



Defence Research and
Development Canada

Recherche et développement
pour la défense Canada

LOOKING *FORWARD* Staying Ahead ²⁰⁰⁵



*FROM LAB COATS
TO BOOTS*

Looking Forward Staying Ahead is a strategic document that challenges all levels of Defence R&D Canada (DRDC) to achieve excellence by setting ambitious goals for the future.

Working within a five-year time frame, *Looking Forward Staying Ahead* outlines strategic directions aimed at bringing together the research centres of DRDC and our partners in the Canadian Forces, the Department of National Defence, and the public and private sectors.

One of DRDC's greatest challenges is to anticipate the future requirements of the Canadian Forces, from technological,

operational research and analysis perspectives. *Looking Forward Staying Ahead* lays the foundation for planning research that will expand the boundaries of current developments and prepare for future threats and opportunities.

Our commitment is to be the best, most responsive and most cost-effective source of information, advice and support in science and technology for defence and security.

March 2006

Additional copies of this report are available from:
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TABLE OF CONTENTS

A Message From the Chief Executive Officer	2
Vision, Mission and Values	4
Introduction	6
Key Objectives	7
S&T Strategy	8
Synchronizing S&T Efforts to Maximize Impact—The Defence S&T Strategy	8
Responding to the S&T Strategy—DRDC’s Implementation Strategy	10
S&T Capability	10
Program Outputs	10
Exploitation	11
Integrating Concepts	12
Business Model	13
Pursuing a Business Model That Stimulates Innovation	13
Corporate Services	14
Building Corporate Services Capacity	14
Ensuring Compliance with Government Priorities and Applicable Policies and Procedures	14
Support to Transformation, Support to Operations and Fielded Technologies	15
Support to Transformation	15
Support to Operations	15
Human Systems Integration	15
Command and Control	17
Mobile Systems	18
Personnel Protection	18
Fielded Technologies	19
Protection of Assets	19
Communications Networks	20
Personnel Protection	21
Developments Supported by the Defence Industrial Research Program	22
Human Systems Integration	22
Intelligence, Surveillance and Reconnaissance	22
Centre for Security Science	23
Conclusion	24
Annex A—Proposed Science and Technology Challenges	25
Annex B—DRDC S&T Programs	27
New Technology Demonstration Program Projects Started in 2005	27
Defence Industrial Research Program Projects Approved to Start in 2006	27
New Technology Investment Fund Projects Approved to Start in 2006	27
Annex C—Acronyms and Abbreviations	28

A MESSAGE FROM THE CHIEF EXECUTIVE OFFICER



Dr. Walker addresses staff during an all-employee meeting and tour at DRDC Ottawa.

Photo: Janice Lang, DRDC

The Canadian Forces and the Department of National Defence are transforming rapidly to ensure success in operations today and for the future. Science and technology is integral to this transformation. The theme of this year's *Looking Forward Staying Ahead* is "From Lab Coats to Boots" and it seeks to highlight the direct connection between the science workers in our labs and the men and women of the Canadian Forces on operations. To remain relevant, our science and technology program must not only help build defence capabilities to address future and emerging threats, but must also tackle immediate high-priority issues facing our sailors, soldiers, airmen and airwomen both in Canada and around the world.

In that respect, Defence Research and Development Canada (DRDC) has deployed a defence scientist to Afghanistan to act as an adviser to the in-theatre Commanders. DRDC will continue to expand its direct support to operations, enhancing our scientists' ability to intimately understand the situations and challenges that our Canadian Forces face.

Defence and security concerns are no longer focused predominantly on operations outside North America. In the post-9/11 era, the perception of the national security environment has changed drastically. As a result, the defence of Canada and North America is clearly the top priority for the Canadian Forces. This reality is reflected in the decision to create Canada Command, whose mission is to defend Canada and Canadians against threats to their security and to assist civil authorities in times of need such as the occurrence of natural or manmade disasters. DRDC is likewise positioning itself to inform, enable and respond to public security priorities –including the needs of Canada Command - where our strengths are appropriate to the task.

Through public security initiatives such as the Chemical, Biological, Radiological and Nuclear Research and Technology Initiative and the Public Security Technical Program, DRDC has demonstrated its leadership both in the delivery of defence- and security-related science and technology and in the coordination of the public security S&T agenda for the Government of Canada. In this latter regard, we are in the process of establishing the new DRDC Centre for Security Science, which in partnership with Public Safety and Emergency Preparedness Canada, will provide program management and coordination for federal S&T directed at the nation's most pressing public safety and security needs.

In short, we are moving ahead in a leadership role to ensure that science and technology is a key contributor both to addressing the public security needs of the nation and to enabling Canadian Forces transformation. Against this backdrop, DRDC has recently launched a two-year project to help take DRDC to the next level as a full-service defence and security science and technology organization. This will build on the organization's strong foundation and lay the groundwork for achieving the Agency's strategic goals. This project, entitled Expedition 07, will address three strategic objectives: our leadership in the development of a Defence Science and Technology Strategy, including positioning DRDC's response; solidifying the role of DRDC in support of public security; and finally, strengthening the enablers for success. This last objective has a particular focus on our management and corporate services capacity.

Collectively, these efforts will help ensure the long-term relevance and impact of science and technology for defence and security in Canada. Through the commitment and excellence of our employees, I am confident that DRDC will continue to enhance our legacy of providing excellence in science and technology to the benefit of the Canadian Forces, Canada and Canadians.

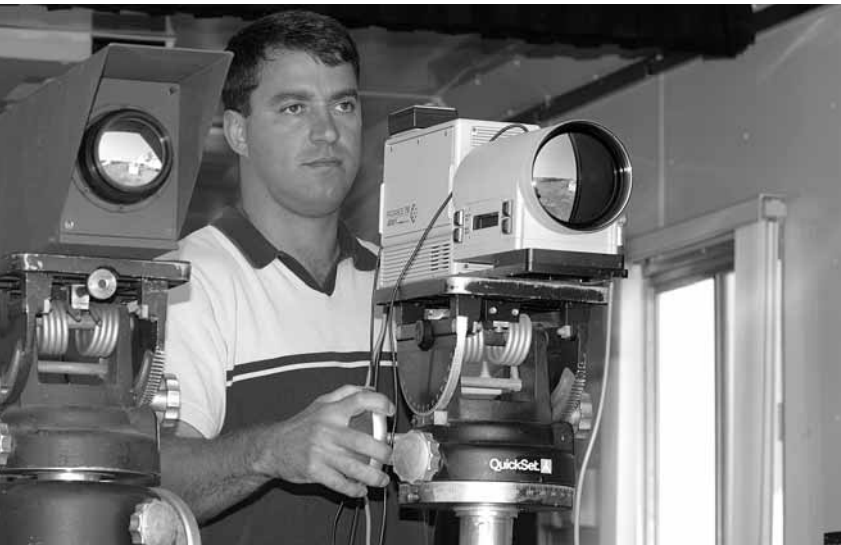


Robert S. Walker
Chief Executive Officer

VISION, MISSION AND VALUES

Our Vision

To be known worldwide as the best in S&T for defence and security.



Calibration of infrared cameras and measurement of sources during the SISWS trial.
Photo: Janice Lang, DRDC

Our Mission

Defence R&D Canada ensures that the Canadian Forces are technologically prepared and operationally relevant by:

- Providing expert S&T advice to the Canadian Forces and Department of National Defence;
- Conducting research, development and analysis to contribute to new and improved defence capabilities;
- Anticipating and advising on future S&T trends, threats and opportunities;
- Engaging industrial, academic and international partners in the generation and commercialization of technology; and
- Providing S&T for external customers to enhance Defence S&T capacity.



On guard wearing gear during SIREQ exercise.
Photo: MCpl Eric Gordon, Canadian Forces Combat Camera



Open House at DRDC Valcartier.
Photo: Michel Vigneault, DRDC

Our Values

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

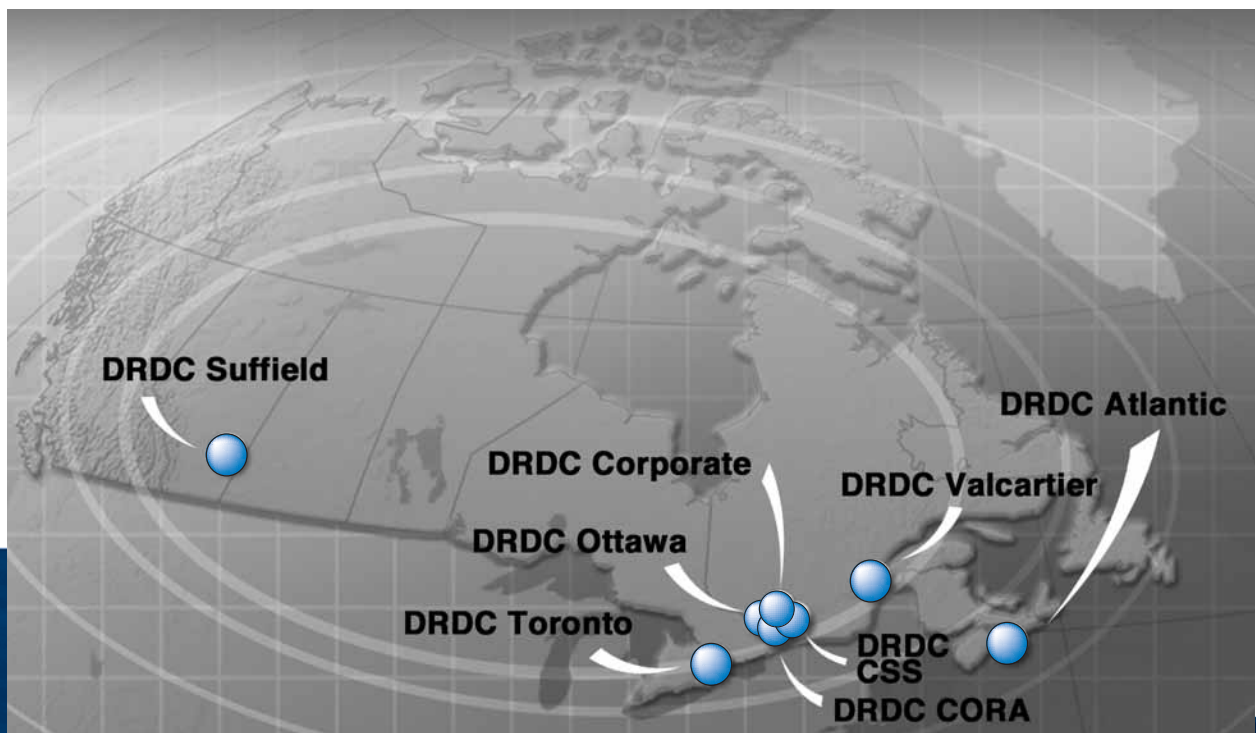
INTRODUCTION

At its seven current research centres, DRDC delivers excellence in leading-edge research, technology and analysis for the Canadian Forces (CF), so that they can respond to the new realities in military operations and plan for the future. DRDC's strong connections to the CF client community through Overview and Advisory Groups, as well as linkages to the Concept Development and Experimentation community, provide the framework for deciding what science and technology (S&T) to pursue. As a key player in The Technical Cooperation Program (TTCP) and the North Atlantic Treaty Organization (NATO) Research and Technology Organization, and through bilateral and multilateral collaborations with the US, the United Kingdom, Australia, France, the Netherlands and Sweden, DRDC is connected internationally and is able to leverage the results of those international collaborations to support the Department of National Defence (DND) and the CF. On the national scene, DRDC plays a leadership role in collaborative horizontal S&T initiatives involving other government organizations, industry and universities.

In order to meet the challenges of the new security environment, the Chief of the Defence Staff and the Deputy Minister have committed to a transformed CF, one that is more relevant, responsive and effective. New command and operational structures have been established. To deliver the right mix of forces to the right place, at the right time, to produce the right result, the CF will focus on integrated operations of maritime, land, air and special operations capabilities. The defence of Canada will be the top priority of the CF, including Canadian airspace and maritime approaches, as well as Canadian interests in the north. Overseas, the focus will be on addressing the challenges of failed and failing states with a mix of combat operations, stabilizing operations, and humanitarian relief and reconstruction efforts, as the lines between war and peace blur.

As a Special Operating Agency of DND, DRDC is fully engaged in the process of CF Transformation. In order to best support this transformation, DRDC is leading the development of a Defence S&T Strategy. This edition of LFSA details the direction that the Defence S&T Strategy is taking to ensure that the CF are

Map of DRDC centres.





CDS General Hillier addresses audience during the CF Transformation Ceremony.
 Photo: MCpl Jill Cooper, CFSU(O) Photo Services

technologically prepared and operationally relevant. The Defence S&T Strategy and DRDC's response to that strategy will encourage CF and DND members to tap more actively into the broad S&T capabilities available not only in-house, but also those available through partnerships with national and international collaborators. Support to CF operations is another area of particular importance to DRDC, and a section of this edition of LFSA describes some of the ways in which DRDC has supported and will continue to support the CF. As well, the new Centre for Security Science is highlighted. This new DRDC centre will provide direct support to Public Safety and Emergency Preparedness Canada (PSEPC), while contributing to and supporting the CF's public security capability needs.

This is a time of real change within DND and the CF. With the theme "From Lab Coats to Boots", this edition of *Looking Forward, Staying Ahead* is emphasizing the ongoing work that is being done in DRDC to support DND and the CF now and in the future. With the development of the Defence S&T Strategy, DRDC will provide the S&T leadership to allow the CF to be effective, ready, relevant and responsive for the challenges of the 21st century.



Advancing through trench system during training exercise.
 Photo: Cpl Terence Fernandes, 32 Canadian Brigade Group

Key Objectives

Each year LFSA sets key objectives to strengthen DRDC's S&T leadership and enhance the relevance and value of its contributions to defence and security. This year LFSA focuses on the following goals: developing a Defence S&T Strategy; developing a DRDC response to that strategy; developing a business model to reflect that strategy; developing a new Public Security centre; and developing integrating concepts for the CF. The following key objectives support these goals:

1. Develop a Defence S&T Strategy for implementation in 2007.
2. Develop a DRDC response to the Defence S&T Strategy by 2007.
3. Develop a Business Model to reflect the changes in the strategic direction of DRDC by 2007.
4. Establish the new Centre for Security Science by 2007 and co-locate it with PSEPC.
5. Implement two targeted initiatives to strengthen DRDC's Management and Corporate Services foundation by 2007.
6. Undertake Network Enabled Operations-related research and development initiatives by 2007.
7. Develop research and development initiatives in Effects-Based Operations to support Canadian planning processes at the strategic, operational and tactical levels by 2007.

S & T STRATEGY

Synchronizing S&T Efforts to Maximize Impact—The Defence S&T Strategy

The new vision for the CF presented by the Chief of the Defence Staff places a strong emphasis on an integrated approach that includes defence, diplomacy, and development. The CF are undergoing a transformation to position them to more effectively address the priorities of the Canadian government. At the same time, DND is aligning its processes and organization to support these priorities.

S&T plays an important role in defence, diplomacy and development but it is important that the right choices are made for future investment. The Defence Policy Statement 2005 refers to “the right equipment and technologies... to perform effectively in demanding operations”.

In this context, DRDC has been mandated to lead the development of a Defence S&T Strategy that will ensure that the department’s S&T investment is directed, delivered and exploited to maximize the benefit to the CF and DND, in effect, to ensure that the greatest possible value and impact is derived from the investment. In addition, DRDC will develop a response to the Defence S&T Strategy with a comprehensive plan that will cover not only an updated capability investment strategy but new program delivery mechanisms and linkages with other stakeholders in Defence and elsewhere. These two initiatives will provide a method to deliver maximum impact of the S&T generated within DRDC and in other parts of the CF and DND.

S&T plays a critical role in all core processes of the department, from development of policy and strategy through force devel-

opment to force generation and force employment. The true impact of S&T takes place through the combined efforts of organizations that include DRDC, ADM (Materiel), ADM (Information Management), ADM (Infrastructure and Environment) and Chief of Military Personnel (CMP). DRDC is leading the development of a Defence S&T Strategy that will guide the generators and users of S&T so they can work more effectively together. This Strategy will be developed through a working group with representatives from the S&T stakeholders throughout DND and the CF.

KEY OBJECTIVE:

Develop a Defence S&T Strategy for implementation in 2007



Canadian soldier meets local children in Kandahar City, Afghanistan. Photo: Sgt Jerry Kean

The strategy will focus on ways to ensure that S&T investment contributes to the realization of the highest-priority, mission-critical outcomes for the CF, by informing, enabling and responding explicitly to the departmental core processes. This will reduce risk, avoid surprise and contribute to the conception, delivery and sustainability of CF capabilities today and for the future. This result will be achieved by strengthening linkages among all the stakeholders, developing innovative solutions and leveraging investments both nationally and internationally. The strategy will provide a basis for a balanced approach to address all aspects of CF/DND core processes as well as near- and long-term needs with a clear mechanism for prioritization and accountability.

The Defence S&T Strategy will identify key outcomes that are enabled by S&T and that will lead to an enhanced capability of the CF and success in operations. These outcomes will cover the range from improving situational awareness and strategic and tactical decision support to better force application and protection. Common outcomes will enhance synchronization of efforts among stakeholders and establish a framework for investment and delivery of output.

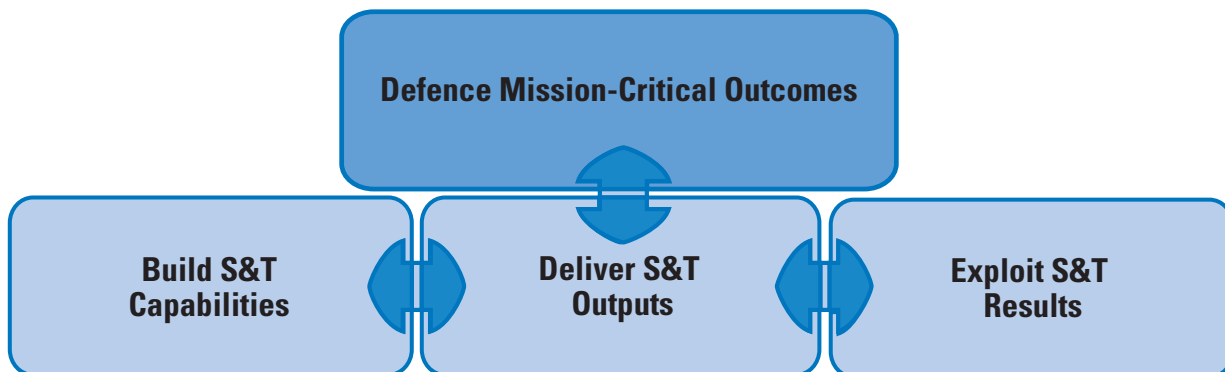
Mission-critical outcomes are defence and security results and end-states that are enabled by S&T and are considered to be critical to the success of the Defence mission. Outcomes provide high-level direction for the S&T Challenges. An example is “Trusted situational awareness, intent prediction and decision making for achieving operational superiority”.



Deploying the SLOCUM glider during the MarSIE trials.
 Photo: Don Glencross, DRDC

S&T outputs in the form of advice, support and specific products provide the essential material to create impact on the core departmental processes of strategy and policy development, force development, force generation and force employment.

The Defence S&T Strategy will be structured so as to address three aspects of the development and delivery of S&T: building capability, delivering S&T outputs and exploiting results.



The Framework for the Defence S&T Strategy

Responding to the S&T Strategy— DRDC's Implementation Strategy

DRDC is developing an Implementation Strategy to address all elements of the Defence S&T Strategy framework. Building capabilities will be addressed through a revision of the Technology Investment Strategy (TIS), which has guided DRDC in developing capability for the past five years. The delivery of S&T outputs will be addressed through the revision and creation of various programs with advice from client groups. Exploitation of the results will be strengthened by adding activities beyond the Technology Demonstration Program and the present commercialization of technologies, including Technology Hubs and the forward deployment of staff.

KEY OBJECTIVE:

Develop a DRDC response to the Defence S&T Strategy by 2007.

S&T Capability

LAST YEAR'S KEY OBJECTIVE:

Update the TIS by 2006

During this past year, the TIS has been revisited and a new S&T Capabilities Strategy is being developed by combining systematic assessment of the present trends in technology opportunities and the needs of the CF.

This analysis has produced a preliminary list of 11 S&T Areas that cover the range of defence science and technology that is needed to address the foreseeable requirements of the CF, as shown in the figure on the

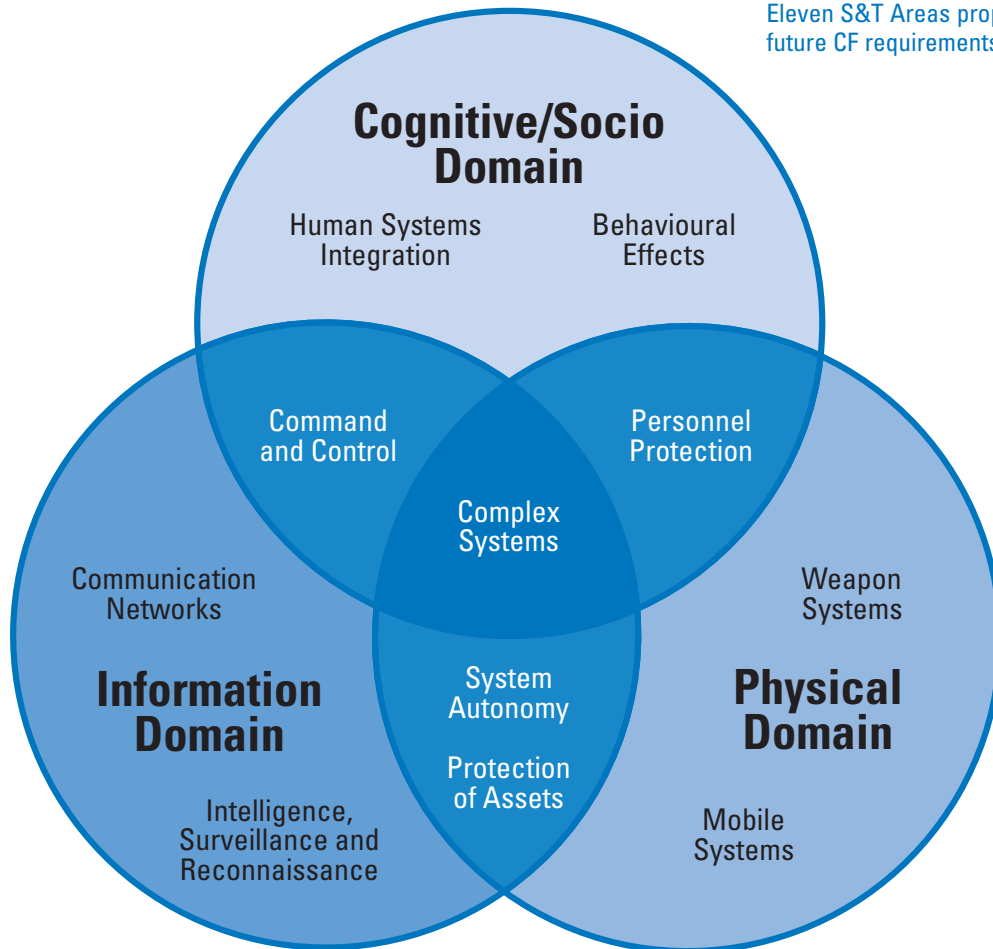
following page. For each Area, S&T Challenges have been proposed to define the problems that will drive investment in S&T capability (Annex A). These have been selected to represent key areas that will support the achievement of outcomes critical to the mission of the CF. Emphasis is placed on areas where DRDC can make a difference and where the capabilities are not available elsewhere.

Program Outputs

DRDC has various programs that deliver results that are useful to the defence and security community: the Applied Research Program (ARP); the Technology Demonstration Program (TDP); the Defence Industrial Research Program (DIRP); the Technology Investment Fund (TIF); Technology Outlook; and Operational Research and Analysis. (Annex B)

The planning process for each of these programs will be modified to ensure that all Defence core processes are considered when selecting projects. This will extend from strategy and policy development, through force development to force generation and force employment. A balance must exist between short-term, operational needs and long-term, strategic needs. Business models will be developed to ensure that linkages with other processes like test and evaluation, concept development and experimentation, and capability based planning are exploited to maximize the benefits of S&T.

Eleven S&T Areas proposed for future CF requirements



Exploitation

The tangible value of S&T capacity is measured by demonstrated impact on core departmental processes including: strategy and policy development, force development, force generation and force employment. Successful achievement of mission-critical outcomes can only be achieved if the S&T investment is based on results and developed in close partnership with the S&T providers and users. Through the development of

strong linkages among key stakeholders, results from research and development (R&D) programs can be transformed into strategic or tactical advice and can enhance the contributions of each unit of the organization.

The linkages will include deployments and organizational arrangements that ensure that all the S&T capabilities within the department can be accessed when needed.

Integrating Concepts

Network Enabled Operations (NEOs) and Effects-Based Operations (EBOs) remain central to the ongoing transformation of the CF.

NEOs is an evolving concept aimed at improving the planning and execution of operations by seamlessly sharing data and information through communications technology in order to link people, processes and networks to facilitate effective and timely interaction between sensors, decision-makers and effects.



Altair UAV used during ALIX trial.
Photo: Canadian Forces Experimentation Centre

In order to advance this concept and as a follow-up to the 2004 departmental NEOs symposium, a working document was produced jointly by DRDC, the Vice Chief of the Defence Staff and the Deputy Chief of the Defence Staff, which articulated NEOs within a Canadian context and identified an initial roadmap for developing and fielding this capability. Integral to this roadmap is recognition of the requirement to build and coordinate capacity along axes focused on people, processes and technology.

To further develop this concept and to assist with the eventual adoption of enhanced NEOs capabilities by the CF, the aim of DRDC is to develop an approach to NEOs-related research and development initiatives.

KEY OBJECTIVE:

Engage in Network Enabled Operations-related research and development initiatives by 2007.

An effects-based approach consists of operations designed to influence the long- or short-term state of a system through the achievement of desired physical or psychological effects. Effects are sought to achieve directed policy aims using the integrated application of all applicable instruments of power or influence. Desired effects, and the actions required to achieve them, are concurrently and reactively planned, executed, assessed and re-planned within a complex and adaptive system or environment.

The adoption of an effects-based approach to conflict has been identified as core to defence transformation. The effects-based concept seeks to control the duration and gravity of a crisis or conflict, allowing participants to achieve tactical and operational effects with less risk or undesired consequence than conventional military operations. This implies a more conscious effort on the part of decision-makers and planners to pursue desired effects that can be measured in terms of physical and psychological effectiveness and visibility.

Concept Development and Experimentation opportunities such as the Multinational Experimentation series have demonstrated the potential of EBOs, but the concept is still evolving to a mature prototype phase. Operationalization of the concept will require political and military leadership to both anticipate and understand the consequences of actions in theatre. Through this process decision-makers will ultimately need to consider: linkages between strategic aims and operational effects; dynamic entities, or 'targets',

within a conflict space; organizational mandates and accountabilities; resources and the appropriate actions required to achieve the desired effect(s); and, resources and supporting processes and capabilities.

To further develop this concept to fielding, the aim of DRDC is to develop EBO-related research and development initiatives at the strategic, operational and tactical levels.

Some of these initiatives are already underway through the Multinational Interoperability Council (MIC), NATO and TTCP collaborative projects. Under the direction of the Canadian Forces Experimentation Centre, several Canadian departments and agencies participated in Multinational Experimentation 4 in March 2006. This experiment was a MIC initiative to test and evaluate processes, organizations and technologies required for a multinational and inter-agency EBO led by an eight-nation plus NATO Response Force coalition.

KEY OBJECTIVE:

Develop research and development initiatives in Effects-Based Operations to support Canadian planning processes at the strategic, operational and tactical levels by 2007.

Business Model

Pursuing a Business Model that Stimulates Innovation

In response to the increasing cadence at which the world is evolving, every organization has to take a very critical look at the way it brings value to its stakeholders. In response to the CF Transformation and as part of the Defence Alignment Initiative, DRDC is migrating towards becoming a full-service S&T organisation that can put scientific knowledge into action.

DRDC has constantly embraced a unique and dynamic approach to conduct its business. Building on successful concepts such as “Client Groups approach” to better focus program on priorities, “Business Lines” to enable the use of custom processes tuned to specific client needs, “External Clients portfolio” to augment capacity and facilitate



Working with the radar cross section measurement equipment during the SISWS trial. Photo: Janice Lang, DRDC

knowledge exploitation, and “Government S&T Program Management services” such as the Chemical, Biological, Radiological and Nuclear Research and Technology Initiative (CRTI) to broaden the impact of DND S&T investments and many others, DRDC has constantly pushed the limit of its business model in order to stimulate innovation.

DRDC must now move to the next level and become a full-service S&T organization. This means that DRDC must be ready to support all departmental core processes – policy, force development, force generation, and force employment. DRDC will have to deliver the full spectrum of S&T services, including analysis and advice, research and development, support to test and evaluation, S&T Outlook, and operational problem solving. DRDC must also be ready to address needs over multiple time horizons, from today to 25 years out.

KEY OBJECTIVE:

Develop a Business Model to reflect the changes in the strategic direction of DRDC by 2007.

Corporate Services

Two key objectives for Corporate Services have been identified in *Expedition 07*, the Agency's strategic action plan. These two objectives are:

- 1) Building Corporate Services capacity and,
- 2) Ensuring compliance with government priorities and applicable policies and procedures.

KEY OBJECTIVE:

Implement two targeted initiatives to strengthen DRDC's Management and Corporate Services foundation by 2007.

Building Corporate Services Capacity

To ensure that the organization has a strong Corporate Services foundation, a plan of action is being developed to address weakened capacity in the following areas: people, processes and technologies. In recognition of the fact that people are our most important resource, the plan of action for capacity building will focus primarily on strengthening human resources.

Ensuring Compliance with Government Priorities and Applicable Policies and Procedures

As an Agency of the Government of Canada, DRDC functions within a complex framework of policies and legislation. This framework sets forth the priorities of the Government, establishes functional parameters and defines how these functions should be carried out. To ensure that DRDC operates in keeping with the Government agenda, DRDC will develop a plan of action that will enable the Agency to self-monitor its progress against numerous Public Service-wide corporate priorities.

SUPPORT TO TRANSFORMATION, SUPPORT TO OPERATIONS AND FIELDED TECHNOLOGIES

LAST YEAR'S KEY OBJECTIVE:

Enhance DRDC assistance to CF operations (domestic and international) in providing expert support, advice and material.

DRDC's support to the CF has addressed needs over multiple time horizons and has come from a number of programs. Support from DRDC's Centre for Operational Research and Analysis (CORA) has mainly come in the form of advice, such as the Operational Research (OR) advice given to the department on Transformation. The support from the other five centres has generally come from fielded technologies developed through the ARP, the TDP and the TIFs, as well as expertise used to solve current CF problems.

Support to Transformation

Over the past year DRDC CORA has been directly involved with CF Transformation. When the Chief of the Defence Staff Action Teams were created, CORA scientists were assigned to each team. The CORA scientists provided analyses including methodologies for



DRDC CORA scientist, Dr. Elizabeth Speed, visits girls' orphanage in Afghanistan.
Photo: Dr. Elizabeth Speed, DRDC CORA.

improved command and control architecture and for developing a more agile and responsive CF. Their work assisted in the creation of new commands: Canada Command (Canada COM); Canadian Expeditionary Force Command (CEFCOM); Canadian Special Operations Forces Command (CANSOFCOM); and Canadian Operational Support Command (CANOSCOM). These commands became operational effective 1 February, 2006.

Support to Operations

A very visible contribution to the support to operations was the deployment of a defence scientist to Afghanistan to be part of the Strategic Advisory Team (SAT) to President Karzai and the Government of Afghanistan. The SAT's mission is to assist the local government in developing the human capacity and processes necessary for designing and implementing its own development program. This year-long deployment is the first step in what ADM(S&T) views as the future model of defence scientists being deployed to operational missions in direct support of the CF.

Human Systems Integration

- DRDC Toronto upgraded the human centrifuge to provide high-G training to pilots and successfully completed 24 high-G courses during 2005, training a total of 135 pilots.



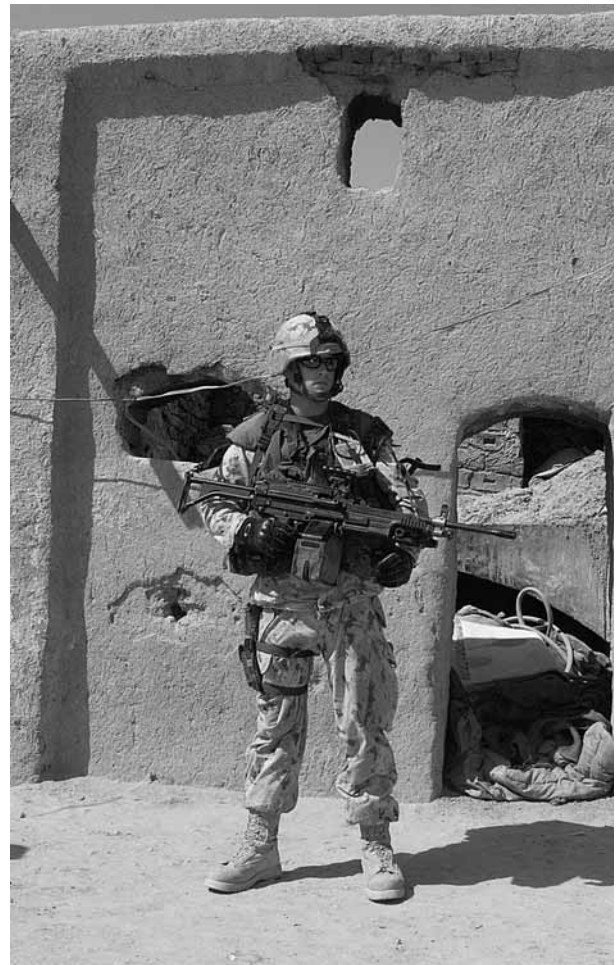
Strapping in to the Human Centrifuge.
Photo: Jim Clark, DRDC

- DRDC Toronto, with the assistance of the Directorate of Air Requirements, is providing a Distributed Mission Operation Centre (DMOC) capability to the Canadian Forces Air Warfare Centre. The role of the DMOC is to integrate resources, develop scenarios, provide virtual or constructive simulations of selected players, and host simulation analyses. DRDC's key simulation assets are the CF-18 Multi-Task Trainer, the Next Generation Threat System, and secure and networked briefing systems.

- The Body Scanning System XXI (BoSS XXI), whose system concept and development originated at DRDC Toronto, measures CF members and determines the most appropriate size of clothing or equipment. This development is paying huge dividends to DND in terms of efficiencies gained in clothing and equipment distribution and stocking. A newly developed variant of the BoSS XXI will measure individuals in a seated posture to predict workspace accommodation requirements and help with pilot selection.



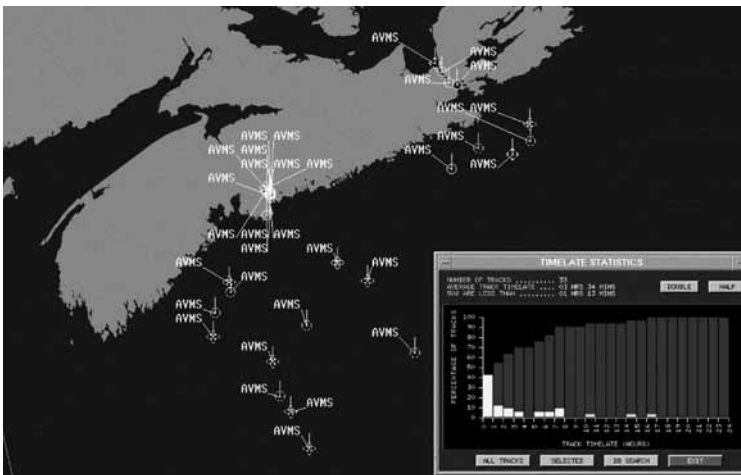
CF-18 Multi-Task Trainer. *Photo: Jim Clark, DRDC*



On patrol, Kandahar, Afghanistan. *Photo: Sgt Jerry Kean*

Command and Control

- DRDC Atlantic provided operational support to *HMCS ATHABASKAN* by integrating information from the Automated Information System (AIS) into her command and control system in preparation for her deployment as flag ship for the NATO fleet. AIS is a self-reporting system for commercial ships that regularly broadcasts data such as the ship's identity, position, and speed, which enhance the situational awareness of naval decision makers aboard ships and at shore-based operations centres. DRDC Atlantic had already developed a self-contained AIS relay system, known as the AIS Vessel Monitoring System (AVMS), and was able to respond quickly to *ATHABASKAN's* request for operational support.



Screen capture of AVMS system



The DRDC Atlantic project team that provided operational support to the *HMCS Athabaskan*.

Photo: Don Glencross, DRDC



HMCS *WINDSOR*, a VICTORIA Class submarine.
Photo: Sgt Roxanne Clowe, Canadian Forces Combat Camera

Mobile Systems

- The VICTORIA Class Submarine Reactivation process uncovered small cracks in the system responsible for expelling the propulsion diesel engine exhaust gases. DRDC Atlantic investigated the origins and the extent of the damage and worked as part of an international team to improve the design and fabrication of these systems. As a result, superior second generation systems have been built and have replaced nearly all of the original defective systems.

Personnel Protection

- The Counter Terrorism Technology Centre (CTTC) supports CF operations in training, testing and evaluation, and operational support. During the next 5-10 years the CTTC will increasingly focus on the urban war context, integrating robotics, simulation and live threat environments as a tool to develop and validate operational concepts and plans before they are used in theatre. In the operational support arena, the CTTC will stand up the Biological Aerosol Detection and Assessment Team in 2006 to act as an added capability to standing teams like the Joint Nuclear Biological Chemical Company and the Health Canada Health Emergency Response Team. Over the next 3-5

years, the CTTC will build the capability to provide an integrated chemical, biological and radiation lab that will be able to support domestic and deployed operations with near real-time sample processing ability and provide commanders with a means to identify threats and protect CF troops and first responders from a clearly identified threat.



Securing a CRTI Mobile Nuclear Lab vehicle inside a CC-130 Hercules. *Photo: Janice Lang, DRDC*

- In support of operations in the area of radiological analysis and defence, a DRDC Ottawa team led multiple exercises in realistic modern-threat scenarios using live-agent sources (a unique capability in North America). These exercises also included reach-back into the National Biological Dosimetry Response Plan and the Federal Nuclear Emergency Plan.

Fielded Technologies

Protection of Assets

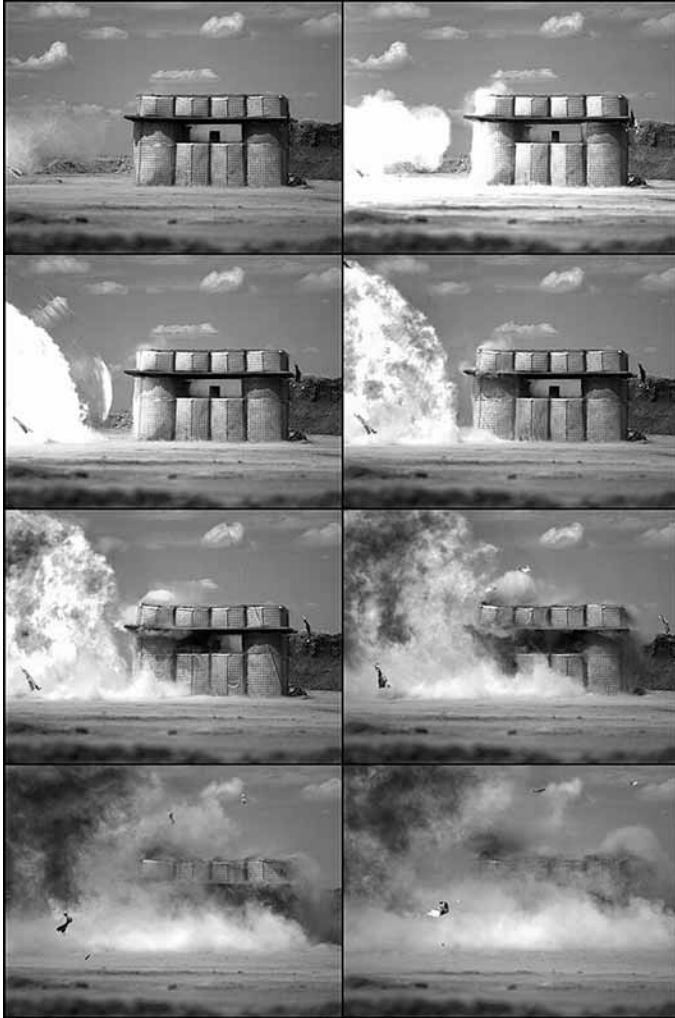
- As part of an interdepartmental team, DRDC Valcartier has increased the protection of our troops by developing an add-on ballistic protection kit for the Heavy Engineering Support Vehicle Wheeled (HESVW).



Searching for debris from a simulation of a radiological dispersal device event. *Photo: Ted Ostrowski, DRDC*

Two add-on ballistic armour systems, developed, tested and manufactured within a 4-week time frame, are now on the HESVW. DRDC is currently conducting R&D to improve the performance of the armour material to provide increased ballistic and Improvised Explosive Device protection to the vehicle occupants.

- DRDC Valcartier has developed a radically new technology, based on pyrophoric liquids, that improves aircraft protection against modern



Blast tests at DRDC Suffield.
 Photo: Scott Trebble, DRDC

infrared-guided missiles. The flare vaporizes a pyrophoric liquid fuel that combusts spontaneously on contact with air, producing a thermal signature very similar to that of an aircraft exhaust. Unique in the world, this new Canadian technology,

which has been in service with the CF since 2001, provides unequalled self-protection against some of the most advanced missile systems.

- In April of 2003, DRDC Suffield began a four-year TDP on 'Force Protection Against Enhanced Blast', which considers both military weapons and terrorist explosive devices. More than a dozen defensive field fortifications of domestic and foreign design were tested for their blast vulnerabilities. A number of design improvements and blast mitigation strategies emerged from this work. Blast vulnerabilities of Temporary Camp components were assessed and design improvements and protection concepts suggested. Camp layout options designed to minimize the impact of an Enhanced Blast Weapon attack were recommended. A number of results from this TDP have already been incorporated by the CF. The final deliverable in the TDP will be an expert system to facilitate design and rapid vulnerability assessments during deployed operations.

Communications Networks

- A state-of-the-art tactical communications Electronic Warfare (EW) sensor system was delivered under contract, to the US Marine Corps for trials, and a copy of that system was delivered to the CF for evaluation. The system provides a capability against modern radio systems that is not available elsewhere. In addition, the tactical capability known as Mobile Electronic Warfare Technology (MEWT), originally created at DRDC Ottawa and now deployed with the Canadian Land Forces, was significantly enhanced during 2005 by the Integrated Communications Electronic Warfare Analysis and Radio-Frequency Sensor (ICEWARS) TDP, with the new EW Signal Analysis (EWSA) component. The EWSA system produces an emitter map from wideband sensor data and provides the first-level analysis for tactical use.



ICEWARS system installed on Bison.
Photo: Janice Lang, DRDC

Personnel Protection

- DRDC Ottawa's 'Stand-off' Radiation Detection System proved to be the best in international trials at the US Pacific Northwest National Laboratories. Under field conditions, the system detected alpha radiation (among other types) at distances of over 1 km, as compared to the standard maximum of 5 cm! The system is now being prepared for upcoming exercises involving the CF.
- The goal of the Multi-Agent Tactical Sentry (MATS) project has been to deliver a suite of CF Nuclear, Biological and Chemical (NBC) sensors integrated onto a mobile unmanned platform. The first system, which was manufactured, integrated, tested, and delivered in less than 18 months, is comprised of a command post in which two ground stations are installed. These ground stations are used to teleoperate the remote vehicles while also providing geo-referenced displays of NBC detections. The end result will be an unparalleled capability within the CF to perform remote detections of NBC threats at an increased level of vigilance while removing the soldier from harm's way.



Command Post and associated MATS remote sensor vehicle.
Photo: Ted Ostrowski, DRDC

- In 2005, the Ferret acoustic system developed by DRDC Valcartier was installed on 11 Coyote-type vehicles deployed by the CF. The Ferret is a passive acoustic system for the detection and localization of small-arms fire. The system offers better protection to Coyotes operating alone or in convoys and to civilian populations exposed to gunfire by informing military personnel of sniper positions, the calibre of bullets used and miss distances.



Ferret acoustic system.

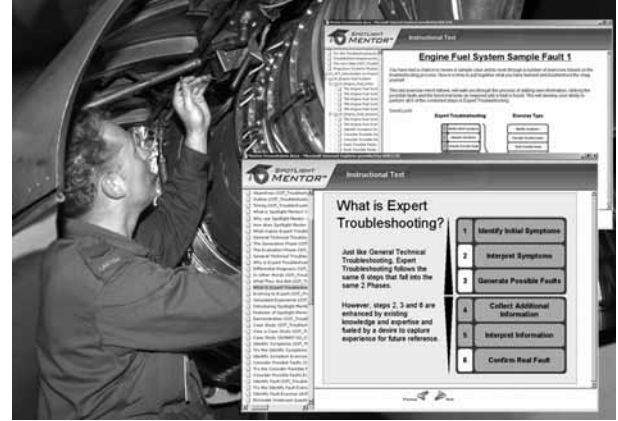
Developments Supported by the Defence Industrial Research Program

Human Systems Integration

- CASEBANK is a case-based reasoning technology aimed at facilitating the maintenance of CF aircraft – initially the CC-130 Hercules. This tool will help in compensating for the demographic losses of maintenance personnel in the CF, and the training of new recruits, both on the shop floor and in the classroom at CFB Trenton. An early version of the system has been proof-of-concept tested in Afghanistan in order to gain operational experience and feedback into the project.

Intelligence, Surveillance and Reconnaissance

- TELOPS Inc., a Canadian company, has developed *FIRST*, a stand-off, chemical gas detection system using combined spectral and imaging capabilities. In June 2005, the TELOP's *FIRST* sensor system participated in a multinational measurement campaign hosted by the UK's Defence Science and Technology Laboratory and Australia's Defence Science and Technology Organization. *FIRST* successfully measured nearly all of the approximately 80 released chemical gases, and performed as well, or better than the other 7-8 sensors present.



CF member works on engine of CC 130 Hercules, shown with screen captures of the CASEBANK technology.
Photo: CASEBANK



TELOPS's *FIRST* sensor system.
Photo: TELOPS Inc.

CENTRE FOR SECURITY SCIENCE

KEY OBJECTIVE:

Establish the new Centre for Security Science by 2007 and co-locate it with PSEPC.

Public security continues to be of major importance both within Canada and abroad.

The DRDC Centre for Security Science will be launched in 2006 based on an agreement between Public Safety and Emergency Preparedness Canada (PSEPC) and DND. The Centre for Security Science will provide direct S&T support to PSEPC in the execution of its mandate, while contributing to and supporting the CF's public security capability needs. It will manage both CRTI and the PSTP, including their pan-Canadian and Canada-US dimensions, and will be highly networked with national and international S&T partners and public security communities.

The PSTP was established in June 2003 to collaboratively deliver S&T solutions to advance Canadian capabilities to prepare for, prevent, respond to, and recover from high-consequence public safety and security events. The program focuses on four main mission areas: Chemical, Biological, Radiological/ Nuclear, Explosives (CBRNE) and Forensics; Critical Infrastructure Protection (Physical and Cyber); Disruption and Interdiction; and Systems Integration, Standards and Analysis.

LAST YEAR'S

KEY OBJECTIVE:

Engage the CF in public security S&T network initiatives under the Chemical, Biological, Radiological and Nuclear Research and Technology Initiative (CRTI) and the Public Security Technical Program (PSTP) by 2006.

The CRTI Laboratory Clusters will continue to practise and enhance their S&T capability and capacity through exercises focused upon their potential role during a CBRN terrorist event. The Radiological/ Nuclear Cluster will build on lessons learned in previous exercises in 2003 and 2005 by expanding to work with the National Response Team (including the Joint NBC Response Company and the Royal Canadian Mounted Police), provincial and local responders in Exercise Maritime Response in the spring of 2006. The exercise included a number of realistic scenarios including smuggling of radiological material and a radiological dispersal device, or dirty bomb. Each of the planned series of four exercises is being scaled up to include more partners, all of whom have the 2010 Vancouver Olympics in sight as a preparation target. Exercise Maritime Response has been included in DND's Joint Forces Strategic Training Plan.

CONCLUSION

This coming year DRDC will focus on the following goals: developing a Defence S&T Strategy; developing a DRDC response to that strategy; developing a business model to reflect that strategy; developing the new Centre for Security Science; and developing integrating concepts for the CF.

The geopolitical environment is increasingly complex with failed and failing states, global terrorism, the spread of weapons of mass destruction, and ongoing regional tensions. In order to meet the challenges of the new security environment, the Chief of the Defence Staff and the Deputy Minister have committed to a transformed CF, one that is more relevant, responsive and effective. DRDC is fully engaged in the process of CF Transformation.

DRDC is leading the development of a Defence S&T Strategy to ensure that the CF are technologically prepared and operationally relevant. The strategy will focus on ways to ensure that S&T investment contributes to the realization of the highest-priority, mission-critical outcomes for the CF, by informing, enabling and responding explicitly to the departmental core processes. In addition, DRDC will develop a response to the Defence S&T Strategy with a comprehensive plan that will cover not only an updated capability investment strategy but new program delivery mechanisms and linkages with other stakeholders in Defence and elsewhere.

DRDC will become a full-service defence and security, S&T organization, supporting all departmental core processes – policy, force development, force generation, and force employment – from “lab coats to boots”. DRDC will deliver the full spectrum of S&T services, including analysis and advice, R&D, support to test and evaluation, S&T Outlook, and operational problem-solving, addressing needs over multiple time horizons, from today to 25 years out.



An eye to the future – infrared eye technology at DRDC Valcartier.

Photo: Michel Vigneault, DRDC

ANNEX A – PROPOSED SCIENCE AND TECHNOLOGY CHALLENGES

The proposed S&T Challenges represent the most important technical obstacles that must be overcome within the 11 proposed S&T Areas. They help to define and focus the effort to establish the specific capabilities needed to achieve the Outcomes. They must stretch current competencies and yet be integrally linked to DRDC's ability to provide S&T to the CF.

1. Command and Control (C2)

- Enhanced decision making in C2 environments
- Flexible and adaptable C2 concepts and structures for achieving common intent
- Effects-based visualization and awareness for the decision maker
- Information Fusion and Knowledge Management and Representation
- Software Protection and Counter Measures

2. Communications Networks

- Robust, reliable networks
- Computer Network Operations
- Robust wireless communications
- Communications Electronic Warfare
- Navigation Warfare

3. Intelligence, Surveillance and Reconnaissance

- Collaborative adaptive sensing
- Sensing systems to exploit diversity (in phenomena, space, time and spectrum)
- New sensing technologies

- Exploitation of target and environment characteristics
- Exploitation of adversaries' emissive systems

4. Complex Systems

- Smart acquisitions and enhanced materiel support
- Capability Based Planning
- Capability Engineering
- Analysis of Integrating Concepts
- Analysis of complex systems and concepts
- Improvements in multi-purpose capability of new and existing systems

5. System Autonomy

- Intelligent Autonomous Systems for operation in complex environments
- Emergent behaviour of simple autonomous systems

6. Mobile Systems

- Condition-based monitoring and prognostic and health management methodologies
- Integrated platform models and their application
- Characterization of effects of environment and expanded operating envelope on vehicles
- Development of efficient energy storage and power sources

7. Weapons Systems

- Non-lethal weapons
- Assessment of the effects of weapons and weapon systems
- Tailored precision weapons
- Enhanced weapons systems for complex environments, including urban operations

8. Personnel Protection

- Evaluation and mitigation of hazards from toxic materials, infectious threats and weapons
- Diagnostic and Adaptive Systems for Environmental Stresses
- Personnel Protection Systems and Signature Reduction
- Casualty Prevention and Management

9. Protection of Assets

- Structures and materials for protection against weapons attacks
- Reduced observability through active and passive signature management
- Active countermeasures for platform protection
- Minimization of impact of military operations, including training, on the environment
- Decontamination of equipment and structures exposed to toxic and corrosive materials

10. Human Systems Integration

- Human performance models for military simulations
- Human Systems Integration
- Monitoring, predicting and enhancing psycho-physiological readiness
- Increased effectiveness and efficiency of the CF Human Resources system
- Distributed, adaptable, and on-demand learning, training and rehearsal

11. Behavioural Effects

- Understanding, prediction and influence of adversaries' intent
- Strategies for promoting collaborative behaviour among teams, agencies, organizations, and societies
- Selection and development of leaders and members consistent with the ethos of the CF
- Strategic Outlook – Tools and models to analyze and assess implications of changes in national and international policy, socio-economic trends and political climate

ANNEX B – DRDC S&T PROGRAMS

DRDC has various programs that deliver S&T results to the defence and security community.

- The Applied Research Program (ARP) has as its objective to advance the defence science knowledge base, to investigate novel and emerging technologies and to explore the military application of those technologies. Decisions are made on annual projects in consultation with representatives of the CF client groups to ensure relevance to operational needs.
- The Technology Demonstration Program (TDP) has as its objective to demonstrate technologies fostered by DRDC and Canadian industry in the context of real and potential future CF capabilities, concepts, doctrine, operations and equipment.
- The Defence Industrial Research Program (DIRP) is specifically aimed at promoting and assisting basic industrial R&D in technology areas that are of interest to the Canadian Forces.
- The Technology Investment Fund (TIF) supports high-risk, high-payoff research projects with potential military applications, which point to new opportunities for investment.
- Technology Outlook provides advice on technology trends, threats and opportunities.
- Operational Research and Analysis provides expert, objective, and timely advice and analytical support to the CF and to DND.

New Technology Demonstration Program Projects Started in 2005

Mechanized Mine Neutralization
Advanced Vehicle Architecture for a Net-enabled Combat Environment (ADVANCE)
Secure Access Management for Secret Operational Networks (SAMSON)
Bio-Sense: Standoff Bioaerosol Sensing, Mapping, Tracking and Classifying System
Maritime Force Protection

Defence Industrial Research Program Projects Approved to Start in 2006

Prognostic and Health Management of Airborne Systems
Handheld Fuel Cell Power Source
Software Defined Radio Switched Multiband Adaptive RF Tuning Unit (SMART-U)
Development of a Programmable Underwater Acoustic Mask

New Technology Investment Fund Projects Approved to Start in 2006

Advanced Materials for Soldier Power Applications Through Waste-Heat Recovery
Novel Supercapacitor Materials for High Output Pulse Energy Applications
Energy Harvesting Materials, Systems Approach for their design and development
Cognitive Radio Techniques for Assured Communications
Tools for the Automatic Extraction and Visualization of Concepts for the Operational Commander
Standoff Spectroscopy Chemical Identification by Femtolaser Terahertz Technique
Development of a New Family of High Performance Infrared Sensors based on Nano-Materials
Knowledge Capture and Modeling through Semi-Automatic Construction of Ontologies from Texts
Crowd Control Modeling and Simulation Capability

ANNEX C – ACRONYMS AND ABBREVIATIONS

ADM	Assistant Deputy Minister	HESVW	Heavy Engineering Support Vehicle Wheeled
ADM (HR-Mil)	Assistant Deputy Minister (Human Resources – Military)	HR	Human Resources
ADM (Pol)	Assistant Deputy Minister (Policy)	ICEWARS	Integrated Communications Electronic Warfare Analysis and Radio-Frequency Sensor
ADM (S&T)	Assistant Deputy Minister (Science and Technology)	IR	Infrared
AIS	Automated Information System	LFSA	Looking Forward Staying Ahead
ARP	Applied Research Program	MarSIE	Maritime Sensor Integration Experiment
AVMS	AIS Vessel Monitoring System	MATS	Multi Agent Tactical Sentry
BoSS	Body Scanning System	MEWT	Mobile Electronic Warfare Technology
C2	Command and Control	MIC	Multinational Interoperability Council
C2IS	Command, Control, Intelligence and Surveillance	NATO	North Atlantic Treaty Organization
C4ISR	Command, Control, Computers, Communications, Intelligence, Surveillance and Reconnaissance	NBC	Nuclear, Biological and Chemical
CBRNE	Chemical, Biological, Radiological, Nuclear and Explosive	NEOps	Network Enabled Operations
CDS	Chief of the Defence Staff	OR	Operational Research
CF	Canadian Forces	PSEPC	Public Safety and Emergency Preparedness Canada
CORA	Centre for Operational Research and Analysis	PSTP	Public Security Technical Program
CRTI	Chemical, Biological, Radiological and Nuclear Research and Technology Initiative	RCMP	Royal Canadian Mounted Police
CSS	Centre for Security Science	S&T	Science and Technology
CTTC	Counter Terrorism Technology Centre	SAT	Strategic Advisory Team
DIRP	Defence Industrial Research Program	SIREQ	Soldier Information Requirements
DMOC	Distributed Mission Operation Centre	SISWS	Shipboard Integration of Sensor and Weapon Systems
DND	Department of National Defence	TDP	Technology Demonstration Program
DRDC	Defence Research and Development Canada	TIF	Technology Investment Fund
EBO	Effects-Based Operations	TIS	Technology Investment Strategy
EWSA	Electronic Warfare Signal Analysis	TTCP	The Technical Cooperation Program
		UK	United Kingdom
		US	United States of America
		USAF	United States Air Force