past year, the Department of National Defence (DND) has focused on establishing defence objectives to support its new strategic direction to increase the overall effectiveness and relevance of the Canadian Forces. In response to this direction, we will implement a Technology Investment Strategy that increases investment in key areas corresponding to future military requirements. At the same time, work will continue in our Defence Research Establishments to deliver science and technology (S&T) products and services to the field for use by the Canadian Forces.

Recognizing the importance of our partners in industry, universities and in allied nations, we will be establishing new programs that facilitate collaboration with partners and increase the science and technology we access through partnering activities. An expanded collaborative program with the United States, the appointment of two new university chairs and new methods for working with the private sector will enhance the scope and effectiveness of the R&D program.

We will also be working more closely with the defence industry to use Technology Demonstration as a means of testing and evaluating new technologies. The aim of this Program is to explore new ways to insert technologies into operating systems and thus enhance Canada's response to defence challenges.

The key to delivering on our objectives for the year ahead is our high calibre of scientific, technical and administrative staff. To ensure that we maintain our high standard of human resources, we will implement a new operational structure – one that brings together best S&T practices with a forward-looking defence R&D program. Overall, our goal is to situate defence R&D as a responsive, innovative and efficient member of the Defence Team into and through the next century.



John Leggat
Chief Research and Development

Our Vision

As Canada's lead defence science and technology organization, our vision is to provide science and technology leadership to the Department, the Canadian Forces, and the Canadian defence industrial base into and through the next century.

Our Mission

As the national authority for providing S&T leadership in the advancement and maintenance of Canada's defence capabilities, the Defence Research and Development Branch establishes key objectives that will meet the elements of the mission:

- Facilitates and enhances the ability of decision-makers to make informed decisions on defence policy, force generation and procurement by providing expert S&T knowledge;

To work towards doubling, by 2002, our investment in four growth areas identified by the Technology Investment Strategy and aligned with Defence Strategy 2020.

In partnership with other elements of DND, to develop a Departmental approach to the use of Modelling and Simulation for testing and evaluating new concepts and systems.

- Contributes to the success of military operations by pursuing R&D activities that provide improved support, knowledge, protection and response to potential threats;

To have at least 10 S&T initiatives/products developed by the Branch ready for implementation by the Canadian Forces by next year.

To initiate five new collaborative R&D projects with the United States.

- Enhances the preparedness of the Canadian Forces by assessing technology trends, threats and opportunities and by exploiting emerging technologies; and

To establish a Technology Outreach Program with Canadian universities by sponsoring two more University Chairs in new technology areas.

To initiate at least five new Technology Demonstration Projects.

- Supports government objectives by contributing to the creation and maintenance of a Canadian defence S&T industrial capability that is internationally competitive.

To license five technology concepts to industry for further development.

To work towards targets of leveraging \$30M from national partners and \$40M from international allies, and generating \$10M in revenue from external sources by 2004.

Our Values

- Scientific integrity and professional responsibility are integral parts of our corporate culture. We are committed to maintaining these attributes and to demonstrating them in all our R&D activities.
- As part of the Defence Team, we are dedicated to providing responsive, efficient and cost-effective services.
- We are committed to developing the skills and expertise of our employees, enhancing their well-being, and building a workforce dedicated to competence and excellence.



Table of Contents

Message from the Chief	i
Our Vision, Mission and Values	ii
Introduction	1
Contribution to Defence Strategic Planning	2
Building a Strategy for the Next Century	2
Advancing the Revolution in Military Affairs	2
Aligning Technology Strengths with Defence Needs	4
Expanding the Use of Technology Demonstration	4
Technology Demonstration Projects	5
Responding to Defence Requirements	6
Transferring Technology to Our Clients	6
Contributions to National and Defence Initiatives	7
R&D Initiatives for the Year Ahead	8
Expanding the Defence S&T Network	9
Working with Our Allies	10
National Collaboration	10
University Partnerships	10
Maintaining a Strong Technology Base	10
Meeting Our Targets	11
Adopting Best Practices in Science and Technology	12
Conclusion	13
Annex A – Defence R&D Activities	14
Annex B – R&D Thrust Summary	15
Annex C – Technology Investment Fund Projects	17
Annex D – Defence R&D Branch Organization, Client Services and Program Formulation	18
Annex E – Resource Summary	19

Introduction

Defence research and development supplies Canada's military with the latest technologies and provides information on technology threats and opportunities, both in theatre and at home. As the Department prepares for the 21st Century defence environment, the role of the R&D Branch in contributing to military strategies is expanding. According to Defence Planning Guidance 2000:

Technology will play an increasingly important role in the equipping, organizing and training of armed forces. Developments in technology, both current and anticipated, pose significant implications for military forces... Moreover, managing the impact of rapid technological change on military operations, communications, equipment, doctrine and force structure represents a significant challenge for the Department.

Our strategy to respond to the emerging defence environment and the change objectives established in Defence Strategy 2020 is set out in this document. The R&D Branch's contribution to the Department's long term strategic plan and our lead role in developing a Canadian response to the Revolution in Military Affairs enhance the ability of decision-makers to make informed decisions about defence policy, force generation and procurement. Our objective is to double the R&D investment in key technology areas that are aligned with DND's strategic direction.

In the year ahead, the R&D Branch will contribute to military operations by once again aiming to have at least 10 S&T initiatives and products ready for implementation by the Canadian Forces. We will also initiate new collaborative R&D projects with the United States to improve our support of defence strategies and our response to potential threats. In addition, our expanded Technology Outreach Program and our new Technology Demonstration Program will contribute to the preparedness of the Canadian Forces while ensuring the efficient use of DND's R&D resources.

Finally, as part of Canada's system of innovation, our goal is to support national objectives while setting new targets for leveraging DND's R&D investment to gain access to a broad technology base. This year, we will take steps to expand existing relationships and develop new programs that bring external R&D performers to work on defence challenges. Our activities with external partners will also be enhanced through the adoption of best science and technology management practices.

Key Objectives from 1999/2000

- *In partnership with the strategic planning element of the Department, to develop a Canadian position on the Revolution in Military Affairs.*
- *To have at least 10 S&T initiatives/products developed by the Branch adopted for implementation by the CF.*
- *To develop a Technology Investment Strategy that responds to the needs of the Department and the CF in 2020.*
- *To initiate at least five new Technology Demonstration Projects.*
- *To establish a business development strategy that maximizes the benefits of defence R&D. Targets for 1999/2000 are to leverage \$26M from external partners and generate \$3M in income from external sources.*

Key Objectives for 2000/2001

- *To work towards doubling, by 2002, our investment in four growth areas identified by the Technology Investment Strategy and aligned with Defence Strategy 2020.*
- *In partnership with other elements of DND, to develop a Departmental approach to the use of Modelling and Simulation for testing and evaluating new concepts and systems.*
- *To have at least 10 S&T initiatives/products developed by the Branch ready for implementation by the CF.*
- *To initiate five new collaborative R&D projects with the US.*
- *To establish a Technology Outreach Program with Canadian universities by sponsoring two more University Chairs in new technology areas.*
- *To initiate at least five new Technology Demonstration Projects.*
- *To license five technology concepts to industry for further development.*
- *To work towards targets of leveraging \$30M from national partners and \$40M from international allies, and generating \$10M in revenue from external sources by 2004.*

Contribution to Defence Strategic Planning

As with other sectors in society, advances in technology are dramatically changing the nature of conflict and in turn, the context in which military strategies and operations are carried out. A key factor in maintaining defence relevance in this environment is a defence technology capability that not only keeps pace with these advances but which can anticipate technological developments over the next quarter century.

For the Defence R&D Branch, this means working closely with our clients and allies to advance strategies that help orient current defence policy toward future requirements. Our contribution to departmental strategic planning recognizes the importance of technology in both planning and preparing for the future military environment.

Building a Strategy for the Next Century

Defence Strategy 2020 was developed by the Department, with input from the R&D Branch, to serve as the cornerstone for defence planning into the next century. This new strategic direction is based on the need for interoperability with allies and modern, combat-capable forces that can respond quickly to crises at home and abroad, in joint or combined operations.

Canada's primary allies are firmly committed to winning future conflicts through technological superiority. To be interoperable with them, Canada's Forces must possess compatible levels of technology and maintain access to relevant information. The Defence R&D Branch is playing a lead role in contributing to this strategy, both through its research and development activities and its leadership role in the national and international defence S&T community.

Key Objective for the Year Ahead

In partnership with other elements of DND, to develop a Departmental approach to the use of Modelling and Simulation for testing and evaluating new concepts and systems.

To achieve the vision set out by Strategy 2020, the Department will need focused R&D efforts targeting leading-edge technologies. For example, the R&D Branch's new Information Operations Program, along with our Modelling and Simulation initiative, will help modernize the force structure. As well, our commitment to expanding opportunities for international collaboration through an enhanced co-operative program with the United States and other close allies will enable us to strengthen key capabilities required to fulfil coalition operations.

Advancing the Revolution in Military Affairs

An important component of the Defence Strategy is the Revolution in Military Affairs (RMA). Driven by the innovative application of new technologies in warfare, the RMA is having a significant impact on the character and conduct of military operations. In response to last year's key objective, the R&D Branch co-sponsored with the Division of Strategic Planning, a symposium, "Canadian Defence Beyond 2010," that brought together stakeholders from the Department, allied nations, universities and industry to discuss Canada's response to the RMA. This symposium and the resulting Concept Paper *Canadian Defence Beyond 2010: The Way Ahead* put forth several recommendations that together will help prepare the Canadian defence community for the RMA-age.

Response to Last Year's Key Objective

Last year, the Defence R&D Branch worked with the strategic planning element of the Department to establish the foundation for a Canadian position on the Revolution in Military Affairs.

The R&D Branch is engaging the RMA through its Technology Investment Strategy, which identifies areas of research relevant to the future operating environment. These areas reflect the rapid integration of information technologies, sensors and precision technologies that form much of the foundation for the future battlespace. Advances in research dealing with Human Factors Engineering, Information Warfare and Knowledge Management will contribute to the Canadian Forces' ability to operate across a broad spectrum of conflict.

Our work over the coming years will continue to focus on the technological advances that are required for an RMA-age force. We recognize that the future is characterized both by uncertainty and rapid technological change. Our strategy is to work closely with military operators and allies to apply our R&D resources in meeting the emerging technology challenges brought about by the RMA.

Selected R&D-focused Recommendations for a Way Ahead in RMA

- *Establish a joint experimentation facility with greater use being made of technology demonstration and a robust modelling and simulation capability.*
- *Initiate closer collaboration with the United States, particularly with their new Battlelab responsible for Joint Experimentation.*
- *Establish a national infrastructure vulnerability centre with DND, industry and other government departments to co-ordinate Canada's response to asymmetric threats.*
- *Ensure that the future S&T program is closely integrated with the Department's objectives and goals to achieve coordination between doctrine, organization and technology resulting in the desired level of interoperability.*



Aligning Technology Strengths with Defence Needs

Translating long-term defence strategy into technological capabilities for the future means drawing on our diverse network of science and technology partners. It also means fostering a human resources regime that rewards innovation and promotes teamwork. Above all, it means ensuring that we are focusing on the right technologies and performing R&D activities relevant to future military operations. To this end, we are implementing a Technology Investment Strategy that addresses Canadian Forces requirements in 2020 and identifies the most promising R&D activities for delivering on the CF's future technology needs.

Last year we identified a set of 10 defence outcomes towards which the R&D program will be aimed. Based on these outcomes, 21 R&D activities (Annex A) will be undertaken by the Branch, with support from our allies and our partners in Canadian industry and universities. The following R&D areas will be targeted for investment growth over the next decade to enable us to respond to Defence Strategy 2020:

- Autonomous Intelligent Systems
- Emerging Materials and Bio-molecular Technologies
- Human Factors Engineering and Decision Support
- Information and Knowledge Management
- Network Information Warfare
- Psychological Performance
- Signature Management
- Simulation and Modelling for Acquisition, Rehearsal and Training
- Space Systems

Response to Last Year's Key Objective

The R&D Branch has developed a Technology Investment Strategy to meet the requirements of its clients into the next century.

Key Objective for the Year Ahead

To work towards doubling, by 2002, our investment in four growth areas identified by the Technology Investment Strategy and aligned with Defence Strategy 2020.

Expanding the Use of Technology Demonstration

Our Technology Investment Strategy relies on the efficient use of resources in evaluating and developing new technologies. The new Technology Demonstration (TD) Program launched this year will be used to assess new technology concepts without having to go to full development of new systems and products. The R&D Branch is using this program to demonstrate and validate technology solutions for new and emerging CF operational systems and concepts, including the capability to respond to asymmetric threats. By using Technology Demonstration, we are also able to give our industrial partners the opportunity to evaluate and display the utility of new technologies and to explore options for inserting them rapidly into operational systems.

Key Objective for the Year Ahead

To initiate at least five new Technology Demonstration Projects.

Technology Demonstration Projects

In keeping with last year's key objective, we initiated seven new Technology Demonstration projects under the new Technology Demonstration Program. In the coming year, we will expand this program to further our use of this effective means of assessing and developing defence technologies.

The following Technology Demonstration (TD) Projects will begin in 2000.

Response to Last Year's Key Objective

Seven new Technology Demonstration projects have been initiated with plans to expand the program in partnership with Canadian industry.

- **Advanced Distributed Mission Training (ADMT):**

This project will demonstrate the potential of Distributed Mission Training (DMT) in mission rehearsal and aircrew training. This TD will be used to evaluate new operational and equipment concepts for acquisition to upgrade the CF-18 Multi-Task Trainers.

- **Command Decision Aids Technology I (COMDAT I):**

This project will build on past and present R&D on Multi-Source Data Fusion and the Human Computer Interface to present the Maritime Tactical Picture to the operator in a more easily understood and meaningful way.

- **Common Operating Picture (COP):** This tool set will contain up-to-date information, gathered from surveillance, intelligence and other sources, on the environment, the status of our adversaries and on our own allied forces. The COP will allow commanders to develop strategic, contingency and/or tactical plans and to monitor the execution of those plans.

- **Future Armoured Vehicle System (FAVS):** This initiative assesses the ability of light armoured vehicles, incorporating advanced technology, to successfully fight and survive against main battle tanks on the future battlefield.

- **Ground Moving Target Indication (GMTI)**

Surveillance*: This Technology Demonstration will add an experimental GMTI mode to RADARSAT 2 civilian remote sensing Synthetic Aperture Radar, creating the world's first space based radar with GMTI capabilities.

- **High Capacity Tactical Communications Network:**

This project will assess future tactical communications technologies and methods of adapting and exploiting these technologies to assist the Land Forces in meeting its requirements for high capacity data and voice communication networks.

- **Tactical Aviation Mission System Simulation**

(TAMSS): This project will create an overall system simulation of the CF146 Griffon that links simulations among Defence Research Establishments, industry and allied nations and demonstrates the contribution of tactical aviation to the situational awareness of the Land Force Commander.

*The Ground Moving Target Indication Surveillance Technology Demonstration begins in 1999.

Responding to Defence Requirements

Our role in strategic defence planning is complemented by the requirement to meet the more immediate needs of the Canadian Forces. Our mission and activities reflect this critical aspect of defence R&D to provide improved support, knowledge and capability to the Canadian Forces.

Key Objective for the Year Ahead

To have at least 10 S&T initiatives/ products developed by the Branch ready for implementation by the CF.

Transferring Technology to Our Clients

Working closely with Canadian Forces clients helps us to ensure that the research we undertake is both relevant and timely. In response to last year's key objective, several S&T initiatives and products developed by the R&D Branch were adopted for implementation by the Canadian Forces. Ten of these projects are listed below.

Response to Last Year's Key Objective

The Canadian Forces adopted 10 S&T initiatives and products for implementation.

The concept of performing a seabed survey using a towed side-scan sonar, recording the images and then comparing these with images obtained after mines were laid, has been incorporated as part of Canada's new mine hunting strategy.

The Space System Concepts and Technologies project provided the Joint Space Project (G2667) with new concepts, techniques and technologies for military space-based surveillance and earth observation systems and applications.

A new mobile nuclear laboratory has been delivered to provide a rapid detection and identification capability to the Canadian Forces Nuclear, Biological and Chemical Response Team.

The Joint Intelligence Information Management System (JIIMS) was transferred to 1 Canadian Division. JIIMS is a document management system designed to meet the specific requirements of intelligence operations.

The passive localization assistant will be incorporated in Canadian Towed Array Sonar System (CANTASS) to assist operators in performing target motion analysis on submarines.

The development of a new computer performance model for AIM 7 and AIM 9 air-to-air missiles provided the Air Force with a state-of-the-art software model to support air operational studies.

A compact version of software for the Canadian Electronic Warfare Operations Centre was developed for deployment with Operation Palladium.

The Electronic Battle Box (EBB) is an integrated suite of planning and decision aid tools specially designed to help staff officers in training and operations. The EBB significantly reduces the time required for planning and allows for a better focus on essential tasks. Several thousand copies of Version 2 of the EBB were delivered to the army and are now being used in operations.

HI-6, a nerve agent antidote, is now available for use by the CF deployed outside of Canada.

The field portable Canadian Integrated Biochemical Agent Detection System (CIBADS) was followed-up for real-time detection of CB agents. A prototype CB Sentry was deployed during Operation Determination on board *HMCS Toronto*.

Contributions to National and Defence Initiatives

Last year the R&D Branch also made some significant contributions to national and departmental initiatives.

The Canadian Centre for Mine-Action Technologies (CCMAT)

The Defence R&D Branch participates in the federal government's Mine Action Initiative (MAI) through the Canadian Centre for Mine-Action Technologies established at Defence Research Establishment Suffield (DRES). With an initial investment of \$17M over five years, CCMAT will provide global support for the International Landmine Treaty by developing new technologies for humanitarian demining.

The Centre brings together members of the Canadian Forces, defence scientists, industry as well as non-government organizations to work on new solutions for humanitarian demining. The CCMAT scope includes mine detection, protection equipment, mine neutralization, enabling technologies and victim assistance. The CCMAT is also working with DGOR and DREV to identify alternative technologies to antipersonnel landmines. Current activities include a multi-sensor hand-held mine detector, mechanical assistance to demining, development of protective clothing, antipersonnel landmine blast characterization, and prosthetic foot development. Further details on CCMAT can be found at their website www.ccmat.gc.ca.

The R&D Branch also participates in an International Test and Evaluation Program to evaluate new technologies for humanitarian demining. In 1999, a team travelled to Cambodia to evaluate an instrumented prodder developed by the R&D Branch. The results are currently being used to improve production design.

The Human in Command

In preparing for the emerging defence environment, military leaders are focusing on the value of their most important resource – people. The primary means by which members of the Canadian Forces have to respond to the life and death decisions they make in the course of operations is through decisive command and control. The R&D Branch recognizes the importance of this aspect of military operations and has undertaken a new program to increase the understanding of 'the human in command'.

This research program is having a significant impact on communications, information, leadership, organizational structures and teamwork in the military. Aspects of this research have already been incorporated into the Land Forces Command doctrine and are being examined by other groups within the Canadian Forces.

Research in this field has also made a significant contribution to international work in Command and Control. A NATO workshop dealing with the human component of Command was held with Canadian scientists taking a lead role in bringing the military operational and scientific communities together to identify issues requiring further research. Work will be ongoing in this area with a second NATO workshop being hosted by the Dutch government in 2000.

R&D Initiatives for the Year Ahead

Over the next year, we will undertake several R&D initiatives to enhance military preparedness. A sample of these initiatives is listed in the table below.

<p>Air</p>	<p>A Technology Demonstration for <i>Directional Infrared Countermeasures</i> will examine and demonstrate the use of a laser system to defeat infrared missile seekers via a Mid-Infrared Active Imaging Mission-Approach-Warning-System/Dazzler. Upon detection, the system will focus and track the laser, and dazzle and defeat the missile seeker.</p>
<p>Maritime</p>	<p>The resources devoted to <i>Shipborne Command, Control, Communications and Intelligence</i> will be increased. Research conducted by the Branch in data fusion/decision support and in Human Engineering will feed planned technology demonstration efforts.</p> <p>A <i>Way Ahead Working Group</i> is being established with the Client to address the requirement for work on sensor integration. This Group will co-ordinate a reorientation of the program and establish the preparatory scientific and planning activities to reduce the risks associated with the Shipboard Integration of Sensors and Weapons Systems Technology Demonstration.</p>
<p>Land</p>	<p>The Land Force <i>Strategic Direction and Guidance</i> has identified the importance of inculcating an understanding of S&T into Future Army planning. A number of initiatives are being considered that promote S&T awareness within the Army, including briefings on significant S&T topics, R&D initiatives, emerging technology threats/opportunities and increased participation in, and support to, Land Force colleges and training centres, in particular, the Land Force Technical Staff Program.</p>
<p>Command, Control Information Systems</p>	<p>An <i>Information Operations</i> program will be initiated to seek to understand the vulnerability of networks in order to protect the various engagement techniques. The program will develop tool sets for network analysis, protection, intrusion detection, deception, reaction and engagement.</p>
<p>Human Performance</p>	<p>Phase I of the <i>Vaccine Development Initiative (VDI)</i> will be carried out in partnership with industry, the biotechnology sector and close allies (United States/United Kingdom). This initiative will allow Canada to develop and provide vaccines to its personnel to protect and defend against biological agents.</p> <p>To increase the awareness and understanding of the expanding risk of asymmetric <i>Chemical/Biological (CB)</i> terrorist threats, the R&D Branch will begin collaborative R&D work with the Health Protection Branch of Health Canada aimed at countering CB threats. Similarly, collaborative work with the US is being discussed, through the department of the Solicitor General of Canada.</p>

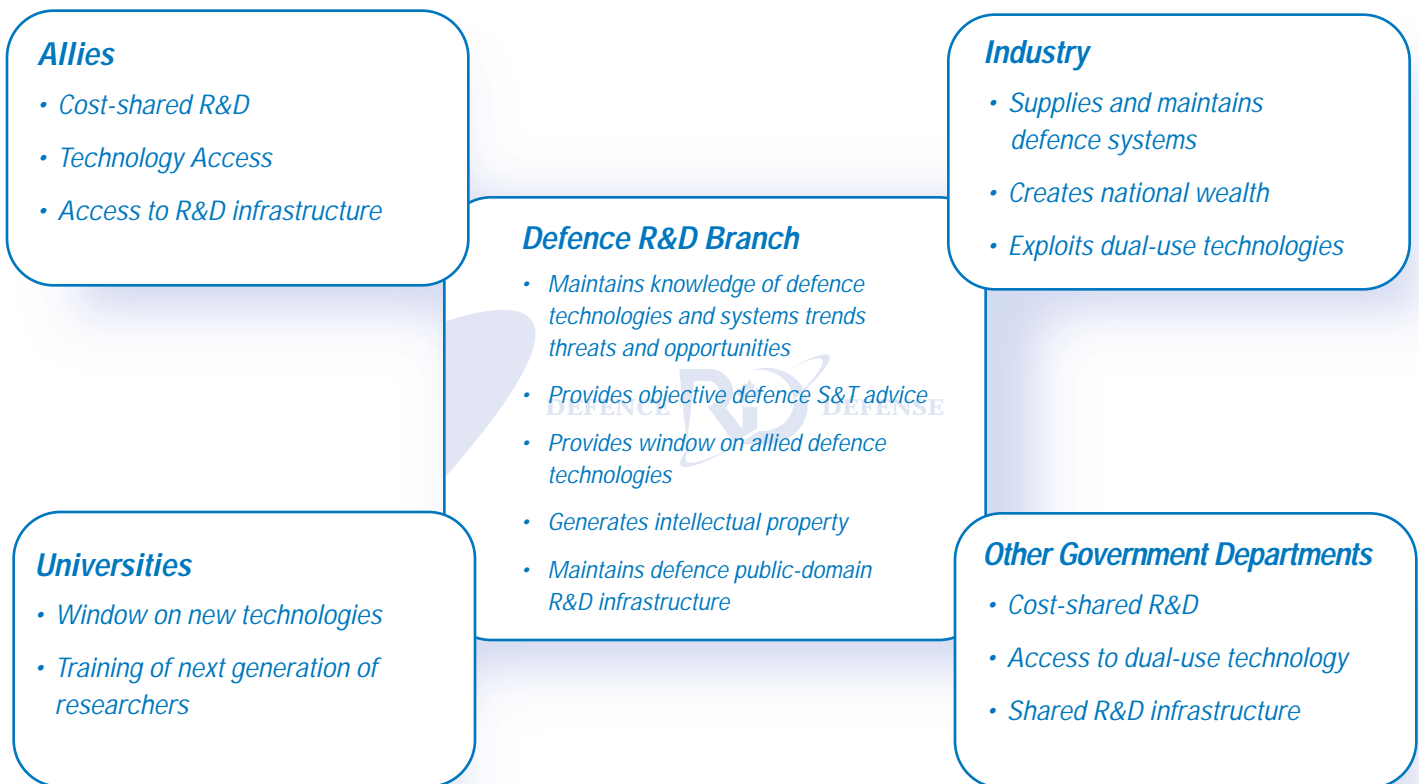
Expanding the Defence S&T Network

The Defence R&D Branch is well positioned to respond to defence requirements and contribute to Canada's innovation system through a national network of Defence Research Establishments and scientific expertise in leading-edge technology areas. We recognize the importance of fostering partnerships and transferring technology and knowledge from our labs for use in Canadian industry. We rely on our partners to provide us with access to a broad technology base and share in the delivery of the defence R&D program. To enhance the effectiveness of these partnerships, we are pursuing new initiatives to promote collaboration and to expand partnering arrangements.

National Network of Research Facilities

The R&D Program is delivered through a structure of Thrusts, distributed among technology areas. A summary of R&D Thrusts is listed in Annex B. These activities are carried out at our five Defence Research Establishments (DREs): DRE Atlantic (DREA) in Dartmouth, N.S.; DRE Valcartier (DREV) outside Quebec City; DRE Ottawa (DREO); Defence and Civil Institute of Environment Medicine (DCIEM) in Toronto; and DRE Suffield (DRES) near Medicine Hat, Alberta.

Network of S&T Partners



Working with Our Allies

Despite the relatively small size of Canada's defence R&D organization, we deliver a comprehensive program of defence technologies to our clients. By participating across a spectrum of international collaborative bodies, including The Technical Co-operation Program (TTCP), the NATO Research and Technology Organization and numerous bi- and multi-lateral arrangements, we gain access, on a quid-pro-quo basis, to leading-edge defence technologies and information.

Last year, our activities in the international arena provided an estimated benefit of \$28M to Canada. Our plan to expand co-operation with the United States while continuing to be active with our other international R&D allies is reflected in our goal to increase this benefit to \$40M annually by 2004.

The **Canada-US Co-operation Initiative** addresses both the requirement for interoperability and reflects of the importance of leveraging our limited resources with one of our closest allies. The aim of this program is to access and share advanced technologies to enlarge competencies, fill technology gaps and reduce the cost of technology development and insertion.

Key Objective for the Year Ahead

In advancing the goals of collaboration and interoperability, initiate five new collaborative R&D projects with the United States.

National Collaboration

Working with the private sector to deliver the defence R&D program not only maintains a Canadian defence S&T industrial capability but also provides us with access to a broad technology base. Last year, the impact of this access was valued at \$26M – this represents research and development that would otherwise not have been available to support military operations. As part of our plan to develop and expand our partnerships with Canadian industry we have established a five year goal to increase the contribution of our partners to \$30M.

The **Defence Industrial Research (DIR) Program** continues to be an important way of soliciting innovative R&D proposals from industry that have potential defence application. The DIR program is a 50/50 cost shared arrangement with industry where projects are selected by an Advisory Committee

comprised of defence scientists, industry representatives and military clients. Next year we will focus the DIR program to further assist small and medium sized enterprises to exploit emerging technologies in partnership with our defence scientists.

University Partnerships

In partnership with the Natural Sciences and Engineering Research Council (NSERC), the R&D Branch will continue to participate in a jointly funded and managed **Research Partnership Program**. This program supports university-based research for defence requirements and is co-funded by the R&D Branch, NSERC and industry.

The R&D Branch continues to co-sponsor **University Chairs** at Dalhousie University and at the University of Victoria to monitor developments in the field of ocean acoustics. Over the next year we will expand our technology outreach with Canadian universities and sponsor two more chairs in other technology areas as part of the Technology Outreach Program.

Key Objective for the Year Ahead

Establish a Technology Outreach Program by sponsoring two more University Chairs in new technology areas.

Maintaining a Strong Technology Base

The goal of the **Technology Investment Fund (TIF)**, funded at \$6M for 2000/2001, is to encourage staff and external research collaborators to put forward innovative ideas to explore new research areas. Proposals are reviewed by peers in industry, academia and other countries for scientific merit and novelty and further assessed on defence relevance and contribution to the Technology Investment Strategy. Technology Investment Fund projects that started in 1999/2000 are listed in Annex C.

Meeting Our Targets

The reality of reduced budgets is that government organizations must become more innovative in funding their programs and where possible, use their expertise to leverage resources and generate additional revenues. The R&D Branch is working to meet this challenge by examining opportunities to use our internal capabilities to meet external demands while continuing to focus on our primary mission of serving DND and the CF. Last year we generated \$3M in revenues from external sources. As we continue to work in partnership with other government departments and the private sector and adopt practices that facilitate more innovative collaboration, we project this figure to increase to \$10M over the next five years.

As part of our commitment to leverage the defence R&D budget more effectively and generate wealth in the economy, we have set aggressive targets for revenue generation and leveraging. While we have achieved the objectives we set for last year, we must continue to focus on new ways to increase the benefits of our partnership, both nationally and internationally.

Key Objective for the Year Ahead

To license five technology concepts to industry for further development

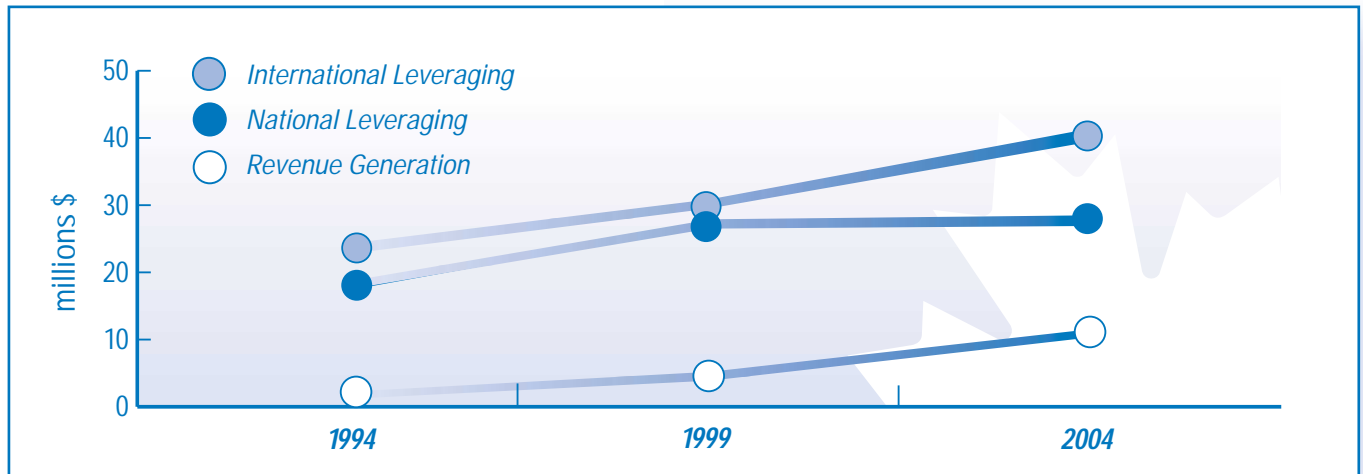
Response to Last Year's Key Objective

Through our business development activities, we generated \$3M from external sources and, through collaboration with national partners, leveraged \$26M worth of R&D last year.

Key Objective for the Year Ahead

To work towards targets of leveraging \$30M from national partners and \$40M from international allies and generating \$10M in revenue from external sources by 2004.

Business Development Activities and Targets



Adopting Best Practices in Science and Technology

The R&D Branch is adopting best management practices in science and technology. These practices reflect the long-term and often uncertain nature of R&D. They also reflect the importance of an effective human resources regime, one which rewards teamwork and encourages innovation. Finally, they will allow the organization to be flexible in establishing partnerships with other S&T performers, both in Canada and abroad, and use these linkages to increase our science capacity.

Effective 1 April 2000, we will become a defence R&D agency with an operating framework geared specifically to the requirements of an R&D organization. Some of the features of the agency that will be implemented over the next year are listed at right:

We have instituted a performance evaluation process that includes peer review, client satisfaction surveys and assessment of delivery against agreed milestones. The Annual Performance Reports will identify areas for improvement and change.

Externally, we are benchmarking ourselves against other defence R&D organizations. In partnership with the United Kingdom, United States and Australia, the R&D Branch is leading an effort to share best S&T management practices. This exercise has also identified areas where we can work in partnership with our allies to advance effective management practices in emerging areas such as knowledge management.

A Human Resources Strategy that includes competency-based profiling to align the S&T workforce with the Technology Investment Strategy, a recruitment and apprenticeship program for recent graduates and succession planning for key positions and for future managers to promote more effective knowledge and information transfer.

Collaboration mechanisms that facilitate the exchange of knowledge, technology and personnel between R&D organizations. These mechanisms will respond quickly to new partnering opportunities and provide flexibility in setting contracts and managing intellectual property.

Financial management tools, such as reinvesting revenues and managing budgets over multi-years to support business development initiatives and enable more effective long-term management of resources.



Conclusion

This document looks ahead to the emerging defence environment of the new century and the R&D response to this environment. New military challenges, advances in technology and a new way of operating in the public sector together define the way in which we will operate internally, as a partner and in the international arena.

We have developed a Technology Investment Strategy that, together with our linkages within the department and with industry and our allies, positions us to deliver a comprehensive defence research and development program for Canada. This R&D contributes to long-term defence needs and improves Canada's science capacity. Over the next five years we will strive to strengthen our role in the Defence Team to meet the technological challenges that are facing the Canadian Forces.

We will manage the defence R&D program to strengthen a culture that promotes excellence, encourages innovation and responds to the needs of our military clients. Managing more efficiently also means leveraging our activities to deliver an R&D program that supplements the defence investment in R&D.

We will continue to monitor our progress at all levels and establish new targets for the years ahead. Effective and responsive defence R&D will help ensure that the Canadian Forces of the next century is combat-capable and technologically prepared. We are focusing on this goal and setting the agenda to meet it.

Annex A - Defence R&D Activities

Listed below are the 10 Outcomes for the 2020 defence program and the 21 Defence R&D activities required to support them:

1. Timely, accurate asymmetric threat assessment and effective countermeasures.
2. Deployed covert, sensor systems with wide area coverage and adaptable resolution.
3. Rapid, reliable automated target identification, tracking and engagement of stealth targets.
4. Information and knowledge management for decision making in a complex environment.
5. Robust, survivable and covert systems for the 2020 warfighting environment.
6. Protection for the warfighter.
7. Lethality matched to mission – wide range of potential weapons effects.
8. Adaptable operator tailored systems.
9. Rapid technology development and insertion
10. Re-configurable simulation for training of individuals and teams, mission rehearsal and acquisition.

Defence R&D Activities

1. Autonomous Intelligent Systems
2. Chemical/Biological/Radiological Threat Assessment and Detection
3. Command and Control Information Systems (C2IS)
4. Communications
5. Electro-Optical Warfare
6. Emerging Materials and Bio-Molecular Technologies
7. Human Factors Engineering and Decision Support
8. Information and Knowledge Management
9. Multi-Environment Life Support Technology
10. Network Information Warfare
11. Operational Medicine
12. Platform Performance and Life Cycle Management
13. Precision Weapons
14. Psychological Performance
15. RF Electronic Warfare
16. Sensing (Air and Surface)
17. Sensing (Underwater)
18. Signature Management
19. Simulation, Modelling for Acquisition, Rehearsal and Training (SMART)
20. Space Systems
21. Weapons Effects

Annex B – R&D Thrust Summary

Thrust	Objective
Maritime	
Maritime Integrated Above Water Warfare	To develop new techniques in sensor signal and data processing, investigate systems integration concepts and improve individual technologies of sensors, weapons and countermeasures associated with above water warfare.
Maritime Command, Control, Communications and Intelligence	To enhance the effectiveness of commanders ashore and at sea by improving command's ability to manage data and information from all sources. More specifically, to develop cost-effective solutions in key areas such as local and wide data fusion, situation assessment, resource allocation, interoperability, computer networks, shipboard multimedia communication and to integrate Above Water Warfare and Under Water Warfare tactical world pictures into an accurate and understandable Maritime Tactical Picture.
Maritime Underwater Warfare	To investigate and develop techniques, concepts, system components and systems for detecting submarine, surface, torpedo, and mine targets. The primary emphasis of the thrust is on Naval and Airborne sonar systems. Electromagnetic detection of submarines from ASW aircraft is also included.
Maritime Mine Countermeasures Systems	To counter a mine threat to CF vessels by: advancing the state of the art in route surveying, mine hunting, mine identification, mine avoidance and ship silencing.
Naval Platform Technology	To maximize Canadian Maritime Forces operational effectiveness and safety by reducing underwater acoustic signatures, improving structural integrity, and establishing safe ship and submarine operational envelopes. To minimize construction, operating and maintenance costs by applying new platform and materials technology to Canada's naval fleet.
Land	
Soldier System	To meet the army's needs for science and technology for the soldier system, whether for system acquisition, maintenance or operation, or for the development of technologically-aware concepts of operation, doctrine or tactics.
Tactical Vehicle Systems	To meet the army's needs for science and technology for tactical vehicle systems whether for system acquisition, maintenance or operation, or for the development of technologically-aware concepts of operation, doctrine or tactics.
Information Operations	To meet the army's needs for science and technology in support of information operations whether it be for system acquisition, maintenance or operation, or for the development of technologically-aware concepts of operation, doctrine or tactics.
Military Engineering	To meet the army's needs for science and technology for combat engineering whether for system acquisition, maintenance or operation, or for the development of technologically-aware concepts of operation, doctrine or tactics.
Munitions & Firepower	To meet the army's needs for science and technology for weapon systems whether for system acquisition, maintenance or operation, or for the development of technologically-aware concepts of operation, doctrine or tactics.
Air	
Air Force Operational Information Management	To explore, develop and demonstrate advanced technologies that can be applied to command, control and intelligence systems to enhance air force effectiveness during normal, deployed, and contingency operations.

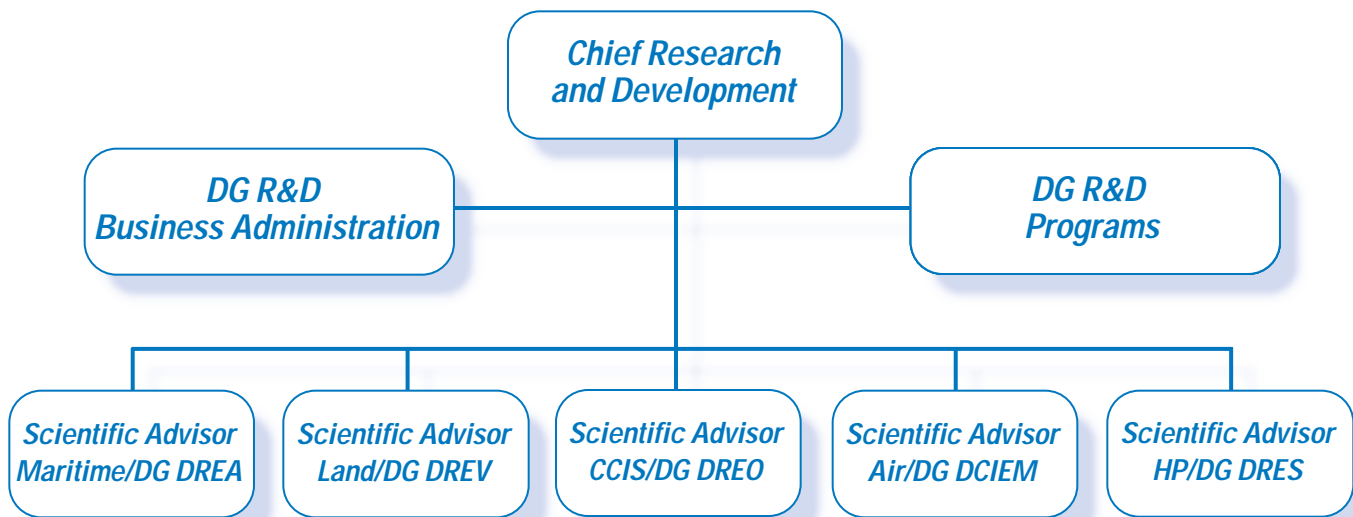
Aircraft Electronic Warfare	To enhance the effectiveness of the self-protection of CF aircraft through the application of electromagnetic technologies, in understanding the threat and in developing countermeasures.
Airborne Surveillance	To develop and exploit surveillance and observation techniques to enhance the surveillance and target acquisition capability of airborne platforms.
Air Weapons Systems	To assist with the improvement to existing weapons systems or the acquisition of new systems by evaluating the threat and system effectiveness, integrating weapon sub-systems and integrating weapons and platforms.
Air Vehicles	To reduce the costs of aircraft operations through the innovative application of S&T, while maintaining or improving airworthiness standards.
Aircraft Crewsystems Technologies	To improve the performance of Aircrews in Canadian Forces Aircraft.
Command and Control Information Systems (CCIS)	
National Level Command and Surveillance	To provide solutions to meet the current and future CF requirements for national level command and control functions. This includes the capability to develop and present the national common operating picture (COP) and to improve the associated strategic wide-area surveillance systems.
Information Operations	To ensure the CF and DND have access to technologies and technical advice which will allow them to establish and maintain information superiority by affecting adversary information while protecting their own; and to enhance electromagnetic surveillance and survivability by exploiting new developments in signal processing, electromagnetic technology and propagation.
Military Information Technology Infrastructure	To meet the CF requirements for world wide, secure, reliable passage of information to support stated and anticipated command, control, and intelligence (C2I) functions.
Space Systems and Technologies for Defence Applications	To support the DND space-policy objectives through the development of capabilities in space systems and technologies; space environment and electronics; space-based surveillance; and surveillance of space.
Human Performance (HP)	
Simulator Training Technologies	To maximize combat readiness and job performance, while maintaining costs, environmental damage, and risk to personnel safety.
Military Operational Medicine	To enhance the CF's capability to assess and prevent health hazards; to prepare for and sustain the delivery of health care and diagnose, treat and manage illness and trauma arising from conventional military operations.
Diving & Underwater Intervention	To support the development and acquisition of effective diving equipment for the CF; reduce injury and death of divers; and optimize the use of divers.
Human Factors in Military Systems	To support DND in the acquisition and operation of effective manned systems through R&D activities that: provide a better understanding of human decision-making; develop models of human capabilities and limitations; support the acquisition of modification of effective human-machine systems and equipment; and develop effective human engineering tools and techniques to support DND projects.
Defence Against Chemical, Biological and Radiation (CBR) Hazards	To conduct R&D leading to improved hazard assessment tools for field commanders, better detection systems, effective medical pretreatments and therapies, improved decontamination equipment, and less burdensome personal protective equipment.

Annex C - Technology Investment Fund Projects

Listed below are the Technology Investment Fund projects that began in FY 1999/2000. Proposals for start-up in FY 2000/2001 have been submitted and are being considered for funding.

99/00 Starts - Project Title	Objective
Active Range-Gated Hyperspectral Remote Detection and Identification of Biological Agents	Develop an integrated Biological agent detection system using a range-gated hyperspectral camera to detect the fluorescence of airborne living cells generated by short pulses from an Ultraviolet laser.
Mid-Infrared Active Imaging MAWS/Dazzler	Develop a technology demonstration of a mid-infrared imaging Missile Approach-Warning-System (MAWS).
Miniaturization of Extremely High Frequency Transmit/Receive Modules for Phased Arrays	Develop a communications transceiver module for future military phased array antenna applications.
Space-Time Adaptive Processing: Algorithm Design & Implementation for Airborne Radars	Research Space Time Adaptive Processing (STAP) algorithms and implementation to assist the CF in future airborne radar requirements.
An Intelligent Recognition System (IRS) for Sensor Surveillance	Develop a low-cost IRS which performs automatic detection and identification by extracting information from the environment.
Helmet-Mounted Fused Infrared/ Image Intensifier for Enhanced Night Vision	Build a helmet-mounted night vision system using both Infrared and Image Intensifier sensors and to present real-time fused imagery to the operator.
Self-Organized, Goal-Driven, Adaptive Learning	Demonstrate adaptive, goal-driven, self-learning using Recurrent Neural Networks in an information processing system for use in threat detection, image analysis, and target recognition.

Annex D - Defence R&D Branch Organization, Client Services and Program Formulation



R&D Thrusts

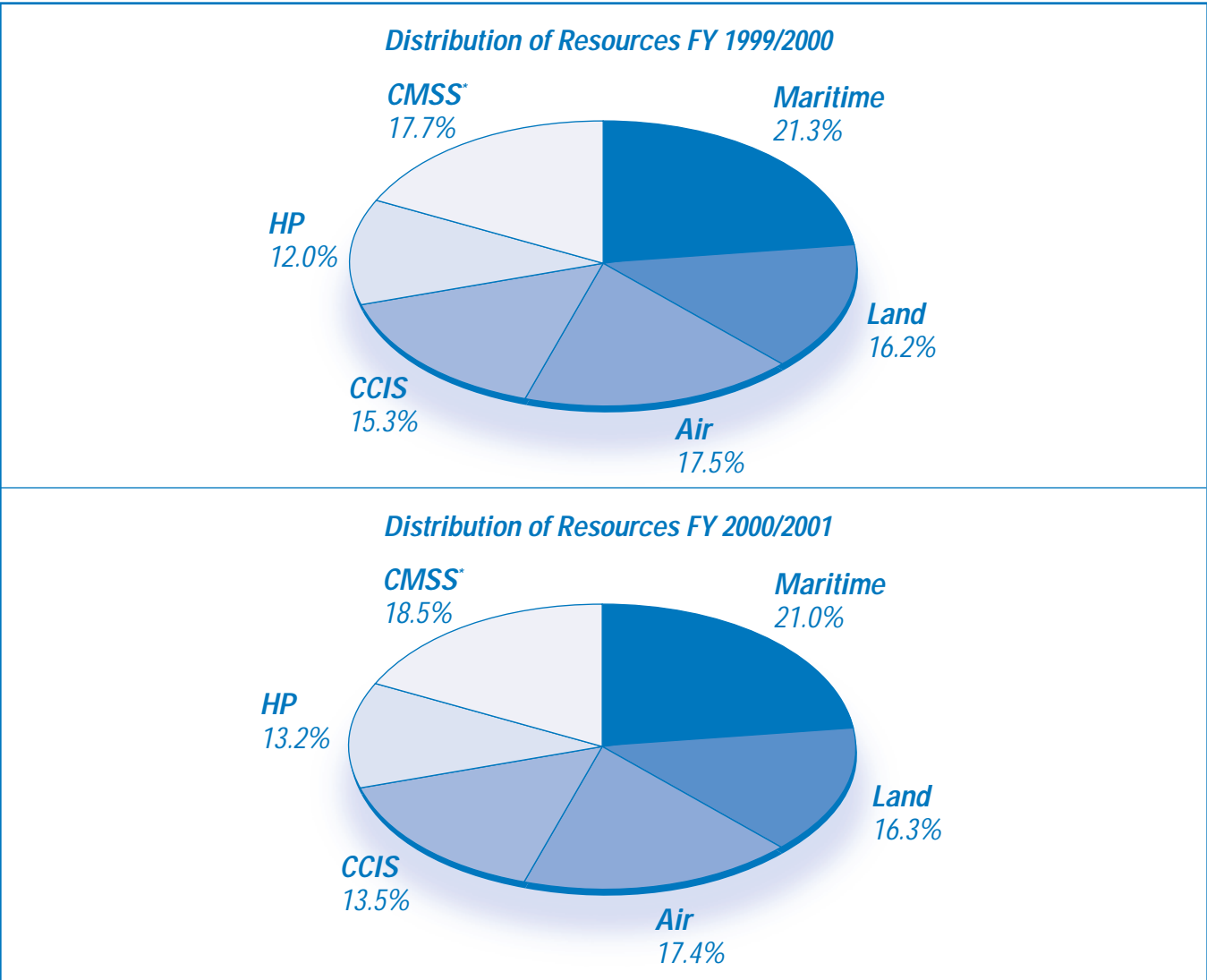
The technical program is delivered through Thrusts — delivery “packages” of R&D activities managed as projects and work units — that are developed in consultation with CF clients. Each Thrust addresses both technology investigation and technology application and is managed by a Thrust Leader who works with a team of R&D staff and external partners. Thrust Advisory Groups, which include client representatives, oversee the Thrust programs. (For more detailed information refer to the current Defence R&D Client Group Service Level Agreements and/or the Research and Development Branch Outline of Program or at <http://www.crad.dnd.ca>.)

The strategic direction, review and approval of the R&D Thrust program are conducted through the co-ordinated activities of designated committees and offices of primary interest. This process includes consultations with client groups at various levels to provide feedback on their priorities.

- The **R&D Advisory Council** is composed of senior representatives from DND, other government departments, industry and universities. The Council provides overall strategic direction and guidance on defence R&D.

- The **R&D Executive Committee (RDEC)** consists of the Branch Directors General and the military R&D advisor. It is chaired by the Chief of Research and Development. This Committee develops implementation guidelines and oversees the management and conduct of the R&D program. Scientific Advisors and their staff develop the R&D program within the guidelines set by RDEC and with advice from CF clients.
- Five **R&D Overview Groups** chaired by senior client representatives review and endorse the respective Client Group Service Level Agreements (SLAs). The Service Level Agreements for the R&D Thrusts that make up the Group SLAs are developed and prioritized by Thrust Leaders and their staff in consultation with subsidiary committees of the Overview Groups.
- The **R&D Program Review Committee (RDPRC)** reviews the defence R&D program to ensure that it reflects overall CF priorities and requirements.

Annex E - Resource Summary



*CMSS: Corporate Management Support Services