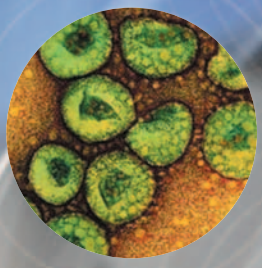
NRC·CNRC

From ***Discovery*** *to* ***Innovation...***



NATIONAL RESEARCH COUNCIL CANADA
ANNUAL REPORT 2004–2005

Science at work for Canada

National Research Council Canada
Conseil national de recherches Canada

Canada

National Research Council Canada
Science at work for Canada
Annual Report 2004-2005

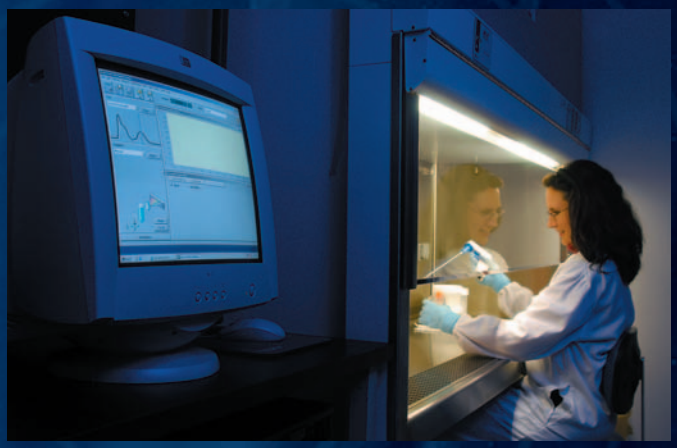
NRC is the Government of Canada's leading resource for scientific research, development and technology-based innovation. Its outstanding people help turn ideas and knowledge into new products, processes and services, creating value for Canada.

As an organization with global, national, regional and local presence, NRC is a keystone of Canada's innovation system. NRC works hand-in-hand with partners from industry, government and universities to help ignite the spark of innovation in communities across the land and to give Canadian companies a competitive edge in today's marketplace.

NRC operates world-class research facilities as well as information, technology and innovation support networks from coast to coast.

In all, NRC is present in over 90 communities across Canada through its network of research institutes and technology centres, the NRC Industrial Research Assistance Program and the Canada Institute for Scientific and Technical Information.

NRC's impact extends even further through the thousands of partnerships, networks, collaborations, and the national and international committees in which it is involved.



NRC's work spans the innovation spectrum from scientific discoveries at the very frontiers of knowledge to technology commercialization. For over eight decades, NRC has successfully forecast Canada's opportunities and adapted itself to meet national priorities as well as the needs of its clients and partners. NRC has organized efforts around key sectors, such as biotechnology, information and communications technologies, aerospace, manufacturing, construction, ocean engineering and others.

NRC has moved into important new fields, such as genomics, fuel cells, bioinformatics, high-performance computing, photonics, nanotechnology and environmental and sustainable development technologies.

Focused squarely on Canada's future, NRC is committed to helping build knowledge and innovation capacity in Canada, and providing the tools to succeed in the knowledge economy.

For more information visit our Web site at: www.nrc-cnrc.gc.ca
or contact NRC at: 1-877-672-2672

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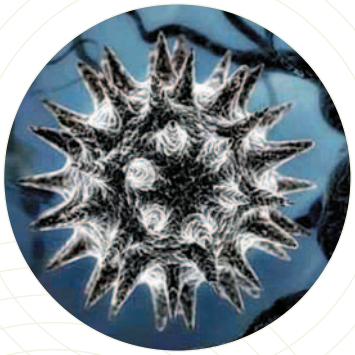

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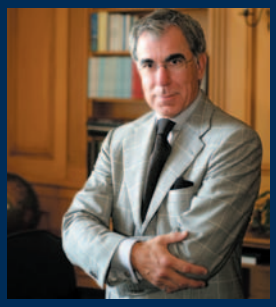
PRESIDENT'S MESSAGE



The National Research Council is a unique organization in Canada and is well positioned to play a lead role in today's innovative society by contributing to the development of a knowledge based economy. However, in order for our organization to reach its full potential, it must continually adapt its research, development, industry support and commercialization programs and services to meet national needs and priorities today, and to be positioned for the future.

This year's annual report highlights some of the ways NRC is meeting this ongoing challenge to respond to the critical science and technology challenges facing Canada now and in the future.

For example, NRC has significantly increased its commercialization activity. In 2004-2005 NRC achieved close to a 60 per cent increase in the number of licenses signed with Canadian industry and other clients for its technology, while the NRC Industrial Research Assistance Program helped to build the innovative capacity of some 11,000 small and medium sized firms across Canada.

NRC's National Technology Cluster Strategy also continued to play its special role in the evolution and growth of community-based innovation across Canada – providing local partnership opportunities for small firms, access to facilities and research expertise, and access to broader international networks. From fuel cells in Vancouver to medical devices and diagnostics in Winnipeg, these activities are driving real economic growth in regions across Canada.

NRC President Dr. Pierre Coulombe speaks with staff at the NRC Dominion Radio Astrophysical Observatory in Penticton, B.C.

To this end, NRC is working with other federal agencies to integrate services and ensure that government resources are combined effectively to meet major challenges in such areas as health, the environment and security. NRC is, in fact, building partnerships locally, nationally, and internationally on behalf of Canada and key industrial sectors.

One sector highlighted in this report is Canada's aerospace industry, which continues to be a major contributor to the Canadian economy. The industry is supported by a number of major new research facilities including the NRC Aerospace Manufacturing Technology Centre in Montreal and the NRC Gas Turbine Environmental Research Centre in Ottawa.

Last year also saw the launch of the NRC Canadian Photonics Fabrication Centre. By helping to reduce time-to-market, the facility is providing companies with a competitive edge, facilitating their success in the global market place. Already the facility is in high demand, making its first significant shipment of photonic wafers to one of the world's largest manufacturers of lasers only 5 weeks after its official opening.

This annual report celebrates these and other achievements; not only as advances in science and engineering research but also as steps toward a stronger, more competitive Canada. They are the achievements of more than 4,000 NRC employees from Victoria to St. John's working on behalf of all Canadians and putting science to work for Canada, everyday.

Dr. Pierre Coulombe
President

INTRODUCTION

Research and innovation are critical to Canada's future economic growth and an improved quality of life for Canadians. Canada must become known as a nation of innovators, one in which all sectors of society can benefit from a globally focused, networked and innovative knowledge economy. But innovation does not simply happen – it requires long-term and strategically directed investments in research, people, infrastructure, networks and relationships.

One of Canada's important challenges is to unleash the value inherent in knowledge and innovation organizations like NRC. The key to achieving this is an approach that mobilizes the public and private sectors, while integrating the elements of innovation at the international, national and community levels. There must be sustained and focused investments from all sectors for the creation of new knowledge and its use in Canadian industry. This effort must span the research spectrum, from basic discoveries that advance the frontiers of knowledge, to the transformation of knowledge into new products, services and technologies for world markets.

NRC will play a key role in helping Canada reach its full potential in research performance and develop the knowledge foundation for the industries of tomorrow.

Working with industry, academia and government, NRC will increase the effectiveness of its innovation systems by fostering national and international networks, and community-based technology clusters. Such efforts will help better Canada's quality of life, improve the environment, protect health and create new sources of wealth.

PARTNERING FOR STRENGTH AND RESULTS

NRC WORKS WITH PARTNERS TO CONTRIBUTE TO GOVERNMENT OF CANADA PRIORITIES. IN 2004-2005, NRC SIGNED 504 NEW FORMAL COLLABORATIVE RESEARCH AGREEMENTS WITH PUBLIC AND PRIVATE-SECTOR PARTNERS AT THE INTERNATIONAL AND NATIONAL LEVELS, WORTH A TOTAL OF $144.5 MILLION. WITHIN CANADA, NRC WORKS SIDE BY SIDE WITH OTHER FEDERAL DEPARTMENTS AND AGENCIES THROUGH ITS INVOLVEMENT IN THE CANADIAN BIOTECHNOLOGY STRATEGY; THE CHEMICAL, BIOLOGICAL, RADIOLOGICAL, NUCLEAR RESEARCH AND TECHNOLOGY INITIATIVE; CANADIAN AEROSPACE PARTNERSHIP; CLIMATE CHANGE AND THE ENVIRONMENT; AND THE NATIONAL MARINE AND OCEAN INDUSTRY ROADMAP PROJECTS.

THE GOVERNMENT OF CANADA'S REGIONAL ECONOMIC DEVELOPMENT AGENCIES (WESTERN ECONOMIC DIVERSIFICATION, FEDNOR, CANADA ECONOMIC DEVELOPMENT FOR QUEBEC REGIONS AND THE ATLANTIC CANADA OPPORTUNITIES AGENCIES) PLAY A MAJOR ROLE WITH NRC IN COMMUNITY INNOVATION AND CLUSTER-BUILDING ACTIVITIES. OTHER FUNDING PARTNERS INCLUDE GENOME CANADA AND THE CANADIAN INSTITUTES OF HEALTH RESEARCH.

NRC – SCIENCE AT WORK FOR CANADA 2004-2005

NRC is a leader in the development of an innovative, knowledge-based economy for Canada through science and technology.

World-Class R&D

NRC performs world-class research that is relevant to Canadians. R&D performed at NRC will contribute to the improved health of Canadians, build a cleaner, sustainable environment and create a safer and more innovative society.

- 1,287 publications in refereed journals
- 95 patents issued
- 742 active patents

Commercialization and Value Creation Capacity

NRC combines its scientific excellence and its S&T information resources in support of innovative Canadian businesses to deliver real economic value for Canada and to ensure its R&D gets into the marketplace.

- $4.8 million in licensing revenues
- Fee-for-service R&D support for 1,348 clients
- 61 NRC spin-off companies launched since 1995, accounting for 500 jobs and $375 million in cumulative private investment
- $80.34 million in research assistance contributions to innovative SMEs through NRC-IRAP
- Approximately 700,000 S&T documents delivered to clients worldwide

Global Connections

NRC is an active player in international research collaborations and partnerships, helping extend Canada's R&D and knowledge creation networks and influence in vital sectors.

- 109 formal research collaboration agreements signed with international partners worth $16.5 million
- Total lifetime value of all current international agreements – $139.7 million
- NRC's partners invest 2.14 dollars for every dollar NRC invests

Community Innovation

Stimulating the growth of community-based technology clusters across Canada is an important part of NRC's business. NRC research institutes, information centres, partnership facilities, research assistance program and networks are central hubs, bringing local and regional interests together with groups of innovative companies to focus on the development of a common area of technology.

Highly Qualified People

NRC researchers are highly respected in the international scientific community.

- 180 positions on editorial boards of scientific publications
- Active in 68 national and international research networks
- 412 adjunct professorships in Canadian universities
- 300 conferences and workshops organized by NRC, 55% increase over last year

NRC — Critical R&D Infrastructure and Facilities for Canada

NRC provides cutting-edge national R&D and business support facilities that benefit universities and industry across Canada. In 2004-2005, NRC invested $67.3 M in new and existing facilities.

NRC has 400 S&T laboratories and facilities for Canadian R&D and innovation. Some examples include:

- Aquaculture Research Station
- Canada Neutron Beam Laboratory
- Canadian Centre for Housing Technology
- High-throughput screening, DNA sequencing, and microarray facilities
- Hydrogen-Safe Laboratories
- Industry Partnership Facilities (incubation space, access to business services and expertise)
- Nanoimprint Lithography Laboratory
- National aerospace facilities (wind tunnels, research aircraft, engine test facilities, aerospace manufacturing facilities, etc.)
- National astronomy facilities
- National metrology facilities
- NRC Canada Institute for Scientific and Technical Information
- NRC Canadian Hydraulics Centre
- NRC Canadian Photonics Fabrication Centre
- NRC Centre for Surface Transportation Technology
- NRC Industrial Research Assistance Program Centres (90 locations across Canada)
- Ocean and marine engineering test facilities (wave tanks, ice tanks, tow facilities)
- Precision and Free-Form Manufacturing Centre
- Ultra-fast Laser Laboratory
- Virtual Environment Technology Centre

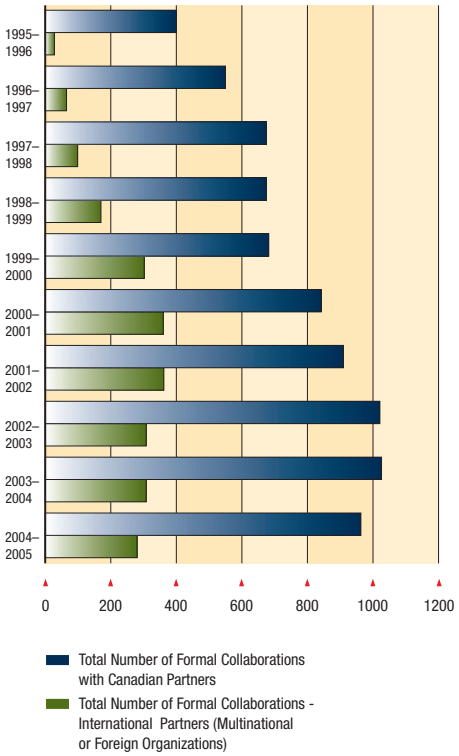
NRC – CORE STRENGTHS FOR CANADIAN INNOVATION

- 19 RESEARCH INSTITUTES
- 5 ADVANCED TECHNOLOGY CENTRES
- SUSTAINED RESEARCH IN CRITICAL SECTORS: BIOTECHNOLOGY, MANUFACTURING, INFORMATION AND COMMUNICATIONS TECHNOLOGIES, AEROSPACE, CONSTRUCTION, NANOTECHNOLOGY, PHOTONICS, ASTRONOMY AND ASTROPHYSICS, FUEL CELLS, OCEAN ENGINEERING, AND OTHERS
- NATIONAL S&T KNOWLEDGE AND INFORMATION RESOURCES
- LOCAL, REGIONAL, NATIONAL AND INTERNATIONAL S&T NETWORKS, PARTNERSHIPS AND COLLABORATIONS – ACCESS FOR CANADIAN R&D TO THE WORLD
- EFFECTIVE CATALYST FOR COMMUNITY-BASED INNOVATION
- NATIONAL STANDARDS, CODES AND MEASUREMENTS, RELATED R&D AND SERVICES
- 57% INCREASE IN NUMBER OF TECHNOLOGIES LICENSED TO THE PRIVATE SECTOR IN 2004-2005 (105 AGREEMENTS)
- RECORD NUMBER OF GRADUATES FROM NRC INDUSTRY PARTNERSHIP FACILITIES, 14

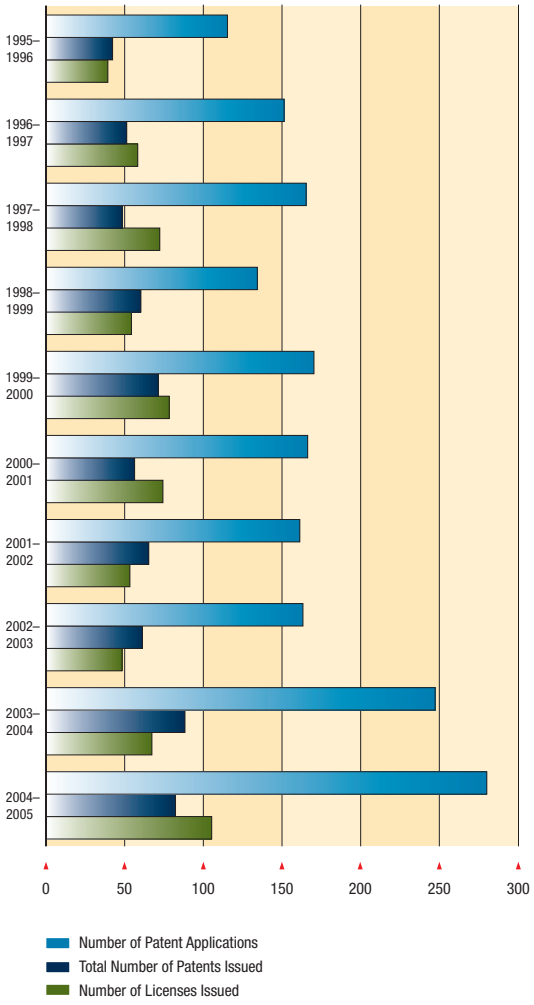
NRC PERFORMANCE INDICATORS

Economic Impact

COLLABORATION



NRC IP PORTFOLIO

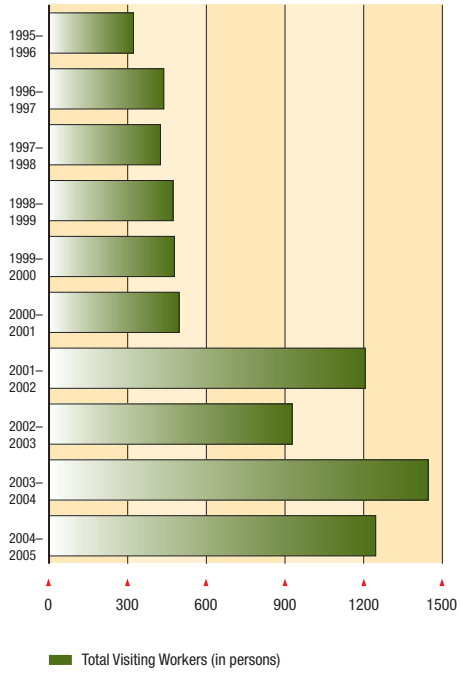


NRC LICENSING REVENUE

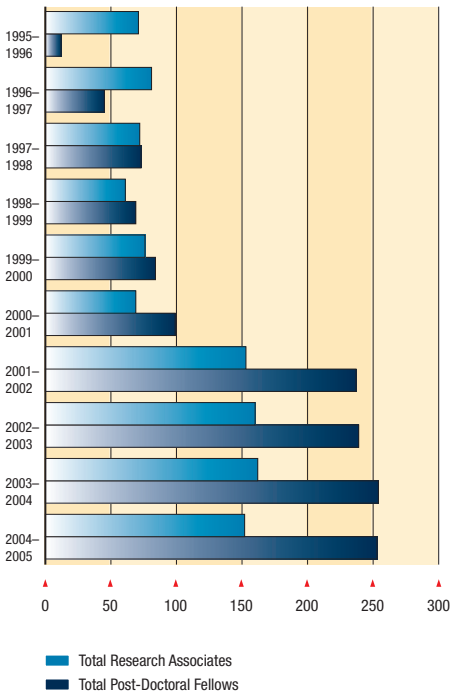
1995–1996	$ 524,300
1996–1997	$ 640,900
1997–1998	$ 1,971,800
1998–1999	$ 1,661,819
1999–2000	$ 1,106,535
2000–2001	$ 4,876,206
2001–2002	$ 4,166,795
2002–2003	$ 7,354,560
2003–2004	$ 5,466,995
2004–2005	$ 4,775,451

Highly Qualified People

NRC GUEST WORKERS



NRC POST-DOCTORAL FELLOW AND RESEARCH ASSISTANTS

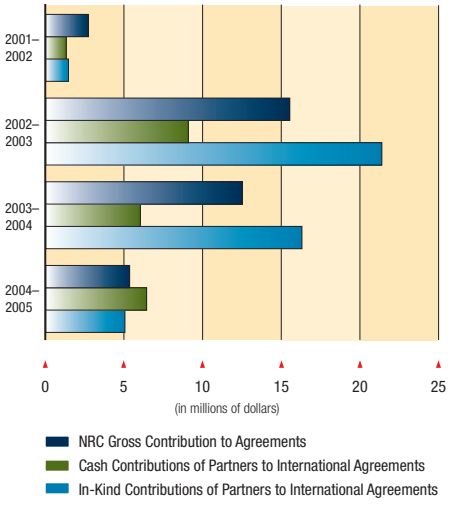


International Reach

NRC INTERNATIONAL REACH

International Conferences Organized	160
Delegations Received	194
Agreements Signed	109
Papers with International Co-Authors	Not Collected for 2004-2005

NRC INTERNATIONAL COLLABORATIONS



HIGHLIGHTS OF 2004–2005

CREATING ECONOMIC IMPACT

"We need to do better at driving technology deep into the economy, and we need to ensure we are investing in the right mechanisms to do that. Research and knowledge trapped in labs or institutions represents a big foregone opportunity to spread the benefits of science to Canadians."

The Honourable David L. Emerson, Minister of Industry (March, 2005)

NRC promotes innovation and creates value for Canada in many ways. It not only enhances Canada's R&D performance, it also develops the cornerstones of wealth creation – new technologies and technology-based enterprises, technology transfer mechanisms, knowledge transfer and dissemination systems and cluster building.

NRC strengthens Canada's innovation system, works to attract foreign direct investment in technology-based firms, and helps build the innovation capacity of Canadian businesses and Canadian communities.

In all its programs and activities, NRC takes an aggressive, entrepreneurial approach to stimulate the innovation that Canada and Canadian firms need to succeed in the global knowledge economy. The approach is designed to gain the most benefit and leverage from the knowledge and technologies NRC generates as well as the many national and international networks where NRC is a member. The approach ensures that NRC can work effectively to meet industry needs and match the capabilities of firms taking technologies to the market.

- NRC licenses technologies resulting from its research to companies helping them gain a foothold in leading-edge market niches.
- NRC provides Canadian industry with technology advice, contribution programs, mentoring, business intelligence and other services as well as access to vital national and international networks through the NRC Industrial Research Assistance Program and the NRC Canada Institute for Scientific and Technical Information.
- NRC provides access to knowledge and expertise through collaborative research opportunities, contract R&D, special interest research groups and other industry-oriented programs.
- NRC nurtures technology-based clusters across Canada, helping stimulate community-based innovation through the growth of new firms, the attraction of highly-qualified people and the attraction of direct foreign investment.
- NRC provides national codes and measurement standards, important support and infrastructure such as Industry Partnership Facilities necessary for companies to grow and prosper.

A VALUED PARTNER TO INDUSTRY

A record number of companies graduated from NRC incubation/co-location facilities in the past year. These companies have used NRC facilities, accessed NRC research expertise and other services to grow their business, build management capacity and hire the highly-qualified staff and attract the investment they need to see them through the difficult start-up period.

In recent years, NRC has worked hard to systematically develop a national network of Industry Partnership Facilities (IPFs) to support the needs of start-up firms. In the past year, as the number of IPFs and co-locating firms continued to grow in technology clusters across Canada, an increasing number of firms graduated from these facilities. In all, 14 tenants graduated from NRC IPFs in 2004-2005, a 27% increase over the previous year. Collectively, these graduates accounted for approximately 92 employees.

One case involved Ottawa-based XYZ RGB, a firm now well known in the tight-knit Hollywood film industry. The firm grew out of NRC's groundbreaking 3D laser scanning technology which XYZ RGB has adapted for use in the film industry. The firm is perhaps best known for helping enable special effects for major films such as the Lord of the Rings. Using a unique 3D laser scanning camera, XYZ RGB can produce digital image files of creatures or characters in truer-than-life detail. These files can then be manipulated by special effects crews to create cinematic magic. Last year, XYZ RGB and NRC were on the short-list for an Academy Award for technical achievement. In the past fiscal year, XYZ RGB graduated from one of NRC's Ottawa-based IPFs.

In St. John's, at NRC's IPF, known as the Ocean Technology Enterprise Centre (OTEC), MadRock Solutions and LewHill Technologies were the first graduates of a new Young Entrepreneurs Program offered through OTEC and delivered in cooperation with Memorial University's Genesis Centre. MadRock's unique lifeboat release system, which benefited from extensive testing in NRC's St. John's facilities, has been certified by several national and international marine registries. This system ensures safe and secure locking of lifeboats, even in extreme weather and sea conditions, and results in a safer launch of lifeboats. MadRock has licensed several pieces of NRC-developed technology, including a lifeboat release system. Both MadRock and LewHill were supported in early stage R&D by the NRC Industrial Research Assistance Program.

The Lord of the Rings: The Return of the King.
Photo New Line Productions © 2003

NRC WORKS CLOSELY WITH COMMUNITY PARTNERS IN DESIGNING AND DELIVERING R&D AND ENTREPRENEURSHIP PROGRAMS AND SUPPORT TO FIRMS INCUBATING IN ITS FACILITIES AS WELL AS ACCESS TO CUTTING-EDGE RESEARCH INFRASTRUCTURE AND EXPERTISE. THIS PROGRAMMING APPROACH HAS BECOME AN IMPORTANT FOCUS OF MANY NRC IPFs. IT NOT ONLY HELPS FORGE STRONGER LINKS WITH KEY TECHNOLOGY CLUSTER PARTNERS ACROSS CANADA, BUT ALSO EXTENDS THE RANGE OF SERVICES AND SUPPORT THAT ARE AVAILABLE TO IPF TENANTS. THIS HAS BEEN THE CASE IN LONGUEUIL, QUEBEC, WHERE NRC, IN PARTNERSHIP WITH VALOTECH AND SUPPORT FROM CANADA ECONOMIC DEVELOPMENT FOR QUEBEC REGIONS CREATED A FACILITY KNOWN AS THE *CROSSROADS FOR INDUSTRIAL MATERIALS INNOVATION*. IN WINNIPEG, NRC IS CONSTRUCTING A NEW CENTRE FOR THE COMMERCIALIZATION OF BIOMEDICAL TECHNOLOGY THAT WILL PROVIDE ACCESS TO A UNIQUE BUSINESS SKILLS DEVELOPMENT PROGRAM FOR YOUNG COMPANIES. AND, WHEN IT OPENS FOR BUSINESS IN 2006, THE NRC NATIONAL INSTITUTE FOR NANOTECHNOLOGY INNOVATION CENTRE IN EDMONTON WILL FEATURE THE COMBINED RESOURCES OF NRC, THE UNIVERSITY OF ALBERTA AND TEC EDMONTON (TECHNOLOGY, ENTREPRENEUR AND COMPANY DEVELOPMENT EDMONTON).

NRC – Global Reach, Local Touch

Innovation is a global issue, rooted in each nation's ability to create, exploit and transform new knowledge into the innovative products that can create a competitive edge in global markets. Science is international.

Canada's participation in international S&T is vital for the nation to gain access to the S&T knowledge and information it needs to succeed in the knowledge economy. This global reach improves the quality of knowledge produced by Canadian researchers. It creates access to the world's best S&T facilities, equipment and talent. It provides vital access to the knowledge generated by researchers in other nations, a necessity for Canada and Canadian businesses. It opens doors for Canadian firms to access the technology opportunities and information they need to remain competitive.

NRC has created international S&T networks of strategic importance for Canada. NRC uses these linkages and networks, not only to transfer S&T information back to Canadian firms, universities and public sector partners, but also to generate new business opportunities for Canadian SMEs.

NRC's international activities are focused on these key objectives:

- Developing/renewing international S&T alliances of value to Canada
- Enhancing NRC's reputation and credibility for leading-edge R&D around the world
- Securing access to international R&D programs and facilities for Canadian researchers
- Promoting international standards harmonization
- Stimulating foreign direct investment in Canada
- Improving its S&T foresight and forecasting for new research and technology domains.

NRC's Global Connections 2004-2005

- 109 Formal collaborative research agreements signed with international partners. Total lifetime value of all current international agreements – $139.7 million
- NRC partners invest 2.14 dollars for every dollar NRC invests
- NRC organized 160 international conferences and workshops
- NRC received 194 official foreign delegations

EFFECTIVE TECHNOLOGY TRANSFER

One of NRC's spin-off companies, Novadaq Technologies received approval from the U.S. Food and Drug Administration for its medical imaging technology. The approval represents a significant business opportunity for the wide-spread commercialization of this world-leading technology.

Imagine a cardiac surgeon watching the blood flow through their patient's heart and arteries during coronary artery bypass surgery. Are there any leaks or blockages in blood flow? If there are, surgeons can repair them while the patient is still on the operating table.

Thanks to Novadaq Technologies, an NRC spin-off company, this scenario is on the way to becoming routine medicine. In early 2005, Novadaq Technologies received FDA (U.S. Food and Drug Administration) approval to market its SPY Intra-operative Imaging System for coronary artery bypass graft (CABG) surgery in the United States. This technology was already in use in Canada, Japan and Europe and was used for the first time in the U.S. at the Stanford University School of Medicine in Stanford, California, in March 2005.

CABG surgery uses arteries from other parts of the patient's body to substitute for clogged heart arteries. According to the American Heart Association, approximately 400,000 CABG surgeries are performed annually in the US, half of the worldwide total. In comparison, Canadians underwent nearly 25,000 CABG surgeries in 2000. These numbers are expected to rise, however, as many as forty percent of Canadians will develop some form of heart disease in their lifetimes. According to the Heart and Stroke Foundation of Canada, cardiovascular disease and stroke currently cause one in three deaths in Canada.

The FDA approval permits Novadaq to sell the SPY Imaging system in the world's largest market and establishes the company in the international medical diagnostics industry. Stanford has announced plans to lead a large U.S.-wide evaluation of the technology which has the potential to replace the well-known angiogram as the new gold standard for assessing cardiovascular blood flow. The real bonus is that this system works in real-time, in the operating theatre.

CANADA'S LARGEST PROVIDER OF SCIENTIFIC, TECHNICAL AND MEDICAL INFORMATION

AS CANADA'S LARGEST PUBLISHER OF SCIENTIFIC AND TECHNICAL JOURNALS, THE NRC RESEARCH PRESS HOLDS AN INTERNATIONAL LEADERSHIP POSITION IN ELECTRONIC PUBLISHING AND S&T INFORMATION DISSEMINATION. THE ON-LINE VERSIONS OF NRC RESEARCH PRESS JOURNALS ARE AVAILABLE FREE TO ALL CANADIAN READERS. IN 2004-2005, USE OF THE PRESS' ELECTRONIC JOURNALS INCREASED DRAMATICALLY AS A RESULT OF INDEXING BY THE INTERNET SEARCH ENGINE GOOGLE. READERS DOWNLOADED ALMOST 1,000,000 ARTICLES, REPRESENTING AN INCREASE OF 138% OVER THE PREVIOUS YEAR'S 420,000. MEANWHILE, ACCORDING TO A SURVEY OF 600 INFORMATION BUYERS IN THE PRIVATE AND PUBLIC SECTORS CONDUCTED BY OUTSELL INC., NRC-CISTI IS RANKED TOP OVERALL FOR DOCUMENT DELIVERY. NRC-CISTI BESTED ALL OTHER KEY COMPETITORS, SUCH AS THE BRITISH LIBRARY DOCUMENT CENTRE AND INFOTRIEVE DOCUMENT DELIVERY.

NRC – Stimulating Community-based Innovation Across Canada

The growing international wave of innovation driven at the local level is based on public and private sector teamwork, partnerships and networks. Canada, given its vast geography, relatively small and dispersed population, and predominance of SMEs, has increasingly taken a collaborative approach to building community innovation over the past decade.

NRC is a nationally accessible, community-based S&T resource for Canadian business. With its R&D industry support and information resources programs, NRC has long played an important role in many Canadian communities.

NRC works with communities across the nation to increase their capacity in key technology fields through jointly developed innovation strategies that support the sustained growth of technology clusters. In 2004-2005, NRC continued to develop and expand its community cluster initiatives in partnership with stakeholders across Canada and focused on achieving four strategic goals:

- Creating a globally competitive research and technology base for cluster development at the community level
- Supporting community leadership, champions and knowledge-based strategies
- Working with stakeholders to leverage funding and new investment in community clusters
- Stimulating the emergence of new firms, jobs, exports and investment growth.

NRC COMMUNITY TECHNOLOGY CLUSTERS — ECONOMIC WEALTH GENERATORS

ATLANTIC CANADA

OCEAN AND MARINE TECHNOLOGIES (ST. JOHN'S)
BIORESOURCES (CHARLOTTETOWN)
LIFE SCIENCES (HALIFAX)
E-BUSINESS (FREDERICTON, MONCTON, SAINT JOHN)
WIRELESS SYSTEMS (SYDNEY)

QUEBEC

ALUMINIUM TECHNOLOGIES (SAGUENAY)
AEROSPACE, BIOPHARMACEUTICALS (MONTRÉAL)

ONTARIO

PHOTONICS (OTTAWA)

WESTERN CANADA

MEDICAL DEVICES, LIFE SCIENCES (WINNIPEG)
NUTRACEUTICALS, PLANT BIOTECHNOLOGY (SASKATOON)
SUSTAINABLE INFRASTRUCTURE (REGINA)
NANOTECHNOLOGY (EDMONTON)
FUEL CELLS (VANCOUVER)

COMMUNITY-BASED INNOVATION – VANCOUVER'S HYDROGEN HIGHWAY

NRC continued to help stimulate community-based innovation across Canada. In Vancouver, NRC was one of several partners that worked together to help launch the unique, large-scale demonstration project that will help profile and test fuel cell technologies being developed in British Columbia.

On April 1, 2004, at GLOBE 2004, the Right Honourable Prime Minister Paul Martin announced Canada's plans to build a Hydrogen Highway™ from the Vancouver Airport to Whistler, in time for the 2010 Winter Olympics. The project is part of the 2010 Olympics' plan for a sustainable Olympics. The Hydrogen Highway™ is also a key component in the BC Hydrogen and Fuel Cell Strategy.

NRC, along with original partners B.C. Hydro and Methanex Corporation, first launched the concept of a hydrogen highway demonstration project in 2002. During 2004-2005, the plan moved from concept to reality.

The Hydrogen Highway™ is a coordinated, large-scale demonstration and deployment program intended to accelerate the commercialization of hydrogen and fuel cell technologies developed in Canada. Along with NRC, several other Government of Canada organizations, including Industry Canada and Natural Resources Canada (NRCan), are partnering with the province of British Columbia in this project. Fuel Cells Canada now manages the program, while Ballard Power Systems is the program champion.

The project comprises seven nodes – each with plans for its own sustainable microcosm employing hydrogen fueling infrastructure as well as a range of transportation and stationary applications. In the past year, the NRC Institute for Fuel Cell Innovation, with funding from NRCan, launched the Hydrogen Highway's™ first hydrogen refueling station. One of the first users of what is now known as the Pacific Spirit station is the Vancouver Fuel Cell Vehicle Program, a recently-launched $5 million initiative that will test and evaluate Ford Focus Fuel Cell Vehicles, in real-world applications, over the next several years.

By creating an early adopter community of technology developers and users throughout British Columbia, the Hydrogen Highway™ will play an integral role in removing barriers to hydrogen and fuel cell commercialization. The project will help Canada develop a critical mass of expertise, knowledge, and experience in this field. It will provide data for developing international codes and standards to govern the implementation and use of these technologies. Best of all, it will stimulate demand for the technology by allowing the media and general public to see first-hand the benefits of a hydrogen economy. Furthermore, it will open doors for international partnership and will create a hydrogen infrastructure legacy associated with a high-profile international event.

INTERNATIONAL PARTNERSHIPS ACCELERATING OILSANDS RESEARCH

NRC CHEMICAL PROCESS RESEARCHERS IN OTTAWA ARE WORKING TOGETHER WITH THE UNIVERSITY OF PETROLEUM IN BEIJING ON AN ATHABASKA OIL SANDS PROJECT. A CONTINUING COLLABORATION WILL ALLOW THE EXCHANGE OF STAFF AND EXPERTISE AND GIVE NRC ACCESS TO KEY FACILITIES FOR RESEARCH ON EXTRACTION TECHNIQUES AT A LARGER SCALE THAN IS POSSIBLE IN CANADA. COUPLED WITH A PARALLEL AGREEMENT WITH SYNCRUDE CANADA, THIS COLLABORATION IS CRITICAL TO THE FUTURE DEVELOPMENT OF OIL SANDS IN CANADA.

SUPPORT OF SMALL AND MEDIUM-SIZED ENTERPRISES

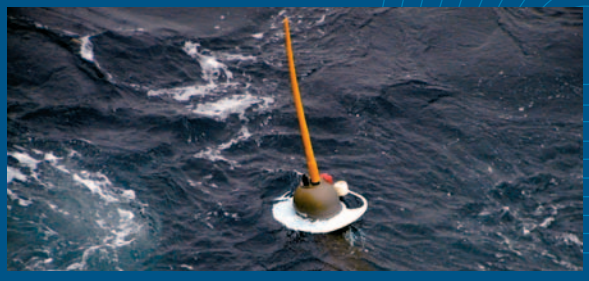
With advice and support from the NRC Industrial Research Assistance Program (NRC-IRAP), a Dartmouth, Nova Scotia company succeeded in starting a new product line to capitalize on a new ocean mapping initiative.

A Dartmouth, Nova Scotia company is helping scientists monitor the state of the earth's oceans. METOCEAN Data Systems has developed a "profiling autonomous float" that can measure the temperature and salinity of oceans anywhere in the world, gathering valuable data about climate change.

The float, called PROVOR, a two-metre-long tube with an antenna at one end, has the appearance of a giant hypodermic needle. Dropped into the ocean from a plane or ship, the float descends to a depth of 2000 metres where it drifts with the underwater current for about 10 days, then ascends slowly, taking measurements all the way. Once at the surface, it sends its data back to the user via satellite, then descends and repeats the process, a cycle called "profiling." Each float has a lifespan of five years.

With this profiling technology, METOCEAN has tapped into a new market created by the ARGO initiative, a global array of 3000 free-drifting floats that measure the temperature and salinity of the upper 2000 metres of the ocean. Scientists and oceanographers use this data to predict long-term changes in the earth's climate. It also serves as an early warning system for predicting global patterns of rainfall, winds, storms, and atmospheric circulation.

The PROVOR float also has potential applications in other areas of marine sciences. For example, it can be fitted with an optical sensor to measure the depth of light penetration in the ocean, something of keen interest to biologists.



The company received help from the NRC Industrial Research Assistance Program (NRC-IRAP). With help from an NRC-IRAP advisor, the company was able to conceive the right plan to help develop this new product. NRC-IRAP also worked to link the company with researchers at Dalhousie University who helped in modeling float behaviour, and in analyzing the composite materials that make up the float's hull. NRC-IRAP also provided funding to help accelerate the firm's R&D work. In all, support by NRC-IRAP helped METOCEAN speed up its development process in time to catch the wave of opportunity that they otherwise would have missed.

IMPORTANCE OF SMEs

CANADA'S NEARLY TWO MILLION SMEs ARE THE KEY DRIVERS OF JOB AND WEALTH CREATION IN ALL SECTORS OF THE CANADIAN ECONOMY. GIVEN THE MAJOR IMPACT OF SMEs ON THE ECONOMY, EFFORTS TO RAISE CANADA'S STANDING AS A WORLD LEADER IN R&D AND TO IMPROVE THE NATION'S ECONOMIC PERFORMANCE MUST TAKE INTO ACCOUNT THEIR VITAL ROLE.

TO SUCCEED, SMEs MUST BE ABLE TO EFFECTIVELY AND EFFICIENTLY ACCESS, DEVELOP AND EXPLOIT THE NEW KNOWLEDGE AND TECHNOLOGIES THAT ARE CRITICAL TO THEIR GROWTH AND PROSPERITY. NRC HELPS STIMULATE WEALTH CREATION BY SUPPORTING SMEs IN CANADA WITH TARGETED SERVICE, ADVICE AND ASSISTANCE.

SME SUPPORT

- CUSTOMIZED ADVICE, INFORMATION AND REFERRALS TO CLOSE TO 11,000 FIRMS ANNUALLY THROUGH NRC-IRAP
- $80.79 MILLION IN RESEARCH ASSISTANCE CONTRIBUTIONS TO INNOVATIVE FIRMS THROUGH NRC-IRAP, SPREAD OVER 2,620 PROJECTS
- SCIENTIFIC AND TECHNICAL INFORMATION SERVICES THROUGH THE NRC CANADA INSTITUTE FOR SCIENTIFIC AND TECHNICAL INFORMATION AND THE NATIONAL NRC INFORMATION CENTRE NETWORK
- 109 COMPANIES INCUBATING AT NRC'S NATIONAL NETWORK OF IPFS IN 2004–2005

SCIENCE AT WORK FOR CANADIANS

"Research is crucial to improving our environment, advancing our health care system and making Canadian firms more productive and competitive. That is why the Government of Canada will continue to do its part – along with the universities and the private sector – to promote research and new technologies."

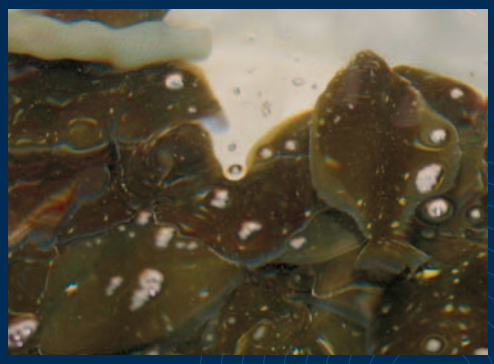
Budget 2005

NRC is more than an R&D and commercialization engine for Canada. At heart, its story is also about people — some 4,000 scientists, engineers, technicians and operational staff — working for Canadians and others around the world.

Truly ground-breaking scientific discoveries now draw from a wide range of scientific skills and expertise. Flexible and highly networked organizations with a diversified pool of research expertise can deliver the most impact. NRC continues to develop its reputation as a world-leading research organization by cultivating multi-institute, multi-disciplinary teams in highly strategic research fields such as nanotechnology, energy technologies and biotechnology.

NRC actively seeks out solutions to national challenges in health, climate change, security, the environment, clean energy and other fields, helping lay the knowledge foundations for Canada's future growth. The focus is solving real problems – those with the potential for saving lives, improving the environment and quality of life, or creating new technologies and industries where Canada can be a world leader.

The following section highlights a few of these achievements and their impacts on everyday life and the future.



FIGHTING THE THREAT OF SARS

NRC researchers are working to improve our understanding and find ways to better combat infectious diseases such as Severe Acute Respiratory Syndrome (SARS). Although largely dormant at present, the world continues to live under the threat of another SARS outbreak. In the past year, two different NRC teams reported progress in the fight against SARS using vastly different approaches, one using the tools of biotechnology and the other using mathematics.

Using math to fight SARS

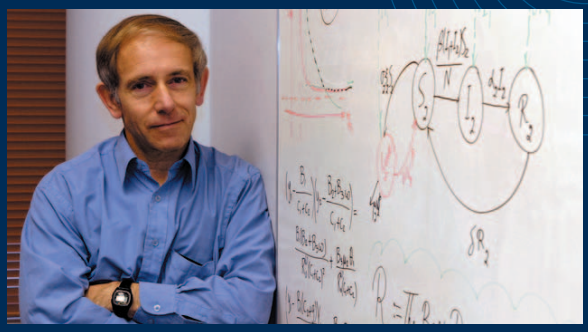
Anyone who visited a hospital in the spring of 2003 will remember spending time in line waiting to be screened for SARS. If another outbreak were to occur, the same sorts of procedures would likely apply. In the continued absence of a vaccine or an effective rapid diagnosis tool, isolation (used for patients with *symptoms* of SARS) and quarantine (used for patients with an *established link* to the SARS virus) remain the best tools for limiting transmission of the virus.

NRC life sciences researchers in Winnipeg are part of a Canadian team that has applied the tools of mathematical modeling to better understand the precise extent to which isolation or quarantine is more effective. The goal of this research is to help public-health authorities make decisions in a situation where the health-care system is stretched thin, or a vaccine is not available.

By analyzing data collected during the outbreak, the team concluded that once the SARS outbreak began in Toronto, screening (used widely at points of entry into the country and at health-care facilities) had little impact on how fast the disease progressed. In contrast, simulations using the same data showed that the size and duration of an outbreak can be greatly influenced by the timely implementation of the isolation program. For example, if authorities had waited as few as five extra days in quarantining and isolating persons with probable cases of SARS, there would have been 16 additional deaths. Ultimately, researchers concluded that the isolation of individuals with symptoms of SARS, under stringent hygiene precautions, can lead to effective control in a community and may even eradicate the disease, provided there are no undetected new admissions of SARS-infected individuals.

Protein Structure

NRC biotechnology researchers based in Montreal are also having an impact on SARS. Using computer prediction and modeling techniques, the team has built a model of the structure of a protein used by the SARS virus to help it reproduce, known as SARS PLpro. Proteins play an extremely important role in all organisms.



Generally speaking, proteins are responsible for carrying out all of the functions necessary for the organism to live.

While identifying proteins is the first step, understanding their physical structure is key to learning more about their function, a task which the team accomplished using computer modeling techniques. The team was able to translate extensive expertise with another related group of proteins, the cysteine proteases, and use this to help in identifying a new and unexpected function for the SARS PLpro. The model revealed that the viral protease might mimic the function of enzymes present in the human host, known as deubiquitinating enzymes. This prediction was later confirmed by the NRC researchers.

Ubiquitination is an important process that helps regulate several key cellular functions. The process, the subject of the 2004 Nobel Prize in Chemistry, involves the addition of a protein called ubiquitin which, when present, sends a message that the ubiquitinated protein has finished its work and needs to be eliminated or "degraded". NRC's model suggests that the SARS PLpro enzyme, in addition to helping the virus replicate, can also reverse the ubiquitination process. The finding has raised important questions about whether this ability to deubiquitinate proteins and, therefore, interfere with important cellular functions could help explain why the SARS virus is so effective in evading cellular defenses. This discovery could lead to new strategies for developing anti-viral drugs against SARS and other related viruses.

BUILDING CLEAN AND SUSTAINABLE TECHNOLOGIES

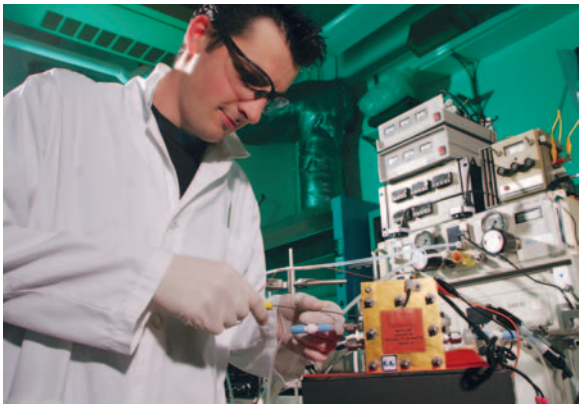
NRC researchers are investigating ways of making fuel cell technologies more efficient, more reliable and cheaper to manufacture. One team, as part of an international research partnership, has designed promising new materials for Solid Oxide Fuel Cells.

Fuel cells are one of the leading contenders for widespread, efficient and relatively clean generation of power for uses not only in the automobile industry but also to generate power for residential applications.

One form of fuel cell technology is the Solid Oxide Fuel Cell (SOFC). SOFCs can use any hydrocarbon fuel (i.e. natural gas) as a source of energy, run at much higher temperatures than Proton Exchange Membrane (PEM) fuel cells (800-1000 degrees C) and tend to be used as stationary power sources.

NRC fuel cell researchers in Ottawa recently completed a multi-year international research project with researchers in the United Kingdom to improve materials used in the production of SOFCs. Improving the chances of market success for fuel cells will depend on achieving decreased costs in their materials and manufacturing. In the case of SOFCs, improving their ability to operate at lower operating temperatures will also reduce costs because it means that system components can be made out of less expensive materials that, ordinarily, wouldn't be durable under high temperatures.

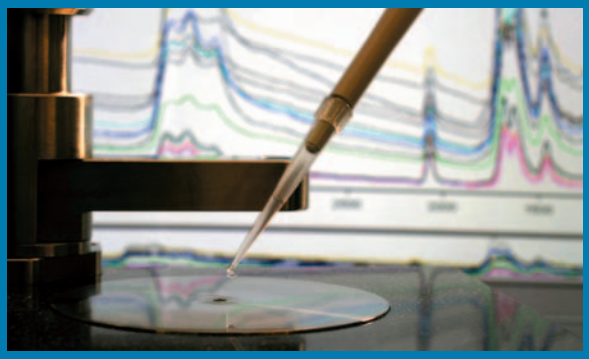
SOFCs run at normally high temperatures because this provides the best environment for the transfer or conductivity of oxygen ions which are necessary to transform chemical energy into usable electric energy. The research team took the approach that, rather than rely on temperature alone, other SOFC materials should be evaluated to determine if they could be engineered so that, by their very structure, the ability of oxygen ions to move freely and quickly would be increased.



The project resulted in the synthesis of a number of unique oxide ion conductors made from the mineral perskovite, already popular for use as a cathode layer in SOFCs. Conventional perskovite cathodes are oxygen deficient, allowing oxygen ions to hop in a path through the structure. In contrast, the group synthesized new structures, into which an additional oxygen-rich layer was inserted. In this case, the excess oxygen, referred to as interstitial oxygen sites, allow oxygen ions to flow quickly and smoothly along this layer. The result is that the cathode layer of the fuel cell becomes extremely efficient, accelerating the electrochemical reaction while also reducing overall operating temperatures. The team has reported success in developing SOFC cathodes that function at 500 degrees C temperature, much lower that current SOFC operating temperatures. The project was carried out with partners from Imperial College as part of a NRC-British Council agreement.

SCIENCE FOR NATIONAL SECURITY

NRC researchers are making important progress in developing a vaccine against a lethal pathogen which has been listed as a bioterrorism threat. In the process, the group is perfecting technology that could have an important impact on the development of vaccines for many other illnesses.



NRC biological sciences researchers in Ottawa have been making good use of their new NRC Level III biocontainment facility, built to allow safe experimentation with lethal pathogens such as *Francisella tularensis* (*Francisella*). *Francisella* is an extremely infectious bacterium, the most virulent strains of which are only found in rodents and rabbits in Canada and the USA. These strains are ranked as one of the four most likely organisms to be used as a bioterrorism weapon, alongside pathogenic bacteria or viruses that cause smallpox, anthrax and the plague.

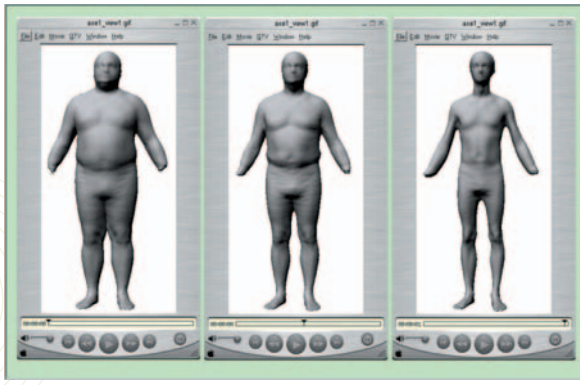
The team has won a series of grants from the U.S. National Institutes of Health (NIH) to support the development of a vaccine against *Francisella*. This funding and the participation of several international partners is evidence of the recognition of NRC's expertise in the field of vaccine development. Major global research partners include Umea University in Sweden, a team of *Francisella* researchers from the U.K. and a private-sector partner from the U.S.

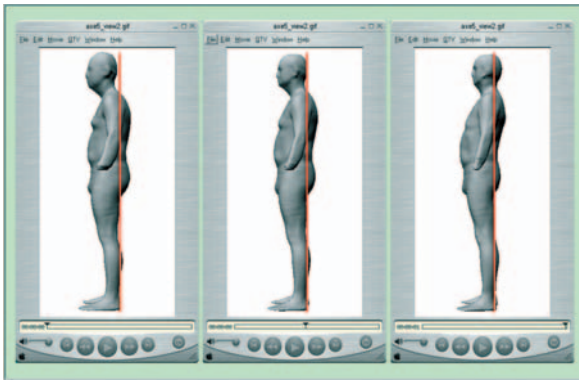
Generally speaking, there are two basic approaches to preparing vaccines, either a live vaccine or what is known as a sub-unit vaccine. Polio, smallpox and tuberculosis are all examples of live vaccines. These vaccines actually carry small amounts of live virus, or bacteria in the case of tuberculosis, which are used to stimulate the body's immune system into producing T-cells and antibodies which then destroy the disease-causing pathogen. More importantly, the production of these immune responses helps program cells to remember what the pathogen looked like and what to do if it ever sees it again. In contrast, sub-unit vaccines contain only fragments of the virus or bacterium that may generate antibodies but not activate the more potent T-cells which can clear infected cells. As a result, while considered safer than live vaccines, clearly a concern with extremely deadly viruses, sub-unit vaccines do not have enough power to rid the body of invading pathogens such as *Francisella*.

To deal with this problem, and to create a truly safe and effective vaccine, NRC researchers have made use of a novel form of lipids (fat) first discovered at NRC more than 25 years ago. These lipids can be formulated to make nanosized vesicles (balloons) known as archaeosomes, that can be loaded with antigens specific to *Francisella* (think of filling up a balloon with water) and, when introduced into a host, fool it into thinking it has encountered the live pathogen. The lipids are able to pass through the membrane of our immune-system cells and, once inside, they release their payload. The resulting presence of antigens *inside* the cell stimulates the production of T-cells. NRC recently signed an agreement with a company to license this technology. The project, which is ongoing, will continue to look for bacterial antigens capable of producing the most pronounced response against *Francisella* and other disease causing microbes that require T-cells to combat them.

THE SHAPE WE'RE IN

NRC researchers bring to life a major database of 3D body scans. Apparel manufacturers and the aerospace industry are several industries where getting an accurate picture of variations in human shape can create a real business advantage.





NRC information technology researchers in Ottawa put the finishing touches on a three-year study of data about the human body shape. Confronting an extremely large data set based on detailed 3D body scans of 6,000 men and women in the United States, Italy and the Netherlands, the team came up with a short set of variables (7) that designers in a number of sectors will be able to use to quickly and accurately predict and respond to numerous variations of human shape.

The results will be critical for designers in the apparel, automotive and aerospace sector, to name but a few. They will be able to design better-fitting clothes off the rack or more comfortable passenger seats for long drives and flights. Better data also results in significant cost reductions and less waste in manufacturing. For example, clothing manufacturers will be able to eliminate, with certainty, production of a number of sizes immediately.

In the late 1990s, as part of an industry/government study known as CAESAR (Civilian American and European Surface Anthropometry Resource Project), 6,000 men and women between the ages of 18-65 in the United States, Italy and the Netherlands were imaged in three poses using a 3D body scanner. The study was the first systematic collection of anthropometric data of its kind and offered significantly improved measurements than those from traditional tools such as the trusty tape measure.

As a result of the NRC-led Human Shape Variability Study, the true potential of this database has been unlocked. In addition to anthropometric data, the database also includes demographic data such as income level and geographic origin. With the new tools from NRC, users will be able to select the particular demographic segment they are interested in and actually visualize what this population will look like and, more importantly, the ranges of shapes and sizes found in this target population. When it comes to designing products, manufacturers will be able to optimize their designs to create, literally, the best possible fit.

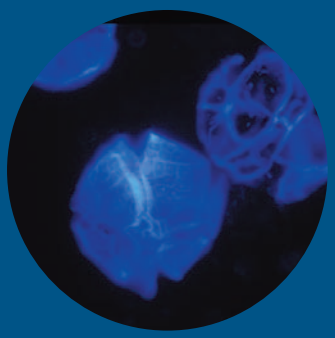
In total, just seven factors shape the vast majority of variation in body types. Not surprisingly the combination of height and weight accounted for the greatest degree of variability, at 34 per cent. In other words, nearly one-third of the time, differences in body types could be explained by looking at difference in height and weight. But the research also pointed to less obvious relationships. For example, posture has a noticeable impact on body types. "Leaning" posture accounts for 15% of variation, followed by the degree of muscularity (9%), arm-torso spacing (4%) and head position (4%).

SAFER SHELLFISH

When we hear the term evolution, it's easy to believe that it refers to something in the past, forgetting that nothing stays the same forever. NRC marine bioscience researchers in Halifax, along with partners in the U.S., have pinpointed an important and unexpected molecular change in soft shell clams that greatly increases their resistance to toxins produced by harmful algae blooms in coastal waters known as "Red Tides". The findings of this study were published in *Nature*.

The discovery is important not only because Canada's shellfish industry is big business, but also because it affects human health. Eating clams or other shellfish that contain large amounts of these toxins impairs the ability of your body to process electrical signals essential to nerve and muscle function, a potentially fatal condition known as Paralytic Shellfish Poisoning. Nerves can't do their job, causing muscle paralysis, because their site of communication, known as the sodium channel, has been blocked by the toxins.

Researchers found that an extremely small change in the DNA, a natural mutation that causes a single amino acid change, greatly decreases the ability of toxins to bind in these channels. Most clams from areas with a history of algal blooms had the mutation and were more resistant than those in regions which have never suffered blooms.



The former were able to accumulate toxins much faster, at a rate approximately seven times higher, than the ones which had never previously experienced red tides. The discovery is important and unexpected because sodium channel proteins found in the membranes of nerve and muscle fibers have remained virtually unchanged between humans and other more primitive organisms for millennia. From the point of view of evolution and biology, such a fact is rare and a sign of the extreme importance of sodium channels for nerve response among organisms. In this case, rapid and extreme environmental change (which has caused increased red tides) has now forced rapid evolutionary change.

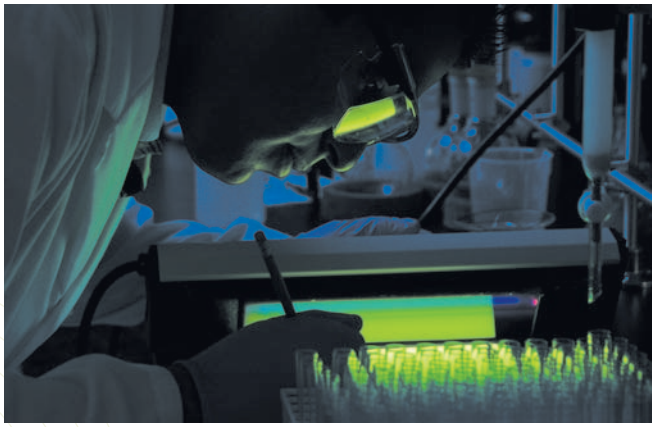
AT THE FRONTIERS OF SCIENCE

"The world and the universe is an extremely beautiful place, and the more we understand about it the more beautiful does it appear."

Biologist Richard Dawkins

NRC helps put science to work for Canada by ensuring that we are active at all points along the continuum that links discovery to innovation.

In addition to numerous discoveries and the development of technologies that will have an impact in the short and medium-term, NRC is also committed to continued exploration and research in areas with much longer time horizons. Science has now entered into the domains of the very fast and very small where new laws and principles hold sway and much remains to be discovered.



Discoveries create knowledge and stimulate innovation because they point out new possibilities and opportunities. Discoveries also help clarify thinking and create the building blocks for future discoveries, of critical importance in all scientific fields, but particularly in new and developing areas of research such as nanotechnology.

R&D LEADERSHIP FOR CANADA

AS THE GOVERNMENT OF CANADA'S LEADING R&D ORGANIZATION, NRC PROVIDES ADVICE AND GUIDANCE ON SCIENCE AND TECHNOLOGY ISSUES TO GOVERNMENT DECISION MAKERS. EACH YEAR, NRC PLAYS A KEY ROLE IN NEW TECHNOLOGY FORESIGHT AND ROADMAPPING STUDIES, WORK WHICH REQUIRES COLLABORATION AND INVOLVEMENT FROM A VARIETY OF STAKEHOLDERS AND WHICH HELPS DEFINE NATIONAL SCIENCE AND TECHNOLOGY PRIORITIES. NRC IS A VALUABLE PARTICIPANT ON THESE ISSUES, HELPING BALANCE PERSPECTIVES FROM OTHER PLAYERS. AS AN ADDED BENEFIT, THE DEPTH OF NRC'S COLLABORATIONS HELPS BRING NEW PARTNERS TO THE TABLE AND HELPS STIMULATE WEALTH CREATION AND THE GROWTH OF COMMUNITY-BASED INNOVATION.

NRC ALSO PLAYS AN IMPORTANT ROLE IN HELPING MANAGE AND DIRECT FUNDING TO LARGE AND COMPLEX SCIENCE FACILITIES IN CANADA THAT HAVE ALREADY ESTABLISHED AN INTERNATIONAL REPUTATION, SUCH AS TRIUMF, AS WELL AS OTHERS THAT ARE POISED TO HAVE SUCH A REPUTATION, SUCH AS THE CANADIAN LIGHT SOURCE.

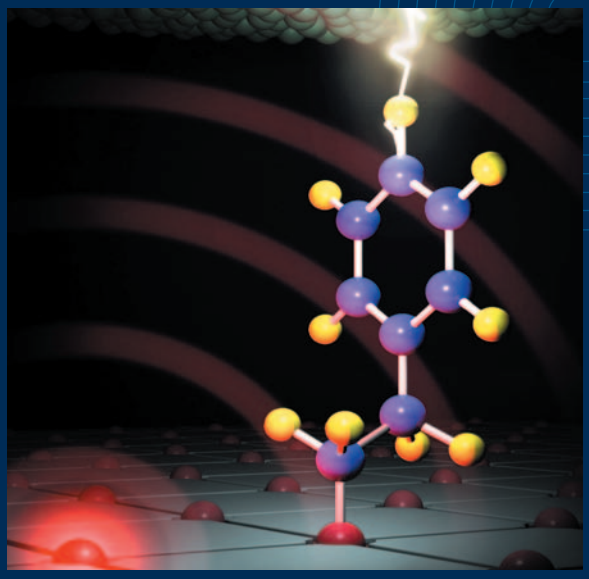
NEW CONCEPT FOR A SINGLE MOLECULE TRANSISTOR DEMONSTRATED

Researchers at the National Institute for Nanotechnology, a joint initiative among NRC, the Province of Alberta and the University of Alberta, demonstrated a prototype of a molecular-based transistor, an achievement that could pave the way for a new generation of electronics.

Computer miniaturization is currently limited by the size constraints of transistors. Each transistor has three electrodes, or electron conducting devices, which must be in physical contact with a conduction channel to allow electricity to flow. Think of a garden hose. There is the pipe to the outside, there is a tap, and there is the hose to deliver the water where needed. When the tap or gate is open, water flows through the hose or channel. When it is not, the water stops. All three components are physically connected to one another. Conventional wisdom holds that future molecular-based transistors have to follow the same model; a molecule must somehow be attached to input and output wires. So far, researchers have not been able to achieve this feat. To illustrate the challenge, imagine trying to get three watermelons to simultaneously touch something as small as a poppy seed. It can't be done.

As it turns out, the team's approach to this challenge was to cause two electrodes to act as three. They have shown that a single atom on a silicon surface, poised next to a molecule, can be charged with a single electron. The electric field emanating from that charge shifts energy levels in the molecule into alignment with energy levels in the electrodes. Like opening the tap connects the water supply to the hose, electrons can flow through the molecules when its energy levels are shifted by the field.

Using a unique technique that the group has now perfected, the team took a silicon wafer and exposed it to hydrogen gas, capping or "passivating" each silicon atom with a hydrogen atom. Using a scanning tunnel microscope (STM), the team removed the cap from one atom, creating a silicon atom with a dangling bond. The wafer was exposed to styrene gas and, a single styrene molecule attached to the same silicon atom with



the exposed bond. The styrene stabilizes itself by abstracting a hydrogen atom from a neighbouring silicon atom. Under the right conditions, that silicon atom becomes negatively charged. The charge emanates a field that shifts energy levels in the styrene molecule. By changing the position of the STM or the voltage of the underlying substrate, the molecular conduit allows for more or less current to flow depending on the presence of the charge and this is the same basic function as a transistor.

The use of a single electron as a gate represents the ultimate in speed and efficiency for transistor action.

NANOTECH ACROSS NRC

NRC RESEARCH TEAMS FROM A NUMBER OF SECTORS INCLUDING MEDICAL DEVICES, ELECTRONICS, FUEL CELLS AND CONSTRUCTION MATERIALS PURSUE RESEARCH AT THE NANOSCALE LEVEL. CURRENT PROJECTS INCLUDE THE DEVELOPMENT OF NEW NANOCOMPOSITE COATINGS TO CREATE NEW AND IMPROVED HIP PROSTHESES, THE OPENING OF A NEW SPECIALIZED LABORATORY FOR NANOIMPRINT LITHOGRAPHY IN LONGUEUIL, QUEBEC, THE CREATION OF NEW MATERIALS FOR FUEL CELLS, NANOSIZED ADDITIVES FOR CONCRETE AND NEW METROLOGY TOOLS APPLICABLE TO NANOTECHNOLOGY.

REMARKABLE FIRST IMAGE OF AN ELECTRON ORBITAL

NRC molecular science researchers in Ottawa achieved a landmark in science in 2004-2005 when they captured the first picture of an electron orbital or cloud, the area in which an electron moves.

Electrons, and changes that happen to them in relation to other molecules, are the basis of all chemical reactions. Creating a 3D picture of an electron orbital is the first step towards creating images of how chemical bonds are broken and formed during reactions. This achievement has major implications for any industry where chemistry is involved, such as the design of new drugs. The ability to observe these changes is to observe the essence of chemistry.

To be able to catch up with these electrons, you have to use a special kind of extremely fast and intense laser which produces laser pulses measured in femtoseconds. Using a femtosecond laser, the team fired a pulse into a vacuum chamber filled with nitrogen gas. Just an instant earlier, another femtosecond laser had been fired to make sure all of the molecules in the gas were lined up in the same direction.

The team deliberately targeted one of the outermost and loosely bound electrons which, with the help of the laser, was temporarily dislodged from the parent nitrogen molecule. Temporary in this case means about 1.3 fs, after which the electron came hurtling back towards the parent molecule. During the process, the electron gains a tremendous amount of energy from the laser and when it collides it creates an intense emission of light in the extreme ultraviolet range, which the researchers have termed high harmonics. One member of the research team suggested that since the electron collision produced the emission, perhaps these high harmonics could give information about the shape of the orbital itself. In other words, if analyzed correctly; this spectrum would reveal the actual underlying shadow of the molecular orbital.

Because of Heisenberg's Uncertainty Principle, an electron in a molecule does not occupy a single point in space. It is spread out in a cloud. Imagine you have a car going around the race track and you take a picture every once in a while and you record the location of the car. Eventually you'll build up the shape the race track. The team was measuring the race track. But measuring an object from one angle does not reveal the true shape of the object. The team used a widely-used technique in medical imaging, known as tomography. By rotating the molecules in the vacuum chamber, they were able to build up a three-dimensional picture of the molecular orbital.

Creating a 3D picture of an electron orbital is the first step towards creating images of how chemical bonds are broken and formed during reactions. The team accomplished this feat through the creative combination of a widely-used medical imaging technique known as tomography and an extremely fast and intense femtosecond laser which was used to temporarily dislodge an electron from its parent molecule.

CANADIAN ASTRONOMY ACHIEVEMENTS FORCE RE-WRITING OF TEXTBOOKS

An international team of astronomers has discovered massive galaxies during an epoch where, according to established astronomy theory, there should only be young, newly-forming galaxies. These striking results were made possible by innovative NRC-designed technologies.

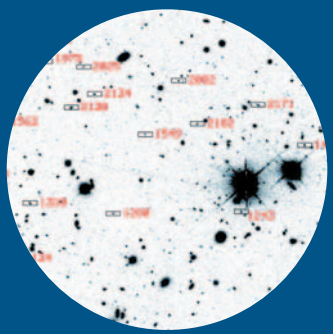
Just as certainly as textbooks are written so, too, are they meant to be revised in the face of new findings. Based on new evidence from an international astronomy project known as the Gemini Deep Deep Survey (GDDS), longstanding views about the beginnings of our universe and the way galaxies are formed are in for a big change.

Astronomy observes and measures signals that originated billions of years ago, a task which becomes more and more complicated the further back one goes. Distance makes signals faint plus there is interference due to the Earth's atmosphere which limits the ability to accurately observe these signals.

The goal of the GDDS is to peer back into a point of time approximately 9–11 billion years ago when the Universe was only 20–40% of its current size. Theory suggests that, during this period, one should find relatively young and actively forming galaxies. The well established hierarchical galaxy formation model holds that massive features only formed later in time from the assembly of smaller galaxies. Instead, the survey has discovered massive galaxies already between 8–11 billion years old. Using a more modern parallel, if GDDS were an archaeology project, it would be similar to finding a transistor radio in an unopened Egyptian tomb – such an advanced technology simply shouldn't be there. Results from the study raise fundamental questions about theoretical/cosmological models for the early Universe, and about the role of cold, dark matter in the formation of the Universe.

The Gemini Multi Object Spectrograph (GMOS), designed and built by NRC, the U.K. Astronomy Technology Centre in Edinburgh and Durham University, has already allowed the Gemini telescope to observe objects at the current limits of technology.

To allow the international science team to observe beyond the technological limits of current ground-based telescopes, engineers and scientists at NRC developed – within a matter of months from concept to completion – a "Nod and Shuffle" technique for the GMOS instrument. Previously unattainable on a large-aperture telescope, this capability subtracts the effects of the sky background, and allows for spectra to be taken of otherwise unobservable objects. The technique involves spectroscopy of both an object and the surrounding blank sky, using delicate movements of the telescope (nodding) and precise shifting of electrons on the detector (shuffling) to obtain a combined spectrum from which the effects from Earth's atmosphere can be subtracted.



NRC EXPERTISE IN DESIGNING THE NEXT GENERATION OF ASTRONOMY EQUIPMENT ALSO HAS BENEFITS FOR CANADIAN INDUSTRY. NANOWAVE TECHNOLOGIES OF TORONTO IS NOW BUILDING EQUIPMENT DESIGNED BY NRC FOR A NEXT-GENERATION RADIO ASTRONOMY PROJECT KNOWN AS ALMA.

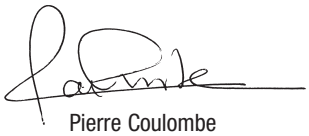
FINANCIAL STATEMENTS

National Research Council of Canada
Management Responsibility for Financial Statements

Responsibility for the integrity and objectivity of the accompanying financial statements for the year ended March 31, 2005 and all information contained in this report rests with the management of the Corporation.

These statements have been prepared by management in accordance with Treasury Board Accounting Standards based upon generally accepted accounting principles, using management's best estimates and judgements where appropriate. Readers of these statements are cautioned that the financial statements are not necessarily complete; certain assets, liabilities and expenses are only recorded at a government-wide level at this time. These statements should be read in conjunction within the context of the significant accounting policies set out in the Notes.

Management has developed and maintains books, records, internal controls and management practices designed to provide reasonable assurance that the Government's assets are safeguarded and controlled, resources are managed economically and efficiently in the attainment of corporate objectives, and that all transactions are in accordance with the *Financial Administration Act* and regulations as well as department policies and statutory requirements.



Pierre Coulombe
President

Daniel Gosselin
Senior Financial Officer

Ottawa, Canada
June 13, 2005

Statement of Financial Position (unaudited)

As at March 31, 2005

(in thousands of dollars)	Current Year		Prior Year	
ASSETS				
Financial assets				
Receivables - non-tax revenues	23,478		14,170	
Less: allowance for doubtful accounts	3,224		722	
		20,254		13,448
Investment - H.L. Holmes Fund		4,039		3,988
Accountable advances to employees		19		62
Other advances and taxes on purchases		3,732		1,516
Total financial assets		**28,044**		**19,014**
Non-financial assets				
Prepaid expenses		9,639		9,185
Inventories held for consumption		3,168		3,212
Capital assets	1,077,535		1,023,988	
Less: accumulated amortization	583,414		547,251	
		494,121		476,737
Total non-financial assets		**506,928**		**489,134**
Total assets		**534,972**		**508,148**
LIABILITIES AND GOVERNMENT OF CANADA EQUITY				
Liabilities				
Accounts payable and accrued liabilities		112,073		92,583
Allowances for employee benefits		34,410		33,616
Deferred revenue		29,604		29,866
Other liabilities		16		12
Total liabilities		**176,103**		**156,077**
Equity of Canada				
Government equity, beginning of year		352,071		314,260
Add: net cash provided by Government		613,937		626,459
Deduct: net operating deficit		628,315		609,188
Government equity, end of year		337,693		331,531
Add: services without charge		21,176		20,540
Net Equity		**358,869**		**352,071**
Total liabilities and government equity		**534,972**		**508,148**

The accompanying notes form an integral part of these statements.

Statement of Operations (unaudited)

For the year ended March 31, 2005

(in thousands of dollars)	Current Year	Prior Year
Revenues		
Sales of goods and services	83,222	74,963
Revenue from joint research projects and cost sharing agreements	19,168	21,864
Other revenue	1,355	10,594
Total revenue	**103,745**	**107,421**
Expenses		
Transfer payments	134,317	132,980
Program expenses		
Personnel operating expenses **(Note 8)**	354,966	354,222
Operating and maintenance expenses **(Note 8)**	192,345	180,742
Amortization expenses on capital assets	46,260	47,501
Loss on disposal of physical assets	285	362
Loss or gain on foreign exchange revaluations at year-end	(119)	(114)
Interest on overdue suppliers accounts	1	-
Bad debts	3,384	114
Losses on write-offs and write-downs	621	802
Total program expenses	597,743	583,629
Total expenses	**732,060**	**716,609**
Net cost of operations	**(628,315)**	**(609,188)**

The accompanying notes form an integral part of these statements.

Statement of Cash Flow (unaudited)

For the year ended March 31, 2005

(in thousands of dollars)	Current Year	Prior Year
OPERATING ACTIVITIES		
Net cost of operations	**628,315**	**609,188**
Non-cash items included in net cost of operation		
Post capitalization revenue	1,213	10,066
Amortization of capital assets	(46,260)	(47,501)
Bad debt expense	(3,384)	(114)
Loss on disposal of physical assets	(285)	(362)
Loss or gain on foreign exchange revaluations at year-end	119	114
Loss on write-offs and write-downs	(599)	(802)
Services provided without charge by other Government departments	(21,176)	(20,540)
Statement of financial position adjustments		
Variation in accounts receivable	10,071	(2,550)
Variation in advances & taxes on purchase	2,173	(19,008)
Variation in prepaid expenses	454	(1,629)
Variation in investments	51	276
Variation in inventories	(44)	(389)
Variation in accounts payable and accrued liabilities	(19,490)	20,535
Variation in allowances for employee vacation and compensatory benefits	(794)	(5,224)
Variation in deferred revenues	262	(2,031)
Variation in other liabilities	(4)	(8)
Cash used in operating activities	**550,622**	**540,021**
Investing activities		
Net Changes in Capital assets	63,315	86,438
Net cash provided by Government	**613,937**	**626,459**

The accompanying notes form an integral part of these statements.

National Research Council Canada
Notes to Financial Statements (unaudited)

Year Ended March 31, 2005

1. Authority and Objectives

The National Research Council of Canada exists under the National Research Council Act of 1966-67 and is a departmental corporation named in Schedule 2 of the Financial Administration Act. The objectives of the Council are to create, acquire and promote the application of scientific and engineering knowledge to meet Canadian needs for economic, regional and social development and to promote and provide for the use of scientific and technical information by the people and Government of Canada to meet Canadian needs for economic, regional and social development.

2. Sources of Funding

The **National Research Council** is primarily **financed by** the Government of Canada through **Parliamentary appropriations** and **statutory authority**. The latter gives the Council authority to spend revenues earned through collaborative research agreements and from fees-for-service-work, sales of publications, rentals of laboratory space, and license fees.

3. Significant Accounting Policies

a) These financial statements have been prepared on an **accrual basis of accounting** in accordance with Treasury Board Accounting Standards. These standards are based on generally accepted accounting principles in Canada. The primary source of the accounting principles is from the recommendations of the Public Sector Accounting Board of the Canadian Institute of Chartered Accountants supplemented by the recommendations of the Accounting Standards Board of the Canadian Institute of Chartered Accountants for situations not covered by the Public Sector Accounting Board. Readers of these statements are cautioned that the introduction of accrual accounting at the departmental level is evolutionary. Not all assets, liabilities and expenses applicable to the department are recorded at the departmental level at this time. As such, the financial statements are not necessarily complete. The accompanying notes provide additional detail and should be read with care. All such assets, liabilities and expenses are recorded at a government-wide level in the financial statements of the Government of Canada.

b) Appropriations provided to the department do not parallel financial reporting according to generally accepted accounting principles. They are based in large part on cash flow requirements. Consequently, items recognized in the statement of operations and the statement of financial position is not necessarily the same as those provided through appropriations from Parliament.

c) All departments including agencies and departmental corporations operate within the Consolidated Revenue Fund (CRF). The Receiver General for Canada administers the CRF. All cash receipts are deposited to the CRF and all cash disbursements made by the Council are paid from the CRF. Net cash provided by the government is the difference between all cash receipts and all cash disbursements including transactions between other departments.

d) Revenue and expense transactions and any related asset and liability accounts between sub-activities within the Council have been eliminated.

e) Revenues are accounted for in the period in which the underlying transaction or event occurred that gave rise to the revenues.

f) Expenses are recorded when the underlying transaction or expense occurred subject to the following:

- **Grants** are recognized in the year in which payment is due or in which the recipient has met the eligibility criteria.
- **Contributions** are recognized in the year in which the recipient has met the eligibility criteria.
- **Employee termination benefits** are expensed as paid. The department does not record any estimated accruals. Accruals for these benefits are recognized in the consolidated financial statements of the Government of Canada.
- **Vacation pay and overtime** are expensed in the year that the entitlement occurs.
- **Contributions to superannuation plans** are recognized in the period that the contributions are made. The department does not record actuarial surpluses nor deficiencies; these are recognized in the consolidated financial statements of the Government of Canada.
- **Environmental liabilities** are not recognized in the departmental books of accounts but are recognized in the consolidated financial statements of the Government of Canada.

g) Receivables are stated at amounts expected to be ultimately realized. A provision is made for receivables where recovery is considered uncertain.

h) Inventories are valued as follows:

- **Not for re-sale** – Inventories not for re-sale comprise spare parts and supplies that are held for future program delivery. Such inventories are valued using the moving-weighted-average method. Inventoried items no longer having service potential are valued at the lower of cost or net realizable value.
- **For re-sale** – Costs relating to inventories for resale are expensed when acquired and therefore no cost of sales is recognized.

i) Intangible assets, such as patents, are not capitalized but expensed when paid All other **capital assets and leasehold improvements** having an initial cost of $5,000 or more are recorded at their acquisition cost in accordance with the Public Sector Accounting Board Recommendations. The capitalization of software and leasehold improvements was done on a prospective basis from April 1, 2001. Capital assets do not include any intangibles, works of art and historical treasures that have cultural, aesthetic or historical value nor any similar assets located in museums. Depreciable capital assets are amortized using the straightline method based on their estimated useful life as follows:

Asset Class	Amortization Period
Buildings and facilities	25 years
Works and infrastructure	25 years
Machinery and equipment	10 years
Informatics hardware	5 years
Informatics software	5 years
Vehicles	5 years
Aircraft	10 years

j) Equity investments are not recognized as assets but as revenue upon the sale of the equity in accordance with the Receiver General of Canada and the Treasury Board Secretariat directives.

k) Transactions in foreign currency are translated into Canadian dollar equivalents using the rates of exchange in effect at the time of the transactions. Assets and liabilities denominated in foreign currencies at year-end are translated using the applicable exchange rates in effect on March 31st.

4. Changes in Accounting Policies

In fiscal year 2004-2005, the services without charge provided by Other Government Departments are included in the financial statements. We have also modified the results for fiscal year 2003-2004 to reflect the change in the accounting policy.

5. Measurement Uncertainty

The preparation of financial statements requires management to make estimates and assumptions that affect the reported amounts of assets, liabilities, revenues and expenses reported in the financial statements. At the time of preparation of these statements, management believes the estimates and assumptions to be reasonable. The most significant item where estimates are used is amortization of assets.

6. Contractual Commitments

Commitments are comprised of contractual and other long-term obligations due and payable in subsequent years. As at March 31, 2005, the NRC had the following outstanding commitments:

Fiscal Year	Grants, Contributions & Construction (in millions)
2005–2006	$ 72
2006–2007	$ 62
2007–2008	$ 62
2008–2009	$ 58
2009–2010	$ 54
Significant commitments for the five-year period included in the above are:	
James Clerk Maxwell Telescope:	$ 5
Gemini Twin Telescope Project:	$ 29
Tri-University Meson Facility:	$223
Canada-France-Hawaii Telescope Corporation:	$ 20

7. Contingent Liabilities

A contingent liability is a potential liability which may become a liability when one or more future events occur or fail to occur. Contingent liabilities are not recognized on the Council's financial statement as a liability until the amount of the liability is firmly established. As at March 31, there were eleven legal actions pending for which no liability is recognized. Also a contingent liability has been reported to Treasury Board regarding 2 contaminated sites. The total contingent liabilities are estimated at $1.5M.

8. Related Party Transactions

The Council is related in terms of common ownership to all other Government of Canada departments, agencies and Crown Corporation. The Council enters into transactions with these entities in the normal course of business and on normal trade terms applicable to all individuals and enterprises except that certain services are provided without charge.

During the year, the Council received services without charge, which are recorded at fair value in the financial statements as follows

(Thousands of dollars)	Current Year	Prior Year
Accommodations provided by Public Works and Government Services Canada	$ 158	$ 158
Salary and associated costs of legal services provided by Justice Canada	$ 944	$ 934
Employee compensation payments provided by Human Resources Development Canada	$ 336	$ 329
Audit services provided by the Office of the Auditor General	$ 245	$ 0
Payroll services provided by Public Works and Government Services Canada	$ 160	$ 165
Contributions covering employer's share of insurance premiums and costs paid by the Treasury Board	$19,333	$18,954
Total Services Provided without Charge	**$21,176**	**$20,540**

GOVERNANCE

NRC COUNCIL MEMBERS

Dr. Patricia Béretta	Vice-President, Marketing and Strategy, Medicalis Inc., Kitchener, Ontario
Dr. Wayne Clifton[1]	President, Clifton & Associates, Regina, Saskatchewan
Dr. André Gosselin[1]	Professor, Centre de recherche en horticulture, Université Laval, Québec, Quebec
Dr. Wayne Gulliver	Chairman and Medical Director, Newlab Clinical Research Inc., St. John's, Newfoundland and Labrador
Dr. Joseph Hubert	Dean, Faculty of Arts and Sciences, Université de Montréal, Montréal, Quebec
Dr. Pascale Michaud	Consultant, Montréal, Quebec
Dr. Gilles Patry	Rector, University of Ottawa, Ottawa, Ontario
Dr. Alan Pelman[1]	Vice-President, Technology, Weyerhaeuser, Vancouver, British Columbia
Dr. Louise Proulx[1]	Vice-President, Product Development, Topigen Pharmaceuticals Inc., Montréal, Quebec
Dr. René Racine[1]	Professor Emeritus, Physics Department, Université de Montréal, Montréal, Quebec
Ms. Salma Rajwani[2]	Chief Information Officer, Acrodex Inc., Edmonton, Alberta
Dr. Inge Russell	Yeast and fermentation scientist (formerly with Labatt Co.), London, Ontario
Dr. Samuel Sami	Professor of Mechanical Engineering, Université de Moncton, Moncton, New Brunswick
Dr. Katherine Schultz[2]	Vice-President, Research & Development, University of Prince Edward Island, Charlottetown, P.E.I.
Dr. David Strong	Former President, University of Victoria, Victoria, British Columbia
Dr. Howard Tennant[2]	President Emeritus, University of Lethbridge, Lethbridge, Alberta
Mr. André Tremblay	Director, Développement des affaires au Québec, Alcan Inc., Ville Saguenay, Quebec
Dr. Louis Visentin	President, University of Brandon, Brandon, Manitoba
Mr. Jean-Claude Villiard[1,2]	Special Advisor, Privy Council Office

NRC EXECUTIVE OFFICERS

Dr. Pierre Coulombe	President (and Chair of Council)
Ms. Patricia Mortimer	Secretary General
Mr. David Simpson	Vice-President Research, acting (Life Sciences and Information Technology)
Dr. Richard Normandin	Vice-President Research (Physical Sciences and Engineering)
Dr. Michael Raymont	Vice-President Technology and Industry Support
Dr. Sherif Barakat	Vice-President Renewal

[1] Member, Executive Committee

[2] Member, Task Force on Governance

NRC RESEARCH INSTITUTES, NATIONAL PROGRAMS AND TECHNOLOGY CENTRES –

Name, Location and General Inquiry Number

NRC Biotechnology Research Institute (NRC-BRI)
Montréal: (514) 496-6100

NRC Canada Institute for Scientific and Technical Information (NRC-CISTI)
Canada and U.S.: Toll Free 1 (800) 668-1222
Outside North America: (613) 998-8544

NRC Canadian Hydraulics Centre (NRC-CHC)
Ottawa: (613) 993-9381

NRC Centre for Surface Transportation Technology (NRC-CSTT)
Ottawa: (613) 998-9639

NRC Herzberg Institute of Astrophysics (NRC-HIA)
Victoria: (250) 363-0001
Penticton: (250) 493-2277

NRC Industrial Materials Institute (NRC-IMI)
Longueuil: (450) 641-5000
Ville Saguenay: (418) 545-5545

NRC Industrial Research Assistance Program (NRC-IRAP)
Toll Free: 1 (877) 994-4727

NRC Institute for Aerospace Research (NRC-IAR)
Ottawa: (613) 991-5738
Montréal: (514) 283-9408

NRC Institute for Biodiagnostics (NRC-IBD)
Winnipeg: (204) 983-7692
Calgary: (403) 221-3221
Halifax: (902) 473-1850

NRC Institute for Biological Sciences (NRC-IBS)
Ottawa: (613) 990-7049

NRC Institute for Chemical Process and Environmental Technology (NRC-ICPET)
Ottawa: (613) 993-3692

NRC Institute for Fuel Cell Innovation (NRC-IFCI)
Vancouver: (604) 221-3099

NRC Institute for Information Technology (NRC-IIT)
Fredericton: (506) 444-0544
Gatineau: (819) 934-2602
Moncton: (506) 861-0950
Ottawa: (613) 993-3320
Saint John: (506) 635-0622

Sydney: (902) 564-6481

NRC Institute for Marine Biosciences (NRC-IMB)
Halifax: (902) 426-6095

NRC Institute for Microstructural Sciences (NRC-IMS)
Ottawa: (613) 993-4583

NRC Institute for National Measurement Standards (NRC-INMS)
Ottawa: (613) 993-7666

NRC Institute for Nutrisciences and Health (NRC-INH)
Charlottetown: (902) 566-7465

NRC Institute for Ocean Technology (NRC-IOT)
St. John's: (709) 772-2479 or (709) 772-6001

NRC Institute for Research in Construction (NRC-IRC)
Ottawa: (613) 993-2607
Regina: (306) 780-3208

NRC Integrated Manufacturing Technologies Institute (NRC-IMTI)
London: (519) 430-7079

NRC Plant Biotechnology Institute (NRC-PBI)
Saskatoon: (306) 975-5571

NRC Steacie Institute for Molecular Sciences (NRC-SIMS)
Ottawa: (613) 991-5419
Chalk River: (613) 584-3311, ext. 6274

NRC National Institute for Nanotechnology (NINT)
Edmonton: (780) 492-8888

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