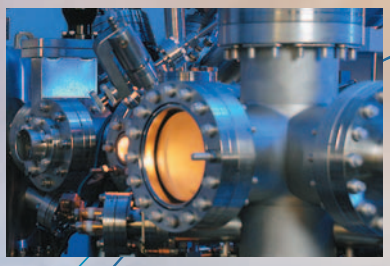
NRC·CNRC

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

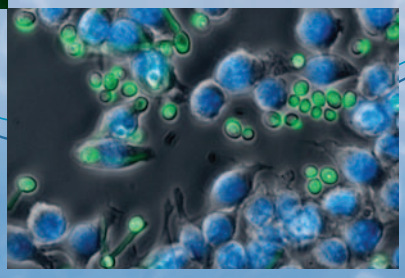
Science at work for Canada



National Research Council Canada

Annual Report

2003–2004



National Research Council Canada
Conseil national de recherches Canada

Canada

National Research Council Canada

Recognized globally for research and innovation, the National Research Council (NRC) is a leader in the development of an innovative, knowledge-based economy for Canada through science and technology.

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

Its outstanding people help turn ideas and knowledge into new products, processes and services, creating value for Canada.

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.

Excellence in R&D

NRC is Canada's R&D and commercialization powerhouse. Its cutting edge research spans the spectrum of science & engineering, with 20 NRC research institutes and 10 other centres across the country. Each helps transform ideas into new products, services and technologies whether that involves partnering with universities and innovative firms or creating new companies.

Taking Technology to Market

NRC combines scientific excellence and entrepreneurship in an institution designed to push the envelope and encourage outside-the-box thinking. The result is a surge in new knowledge and commercialization — patents, licensing, new companies — and wealth creation for Canada.

Community Innovation

Stimulating the growth of community-based technology clusters across Canada is an important part of NRC's business. NRC research institutes and networks are central hubs, bringing local and regional interests together with groups of innovative companies around a common area of technology. NRC and its partners are actively expanding research capabilities, building new facilities and augmenting knowledge and industry support networks from coast to coast.

On the World Stage

NRC is an active player in international research collaborations and partnerships — over 60 formal arrangements with 22 nations along with hundreds of informal alliances. NRC's global reach helps Canada access the world's best S&T talent, facilities & networks and creates opportunities for Canadian companies abroad.

Outstanding People

Great people. Great minds. NRC is home to nearly 4,000 creative and highly skilled employees. Its people have earned international acclaim for excellence in leading-edge research and innovation — they are held in the highest regard by their peers, colleagues and collaborators. And where else but NRC have employees won a Nobel Prize for science, an Academy Award and helped Canada capture Olympic Gold.

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National Research Council Canada
Annual Report 2003–2004

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President's Message

Over the past decade, the Government of Canada has invested significantly in research. It has done so with the hope that this new knowledge base can become the foundation of new businesses, jobs, and technology-based economic benefits for Canadians.

NRC has been taking an aggressive, entrepreneurial approach to converting that knowledge into economic benefits and to stimulate innovation that Canada and Canadian firms need to succeed in the global knowledge economy. I believe that the 2003–2004 NRC Annual Report shows that NRC has stepped up to the plate and is not only delivering economic and social value in putting science and engineering discoveries to work for Canada, but is also playing a unique role in addressing the national commercialization challenge.

NRC has done so by contributing, along with partners and key stakeholders, to the emergence and sustainability of strong, innovative communities through our National Technology Cluster Strategy while at the same time maintaining its core strengths and its links to leading-edge research and development, the base from which we make our unique contribution to Canada and serve all Canadians.

There are many ways to tell this story, but the most compelling is through specific stories of tangible examples of economic and social impacts flowing from NRC's capacity to innovate and work with others as we build the 21st century economy and I invite you to read some of these stories in the following pages.

Dr. Michael Raymont

President (Acting)

Introduction

NRC·CNRC Science at work for Canada

NRC is the Government of Canada's leading resource for science and technology development and commercialization. NRC works across the innovation spectrum, translating scientific discoveries at the frontiers of knowledge into the development and commercialization of products needed by Canadians and Canadian companies, for the world's marketplaces.

Over the past year, NRC continued to strengthen its contributions in putting science to work for Canada through new knowledge, through assistance to industry and through the creation of true economic value.

NRC increased its efforts to commercialize research, to help fuel the growth and innovative capacity of small- and medium-sized businesses, and to strengthen innovative forces through its technology cluster development work. In the past year, NRC continued to streamline its approach to intellectual property management and the transfer of technologies. It increased its capacity to support innovative companies, providing single-window access to NRC strengths: research and research assistance services; technology transfer expertise; business advice and assistance; global networks; world-class facilities; incubation space; information and intelligence services; and industry standards work. NRC's national network of Industrial Partnership Facilities (IPFs) provides access to these unique resources.

In today's innovative, knowledge-based economy, new technologies are critical to Canada's success in increasing its productivity and creating new wealth. The new economic reality is that Canada, like other leading nations, is competing in a flat-out race among global competitors. It takes focused investment in R&D coupled with business intelligence, partnerships and global networks to first find and then realize the best opportunities for economic growth.

NRC is unique in its ability to identify Canada's science and technology-based opportunities and then adapt its R&D, industry support and commercialization services, programs and networks to meet national needs and priorities.

NRC has successfully established far-reaching R&D programs, partnerships and knowledge networks in cutting-edge fields such as aerospace, biotechnology, fuel cells and nanotechnology. NRC has also built technology and commercialization platforms that are critical to moving new discoveries into the marketplace. In the past five years, NRC has merged these long-term strengths in R&D, knowledge dissemination, technology transfer, community-based innovation, global outreach and SME support into initiatives that focus on Canada's future and on delivering what Canada and Canadians need to succeed in the world. Just some of these accomplishments are highlighted in the 2003–2004 Annual Report.

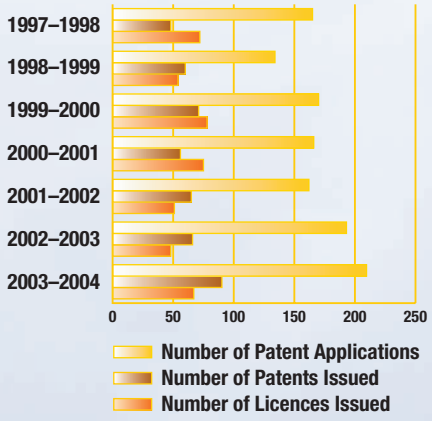
NRC Performance Indicators

Creating **Economic Value**

NRC **Licensing Revenues**

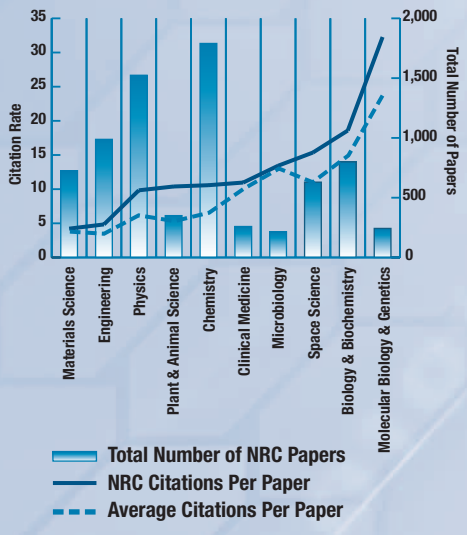
1997–1998	$1,971,800
1998–1999	$1,661,819
1999–2000	$1,106,535
2000–2001	$4,987,000
2001–2002	$3,840,000
2002–2003	$7,354,560
2003–2004	$5,466,995

NRC **Patents and Licences**



Research **Excellence**

NRC **Citation Rate versus Overall Average Citation Rate** (1993–2003)



Source: Institute for Scientific Information

Global **Reach**

NRC **International Activities**

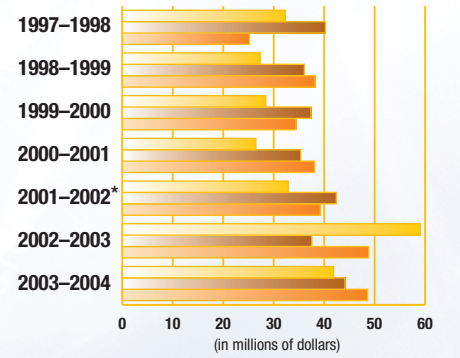
Conferences Organized	149
Delegations Received	206
Agreements Signed	119
Papers with International Co-Authors*	462

* Accounts for 45% of all papers published by NRC.

Economic Value

NRC **Partnerships**

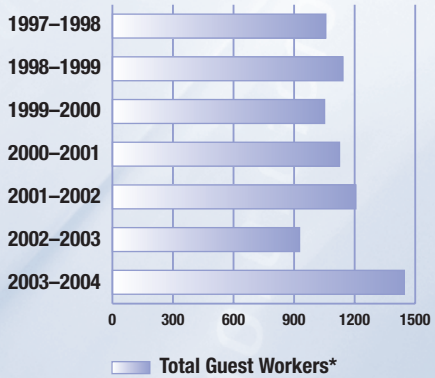
Contributions to NRC **Agreements**
(NRC, Cash and In-Kind Contributions)



* Began counting international contributions to agreements in 2001–2002.

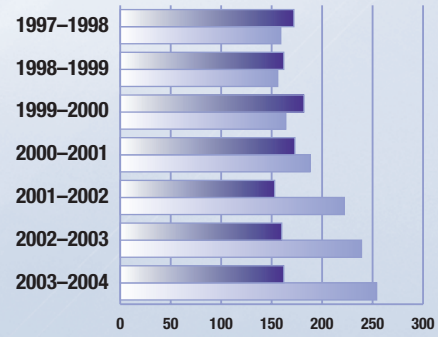
Highly Qualified **People**

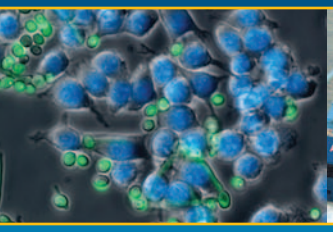
NRC **Guest Workers**

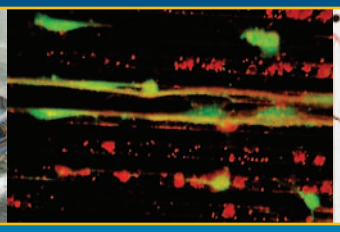
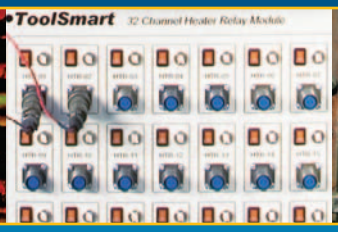


* Defined as workers from the private sector, universities, international research institutes, etc.

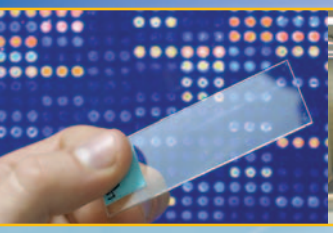
NRC **Post-Doctoral Fellows and Research Assistants**



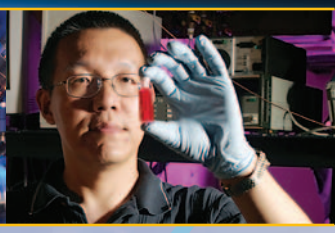


Highlights







Delivering Economic Value

From Discovery to Marketplace — **NRC and Commercialization**

"Canada is developing an environment in which ideas flowing from scientific discovery are being generated at an unprecedented rate. Now we must focus on bringing these ideas to market; to realizing their commercial potential. That is what will drive our economy forward, increasing investment and employment."

The Honourable Ralph Goodale, Minister of Finance, March 2004

From the Space Shuttle to the Silver Screen — The 3-D technologies research program at the NRC Institute for Information Technology (NRC–IIT) has produced a highly successful technology platform. The result — technology licences involving many different companies that offer diverse products and services. Examples include: a space vision system to be used by NASA for the on-orbit inspection of space shuttle surfaces; special effects wizardry created by Ottawa-based firm, XYZ RGB (a second-generation NRC spin-off firm), in major films such as The Lord of the Rings *and* Catwoman*; and scans of important heritage sites and works of art. In total, research activities have produced 41 licences involving 27 firms and generated approximately $2.7 million in revenues over the past 5 years.*

NRC is in business on behalf of Canada. It helps create real economic value, not only by capitalizing on its research capabilities, but also through its ability to commercialize its new discoveries and to help businesses move new products from the lab to the market. Commercialization is key to increasing exports, increasing productivity, to creating new firms and helping small and medium-sized companies grow and become globally competitive. NRC makes significant contributions in helping create true economic impact:

- Licensing NRC technologies, which creates immediate opportunities for firms, helps companies gain a foothold in leading-edge market niches and provides NRC with market intelligence.
- Providing industry with pre-commercialization, 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.
- Providing access to knowledge and expertise through collaborative research opportunities, IPFs, special interest research groups and other industry-oriented programs of NRC.
- Helping companies create new products and/or new technologies.
- Creating new companies from its research when there is no outside receptor capacity to take advantage of breakthrough technologies with commercial potential.
- Nurturing the development of unique technology-based clusters across Canada focused on matching local and regional strengths to national and global economic opportunities.

In all its programs and activities, NRC takes an aggressive, entrepreneurial approach to stimulate the growth of the highly-innovative, knowledge-intensive firms that Canada needs to succeed in the new global economy. The following section highlights just some of the value creation work and resulting impacts NRC realized over the past year.

Economic Impact Through **Technology Licensing**

The licensing of NRC technology creates immediate impact by helping companies reduce the time to market for new products and services. NRC also gains valuable knowledge of market demands so that it can better tailor its research and technology development efforts. One recent example is the successful licensing of a NRC technology by Comtek Advanced Structures (Comtek) in the rapidly growing area of aerospace composites.

NRC and Comtek Advanced Structures

Airplane parts manufactured from composites represent a fast-growing segment of the aerospace sector and are the subject of a number of research efforts at the NRC Institute for Aerospace Research (NRC-IAR). In the past year, NRC-IAR composites processing technology helped Burlington, Ontario-based Comtek develop a cost-effective method for producing high-quality parts for the new Airbus 380, a wide-bodied jet designed to carry 550 passengers. The new aircraft will start test flights early next year.

Manufacturers such as Comtek are facing demands from customers for sharp reductions in processing costs. Composite processing, which generally involves heating parts in an oven or autoclave, consumes substantial energy and offers no more quality control over the curing process than baking cookies in the oven; in other words, parts are either "done" or they're not. NRC-IAR has created a suite of technologies, known as ToolSmart, to address this problem.

ToolSmart provides a moulding technology to produce the part as well as a modeling tool to accurately determine resin curing rates. Together, the ToolSmart technologies result in a 30 per cent reduction in processing costs, a 60 per cent reduction in energy costs and much higher quality parts. Comtek licensed one component of the ToolSmart package — calculations for the amount of time needed to cure composites — and was able to produce high-quality parts at a lower cost. As a result of its dealings with Comtek, NRC-IAR also received important market intelligence about this technology, and real-life demonstration of different options for bundling and commercializing the ToolSmart package.

Economic Impact Through **Research Collaboration**

Research collaborations and fee-for-service work with the private sector are other key commercialization tools. In the case of Robert Allan Ltd. (RAL), a research collaboration with NRC produced a new ship design and sales of this unique high-performance escort tug to international clients.

NRC Helps Boost Sales of Escort Tugs

"The results of this research have enabled Robert Allan Ltd. to take a position of real international leadership in the design of high-performance escort tugs."

Robert G. Allan
President
Robert Allan Ltd.

If you live in one of Canada's port cities, or have had the chance to visit the waterfront areas of a port in Canada or elsewhere, you know about tugboats and their role in helping ships and barges in and around the port. Escort tugs are a special class of tugs that play an important role in the worldwide oil transportation network, helping massive oil tankers navigate and manoeuvre portside.

As a result of a long-term research collaboration with the NRC Institute for Ocean Technology (NRC-IOT), Vancouver naval architect RAL recently won major design contracts with several clients for a new class of escort tugs. As an example, RAL signed a contract with clients in the United Arab Emirates for a fleet of these vessels for oil operations in the Middle East. As well, a new tug for Norwegian owners is now under construction in shipyards in Spain.

The R&D collaboration used NRC-IOT's specialized facilities for testing three different hull designs and two different propulsion systems. The new tugboat has a hull design that makes it more stable while under load, performs equally well in a fore and aft direction and, overall, provides the same benefits as longer, more powerful tugs. Boat length is one of the key factors in terms of the overall cost of vessels. Every metre that can be reduced will result in major savings in building costs. The result is a more competitively-priced product.

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. Examples include:

- National metrology facilities
- Canadian Centre for Housing Technology
- National aerospace facilities (wind tunnels, engine test facilities, aerospace manufacturing facilities, etc.)
- National astronomy facilities
- Ocean and marine engineering test facilities (wave tanks, ice tanks, tow facilities)
- NRC Canadian Hydraulics Centre
- NRC Canadian Bioinformatics Resource
- NRC Centre for Surface Transportation Technology
- Virtual Environment Technology Centre
- High-throughput screening, DNA sequencing, and microarray facilities
- Aquaculture Research Station
- Ultra-fast laser laboratory
- Hydrogen-Safe Laboratories
- Canada Neutron Beam Laboratory
- NRC Canadian Photonic Fabrication Centre
- Access to TRIUMF, Canadian Light Source, Sudbury Neutrino Facility
- NRC Information Centres
- Industry Partnership Facilities (incubation space, access to business services and expertise)
- NRC Industrial Research Assistance Program Centres (70 centres across Canada)

In all, some 400 S&T laboratories and facilities for Canadian R&D and innovation.

Economic Impact Through **Support of Innovative SMEs**

The NRC Industrial Research Assistance Program (NRC-IRAP) is another key NRC resource helping increase the innovation capacity of small- and medium-sized enterprises (SMEs). NRC-IRAP helped Frantic Films break into Hollywood with a unique special effects software system, resulting in contracts for several major films such as *The Core* and *X2: X-Men United* that led to new jobs and revenue sources.

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 access, develop and exploit new knowledge and technologies 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 12,000 firms annually through NRC-IRAP
- $87.4 million in contributions to innovative firms through NRC-IRAP (2003–2004)
- Information services through NRC-CISTI and the national NRC Information Centre Network
- 115 companies incubating at NRC in 2003–2004
- 5 new IPFs completed, 2 under construction

Bringing the Tar Monster to Life

"In the bigger film market it's all about uniqueness and what you can bring to the table that's different than everyone else. NRC-IRAP provided us with technical expertise when we wouldn't otherwise have been able to afford it."

Ken Zorniak
CEO Frantic Films

When the Tar Monster oozed its way onto movie screens across North America in March 2004, the audience at Winnipeg's Towne Eight theatre cheered and clapped. Not for the evil viscous blob in the feature film *Scooby Doo II*, but for its creators, Winnipeg-based Frantic Films.

© 2004 Warners Bros. Studios
Image provided by Frantic Films

Frantic's computer programmers and artists had spent six months creating the Tar Monster's five-minutes of silver screen fame using their unique, in-house "Flood" software. Developed with the technical and financial support of NRC-IRAP, "Flood" has rapidly emerged as one of the world's leading tools for animating fluids, from water to tar.

Frantic's early success was fuelled primarily by its creative talent, but the company soon realized that future success in landing major contracts demanded a technical edge. The company focused efforts on developing improved software to animate fluids. After months of development — including scouring the fluid dynamics scientific literature and examining existing fluid simulation systems — the programming team produced the first version of the "Flood" software.

The software debuted in 2003 at an animation industry event, where it quickly caught the attention of major studios. "Flood" is now one of the top fluid simulation tools in the world. Frantic has applied for a number of patents on the software. Based on "Flood's" strength, Frantic was able to win the Tar Monster contract against competition from the major U.S.-based studio already working on *Scooby Doo II*.

Building Engines of Wealth Creation — **Community-Based Technology Clusters**

By bringing local partners together and providing direct access to its research expertise, specialized infrastructure and knowledge networks, NRC is helping build community technology clusters across Canada. Such clusters are an important driver of real economic growth.

Semi-Solid Forming of Aluminium

While Canada is a world leading producer and exporter of aluminium, it has not developed expertise as a manufacturer of value-added aluminium products. In 2001, NRC made a commitment to match its expertise in industrial materials with local manufacturing capacity in Quebec's Saguenay region to support the growth of a manufacturing cluster in aluminium parts. This commitment marked the beginning of the NRC Aluminium Technology Centre (NRC-ATC).

In the fall of 2003, the NRC-ATC facility reached completion, and equipment and personnel began moving in. However, even before the facility was finished, NRC was at work helping automate and industrialize a novel manufacturing process technology for production of high performance aluminium parts, patented by Alcan Ltd.

The technology represents a significant new manufacturing process for possible use in the huge auto parts markets and points the way to a new industry for the region.

The new process, known as semi-solid forming, uses billets of aluminium produced locally. This raw material is heated until it reaches a consistency similar to paste, and is then dropped into a high-pressure injection system used to cast a part.

The process has a number of advantages over existing techniques. For example, the lower temperature needed to produce the paste ensures that the specific molecular properties of the alloy are not destroyed by high temperatures, something that happens with current liquid casting techniques. The process also results in a shorter manufacturing time. Alcan benefited from NRC's expertise in high-pressure molding and, with the resources available through the NRC-ATC, was able to successfully automate and demonstrate the new process in action. The project is now at the pre-commercialization stage.

NRC Community Technology Clusters — Economic Wealth Generators

Atlantic Canada

Ocean and Marine Technologies (St. John's)

Nutrisciences and Health (Charlottetown)

Wireless (Sydney)

Life Sciences, Marine Biosciences (Halifax)

e-Business (Fredericton, Moncton, Saint John)

Quebec

Aluminium (Saguenay)

Aerospace, Biopharmaceuticals, Industrial Materials (Montréal)

Ontario

Photonics, Life Sciences (Ottawa)

Western Canada

Medical Devices (Winnipeg)

Nutraceuticals, Plant Biotechnology (Saskatoon)

Sustainable Infrastructure (Regina)

Nanotechnology (Edmonton)

Fuel Cells (Vancouver)

Bringing Science to Life

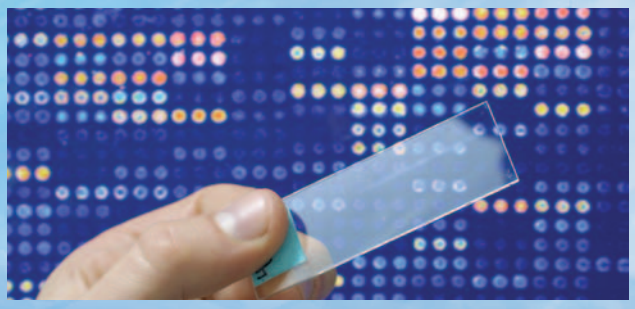
"Any sufficiently advanced technology is indistinguishable from magic."

Author, Arthur C. Clarke

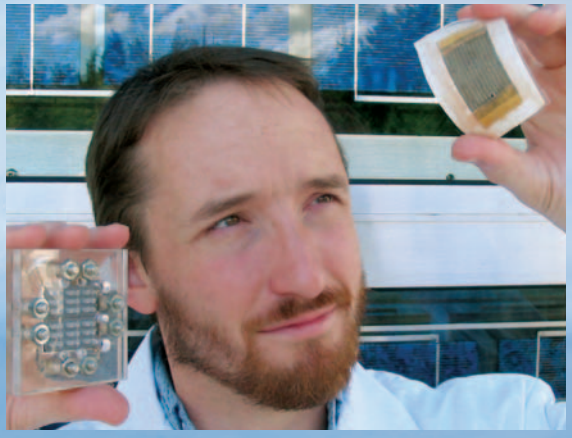
NRC is more than an R&D and commercialization engine for Canada. At heart, its story is also about people — some 4,000 scientists, engineers, technicians and operational staff — working for Canadians and others around the world.

NRC uses its expertise, its facilities, its networks and its connections to tackle major challenges facing the country and the world: improved health; better and safer food; a cleaner sustainable environment; improved security; alternative forms of energy; better and safer work and home environments; and a host of others. Every year, NRC delivers results that go beyond science or the economy, creating social and quality-of-life benefits for Canada and Canadians.

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



Researchers at the NRC Biotechnology Research Institute (NRC-BRI) have designed a special biochip that can be used to rapidly and accurately identify water-borne pathogens, providing answers in hours as opposed to days which is the case with other detection methods. The biochip is made by placing synthetic gene probes unique for each pathogen in rows and columns on a micro chip. The chip works when it is exposed to DNA extracted from bacteria present in the water sample. If a pathogen is present, its DNA attaches to its complementary probe on the chip and a fluorescent signal reveals its presence. Possible uses include monitoring the water quality of beaches, groundwater, and drinking water.



Comparison of traditional rigid micro-fuel cell (left) and prototype flexible fuel cell (right) created by researchers at the NRC Institute for Fuel Cell Innovation. This unique design allows the fuel cell to be bent in half without affecting its properties and holds potential for novel applications such as wearable electronic devices.

Better Quality of Working Life
and Increased Organizational Productivity

The construction industry, and the codes and standards that guide it, affects almost every part of our daily lives, from the infrastructure of our cities and towns to our workplaces and homes. The NRC Institute for Research in Construction (NRC-IRC) is responsible for Canada's Building Codes as well as for undertaking research in support of the construction industry, an industry with huge impact, both economic and social, for Canadians. NRC-IRC recently released the results of a multi-year study into open-plan office environments. The project was designed to help create better office working conditions to the benefit of employees and the organizations they work for.

Building a Better Office Cubicle

More than 70 per cent of employees work in open office environments. Although this type of design is supposed to be cost effective, poor designs often lead to poor working conditions (bad air quality, not enough light, too much noise, etc.), reduced occupant satisfaction and, ultimately, decreased productivity for the organization.

Known officially as COPE (Cost-effective Open-Plan Environments), a major NRC-led study provided a number of recommendations for designers. These range from considerations about construction materials, such as ceiling tiles that absorb sound and surfaces that reflect light, to factors that allow occupants more control over their environments. The study also resulted in two unique software tools for designers that assess the impact of different building materials and design choices on the overall office environment. The study merged research strengths in a number of different fields such as acoustics, ventilation, lighting, and psychology.

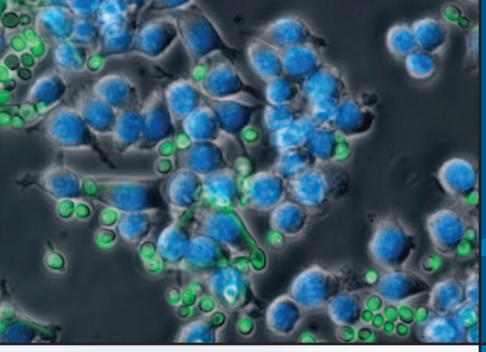
The COPE findings will be featured as part of NRC-IRC's ongoing "Building Insight" seminar series, which travels to cities across Canada.

Partners for the COPE Study were: Public Works and Government Services Canada, Building Technology Transfer Forum, USG Corporation, Ontario Realty Corporation, British Columbia Building Corporation, Steelcase Inc., and Natural Resources Canada.

The Science of Human Factors

The COPE study involved human factors research, the study of people and their interactions with their environments.

This field of study is extremely diverse and helps shape research projects at a number of different NRC institutes such as NRC-IAR (where human factors research is used to help build better cockpit display systems) and NRC-IIT (to build better and more intuitive computer user interface tools).

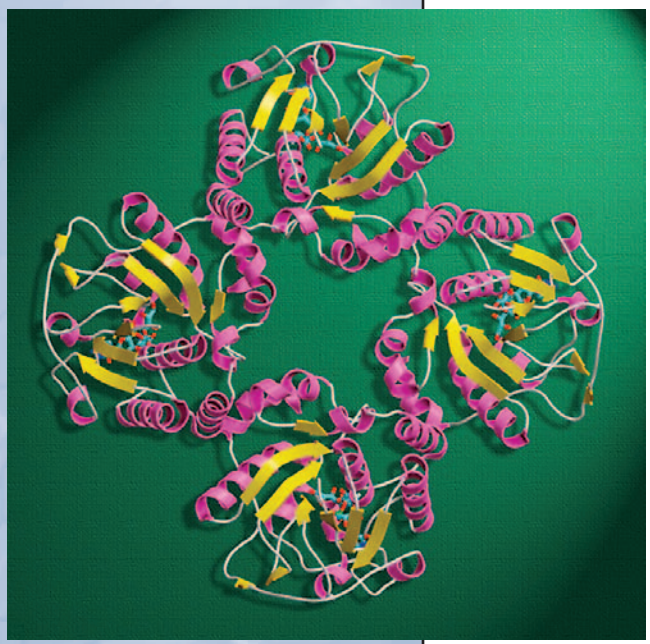


The Battle for **Better Health**

A number of NRC's research activities focus on improving people's health in Canada and around the world. In recent years, this has resulted in a number of world firsts, such as a non-invasive test for colon cancer, or a new vaccine against Meningitis C which has saved countless lives of young children across the world. In the past year, two different NRC institutes achieved world firsts in the fight against infectious diseases.

NRC Genomics and Health Initiative

NRC's Genomics and Health Initiative (GHI), now in Phase 2 and preparing for Phase 3, represents an investment of more than $75 million between 2002–2005. GHI projects pursue research at the leading-edge of convergence between traditional life sciences fields and complementary fields such as photonics, information technology and nanotechnology. The anticipated results are new knowledge and expertise as well as new technology platforms that will be of great economic and social value for Canada. So far, GHI has yielded 191 publications, 33 patent applications, seven (7) patents, three (3) licences and one (1) spin-off company.



Fighting and Learning from Infectious Diseases

The bacterium *Campylobacter jejuni* is the most common cause of foodborne illness in North America. Approximately one in a hundred people are infected and, of those, one in a thousand can develop a form of paralysis known as Guillain-Barré syndrome (GBS). Scientists from the Ottawa-based NRC Institute for Biological Sciences (NRC-IBS), in collaboration with scientists at the University of British Columbia, achieved a world first when they determined the structure of the sialy-transferease enzyme.

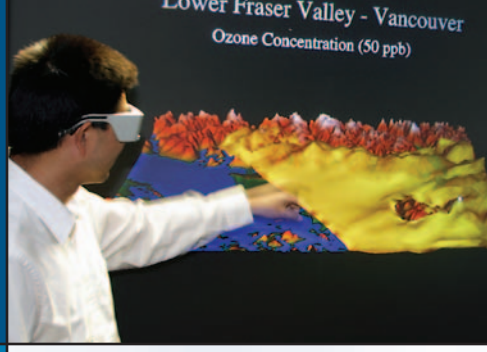
This enzyme is thought to play a key role in making a cell surface carbohydrate on the bacterium which mimics the function of a human cell surface carbohydrate. Both are used as a means to communicate between cells, either bacterial or human. This bacterial structure then triggers an immune reaction which targets human cells as well as the bacterium; in effect, the body receives a signal that something is wrong, the immune system starts working to fight the supposed infection and, in the process, ends up triggering GBS and paralysis.

The finding has major implications for helping eradicate strains of *C. jejuni* which cause GBS, but also has broader applications for other health therapies.

Elsewhere, scientists at NRC-BRI in Montréal spearheaded an international effort resulting in the first complete annotation of the *Candida albicans* genome, a medically important human fungal pathogen. The genome of this potentially fatal fungus had previously been sequenced, at least partially, but never fully annotated. In today's genomic world, a sequenced genome is not completely useful until it has been annotated — a feat made possible only by human intervention.

Researchers from the international *Candida* community were called upon to systematically verify sections of the genome according to their area of expertise, to see whether computer-generated predictions of the genes were correct. The annotation process started in 2002 and required approximately two years of work to define the complete collection of protein-coding sequences of the genome. The annotation is a critical step towards understanding the behaviour of *Candida* and in finding weaknesses that can be exploited on the way to a treatment or cure.

Watching and Helping **the Environment**



A large number of NRC research programs focus on the physical environment around us and on finding ways to reduce and reverse adverse industrial environmental impacts. As an example, NRC-IAR and Environment Canada continued their work over the past year on a number of projects involving the up-close study of hurricanes. Such work provides important data about the mechanics driving hurricanes and how they change as they track northward.

Flying into the Eye of the Storm

Last Fall, NRC-IAR's Convair 580, a twin-engine turboprop aircraft that has been extensively modified for research operations, flew into the eye of Hurricane Juan, not once, but several times as Juan battered the coast of Nova Scotia. State-of-the-art instruments recorded remote and in-situ measurements of principal cloud and environmental parameters, including wind, cloud structure and composition, temperature, humidity, and atmospheric pressure. Ten days earlier, the aircraft made a flight through Hurricane Isabel as it moved over Lake Ontario, the team's first experience studying an over-land hurricane.

Why undertake such dangerous missions? Improving our understanding of what goes on in these types of cloud structures, and how it applies to aircraft performance helps make flying safer. It also helps meteorologists improve weather forecasting techniques, understand weather patterns and provide better severe weather warnings. Next hurricane season, NRC-IAR's Convair will once again pierce the heart of tropical storms assailing Canada to seek out more answers about what drives one of nature's most violent manifestations.

NRC an Active Participant in Environmental Research

Helping track hurricanes is just one of a number of environmentally focused research activities at NRC. In the past year, the NRC Institute for Chemical Process and Environmental Technology (NRC-ICPET) and its partners successfully demonstrated an NRC-developed technology for real-time monitoring of particulate emissions from car engines. The tool is the first of its kind and, with increasingly stringent emissions requirements, is poised to become a key technology.

Other NRC research institutes contributed significant research towards helping improve soil and water quality. Montréal-based NRC-BRI boasts perhaps the largest contingent of researchers in Canada working in the area of environmental biotechnology and leads the Montréal Centre of Excellence in Brownfields Research.

Responding to
National Security Challenges

NRC research is contributing its expertise in helping Canada respond to threats to national security. Important research is under way to develop new technologies for the rapid detection of harmful biological and chemical agents.

In the Name of Security and Public Safety

Several other NRC institutes, along with partners from universities, the public and private sector are involved in other CRTI research projects. The NRC Steacie Institute for Molecular Sciences, NRC-IMI and other partners are developing novel nucleic acid biosensors for the real-time detection and identification of biological pathogens. The NRC Institute for National Measurement Standards and partners are developing innovative technologies for rapid analysis of radionuclides of concern in a radiological or nuclear terrorist attack. Meanwhile, NRC is a founding partner of the Canadian Police Research Centre (CPRC), along with the Royal Canadian Mounted Police, and the Canadian Association of Chiefs of Police. CPRC has helped Canada build a distinguished record of public safety technology successes, including commercializing NRC's explosives detection technology, a core element in current airport security.

New Defenses against Terrorist Threats

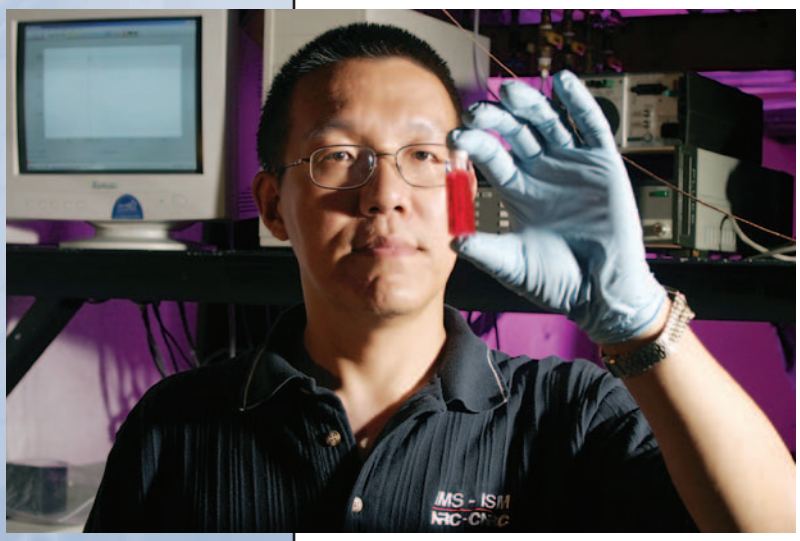
Using funding from the Government of Canada's CBRN (Chemical, Biological, Radiological and Nuclear) Research & Technology Initiative program, an NRC project broke new ground in the development of sensing technologies.

A joint project involving the NRC Institute for Microstructural Sciences (NRC-IMS) and NRC-ICPET, in partnership with Memorial University and Defence Research and Development Canada in Suffield, Alberta, has demonstrated a technique known as "molecular imprinting" to detect specific chemical species. The process involves the ability to actually "print" the shapes of specific molecules into a specially-formulated polymer substrate. While other similar methods involving molecular imprinting have been developed to detect chemical species, they have proven far from ideal since in these approaches the chemical becomes part of the polymer's structure. The net effect is that the identification process involves several steps and becomes lengthy.

The new technique being developed by NRC and its partners will offer a much faster and simpler process involving fewer steps. The technology is based on the synthesis of new polymeric materials and their fabrication into detection devices that recognize and bind specific chemical species. A specific molecule of interest is first attached to a stamper and pressed into a polymer. The polymeric material then organizes itself and molds around the stamped molecule. The molecule attached to the stamper is then removed from the polymer, creating a cavity or "lock" that can only be filled by the same molecule or "key." A scan of the surface can determine whether a chemical of interest is bound. The concept has been tested using a simple test molecule theophylline, a molecule related chemically to caffeine but different only by the presence of one methyl group.

Preliminary evidence has shown that this sensing device can preferentially bind theophylline over caffeine. Using this approach, chips can be printed with an array of different target molecules. In addition to the sensing of chemical species, the same technology could also be used to analyze the presence of metabolites and play a role in an emerging biotechnology field known as metabolomics.

Technologies like these have a number of security applications including the detection of dangerous biological and chemical agents which might be used in a possible terrorist attack.



At the Frontiers of Science

"We want a Canada that is a world leader in developing and applying the pathbreaking technologies of the 21st century — biotechnology, environmental technology, information and communications technologies, health technologies, and nanotechnology. Applying these capabilities to all sectors to build globally competitive firms, from start-ups to multinationals. And creating high-quality jobs that will meet the ambitions of young Canadians — and keep them in this country, working to build an even greater Canada."

Speech from the Throne, October 2003

The Universe According to Bob — An inflatable aerostat nicknamed "Bob" is at the heart of an innovative Canadian design being proposed for the next generation of radio astronomy equipment. Known as the Large Adaptive Reflector, work is being carried out by the NRC Herzberg Institute of Astrophysics in Penticton, B.C.

It's often said that scientific discoveries don't begin with the fabled "Eureka" but rather with … "Now, that's funny…"

Discoveries often provide a reason to be optimistic, standing as they are at the very edge of the known, pointing towards new possibilities and opportunities. This distance from "what is" to "what might be", creates a long lag time between the discovery of new phenomena or breakthroughs and their impact in the real world. Nuclear magnetic resonance technology, for example, was first developed in physics labs in the 1940s but only decades later did it become the backbone of MRI machines that today are so indispensable in hospitals and clinics worldwide. Even today, new uses and refinements of this technology continue to proceed at a furious pace, with no end in sight.

For over 80 years, NRC has stood as a unique scientific and engineering research and development resource for Canada, working to support industry and improve the lives of Canadians. Today, NRC continues its leadership role in making groundbreaking new discoveries and helping bring them to the stage where they can be put to work for Canada through new products, new cures, new processes and new materials, to name but a few. These discoveries are focused not only in strategically important but relatively new disciplines such as nanotechnology, but also in fields with present-day applications — aerospace, construction, information technology, manufacturing, transportation and others. And, increasingly, NRC research efforts are being deliberately integrated and merged to explore the advantages of convergence. In the upcoming section, read more about two notable achievements.

Pushing the Limits —
New Health Research Tools

NRC research is dismantling longstanding barriers between many different research domains, such as life sciences and computing devices. The purpose is to create powerful new technology platforms and new economic opportunities for innovative firms. One such technology is being developed as part of a research collaboration between NRC-IMS and NRC-IBS. In this case, new technology developed by the team will improve our understanding of important biological processes, such as cell communications and signaling, and lead to improved drugs and treatments for neurodegenerative diseases.

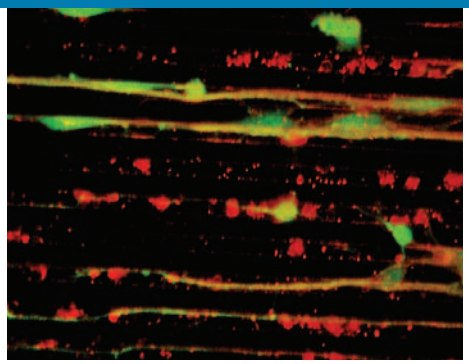
Convergence of Technology Creates Economic Opportunity

Projects such as the "brain on a chip" harness the capabilities and expertise from several different domains. Work such as this helps diversify and accelerate activity within technology clusters where such projects are taking place. For example, similar convergence-oriented projects with life sciences applications are ongoing in Halifax (aquaculture, life sciences), Montréal (biopharmaceuticals), Longueuil (industrial materials), Ottawa (photonics, life sciences), Winnipeg (medical devices), Saskatoon (plant biotechnology/nutraceuticals) and Edmonton (nanotechnology). Such projects also benefit industrial partners since collaboration with NRC opens the door to numerous opportunities with NRC institutes having potentially compatible or complementary technologies and expertise.

"Brain on a Chip": Opening the Door to More Effective Drug Therapies

At its most basic level, biology involves communications between cells, communications that are necessary for organisms to perform and manage the many functions required to sustain life. Disease often arises due to malfunctions in these communications pathways with the result that a critical message is not sent, or that the wrong message is sent. Ion channels play an integral role in a multitude of signalling pathways, serve to maintain ion homeostasis, and generate and propagate electrical responses, or "action potentials". Ion channels have been implicated in a variety of disease states and, therefore, have potential as therapeutic targets for disease intervention.

Researchers at NRC-IBS and NRC-IMS have teamed up to develop better tools to understand how ion channels work in cell networks, efforts that will lead to novel research in the field and ultimately to more effective drug therapies to combat neurodegenerative diseases such as Alzheimer's disease.



The team has been working with technology to grow neuron (brain) cells on a specially-prepared silicon chip with micro and nano-scale features. Using this system, cells can be made to grow in an orderly fashion and follow specific patterns, advantages not possible with conventional cell culture techniques where new neurons grow in a random fashion. Such work will help improve basic research into how neuron cells communicate with each other. Using this synthetic network, different neurons can be made to snap together like pieces of "Lego", allowing scientists to systematically study relationships between different neurons. More intriguing, the team is also developing a novel electrical/mechanical interface with these neural networks. The result could, in the future, help users process samples more quickly, speeding up the drug discovery process in the same way automated DNA sequencing helped drive the genomics revolution over a decade ago.

Investing in Strategically Important Technologies — **Nanotechnology**

Nanotechnology is a strategically important area of research for Canada. NRC is helping Canada stake its place in this fast-growing and revolutionary field through its focused and integrated program of nanoscale research and some of the world's best research facilities being built at the National Institute for Nanotechnology (NINT).

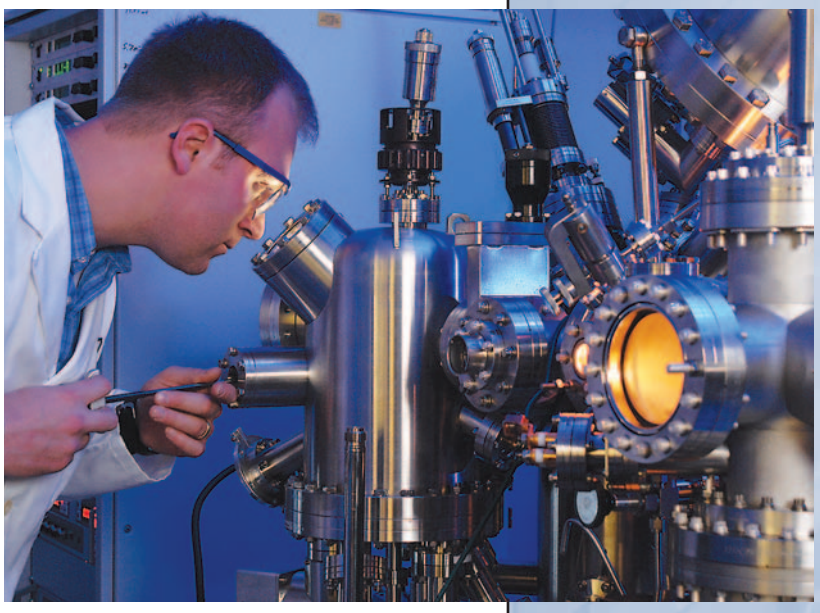
Construction Codes for Molecular Assembly

One important area of nanoscale research involves joining organic molecules with silicon, a well-known substance that plays a central role in all modern electronic devices. Organic chemists can tailor-make molecules with numerous useful properties, such as conductivity and the ability to transmit light. Such molecules can then be used to create more powerful and flexible versions of traditional circuitry found on silicon chips, such as wires and transistors.

But, many challenges must be overcome before such devices can be built and sold in the marketplace. A number of key questions remain to be answered: What modifications are needed to join different kinds of molecules with different properties to the same piece of silicon? How can we control the location where a chemical reaction will take place? How can we control the extent of this reaction? Researchers at NINT in Edmonton, Alberta, have been trying to establish these kinds of "construction codes", codes that are critical to the future builders of molecular-scale devices.

In the past year, NINT researchers demonstrated a reversible process for controlling chemical reactions on the surface of silicon. The group worked with a chemical effect known as passivation, which produces a layer of oxidation and effectively limits any further chemical reactions on the target surface. By way of example, when painting a room, putting a piece of tape down to protect wall trim would be, in effect, "passivating" this surface — it is protected against paint. When the tape is removed, a different paint with a different colour can be applied to the trim. The "tape", in the case of chemical reactions with silicon, was supplied through the use of TEMPO, a stable radical, which was used to passivate chemically-reactive areas on a hydrogen-terminated silicon surface, known as dangling bonds. Using a scanning tunnel microscope, researchers also demonstrated the ability to remove this passivation effect. With this approach, it's possible to control, at will, the areas that are chemically reactive, turning on or off this potential as needed.

The result is that users can determine the exact location where molecules will be joined to the surface and can use different molecules with different functions on the same surface — a promising advance in defining the "construction codes" for molecular-scale electronic devices, which could have applications in numerous fields from electronics to biotechnology.



Nanotech Across NRC

Many NRC institutes pursue research at the nanoscale level, involving research into applications for medical devices, electronics, fuel cells and construction materials. Current projects include the development of new nanocomposite coatings to create new and improved hip prostheses (NRC Integrated Manufacturing Technologies Institute). Elsewhere, researchers at NRC-IMI continued work in the area of nanocomposites and opened specialized facilties for nano-imprint lithography. And, researchers at NRC-ICPET patented a new environmentally friendly and low-cost method to generate Platinum/Ruthenium alloy nanoparticles used as a fuel-cell catalyst.

Financial Information

National Research Council Canada

Management Responsibility for Financial Statements

Responsibility for the integrity and objectivity of the accompanying financial statements for the year ended March 31, 2004 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 judgments 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.

Michael Raymont
President (Acting)

Daniel Gosselin
Senior Financial Officer

Ottawa, Canada

15-06-2004

National Research Council Canada

Statement of Financial Position (unaudited)

as at March 31, 2004

(in thousands of dollars)	Current Year		Prior Year	
ASSETS				
Financial Assets				
Accounts receivable — non-tax revenue (Note 3-g)	14,170		17,036	
Less: allowance for doubtful accounts	722		1,038	
		13,448		15,998
Investment — H.L. Holmes Fund		3,988		3,711
Accountable advances to employees		62		65
Other loans and advances		1,516		20,522
Total financial assets		**19,014**		**40,296**
Non-Financial Assets				
Prepaid expenses		9,185		10,814
Inventories held for consumption (Note 3-h)		3,212		3,601
Capital assets (Note 3-i)	1,023,988		934,464	
Less: accumulated amortization	547,251		505,565	
		476,737		428,899
Total non-financial assets		**489,134**		**443,314**
Total assets		**508,148**		**483,610**
LIABILITIES AND GOVERNMENT OF CANADA EQUITY				
Liabilities				
Accounts payable and accrued liabilities		92,583		113,118
Allowances for employee benefits		33,616		28,392
Deferred revenue		29,866		27,835
Other liabilities		12		5
Total liabilities		**156,077**		**169,350**
Equity				
Government Equity, beginning of year		314,260		221,887
Add: net cash provided by Government		626,459		646,123
Deduct: net operating deficit		(588,648)		(553,750)
Government Equity, end of year		**352,071**		**314,260**
Total Liabilities and Government Equity		**508,148**		**483,610**

The accompanying notes form an integral part of these statements.

National Research Council Canada

Statement of Operations (unaudited)

for the year ended March 31, 2004

(in thousands of dollars)	Current Year	Prior Year
Revenues (Note 3-e)		
Sales of goods and services to parties outside the government	69,663	74,779
Sales of goods and services to parties within the government	5,300	4,775
Revenue from joint research projects and cost sharing agreements	21,864	16,874
Other revenue	10,594	4,824
Total revenue	**107,421**	**101,252**
Expenses (Note 3-f)		
Transfer payments	132,980	147,170
Program Expenses		
Personnel operating expenses	350,672	295,142
Operating and maintenance expenses	163,752	169,294
Amortization expenses on capital assets (Note 3-i)	47,501	41,410
Loss on disposal of physical assets	362	217
Loss on foreign exchange	—	—
Loss or gain on foreign exchange revaluations at year-end	(114)	141
Bad debts	114	1,030
Losses on write-offs and write-downs	802	598
Total program expenses	563,089	507,832
Total expenses	**696,069**	**655,002**
Net deficit	**(588,648)**	**(553,750)**
Net assets / liabilities, beginning of year	314,260	221,887
Add: net cash provided by Government	626,459	646,123
Net assets / liabilities at end of year	**352,071**	**314,260**

The accompanying notes form an integral part of these statements.

National Research Council Canada

Statement of Cash Flow (unaudited)

for the year ended March 31, 2004

(in thousands of dollars)	Current Year	Prior Year
Net results (deficit)	**(588,648)**	**(553,750)**
Deduct: non-cash items included in net results		
Amortization of capital assets	47,501	41,410
Losses on write-offs and write-downs	802	598
Net loss on disposal of physical assets	362	217
Statement of financial position adjustments		
Change in liabilities	(13,273)	6,617
Change in cash, receivables, prepayments, inventories, prepaid expenses and deferred charges	26,387	(19,321)
Adjustment to equity:		
Net Equity Advance	—	(5,438)
Post Capitalization of Assets	(10,066)	—
Cash applied to operating activities	**(536,935)**	**(529,667)**
Investing Activities		
Net acquisitions of capital assets	(88,155)	(50,430)
Work-in-progress	(1,369)	(66,026)
Increase in investment	—	—
Net cash provided by Government	**(626,459)**	**(646,123)**

The accompanying notes form an integral part of these statements.

Year ended March 31, 2004

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 licence 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.
- **Services provided without charge by other government departments** are not recorded as operating expenses. The following are the more significant types of services provided without charge: banking services provided by Public Works and Government Services Canada; contributions covering the employer's share of employee insurance premiums and costs paid by Treasury Board Secretariat; workmen's compensation coverage provided by Human Resources Canada; salary and associated costs of legal services provided by Department of Justice; and audit services provided by the Office of the Auditor General. In fiscal 2003–2004, these services amounted to about $15.0 million.

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 straight-line method based on their estimated useful life as follows:

Asset Class	Amortization Period
Buildings and facilities	25 years
Works and infrastructure	25 years
Equipment and office furniture	5 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

There was no changes made to the accounting policies in fiscal year 2003–2004.

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, 2004, the NRC had the following outstanding commitments:

Fiscal Year	Grants and Contributions (in millions)
2004–2005	$57
2005–2006	$36
2006–2007	$36
2007–2008	$36
2008–2009	$13

Significant commitments for the five-year period included in the above are:

James Clerk Maxwell Telescope:	$5
Gemini Twin Telescope Project:	$35
Tri-University Meson Facility:	$97
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 sixteen legal actions pending for which no liability is recognized.

Governing Council and Officers
— MARCH 31, 2004

NRC COUNCIL MEMBERS

Dr. Patricia Béretta	Vice-President, Marketing and Strategy, Medicalis Inc., Kitchener, Ontario
Dr. Wayne Clifton	President, Clifton & Associates, Regina, Saskatchewan
Dr. André Gosselin	Professor, Centre de recherche en horticulture, Université Laval, Québec, Quebec
Dr. Wayne Gulliver	Chief Executive Officer, Advanced Immuni T Inc., St. John's, Newfoundland and Labrador
Mr. David Halliday	Vice-President, AMEC Dynamic Structures Limited, Port Coquitlam, British Columbia
Dr. Joseph Hubert	Dean, Faculty of Arts and Sciences, Université de Montréal, Montréal, Quebec
Dr. Pascale Michaud	Consultant, Montréal, Quebec
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Dr. Alan Pelman	Vice-President, Technology, Weyerhaeuser, Vancouver, British Columbia
Dr. Louise Proulx	Vice-Principal (Research), McGill University, Montréal, Quebec
Dr. René Racine	Professor Emeritus, Physics Department, Université de Montréal, Montréal, Quebec
Ms. Salma Rajwani	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
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Dr. David Strong	Former President, University of Victoria, Victoria, British Columbia
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Dr. Louis Visentin	President, University of Brandon, Brandon, Manitoba
Mr. Jean-Claude Villiard	Deputy Minister, Industry Canada, Ottawa, Ontario

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Ms. Patricia Mortimer	Secretary General
Dr. Peter Hackett	Vice-President Research (Life Sciences and Information Technology)
Dr. Richard Normandin	Vice-President Research (Physical Sciences and Engineering)
Dr. Michael Raymont	Vice-President Technology and Industry Support

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