NRC · CNRC

From Discovery to Innovation...

Value for Canada

NRC Annual Report 2000-2001

National Research Council Canada
Conseil national de recherches Canada

Canada

NRC is a knowledge and innovation organization working to help Canadians achieve a high quality of life and enjoy a prosperous, innovative economy. NRC is a unique asset, both for Canada and in the world.

NRC spans the innovation spectrum, from research discovery at the frontiers of knowledge to technology commercialization. It addresses critical national issues and helps position Canada to respond to future opportunities and emerging challenges. It is a recognized international research performer, technology development and innovation organization. NRC provides Canada's scientists and businesses with access to leading edge research facilities and infrastructure, as well as the best scientific, technical, medical and research information in the world through its Canada Institute for Scientific and Technical Information (CISTI). These resources and contributions are critical to helping Canada develop a society that is adaptive, innovative and capable of providing the best quality of life for all Canadians.

National
Research Council
Canada

As an organization with global, national, regional and local presence, NRC is a keystone of Canada's innovation system, providing scientific and engineering infrastructure, research and knowledge to Canada's public, academic and private sectors. Its unique strength lies in its broad connections to other innovators and its ability to mobilize these connections in response to national goals and priorities. In all, NRC is present in more than 90 communities across Canada, with a network of 17 research institutes, six technology and innovation centres, 17 NRC Information Centres, 260 industrial technology advisors in its Industrial Research Assistance Program and more than 1,000 Canadian Technology Network members. Its virtual presence stretches even further, through thousands of partnerships, collaborations, national and international committees and networks in which it participates on behalf of Canada and Canadian interests.

NRC is a strategically focused, integrated and adaptive knowledge organization, helping leverage the value of its investments to the benefit of the nation, industry and all Canadians. NRC is unique in its seamless integration of strategically focused research, national standards activities, scientific and technical information programs, and industrial research advice, assistance and innovation services. NRC has continually forecast Canada's opportunities and adapted its research portfolio and innovation support services, networks and systems to meet national priorities and the needs of its clients and partners. It has organized itself around key sectors such as biotechnology, information and communications technologies, aerospace, manufacturing, construction and others, and has moved into important, new strategic areas such as genomics, fuel cells, nanotechnology, bioinformatics, photonics, and urban infrastructure. It has also developed new programs aimed at entrepreneurship and new business creation, increasing the innovation capacity of small and medium-size enterprises (SMEs), sustainable development for SMEs, and the training of highly qualified youth.

NRC is focused on Canada's future and is committed to delivering what Canada needs to build a culture of innovation and to succeed in the global innovative, knowledge economy.

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

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ISION

As Canada s foremost R&D Agency, NRC will be a leader in the development of an innovative, knowledge-based economy through science and technology.

We will realize this vision by:

- Being dedicated to excellence in advancing the frontiers of scientific and technological knowledge in areas relevant to Canada
- Carrying out research, in collaboration with industrial, university and government partners to develop and exploit key technologies
- Providing strategic analysis and national leadership to integrate key players in Canada s system of innovation
- Taking a more aggressive, entrepreneurial approach to ensure the transfer of our knowledge and technological achievements to Canadian-based firms.

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President s Message

NRC An Organization on the Move!

Dr. Arthur J. Carty

2000-2001 was a year of outstanding achievement for NRC. It was the final year of NRC s Vision to 2001, a five-year strategy targeted to put NRC at the centre of the nation s R&D and innovation agendas, and to help Canada develop an innovative knowledge-based economy and a higher quality of life for all Canadians.

NRC s work over these past five years has responded directly to the needs and priorities of the government, of industry and of all Canadians. Its successes in R&D, in technology development and commercialization, in opening international doors for industry, and in nurturing the growth of Canadian innovation nationally, regionally and at the community level across Canada are there for all to see:

- Top-flight R&D facilities, infrastructure and networks for Canada
- Leading edge R&D discoveries in the fields of science and engineering from the chemical, physical and biological sciences to aerospace and construction; from information and communications technologies to e-business and manufacturing
- New national initiatives in transformational sciences and technologies in fields such as genomics, bioinformatics, photonics, microstructural sciences, molecular sciences, astrophysics and nanotechnology
- Strategic innovation initiatives to help develop and mature globally competitive, community-based technology clusters and increase the innovative capabilities of small and medium-sized, technology-based businesses
- New programs and initiatives to take NRC technologies to market more quickly and effectively through better management of intellectual property; increased licensing, joint ventures, partnerships and collaborations to commercialize technologies; the creation of spin-off and start-up companies; the development of incubator and industrial partnership facilities; and many other innovative alliances and partnerships
- New initiatives to attract, train and retain highly skilled talent for Canada.

2000-2001 was also a year of renewal and recommitment, as NRC moved to chart its course for the next five years. Over the past 18 months, NRC has undertaken the most extensive consultations in its history, engaging hundreds of stakeholders inside NRC, as well as from government, industry, academia and key interest groups.

As this new Vision is launched and begins to take hold, NRC s contributions to the development of Canadian innovation and an improved quality of life for all Canadians will reach new heights. This new strategy sharpens NRC s focus on the needs and opportunities of Canada and all Canadians.

It builds on NRC s strategic strengths, its national and international leadership and reputation in research, development and innovation, and most of all, the exceptional dedication, creativity and contributions of its people.

NRC truly is an organization on the move an organization with a proven track record and a clear plan for the future doing what needs to be done: putting science, technology and innovation to work for Canada.

"Our objective should be no less than to be recognized as one of the most innovative countries in the world. Achieving this will require a comprehensive approach and the support and participation of all governments, businesses, educational institutions and individual Canadians… An innovative economy is essential to creating opportunity for Canadians."

Speech from the Throne
JANUARY 30, 2001

NRC Value for Canada

NRC creates value for Canada and Canadians in many ways. It enhances Canadian research and development performance. It develops new technologies and technology-based enterprises, technology transfer mechanisms and knowledge transfer systems, the cornerstones of wealth creation. It strengthens Canada s innovation system and fosters a culture of innovation essential to success in the global economy. And, it helps improve the quality of life for Canadians.

The emergence of the global knowledge economy, driven by innovation, has created many new opportunities and pressures for national research organizations around the world. NRC, as Canada s leading R&D agency, works with partners from all sectors to build and improve the effectiveness of Canada s innovation systems, by nurturing national and international networks and collaborations, and fostering the growth of community-based technology clusters. It also forges new alliances that anticipate future knowledge-based industries and generates and diffuses its new knowledge aggressively through its commercialization, technology transfer and entrepreneurship activities.

NRC continually develops new solutions, technologies and innovations that safeguard our environment, improve and protect health, create new sources of wealth, and help Canada adapt to the global economy. New, higher paying jobs in exciting new industries, cleaner production processes, new medical devices and treatments, and health management practices and technologies are just a few of the contributions of NRC that improve our quality of life and spark real opportunities for economic growth.

NRC has become a more agile, adaptive organization through its focus on entrepreneurship, encouraging new research-based enterprises to spin-out of its laboratories, enhancing its licensing activities and improving its dissemination and diffusion of technical information and advice. In the past year, more than 75 firms were incubating at NRC. In the past six years, NRC has created nearly 50 firms. And, over the five years of the Vision, literally thousands of collaborations and hundreds of licenses to commercialize discoveries have been signed activities that have generated valuable intellectual property, thousands of new technology-based, high talent jobs and revenues for firms in excess of one billion dollars.

"Innovation doesn't just happen. It requires investment. It requires basic research. It requires infrastructure. It requires imagination and creative management. It requires a sea change in much of our approach to the economy."

The Honourable Paul Martin
MINISTER OF FINANCE

Innovation Building Canada's Capacity

NRC is the Government of Canada's most powerful resource for supporting science and technology-based innovation in every region of Canada. It makes key contributions to every sector of the economy, working in partnership with industry, governments and universities across the research and innovation spectrum.

Strategic, Long-term, Sustained R&D

NRC works in fields of strategic national importance, making sustained investments in research to advance the frontiers of knowledge and develop technologies in areas most relevant to the current and future needs of Canada and Canadians.

Unique Facilities – Fundamental National Capacity

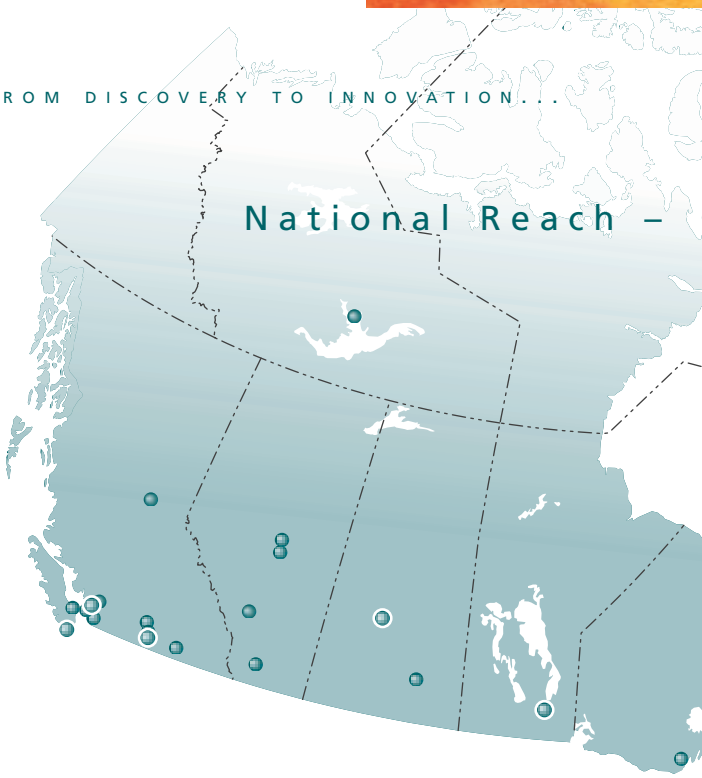
NRC is the home of unique national scientific and engineering research facilities, the nation's largest collection of scientific, technical and medical (STM) information, and Canada's source for science-based measurements and standards. These facilities open new opportunities and leverage Canada's investments in government R&D through collaborations with other federal organizations, universities and industry and pave the way for international collaboration and cooperation in key fields for Canada.

World Class People

With a workforce of some 3,400 of the world's best scientists, engineers and technical staff, and more than 1,000 guest workers from Canada and around the globe, NRC conducts world-leading R&D in the key fields most relevant to the needs of industry and Canada, helping create the products and services of tomorrow, today.

Local, Regional, National and International Networks – Vital Links in the Innovation Game

NRC not only houses Canada's best S&T infrastructure, knowledge and technology transfer systems, it is also at the heart of key networks including CISTI, the Industrial Research Assistance Program (IRAP) and the Canadian Technology Network (CTN). NRC's institutes also have ties with many other government-based agencies as well as extensive national and international connections. These networks, coupled with the thousands of collaborations and partnerships NRC has in Canada and around the world, are vital elements, helping bring together the key players and components of Canada's innovation system.



NRC – Core Strengths for Canadian Innovation

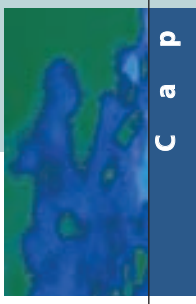
- 17 research institutes
- 6 innovation and technology centres
- 3,400 highly skilled staff
- Sustained research in critical sectors: biotechnology, manufacturing, information and communications technology, aerospace, construction, ocean engineering, molecular sciences, astronomy and astrophysics
- Research in emerging sectors: nanotechnologies, bioinformatics, photonics, fuel cells, and others
- National S&T knowledge and information resources and management systems
- Technology advisory, financial and other innovation support services and networks for industry
- Technology development, transfer, diffusion and commercialization infrastructure
- Incubator facilities, support for start-ups and spin-offs
- Local, regional, national and international networks – access for Canadian R&D and technologies to the world
- Standards, codes and measurements – enhancing industrial access to the world marketplace
- Local, regional, and national technology clustering initiatives

Local Touch

In addition to their national mandates, NRC's institutes, innovation and technology centres, IRAP, CTN, and CISTI, provide a visible and valued federal government presence and access point for industry and universities in over 90 locations across Canada.

NRC: National Facilities – Fundamental Infrastructure for Science and Industry

- Industry partnership and incubator facilities – 75 firms in 2000-2001
- Large-scale protein purification facility
- Ultra-fast laser laboratory
- Nuclear magnetic resonance facilities
- Mass spectrometer facilities
- Aquaculture research station
- DNA sequencing and micro-array facilities
- Epitaxy growth systems
- High Throughput Screening (HTS) facilities
- Marine dynamics test facilities
- National aerospace facilities including wind tunnels, fixed and rotary wing research aircraft, gas turbine engine and combustion test cells, and structures & materials testing facilities
- Virtual Environment Technology Centre
- Canadian Centre for Housing Technology
- Canadian Bioinformatics Resource (CBR)
- National metrology facilities
- Astronomical observatories and data systems



Building National R&D Capacity

NRC makes strategic investments in R&D facilities, support programs and networks in every part of Canada. These investments target key national needs and opportunities in the emerging economy. NRC's research institutes are the core of NRC's innovation capacity. Their connection with other NRC strengths in infrastructure and systems, as well as the industrial advice, partnership and support efforts of IRAP and CTN, form the backbone of NRC's national innovation infrastructure.

In 2000-2001, NRC made significant contributions to Canada's R&D, innovation infrastructure, and capacity across Canada.

New Micro-imaging Facility in Halifax

In April 2000, NRC opened an upgraded micro-imaging facility at its Institute for Marine Biosciences (IMB) in Halifax. The new Microscopy Facility supports scientific research in sectors ranging from aquaculture and forestry to health care and pharmaceuticals. Knowledge gained from studying organisms involved in cellular and sub-cellular processes can lead to new product developments in these fields. One example: in genomics, the capability to view gene expression within organisms provides essential information for the development of new drugs and therapies.

DNA Sequencing Facility Opens

In June 2000, NRC opened one of Canada's largest, most advanced DNA sequencing facilities in Halifax. The new facility supports the development of biotechnology applications in human health, food crops and the environment. The funding of $1.5 million was part of NRC's Genomics and Health Initiative. When coupled with the Atlantic Canada Genome Centre, the region will have a significant genomics capability that will contribute to the growth of an industrial technology cluster in life sciences. The facility will also provide extensive data management and analysis through NRC's Canadian Bioinformatics Resource.

NRC also strengthened its capacity in genome science with the installation of a state-of-the-art supercomputer, unique in Canada, at IMB. The supercomputer, called a GeneMatcher, enhances bio-informatics research capabilities in-house as well as for the CBR. The CBR provides

bio-informatics support to genomics researchers at NRC and other government and university sites, as well as to private sector partners.

CBR – Expanding Horizons in Bio-informatics

During 2000-2001, NRC continued to expand CBR, adding new members including the University of Calgary, Agriculture and Agri-Food Canada (London, Ont.), and the Montréal Network for Pharmaco-Proteomics and Structural Genomics to its list. As well, through a new collaborative agreement with the University of Calgary, CBR nodes are being upgraded at NRC's Plant Biotechnology Institute in Saskatoon and the Regional Innovation Centre in Vancouver. Researchers across Canada use CBR extensively: in 2000-2001, approximately 220,000 pages were retrieved monthly from the CBR Web site, a clear demonstration of the importance of this much needed bioinformatics support resource to Canada.

New NRC Aerospace Manufacturing Technologies Centre (AMTC)

In October 2000, Prime Minister Jean Chrétien announced a new NRC Aerospace research facility to be built in Montréal on the campus of the University of Montréal. This new advanced technology centre will focus its work on research and development to improve aerospace manufacturing technologies in Canada.

The funding for the AMTC, totalling $46.5 million over five years, will be used to develop core competencies and demonstrate modern methods of manufacture for the aerospace industry that have the potential for significant cost savings, while maintaining quality, reliability and performance. The AMTC will accommodate up to 100 people distributed in four major research programs:

- Advanced Metal Products
- Information Systems and Computational Methods
- Advanced Composite Products
- Functional Materials.

A key focus for the AMTC will be to facilitate the transition to next generation manufacturing, particularly among small and medium-size firms.

The AMTC will be implemented under the leadership of NRC's Institute for Aerospace Research (IAR) and will engage a number of other NRC institutes, including its Industrial Materials, Integrated Manufacturing Technologies, Information Technology, and Chemical Process and Environmental Technology institutes, as well as university, government and industry partners.

New "HTS" Facility – Increased Capacity for Drug Research

HTS, or High-Throughput Screening, is playing an increasingly important role in the pharmaceutical industry. The increasing number of targets and compounds have created severe bottlenecks in the drug discovery process – a particularly acute problem for smaller biotech companies where the inability to screen compound libraries quickly, and at reasonable cost, is a major issue. NRC opened a new HTS facility at its Biotechnology Research Institute (BRI) in Montréal in 2000-2001 that will help industry deal with this key problem. Through the use of robotics and automation, the facility makes it possible to test large numbers of samples quickly and to validate novel assays under development.

"The National Research Council has been instrumental in helping Canada's aerospace industry position itself among the top five world leaders in the sector. The Aerospace Manufacturing Technology Centre will provide leadership to boost domestic and foreign investment in our aerospace industry and promote Canada as a significant contributor to worldwide aircraft manufacturing and transportation."

The Right Honourable Jean Chrétien
PRIME MINISTER OF CANADA

Advanced Aluminum Technology Centre for Canada

In October 2000, the Honourable Martin Cauchon, Minister of National Revenue and Secretary of State responsible for Canada Economic Development (CED), announced a $52 million investment by the government for a new NRC research centre in the Saguenay – Lac-Saint-Jean region.

"Canada is well-positioned in world markets as the fourth-largest aluminum producer in the world and second-largest exporter. However, as the Technology Roadmap has shown, one challenge remains: to strengthen our position in the processing sector. The Centre's activities and the mobilization of the entire existing national infrastructure will enable the Canadian industry to develop this sector and carve out a prime position for itself in international aluminum product markets."

The Honourable Martin Cauchon

MINISTER OF NATIONAL REVENUE AND SECRETARY OF STATE FOR THE ECONOMIC DEVELOPMENT AGENCY OF CANADA FOR QUEBEC REGIONS

The new NRC Advanced Aluminum Technology Centre, funded jointly by CED and NRC, brings to life the first recommendation of the *Canadian Aluminum Industry Technological Roadmap*, to which NRC contributed.

The new centre will meet the needs of the entire Canadian aluminum industry and will have considerable impact on the development of aluminum processing companies in the region. The centre will be home to some 80 researchers, technicians and technical staff working to support industry, primarily SMEs, in their efforts to adopt leading edge aluminum processing technologies. These new technologies will help Canadian industry through more efficient manufacturing techniques and the creation of high-value added products and services.

DNA Microarray Facility – Small Solutions to a Big Problem

NRC is addressing a big question – how do certain human pathogens cause disease – with tiny tools (DNA "chips"), using its new DNA microarray facility at BRI in Montréal. The availability of data from completely sequenced genomes for a growing number of organisms has opened up the field of genomic transformation profiling which involves looking at the expression of all the genes in an organism in response to some environmental signal or genetic modification. The DNA microarray, also known as the DNA chip, is the tool that allows researchers to undertake this profiling. Within a year of opening this facility, researchers are producing chips for profiling of the *C.albicans* genome. These chips are a central part of the NRC Genomics and Health Initiative (GHI) Candida genomics program and are being used by a number of academic collaborators as well. Although BRI's research work is directed at the construction of chips to investigate *C.albicans*, this DNA synthesis capacity, microarray spotters and scanners can be used for any similar project.

Performance-based Codes On the Way

NRC's Institute for Research in Construction (IRC) made significant progress on the five-year program to transform the national construction codes into an objective-based format and improve the code development system. The first issue of these codes is expected in 2004.

- NRC, provinces and the territories reached formal agreement on an approach to the codes
- National and provincial building, plumbing and fire codes were analysed and comprehensive public consultations were conducted with respect to objectives and formats of future codes
- An agreement is in negotiation to formalize a partnership and model for development of national model codes as well as provincial codes.

Ultimately, this work will reduce costs for the construction industry in Canada. It will also facilitate the development and use of more innovative products and practices – while addressing safety and health for all Canadians.

National Guide to Municipal Infrastructure

Funding was obtained, key committees established and technical work begun on the development of a *National Guide to Sustainable Municipal Infrastructure: Innovations and Best Practices*. Published by NRC's Institute for Research in Construction (IRC), the Guide, funded under the Infrastructure Canada Program, will be implemented by the Federation of Canadian Municipalities (FCM) in partnership with NRC. It will provide a vital roadmap to the best available solutions for addressing infrastructure issues and be the focal point for the Canada-wide network of stakeholders focused on infrastructure operations and maintenance. More than 90 municipalities support the initiative. A federal government investment of $12.5 million was committed to the

project, targeted for completion over the next four years.

In 2000-2001, in support of this project, NRC:

- Developed policies and procedures for the Guide
- Established committees and working groups (made up entirely of volunteers)
- Organized a national associations forum
- Organized a federal, interdepartmental meeting on infrastructure involving 12 key organizations
- Continued the promotion of the Guide initiative with stakeholders across Canada.

"A National Guide to Sustainable Municipal Infrastructure represents another important step towards realizing our fundamental objective: using new technologies and best practices to provide 21st Century infrastructure to improve the quality of life of all Canadians."

The Honourable Lucienne Robillard

MINISTER RESPONSIBLE FOR INFRASTRUCTURE

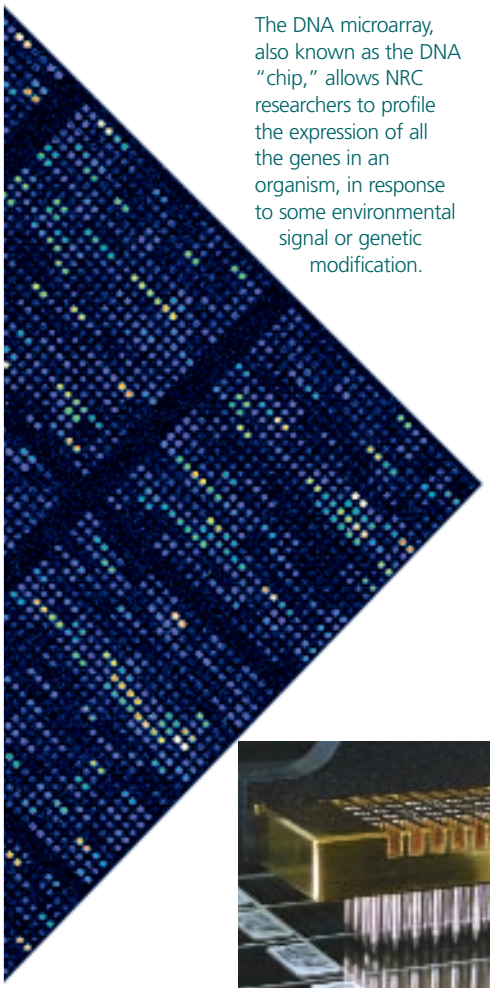
A New Virtual Reality Centre for Winnipeg ... and the Nation

NRC's IRAP and Integrated Manufacturing Technologies Institute came together to work with the Economic and Technology Council of Manitoba to help define and create a new Virtual Reality Centre in Winnipeg that will leverage the expertise of NRC's own Virtual Environment Technologies Centre in London, Ontario. This new Winnipeg centre will offer more to the region than cost-effective design, prototyping and testing for companies – NRC's Institute for Biodiagnostics in Winnipeg will take advantage of the new centre to bring an added dimension to its Magnetic Resonance Imaging research.

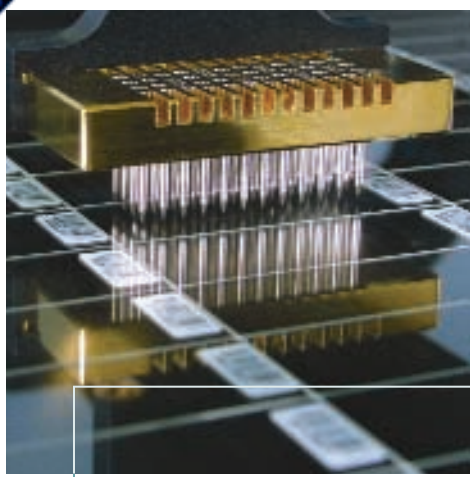
Building Astronomical Capacity for Canada

In January 2001, NRC acquired new laboratory space at its Herzberg Institute for Astrophysics (HIA) in Victoria, B.C., providing state-of-the-art facilities for advanced astronomical instrumentation work, including an integration and test facility, with a cold chamber and a tilt-table to simulate the conditions of telescopes such as GEMINI. There is also an electronics lab and specialized rooms for assembling and testing detectors.

Construction of NRC's first institute-based Interpretive Centre was completed in Victoria at HIA, as was the design and contracting of exhibits. This new Centre provides a large exhibit hall, with a Starlab planetarium and 60-seat multipurpose theatre. HIA has attracted more than one million visitors to NRC since its observatories opened, so this Interpretive Centre will be a much appreciated and much used facility for Canadians and Canadian youth.

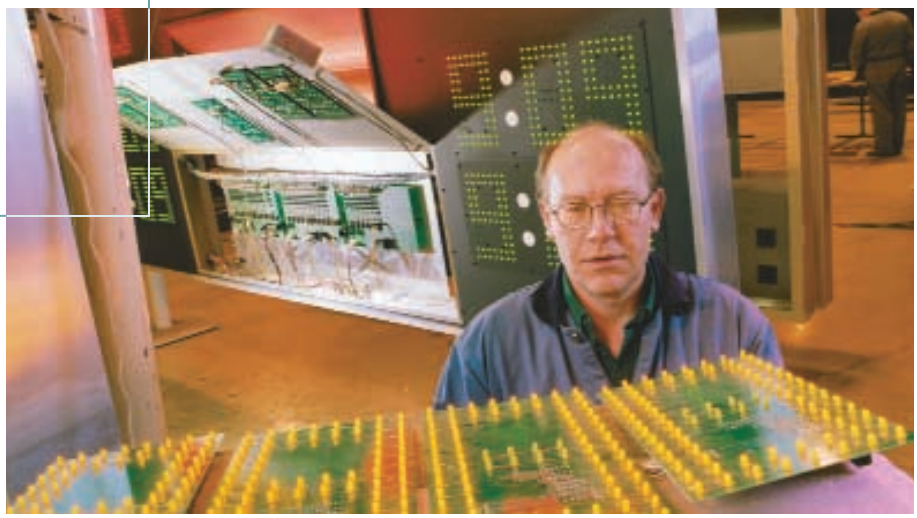


The DNA microarray, also known as the DNA "chip," allows NRC researchers to profile the expression of all the genes in an organism, in response to some environmental signal or genetic modification.



"What we're getting from IRAP is more than funding. We're getting a new perspective and a real education," says Kodiak Industries president Mark Wiese.

The Winnipeg company manufactures specialized equipment such as telescoping spectator seating and scoreboards for school gymnasiums.



Stimulating the Innovative Capabilities of SMEs

Much of the growth of Canada's economy and innovation capacity can be attributed to value, wealth and job-creation by small and medium sized businesses. One of NRC's primary objectives is to link its diverse networks, programs and infrastructure to SMEs to help them access, develop and exploit new technologies essential to their growth.

NRC's principal program to help stimulate the innovative capabilities of SMEs is its Industrial Research Assistance Program. IRAP is a federal government catalyst that links a diverse network of organizations and programs to help Canadian SMEs develop and exploit technology in a competitive knowledge-based economy. Through expert advice and financial assistance, the program provides customized solutions to some 12,000 Canadian industrial firms to help them increase their innovative capacities.

IRAP helps SMEs manage and reduce the risks inherent in the innovation process. Its network is built on the knowledge and skills of more than 260 Industrial Technology Advisors (ITAs), 140 partner organizations at the regional level known as Network Members and 1,000-plus members within the Canadian Technology Network (CTN).

Increasing Innovation Capacity – 2000-2001 Highlights

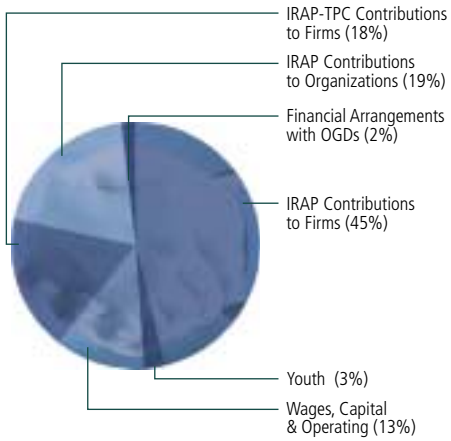
In 2000-2001, IRAP's total level of activity amounted to $142.61 million, including $95.7 million in contributions directly to 3,382 SMEs for 3,877 innovation capacity building projects, and $25.47 million in IRAP-Technology Partnerships Canada (TPC) contributions for pre-commercialization assistance (PA). Through its expenditures, IRAP has helped to build SME innovation capacity in terms of:

- Increased skills, knowledge, technical competencies and innovation
- Improved management practices
- Enhanced linkages
- Improved financial performance.

IRAP-TPC – Pre-commercialization Assistance to SMEs

NRC's IRAP and Technology Partnerships Canada, a special operating agency of Industry Canada, have joined forces to support innovative SMEs by investing in projects at the pre-commercialization stage. In 2000-2001, IRAP-TPC provided $25.47 million in repayable contributions to 159 innovation projects involving 157 clients, of which 79 were new to IRAP.

IRAP Total Level of Activity in 2000-2001
Total: $142.61M

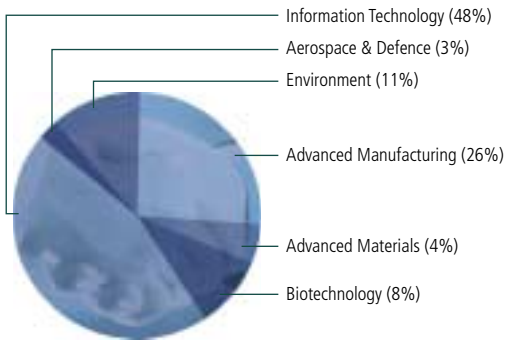


International Initiatives

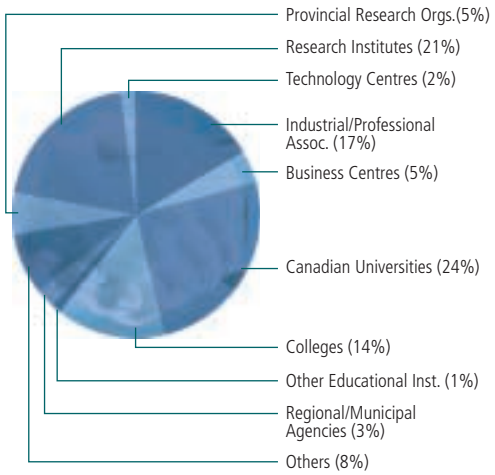
IRAP's international activities focus on participating in technology missions, establishing formal linkages with other countries and receiving foreign missions in Canada. In 2000-2001, IRAP participated in three technology missions to Asia involving 29 SMEs, organized 44 information-sharing events, signed two new international agreements and responded to an increased number of countries seeking information on IRAP and the CTN.

- Mission to Seoul, Korea: In May 2000, IRAP conducted a technology mission with 14 information technology (IT) companies. Over 175 meetings resulted in eight memoranda of understanding.
- Mission to Hong Kong: In November 2000, a group of 15 IT companies were hosted by the Hong Kong Productivity Council (HKPC) for a technology matching session. Clients from British Columbia and Alberta signed 12 memoranda of understanding in Hong Kong as a result of this event.
- Hong Kong – Matchmaking Event: In August 2000, a scoping mission with IRAP representatives helped identify suitable partners for IRAP matchmaking. HKPC agreed to work with IRAP and a memorandum of understanding was signed between the two organizations. In parallel, IRAP representatives, who had joined the Team Canada mission to Hong Kong in November 2000, signed a letter of intent with HKPC to jointly promote IRAP and CTN-type events.
- In mid-2000, an agreement with ANVAR (Association nationale de valorisation de la recherche, France) was signed and a work plan of activities was completed. ANVAR is a $300 million per year technology assistance program for SMEs. IRAP and ANVAR have engaged in an exchange of industrial technology advisors (ITAs) for a one-year period to learn from each organization's best practices and to stimulate mutual SME linkages.
- IRAP assisted the government of Thailand in preparing a training program to expand its own IRAP-CTN-like program. A memorandum of understanding was prepared. Thailand will support the costs of one of two Canadian ITAs who will begin a one-year assignment in Bangkok in the summer of 2001.

IRAP-TCP Projects by Technology Areas



Distribution of NM by Type of Organization



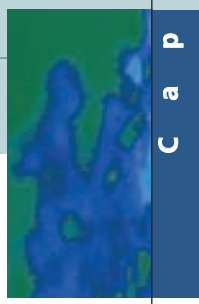
"Accurate, real-time prediction of future ship trajectory is a critical new technology which will enhance the precision of vessel manoeuvring and directly improve navigation safety and efficiency in confined waters. The SPS is the enabling technology which will support the future implementation of fully automatic steering from berth to berth."

Captain John Pace
CANADIAN STEAMSHIP LINES

Ship Safety and Economy with SPS

Since 1993, IRAP's technical advice and financial assistance has helped CORETEC Inc. of Newfoundland to develop several innovative products and services designed to increase safety and to improve the efficiency of marine and offshore operations.

With the support of IRAP, CORETEC Inc. developed a Ship Predicator System (SPS) that provides accurate, short-term prediction of ship trajectory in confined or restricted waters, helping ships officers to accurately track the safety and fuel economy of their vessel's operations. With a staff of 30 full-time employees, the firm has increased the number of technical staff from two in 1993 to 16 in 2000.



Strengthening the Canadian Innovation System

In addition to its direct advice, assistance and support to SMEs, IRAP plays a key role in the development of Canada's Innovation system through the development of networks and linkages with key players in the innovation system.

- **The Canadian Technology Network**
  The CTN is a network of more than 1,000 organizations committed to enhancing Canada's innovation infrastructure. NRC's industrial technology advisors (ITAs) play a critical role in liaison between IRAP and the CTN. In 2000-2001, CTN was active in organizing 439 seminars and conferences, up from 260 in 1999-2000. IRAP's total contribution to CTN amounted to $3.89 million. CTN also responded to 2,770 queries in 2000-2001 and provided advisory services to 2,820 clients.
- **Network Member Organizations**
  IRAP has partnership agreements with some 140 organizations at the regional level. These Network Member (NM) organizations complement NRC's innovation services to SMEs. In 2000-2001, NM industrial technology advisors continued to work directly with SMEs to help build and strengthen regional innovation systems. IRAP's total contributions to NM organizations amounted to $23.97 million in 2000-2001.

The collaborations between IRAP and NM organizations extend beyond the provision of ITA services. They work together with regional and local players to strengthen their knowledge and competencies in innovation business areas. They lead or provide support to multi-stakeholder events and initiatives to increase regional innovation capacity and collaboration.

- **Linkages with Other Innovation Players**
  In 2000-2001, IRAP developed closer links with Federal Partners in Technology Transfer (FPTT), an initiative that enables industrial technology advisors and their industry clients to develop their technology and knowledge transfer capabilities, especially as they relate to the protection and exploitation of intellectual property. IRAP also reinforced its ties with NRC research institutes through client visits and collaborative research projects. As well, IRAP has formed strong alliances with regional organizations with the objective of increasing the innovation capacity of communities.

Technology Network and Technology Sector Groups

IRAP's Technology Network (TN) group promotes a national networking framework to increase the effectiveness of ITAs, SMEs and IRAP management. The group also takes the lead in coordinating the activities of IRAP's Technology Sector groups,

whose scope and mandate have been modified to enhance the ability of ITAs to serve their SME clients. Activities are focused on the following 10 sectors: agri-food, bio-technology, chemical processing, communications, construction, electronic and signal processing, sustainable development, aerospace manufacturing, manufacturing and materials, and software. In 2000-2001, nine Technology Network ITAs provided assistance to 172 IRAP clients on 188 projects in nine provinces.

Technology Visits Program and Innovation Insights Program

The Technology Visits Program (TVP) and Innovation Insights Program (IIP) are organized by the Canadian Manufacturers and Exporters and funded in part by IRAP. Both are designed to promote best manufacturing practices and peer-to-peer exchanges. The TVP allows participants to visit the site of host companies and tour their facilities, while the IIP has both a visit and networking element, allowing technology discussions among hosts and visitors. In 2000-2001, 27 companies across Canada hosted TVP exchanges involving more than 770 participants, while 74 companies hosted IIP activities involving nearly 1,300 participants. Two international missions also were organized under the IIP: a visit to Florida's technology triangle to observe best practices in manufacturing, and a visit to France to see its aircraft technology practices in action.

Youth Initiatives

To help SMEs deal with the current shortage of highly qualified personnel, IRAP manages two youth internship programs on behalf of Human Resources Development Canada. In 2000-2001, 631 graduates were placed in 581 SMEs for a total of $4.9 million in contributions to firms.

Sustainable Development

IRAP fosters the integration of sustainable development practices into the innovation practices of SMEs and helps them become more competitive through this process. The Eco-Efficiency Innovation (EEI) initiative is a joint undertaking by IRAP and the Ontario Centre for Environmental Technology Advancement (OCETA), with widespread collaboration from federal government departments, industry associations, and with major funding support from the Technology Early Action Measures (TEAM). So far, 51 eco-efficiency audits have been completed or initiated, and a further 25 are under way. Design for Environment (DfE) is the systematic integration of environmental considerations into product and process design. Considerations include improved choice and the use of materials with better product functionality and durability, leading to enhanced productivity and competitiveness.

"IRAP's scientific credibility really helped when we were looking for venture capital. IRAP also helped us see the commercial applications of our discoveries. Thanks to them, the company is on solid ground and we can afford to plan strategically in a sector that is enjoying exponential growth."

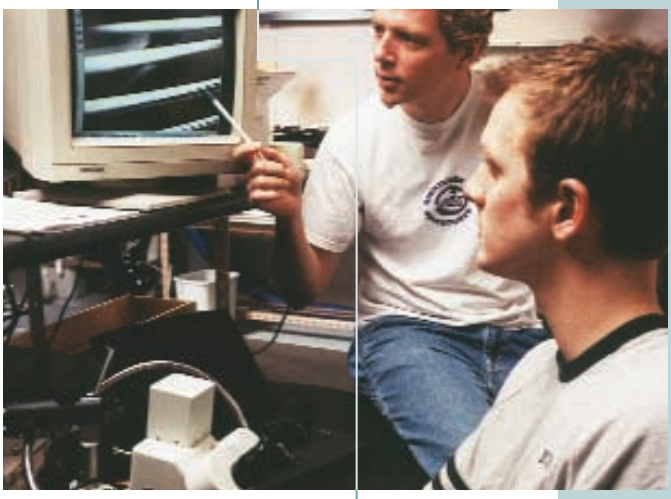
Dr. Rino Camato
PRESIDENT
GENEKA BIOTECHNOLOGY

Geneka Biotechnology – World Leader

Thanks to the financial and technical support of IRAP, Geneka Biotechnology is now the international benchmark for functional genomic research. All over the world, pharmaceutical researchers who specialize in gene regulation now depend on this firm's products. The company has developed kits that identify 130 promising factors and produces over 1,000 products that analyse these transcription factors. According to its founder, Geneka Biotechnology has a five-year lead on the rest of the world, placing Canada at the leading edge of functional genomic research. Thanks in part to the advice of IRAP ITAs and to research funding, the company has surpassed all its product development goals. Since 1996, the company has grown from four to 42 employees and their research facilities have grown from 35 to nearly 1,800 square metres. Sales have surpassed all estimates and have doubled every six months.

"We had a general idea that we would apply the technology to computer-input devices, but we didn't know which sector to target. The MART gave us a road map that has proved robust. We still follow it today."

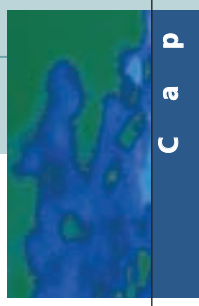
Rob Inkster
PRESIDENT AND CEO,
TACTEX CONTROLS INC.



Smart Fabric – New Generation of Control Device

A unique, pressure-sensing touch pad developed by Victoria, B.C. firm Tactex Controls Inc., allows musicians to reach new heights of artistic expression. The patented MTC Express is a mouse-pad-sized, multi-touch controller that can be played like an "instrument," or used to control mixers and other sound processors. It can be produced in different shapes and different coverings for a variety of industrial applications.

The core technology for the multi-touch controller is based on fibre optic technology. In 1998, with only two employees, the company took a giant step forward with NRC support, under the Market Assessment of Research and Technology (MART) program, a jointly funded NRC-B.C. government initiative. In 2000, the firm employed 18 staff and was planning to expand its 4,000 square foot facility.

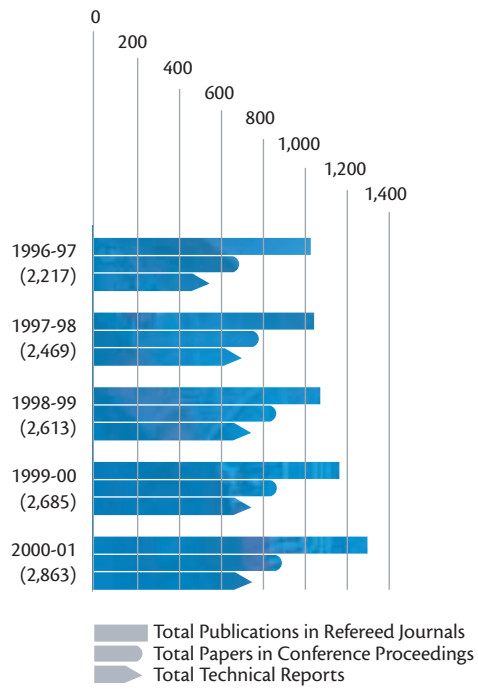


Knowledge: The New Currency of the Innovation Economy

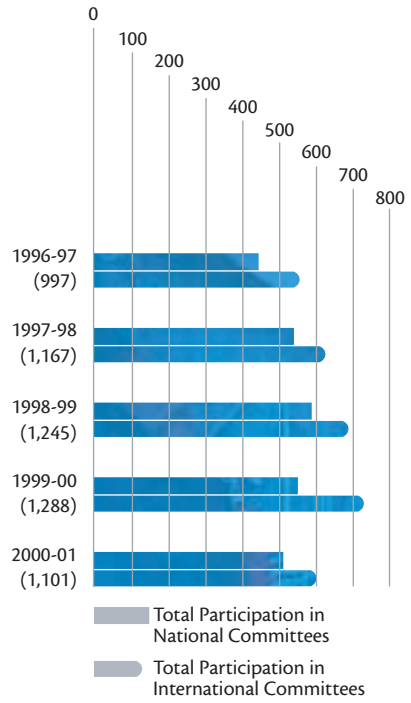
In today's economy, the creation of new knowledge and its transformation into new products, processes and services, are as fundamental to economic growth and prosperity as physical infrastructure and financial capital. NRC contributes to the creation of leading-edge knowledge through its core research and development efforts, as well as to the effective dissemination of this knowledge to Canada's scientific and industrial communities.

NRC's capacity to create and disseminate new knowledge can be demonstrated in a number of ways. Publications in peer-reviewed journals, conferences and other key fora are one method. In 2000-2001, NRC published over 1,250 papers in leading peer-reviewed journals around the world, including *Science and Nature*, had more than 800 papers published in conference proceedings, produced over 700 technical reports and wrote or contributed to over 90 books. NRC also gave over 940 invited presentations, and shared expertise, knowledge and information with the scientific, technical, medical and industry communities through participation in over 1,100 national and international committees. NRC researchers also held the editorship or sat on editorial boards of some 120 S&T publications.

NRC Publications



NRC Membership on Committees



CISTI – Vital Information Infrastructure for Canada

The role of NRC's Canada Institute for Scientific and Technical Information as Canada's major scientific, technical and medical (STM) information resource has assumed a steadily growing importance in the emerging economy.

Through its dual function as a STM library and scientific publisher, CISTI maintains, publishes and provides access to the STM information resources essential to Canadian research, industry and health communities. CISTI provides access to Canadians through 17 NRC Information Centres (NICs) across Canada, as well as virtually via the Internet. Two new NICs are being built in Atlantic Canada – one in Prince Edward Island, the other in New Brunswick – to support new facilities resulting from NRC's Atlantic Canada technology cluster development initiatives. CISTI is also planning a new NIC to support the NRC Aerospace Manufacturing Centre being constructed in Montréal.

Under its mandate to establish, operate and maintain a national science library for Canada, CISTI maintains one of the largest collections of STM information in the world:

- 49,322 scientific journals (including 12,074 active subscriptions)
- Access to 3,582 licensed electronic journals
- 600,207 monograph titles (including 186,410 conference titles)
- A large collection of technical reports.

As Canada's largest scientific publisher, CISTI's NRC Research Press publishes yearly:

- 14 peer-reviewed, internationally recognized scientific and technical journals
- A growing list of monographs and conference proceedings.

In 2000-2001, CISTI:

- Provided over one million documents worldwide (up 16 per cent)
- Sold 18,738 NRC Research Press subscriptions
- Received 10,000 submissions from authors in Canada and around the world; following peer-review, 6,300 were published
- Extended its reach internationally with document delivery orders from the United States reaching 294,454 (up 14 per cent) and 78,620 from other international sources (up 66 per cent)
- Reported a significant increase in document delivery orders filled through international partners – from less than 25,000 in 1999-2000 to more than 40,000 in 2000-2001
- Provided access to 10,444 electronic titles on the NRC Virtual Library
- Saw increased use of the CISTI Catalogue – up 42 per cent – with 313,610 document orders placed.

In addition, significant effort went into the complete reorganization and redesign of *CISTI Source*, CISTI's current awareness service with integrated document delivery. The updated *Source* will provide new and extended features, additional content and services and a wider range of subscription options. The new *Journal Content Alert* was launched in March 2001, with other features to be phased in over coming months. Full functionality is expected by the fall of 2001.

The following are other major initiatives undertaken by CISTI in 2000-2001 to enhance access and service.

National Electronic "Infostructure" Developed

CISTI developed a national e-infostructure capacity in St. John's, Newfoundland, at NRC's Institute for Marine Dynamics (IMD). This initiative represents a significant step towards the realization of a national electronic information network for Canada. The network can be used to provide continuing access to and retention of electronic STM information resources for Canadians. The new e-infostructure, installed as part of NRC's Atlantic Canada technology cluster development initiatives, consists of four main components: a network of servers, a data storage facility, advanced software, and a team of CISTI information specialists.

Free Access to NRC Research Press Electronic Journals

Through an agreement between the NRC Research Press and the Depository Services Program of Public Works and Government Services Canada (PWGSC), all Canadians now have free access to the 14 scientific and technical journals published by NRC. Beginning January 1, 2001, these peer-reviewed journals, which cover a wide range of scientific disciplines, were made available free to anyone in Canada with a Canadian IP (Internet Protocol) address.

New "Products for Innovation"

CISTI also began development of a new series of "Products for Innovation" that will enhance its services to industry, particularly SMEs. The new products will include competitive technical intelligence, technology road mapping, technology forecasting, and support to strategic planning within NRC. CISTI will play the role of integrator, contributing to these activities, promoting awareness, benchmarking best practices and supporting cooperation and collaboration among federal government organizations in these fields.

New International Partnerships

CISTI and the Institut de l'information scientifique et technique (INIST) of France signed a document delivery agreement providing CISTI clients with access to the largest French collection of S&T documents, as well as to their specialized STM information. In a similar vein, CISTI also signed an agreement with the Korea Institute of Industry and Technology Information that provides CISTI clients with access to that country's largest collection of S&T documents.

Police Info Online

The full catalogue of the Canadian Police College Library (CPCL) is now available on the Web through CISTI. The new system provides police personnel across Canada with ready access to this important collection of research information on police-related subjects.

Talent for Canada

NRC is committed to helping build the critical mass of skilled people that are the foundation of Canada's success in the knowledge-based economy of the 21st century. NRC's contributions take many forms across the country, from student programs and youth outreach activities, to guest workers and expert resource exchanges with other S&T organizations around the world.

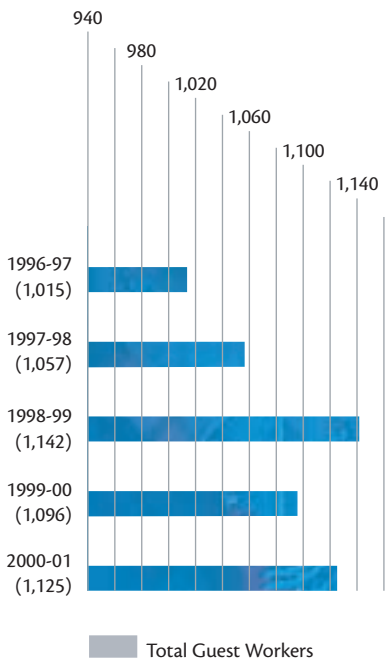
Guest Workers

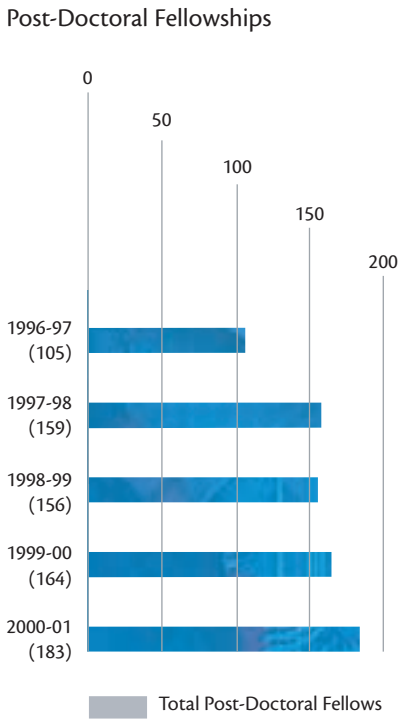
NRC institutes, technology centres and innovation centres engaged over 1,100 guest workers from Canadian and foreign universities, companies and other organizations, in research projects and other activities at NRC. Not only does NRC benefit from the participation of guest workers in collaborative projects, their home organizations gain equally from the training provided and the transfer of knowledge and know-how.

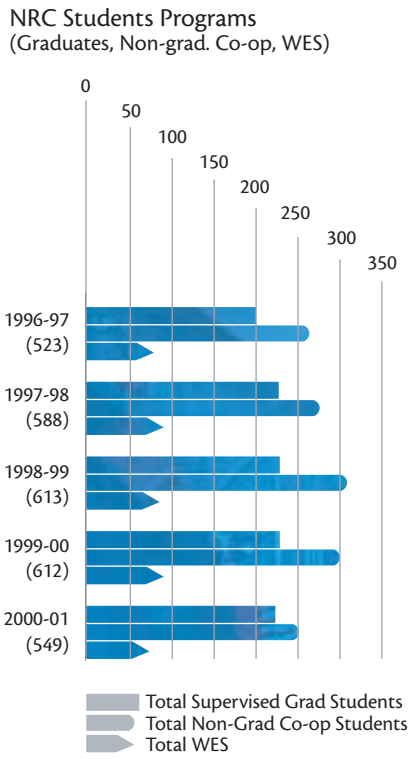
Student Programs

In 2000-2001, NRC student programs provided direct, hands-on training and development work for nearly 550 graduate, co-op and summer students, and some 180-plus post-doctoral fellows (PDFs).

NRC Guest Workers





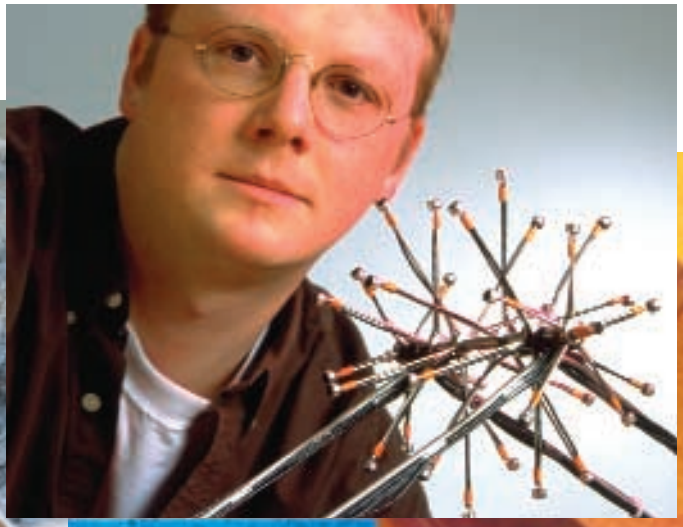


The Women in Engineering and Science (WES) Program continued to encourage talented women students to pursue professional careers in engineering and science.

Helping Young Canadians Reach their Potential

In addition to direct experience and training activities, NRC staff also work to interest young Canadians in careers in science and technology though a variety of outreach activities. Highlights of NRC's public awareness in 2000-2001 include:

- Partners in Education Program for Secondary Schools: NRC has formal partnership agreements with five high schools in the Ottawa region. Two other schools joined in as pilot partnerships in 2000-2001. Through this program, secondary school students are given the opportunity to interact with scientists in a research environment, visit local NRC labs, and participate in demonstrations conducted by researchers
- Canadian National "Marsville:" NRC provided national support to this pan-Canadian space science/astronomy program designed to create a positive image of the technological environment of the 21st century. Students in grades 5 to 8 collaborated in teams, like scientists, and communicated through Internet connections with their counterparts in other regions of the country for a period of three months. Scientists and engineers served as mentors and worked directly with teachers and students, in the classroom and online
- Learn Canada: a multi-partner CANARIE-funded project established in 1999 to develop a broadband, interactive virtual learning community for K-12 educators. In 2000-2001, NRC's Institute for Information Technology developed Learn Canada's Video Sharing and Annotation Server, mounted on CA*.net3. This new, multi-purpose tool is used by teachers to enhance collaboration and develop best practices. Teachers used digital video to capture meetings and then upload excerpts to the server, making them available to other teachers to view and annotate with comments on the content
- Virtual Classroom: the ongoing, award-winning Virtual Classroom project, a collaboration of NRC and the Communications Research Centre Canada (CRC), continued in 2000-2001 with experiments on Web-based technologies and collaborative distance learning models that can help improve education. Experiments focused on Web-based remote-control applications in virtual mentoring. Teachers and students were engaged from two secondary school engineering classes and, in concert with NRC, used these remote-mentoring technologies to have students create a virtual 3D National Arts Centre Southam Hall and Theatre
- Aventis Biotech Challenge: NRC partnered with Aventis Pasteur, the Biotechnology Human Resources Council and local organizations to host award-winning student competitions in seven regions across Canada. The aim is to improve the quality of biotechnology education in Canada by offering high school students hands-on experience.



In 2000-2001, NRC student programs provided direct, hands-on training and development work for nearly 550 graduate, co-op and summer students, and some 180-plus post-doctoral fellows.

Students had the opportunity to work with top scientists in world-calibre laboratories. In addition to these competitions, a three-day exhibition held in Ottawa featured lectures by experts from IOGEN Corp, Agriculture Canada, the Royal Canadian Mounted Police and NRC on topics such as DNA typing, transgenic plants, biomedical engineering and osteoporosis.

The NRC Employment Philosophy: Excellent People – Employer of Choice

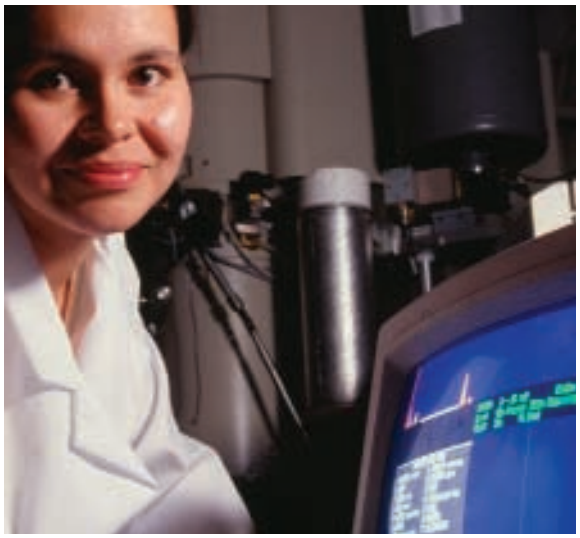
The foundation of NRC's vision and contributions to Canada is its people. The core of NRC's performance and success is the knowledge, imagination, dedication and creativity of its staff and its ability to attract, retain and be a preferred home for the "best of the best."

In 2000-2001, NRC launched its E*mployment Philosophy*, a comprehensive strategy for developing the human and intellectual capital that is crucial to driving innovation and discovery. The P*hilosophy* rests on four principles:

- Recruit and retain outstanding people
- Give them the opportunity to grow professionally, to utilise their strengths and to deliver to the maximum of their capabilities
- Reward them based on their level of productivity
- Create a respectful partnership with trust and understanding between them and NRC.

For employees, the intent of the P*hilosophy* is to create an NRC which is known for its:

- Competitive salaries, benefits and job continuity benefits
- Top quality management and leadership
- Important programs and interesting jobs
- Extensive learning, personal growth and career enhancement opportunities
- Inviting, participative organizational climate, featuring respect, recognition, teamwork and sensitivity to the need for balance between work and personal life



- Employee access to the latest in technology, equipment, facilities and business practices as part of a focus on continued enhancement of personal employability.

  For NRC, the intent is to create an organization known for its ability to:
- Recruit and retain the "best of the best"
- Achieve high levels of employee commitment, affiliation and retention
- Achieve high levels of organizational competency, productivity, impact and client success
- Maintain high levels of intellectual capital and change-readiness within the NRC workforce
- Achieve the spirit, as well as the letter, of legislative and regulatory imperatives such as Occupational Safety and Health, Employment Equity, Pay Equity and Official Languages.

Toward a Culture of Innovation for Canada

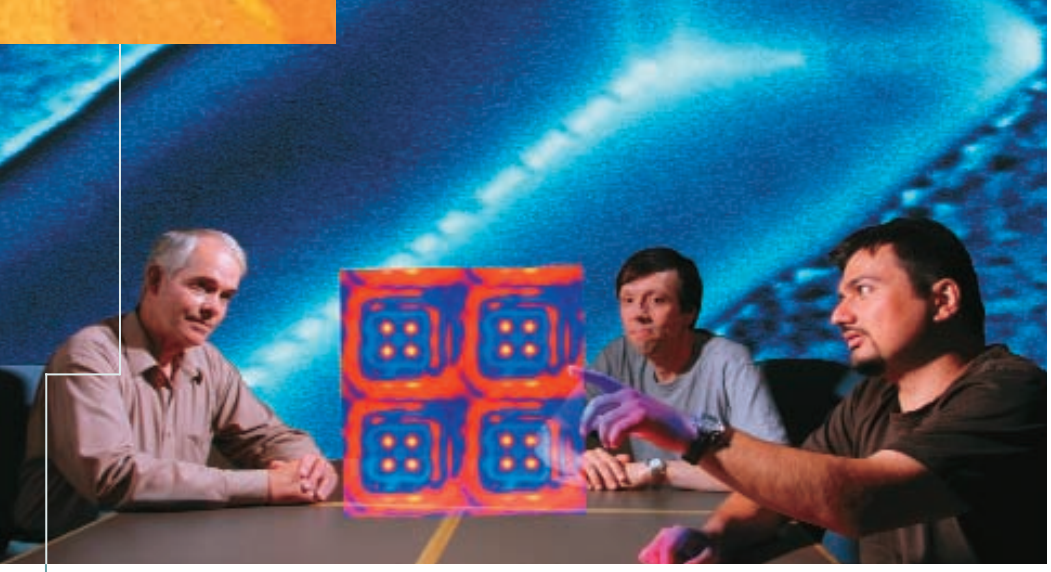
"In the areas where creativity – scientific and artistic – collaborate, there are myriad examples of a synergy which leads to invention and benefit. And benefit, I may add as a footnote, is only a reasonable, practical outcome in a society of fruitful collaboration…For discovery is really what creativity in both the arts and sciences is all about."

Her Excellency, The Right Honourable Adrienne Clarkson
GOVERNOR GENERAL OF CANADA

Throughout its history, many of NRC's greatest contributions to Canada and the world have come from innovative connections that were unusual in their time. The multi-billion dollar Canola crop had its origins when plant breeders, scientists and farmers collaborated with NRC experts in chemistry and scientific instrumentation. NRC physicists and engineers played a pivotal role in Canada's leadership in computer animation technology when they invited artists and filmmakers from the National Film Board of Canada to their laboratories in the early 1970s. More recently, NRC has helped merge biological sciences and communications technologies in the new field of bioinformatics – helping underpin the revolution in genomics.

It was against this backdrop of experience and forward-looking research and innovation that NRC marked the beginning of the new millennium with a project that celebrated its history and renewed its long-standing commitment to creative alliances that foster innovation and creativity.

The initiative, known as the Millennium Conferences on Creativity in the Arts and Sciences, created a conference series designed to augment and challenge existing strategies and approaches in science, technology and innovation in the knowledge-based economy through new ideas, new concepts and new partnerships to both connect and tap the synergies of the Arts and Sciences.



"It is the federal government's view that not only must we make visible wise investments across the entire spectrum of disciplines in fields of knowledge, in both the physical and social sciences, but just as critical is the creation and maintenance of the links between them."

The Honourable Herb Gray, P.C. M.P
DEPUTY PRIME MINISTER OF CANADA

The centrepiece event in this series was *Creativity 2000*, a conference co-sponsored by NRC, the National Arts Centre (NAC) and the Canada Council for the Arts, along with other national and international government and private sector organizations. The conference brought together world leaders in the arts and sciences communities on June 21, 2000, at the National Arts Centre, in Ottawa, for discussion of issues of common interest before an audience of business leaders, academics, scientists, artists and some of Canada's best and brightest post-secondary students from across Canada.

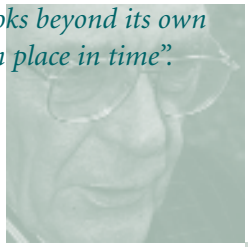
The highlights of the conference were captured in a book titled *Renaissance II: Canadian Creativity and Innovation in the New Millennium*. Another legacy of this conference was a collaboration agreement between NRC and the NAC to work together in the demonstration and testing of broadband technology to enable interactive music lessons and performances from remote locations.

Since the Conference series, NRC and the Canada Council for the Arts have also pursued a collaboration that will lead to the development of a new program to bring together artists and NRC researchers under an "Artist in Residence" umbrella, emulating successful innovation initiatives in industry and other national research organizations in other countries.

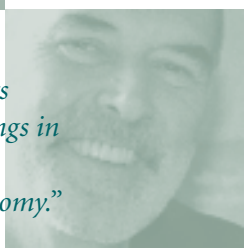
CREATIVITY

"Perhaps the best way for a nation to encourage creativity within its own borders is to adopt a vision that looks beyond its own borders, its own interests, and even its own place in time".

Sir John Maddox
AUTHOR, SCIENTIST,
FORMER EDITOR OF NATURE



"And we believe that Canada's future, in a knowledge-based economy, will be shaped by creativity and innovation. The arts stimulate the brain's synapses. They get us thinking about things in new ways. The artistic capacity of a nation will have a direct impact on its ability to compete in this knowledge-based economy."



Peter Herrndorf
DIRECTOR GENERAL AND CEO
NATIONAL ARTS CENTRE CANADA

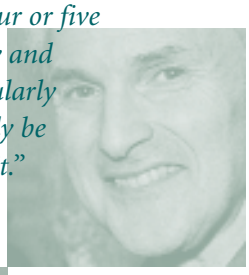
"We are magical beings, as human beings, because we have this power of creativity. No other beings on this planet have this gift because their patterns of existence are set and just as a deer is always a deer, a bear can only be a bear, a fish only a fish. But, we can recreate ourselves and create the tools to be anything we want… we're not limited. All we have to do is declare our intentions powerfully and keep our word, not operate on reason but on total commitment, and we make our visions happen."

Douglas J. Cardinal
ARCHITECT

"When it comes to creativity, I don't think you should underplay resistance to structure. Structures aren't always bad; if I didn't have anything to react against, I wouldn't be able to do my work."

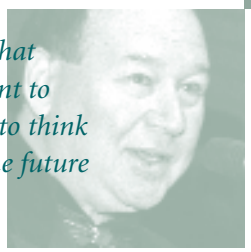
Don McKellar
FILMMAKER

"If you have faith… if you actually believe that you are going to get there, you are going to get there. Whatever thing you like… three, four or five things… just do each of those things to the best of your ability and don't give up. Even though you may not think you are particularly good at it, if you really do it as best you can, you will probably be better than someone who could have done it better, but didn't."



Sir Harry Kroto
NOBEL LAUREATE IN CHEMISTRY

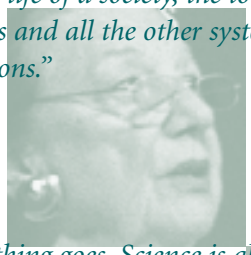
"NRC is one of the few organizations that tolerates this linkage of creators – I want to encourage them, and you, to continue to think of the arts and artists as partners in the future that we're inventing together."



Paul Hoffert
INFORMATION TECHNOLOGY RESEARCHER, COMPOSER, MUSICIAN, AND ARTS LEADER

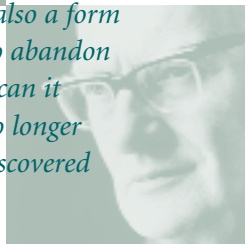
INSIGHT

"People with sometimes unnerving frequency ask the question, what is culture and art? Well, culture can be looked on as a high-speed evolutionary device, an outrunner of biological natural selection, serving the interests of a complex society by bringing into focus what is important to it. Culture comprises the life of a society, the totality of its religions, myths, art, technology, sports and all the other systematic knowledge transmitted across generations."



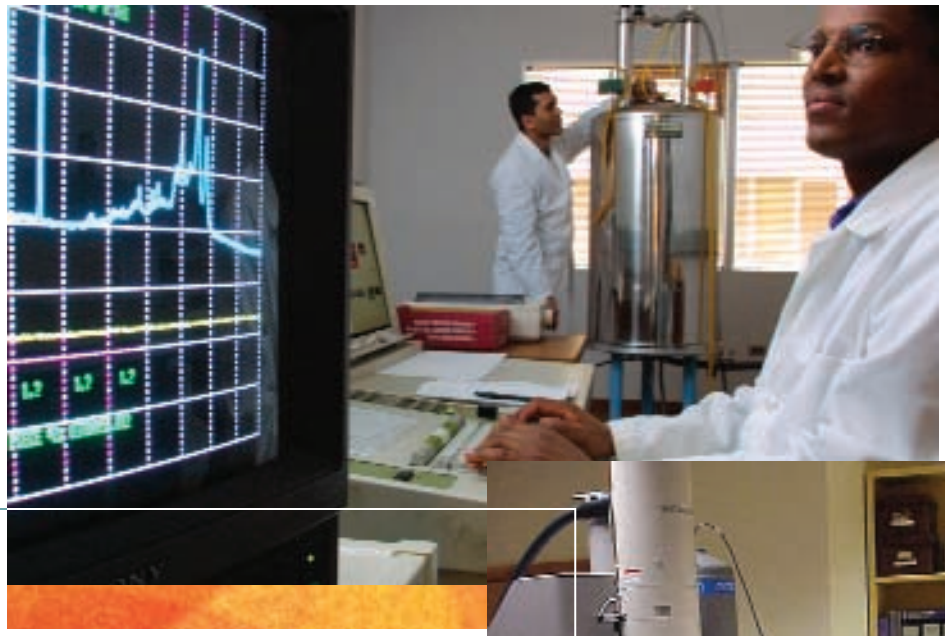
Shirley L. Thomson
DIRECTOR, CANADA COUNCIL FOR THE ARTS

"Creativity is a form of play where anything goes. Science is also a form of play: play restrained by the physical universe… We have to abandon the idea that schooling is something restricted to youth. How can it be, in a world where half the things a man knows at 20 are no longer true at 40 – and half the things he knows at 40 hadn't been discovered when he was 20."



Sir Arthur C. Clarke
AUTHOR AND FUTURIST

Researchers at NRC's Institute for Biodiagnostics in Winnipeg are developing an innovative, non-invasive diagnostic test for colon cancer that could prevent thousands of deaths.



NRC's new Microscopy facility at its Institute for Marine Biosciences in Halifax supports scientific research in sectors ranging from aqua-culture and forestry to health care and pharmaceuticals.

"One of our government's principal goals is to ensure that all Canadians have the opportunity to participate in Canada's economic development. Through organizations like the National Research Council, we will work together to build on the strengths and opportunities that exist in our communities and develop globally competitive technology centres in all regions of Canada."

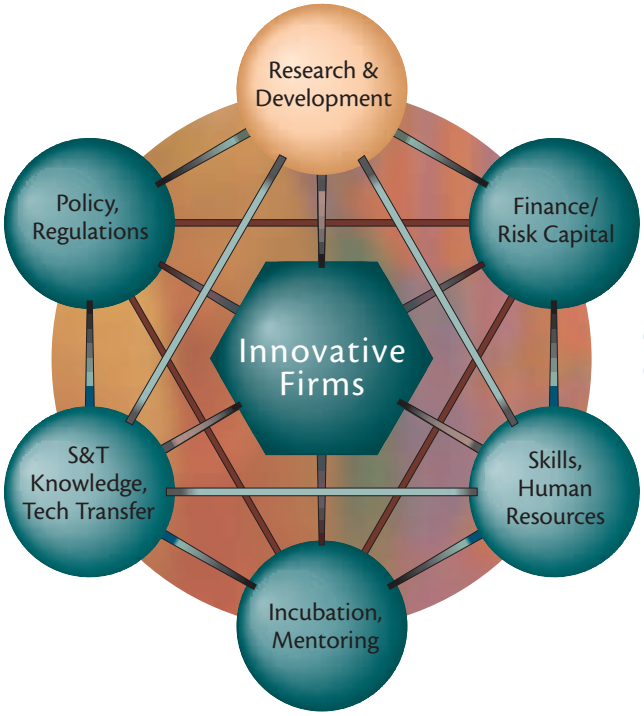
The Honourable Brian Tobin
MINISTER OF INDUSTRY

Community-based Innovation

Canada's Newest Engine of Value Creation

Given its vast geography, relatively small population and the predominance of SMEs, Canada has increasingly recognized the need to adopt community-based approaches to foster the innovation necessary for Canada to reach its full potential in the 21st century.

NRC is a nationally accessible S&T resource for Canadians and Canadian businesses. NRC plays an active, dynamic role in developing the innovative capacity and economic potentials of Canada's communities. It has had real impact in helping build world-class innovation clusters in centres like Saskatoon, Montréal and Ottawa. NRC is working to augment these roles to meet the needs and opportunities of other communities across Canada, through new partnerships in key technology fields, jointly developed long-term strategies and development of locally-based, nationally and internationally-linked R&D and innovation programs and facilities, as the basis of future community technology clusters.



Building Technology Clusters: The Key Components

NRC: Atlantic Canada Cluster Initiatives

"The Atlantic Investment Partnership is a bold plan to ensure that not only can Atlantic Canadians take their rightful place in the new economy, but that they can make their place at home – in Atlantic Canada. Its focus will be on helping to close the skills, innovation and productivity gaps with other parts of Canada. And its method will be by way of partnerships; partnerships with governments, communities, businesses, universities, colleges and research institutes."

The Right Honourable Jean Chrétien
PRIME MINISTER OF CANADA

On June 29, 2000, Prime Minister Chrétien announced a new approach to regional economic development in Atlantic Canada: the Atlantic Investment Partnership (AIP). The $700 million, five-year initiative balances strategic investments and initiatives designed to build new partnerships that will strengthen the region's capacity to innovate and compete in the global knowledge-based economy.

Under the AIP, NRC received $110 million, to be spent over five years, for the expansion of its facilities in Atlantic Canada to nurture development of community-based technology clusters that tap the region's emerging strengths.

Since the announcement in June, NRC has worked closely with communities across Atlantic Canada, bringing together key players to identify and develop action plans suited to their strengths and emerging opportunities in fields that have the potential to produce globally competitive technology clusters.

In Nova Scotia

NRC has worked closely with members of the province's life sciences community, to help the


Tourism Nova Scotia

"It is interesting to note that until NRC started to become more involved in the "sectoral" approach to the life sciences, we had a somewhat fragmented community approach… NRC's reputation and unbiased approach toward our region enabled [NRC] to play that role more effectively than others more closely associated with individual/region turf issues… In essence, several people involved in economic development and the life sciences indicated that Halifax has accomplished more in the last year in terms of creating an integrated approach to life sciences than they have been able to achieve in several years. They are looking to Halifax as a model and are astounded that we have been able to convince hospitals, universities and companies to actually put money on the table and work together… NRC must be given a good share of the credit for helping us advance our community."

Stephen Dempsey
VICE PRESIDENT
GREATER HALIFAX PARTNERSHIP

region become one of the world's top R&D centres in this sector. NRC, InNOVACorp, Dalhousie University, the Atlantic Canada Opportunities Agency (ACOA), the Greater Halifax Partnership, BioNova and industry in Nova Scotia are convinced that Halifax, with its strong R&D base and growing high tech sector, can form a world-class technology cluster. NRC will use its strengths in research and partnerships in genomics, biotechnology and medical diagnostics, and increase the capacity of its Institute for Marine Biosciences in Halifax, as its key contributions to the community.

The progress made in the first nine months in Halifax has been impressive:

- In September 2000, members of local business, university and government communities mapped out a plan for the development of the life sciences technology cluster at Halifax's first Innovation Round Table, hosted by NRC. As a result of the Round Table, an integrated infrastructure program will be set up in Halifax to support innovation and the commercialization of technologies in the life sciences, including genomics, bioinformatics, nutraceuticals, telemedicine, biodiagnostics and other fields. NRC's major contribution is a new industry partnership facility for 10 to 12 new companies, to be located at IMB. NRC will also apply expertise from its Institute for Biodiagnostics to help develop a Brain Repair Centre in Halifax.
- In January 2001, a not-for-profit corporation, the Life Sciences Development Association (LSDA) was established to guide the development of a strategic plan and tactics for the life sciences cluster. It is co-chaired by IMB's Director General and Dalhousie University's Dean of Medicine. The vision of the LSDA is to create a "Life Sciences Research Village" that will provide the infrastructure and support for true integration of the community in the life sciences area. To date, the stakeholders have worked together to secure the needed funding for the LSDA, started to inventory the research space available in the area and compiled a list of short, medium and long-term needs for the community.

In Cape Breton, new NRC investments will capitalize on the strengths of the region's important information technology sector. In September 2000, NRC announced it would establish a research group in Sydney, connected to its national capacity and R&D strengths in information technology. This announcement was the outcome of extensive, formal collaborations and a Round Table hosted by NRC involving key industry, academic and government stakeholders in Cape Breton's IT sector. In addition, NRC's IRAP is initiating an internship project with the University College of Cape Breton for up to 10 graduates per term to join the new NRC IT research group.

NRC has consulted with local companies about the details of the research program. The community consultation process will continue through participation in the Technology Advisory Group – TAG – a local high-tech community organization in Sydney.

In Prince Edward Island

The expansion of NRC's IRAP and CISTI presence in P.E.I. will help increase the province's receptor capacity and strengthen the province's innovation infrastructure. CISTI is working to establish an NRC Information Centre in the province, and IRAP will expand its ITA presence.

NRC, in consultation with the University of Prince Edward Island, industry and other major stakeholders, is planning to establish a research effort to help attract new investment to the Island. NRC is also leading a bioresources technology roadmap exercise, with Industry Canada, to help identify existing and emerging technologies with the greatest promise and potential for world-class development.

In Newfoundland

"This initiative will allow Newfoundland to build on its strengths and identify niche markets that will strengthen the province's place on the world economic map by developing a world-class technology cluster."

Jerry Byrne, M.P.

An ocean technology cluster is emerging in St. John's, Newfoundland, around NRC's Institute for Marine Dynamics (IMD), Memorial University of Newfoundland and a number of area firms. For the past 15 years, IMD labs have provided research, expertise, advice and world-leading facilities for new ocean technologies for shipping and offshore development. NRC will expand its facilities and capacities to meet the future needs of the community and to provide the R&D foundations for the emerging ocean technology cluster.

In January 2001, more than 100 members of Newfoundland's business, academic and government communities met in St. John's to chart the course for development of this cluster. As a result, NRC will expand its research programs at IMD, develop new facilities to support local entrepreneurs, start-ups and spin-offs from NRC, increase support from its IRAP, CTN and CISTI programs and work to attract further investments from partners to the community.

In New Brunswick

"We're here today to see how we can put NRC's successful cluster model to work for New Brunswick. It requires an assessment of our strengths, a blueprint for change and new investment to put the plan into action. Our goal today is to build consensus on how New Brunswick can focus its resources and create an action plan to spur innovation and develop a world-class high tech cluster."

The Honourable Claudette Bradshaw
MINISTER OF LABOUR

A new NRC Institute devoted to e-business and information technology will be the centrepiece for a new technology cluster development initiative for the province. The institute will establish research collaborations and close working relationships with companies, universities, and other partners across the province, and will tie in closely with NRC's national facilities and institutes. The new institute will have its main base in Fredericton, with satellite laboratories in Moncton and Saint John. A high-speed broadband network that includes Miramichi will link all the centres.

The total budget for this new e-business research program is $25 million over five years from NRC's AIP funding, and $12 million in additional funds from the Province and ACOA, through the New Brunswick Regional Economic Development Agreement. The entire program will have 60 full-time NRC staff and 30 to 40 guest workers, visiting scientists and industrial researchers. In addition, CISTI will establish a new NIC at the institute and IRAP will expand its participation in the province to support emerging industries in the developing cluster.

NRC's Atlantic Report Card – 2000-2001

June 29, 2000:	Atlantic Investment Partnership announced
July/August 2000:	NRC – preliminary consultations across the region
September 2000:	Bringing the players together:
	▪ Round Tables begin in Halifax and Sydney
	▪ Siting process in New Brunswick under way
October 2000:	Fredericton selected for NRC e-business institute
December 2000:	Interim Board – Life Sciences Development Assoc. in Halifax
January 2001:	New Brunswick Round Table in Moncton
	Newfoundland Round Table in St.John's
February 2001:	Industry overview study begins – P.E.I.
	P.E.I. Bioresources technology roadmap exercise under way
March 2001:	Recruitment under way for Nova Scotia and New Brunswick

Community Innovation Initiatives Across Canada

Throughout 2000-2001, NRC continued its commitment to the maturing clusters in Montréal, Ottawa and Saskatoon, and to nurturing the emergence of new innovation initiatives in every region.

In Québec

New Industry Partnership Facility and Labs for Biotech

In collaboration with Montréal International, NRC's Biotechnology Research Institute took part in developing the strategy for the further development of the biotechnology and biopharmaceuticals cluster in Montréal, the second largest concentration of biopharmaceuticals organizations in North America. Among the multi-nationals NRC has helped attract to the area or is collaborating with are: Merck Frosst Canada, AstraZeneca, Boehringer-Ingelheim (Canada) Ltd., Lallemand Inc., DSM Biologics, Shire Pharmaceuticals Group (for BioChem Pharma) and ProMetic. BRI also collaborates with major national and international organizations such as: the Defence Research Establishment Valcartier, Geo-Centers Inc., and the U.S. Army Corps of Engineers.

The institute opened a new wing of R&D laboratories designated to accommodate the area's rapidly expanding biotechnology companies. The new facility, covering 5,500 square metres, provides incubation opportunities for firms needing modern labs and offices, access to collaborative arrangements and flexible leasing options. In addition to this industry partnership facility, BRI built an environmental pilot plant of some 500 square metres and new corporate offices, to support the fast growing biotechnology and environmental technology clusters in the region.

New Industry Partnership Facility for Advanced Materials

Working with Canada Economic Development, private businesses, industry associations, venture capitalists and other partners, NRC's Industrial Materials Institute (IMI) established a new industry partnership facility in the greater Montréal region. This new facility will focus on stimulating the emergence of new firms and on promoting the rapid adoption of next generation materials technologies and their manufacture.

New Training Program for Industry

The Canadian Plastics Industry Association and the University of Laval are sponsoring a specialized

training program given by NRC's Industrial Materials Institute for plastics industry personnel. NRC helped develop the program and provides the training from its site in greater Montréal, providing its unique expertise and access to the IMI personnel and equipment to participants in the program.

In Ontario

A "Roadmap" for Photonics – Harnessing the Power of Light

NRC is part of the Steering Committee of the Canadian Photonics Consortium (CPC), which began the task of defining the potential themes for a national photonics roadmap exercise in 2000-2001. Using questionnaires and workshops across Canada, CPC engaged members from universities, government and industry working in the emerging field of photonics to develop the key areas to be mapped and define the process that will be used to set the course for the future of the industry in Canada.

NRC's Institute for Microstructural Sciences (IMS) is also integrating its research program with the activities of the Canadian Institute for Photonics Innovation (CIPI). CIPI, a member of the Networks of Centres of Excellence, works to harness and develop the talents of Canadian researchers to put Canada at the forefront of photonics research. IMS is working in five key areas: nanotechnology for photonics, engineering of photonics devices, ultra fast photonics technology, photonics for information technology and precision photonics measurements.

Ottawa Round Table 2000 – Innovation in Canadian Enterprises

Leaders from government, industry, research and education gathered in April 2000 at the fifth annual Ottawa Regional Innovation Round Table co-hosted by NRC and the Canada Foundation for Innovation. The Round Table focused on ways and means to foster innovation in Canadian enterprises. The event featured the first-ever regional innovation awards and the announcement of a unique collaboration between the NRC, the National Arts Centre, the Canada Council for the Arts and other partners and sponsors for a major conference featuring world leaders in the arts and sciences – *Creativity 2000*.

The Ottawa Round Table 2000 is just one of a long list of successes for this innovation initiative. Other achievements include: the formation of Vitesse Re-skilling to address shortages of software engineers in the region; changes in immigration rules for IT workers; R&D tax credit issue resolution; the development of major industry partnership facilities; and the nurturing of some 70 local spin-offs and start-ups in the region.

In Western Canada

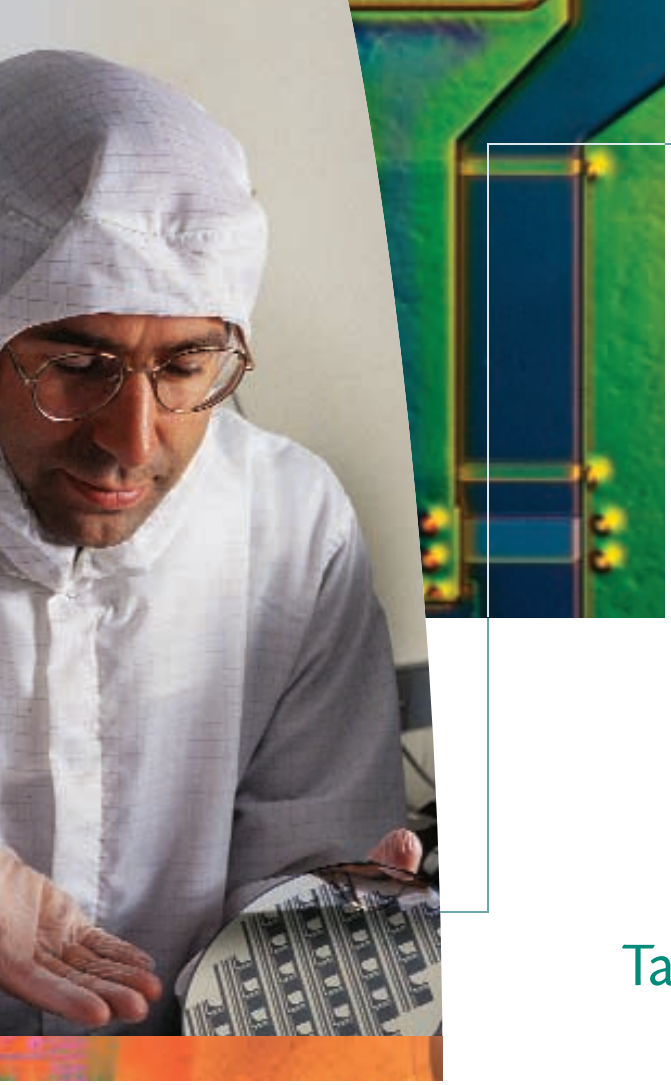
New Industry Partnership Facility – Increasing Innovation Capacity

In June 2000, NRC's plans for the construction of a new Industry Partnership Facility at its Plant Biotechnology Institute (PBI) in Saskatoon were unveiled. The $15.4 million, 7,500 square metre addition will house incubator facilities for start-up companies that include laboratories, offices, analytical services and controlled-environment growth rooms. The Canada-Saskatchewan Western Economic Partnership Agreement, the Canada-Saskatchewan Agri-Food Fund and the Province of Saskatchewan provided funding for the expansion.

NRC's institute, AAFC, the University of Saskatchewan and private sector companies have worked together to build one of the greatest technology cluster successes in Canada in agricultural biotechnology. Innovation Place Research Park in Saskatoon boasts some 100 SMEs, working in fields of emerging importance in the plant biotechnology and agricultural biotech fields. The long-term collaborations among partners have resulted in major success stories: the $2 billion industry in Canola and the development of the highly successful McKenzie wheat being just two.

Okanagan Innovation Forum Draws Ottawa HighTech Gurus

In February 2001, the Okanagan-Shuswap region of British Columbia held its first Regional Innovation Forum, co-sponsored by NRC and the Okanagan University College, designed to promote the area as a knowledge-based, innovative, entrepreneurial region. It brought together over 100 industry, research, education and government participants to plan the development of an innovative, entrepreneurial culture. Experts from Ottawa's high tech cluster shared their experiences with local players. Discussions at the Round Table focused on innovation in the region's key economic opportunity areas: agriculture, including the wine and fruit industry, manufacturing and high technology.



"It's not just a bit better, it's a huge leap forward. Most people don't realize what great technologies come from the embryonic environment of the National Research Council."

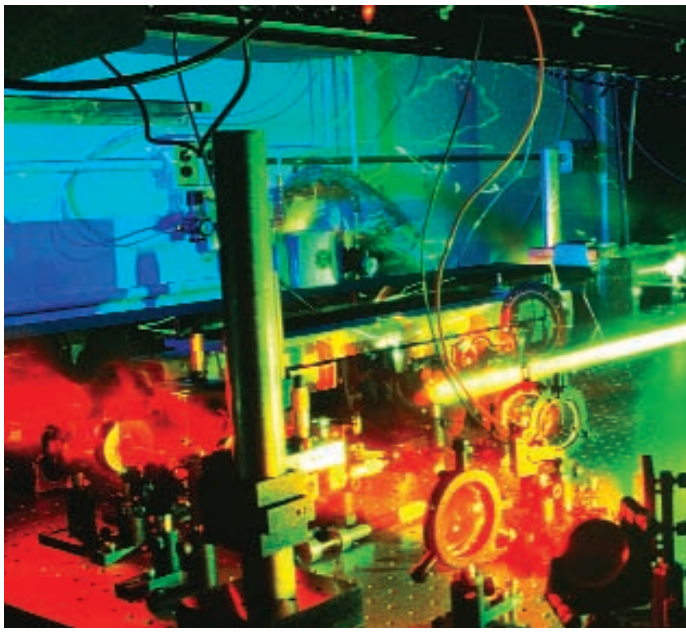
David Berkleman
PRESIDENT, ARIUS 3D

Taking Technology to Market

In all its programs, NRC takes an aggressive, entrepreneurial approach to move new knowledge out of its labs and into the marketplace. The commercialization of discoveries and know-how is a key part of how NRC ensures that its investments pay off for Canada, for industry and for Canadians. NRC's approach is to gain the most benefit and leverage from the knowledge and technologies it generates. From collaborative R&D, through licensing and the creation of new enterprises, NRC pursues wealth creation through innovation.

Measures of Success

- NRC's patent portfolio holds close to 600 technologies
- Income from R&D services, sales, collaborative agreements and licensing currently exceeds $100 million
- NRC has over 1,200 formal collaborations with partners from industry, universities and international organizations
- Since 1995-96, NRC has helped create 49 new companies across Canada
- 75 companies are incubating at NRC, with new partnership facilities being brought online in Atlantic Canada, Québec and Saskatchewan.

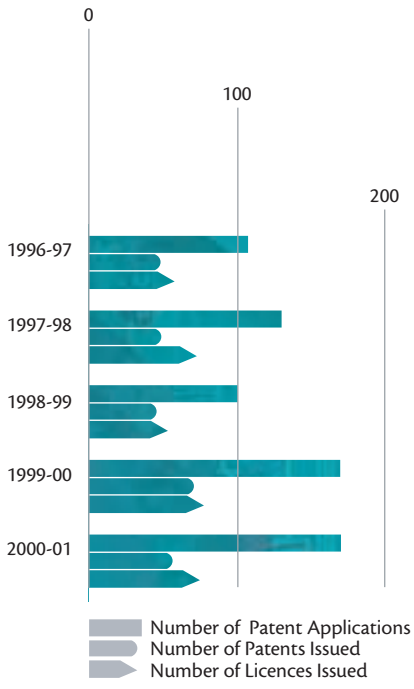


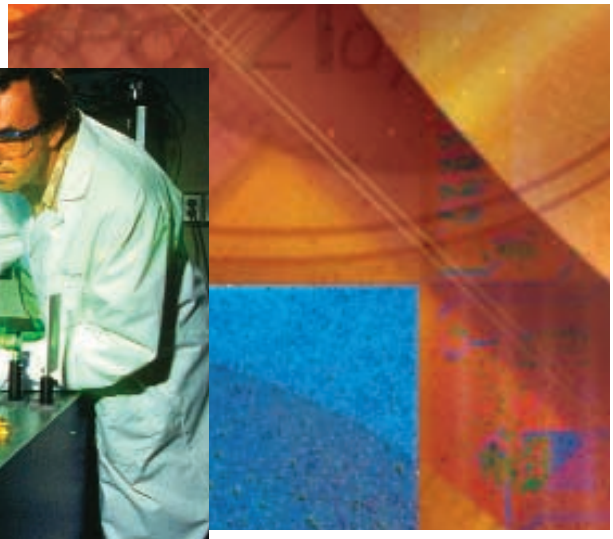
Intellectual Property

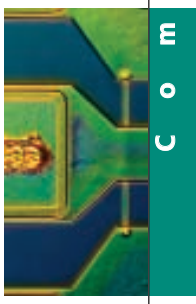
The importance of intellectual property (IP) has grown dramatically in the past decade. Original discoveries, know-how, software and new technologies – protected by patent or copyright – are the foundations of products, process innovation and commercialization.

NRC has developed a collection of proven IP management tools and practices to steer the process of evaluation, protection, exploitation and transfer of technologies to receptor firms.

NRC Patents & Licenses







Collaborations and Partnerships

One of the best ways to transfer knowledge is through collaborative research. NRC research institutes team up with industrial partners to create new technologies and improve existing products or processes.

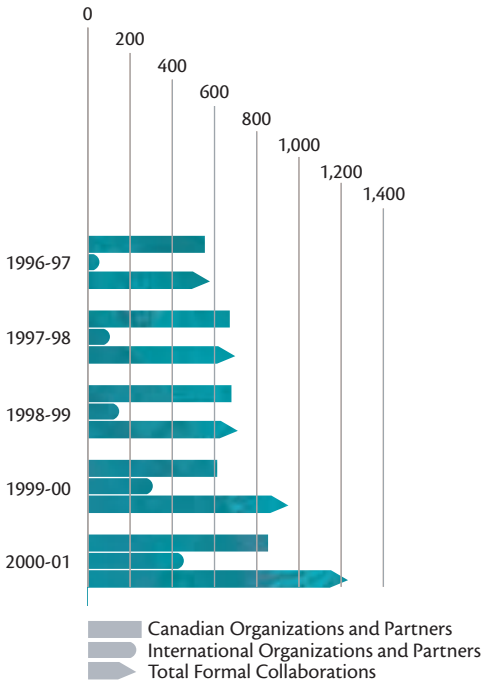
Under such agreements, both sides share funding and management of medium to long-term research. Industry partners are involved early to ensure that projects align with both marketplace and NRC needs. Partners work side by side with NRC teams, increasing technical expertise in the firm and improving the odds for commercial success. Collaborations range from projects with single companies to multi-partner arrangements with small and large firms, as well as university partners.

Over the past five years, NRC partnerships with industry have doubled, while those with public organizations have nearly tripled, and those with university organizations have grown five-fold. The value of agreements and collaborations reached nearly $400 million in 2000-2001.

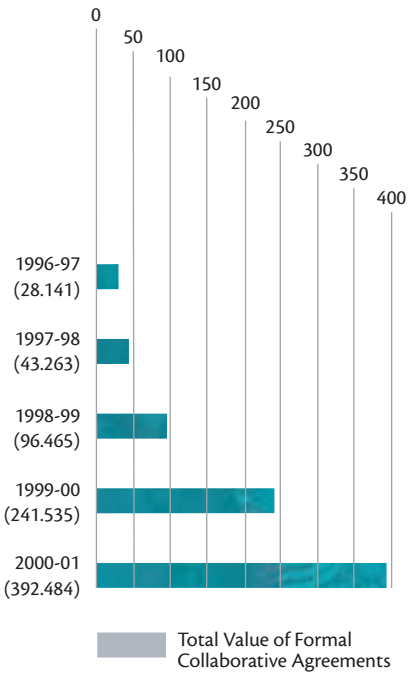
Investments by NRC are heavily leveraged. In the past two years, partner contributions have held at approximately three dollars for each dollar invested by NRC.

Often, the Government of Canada retains IP generated by the collaboration, while partners hold licenses (some exclusive) negotiated in advance to exploit and market the technology. When it is in the best interests of both parties, intellectual property may be assigned to the partner organization.

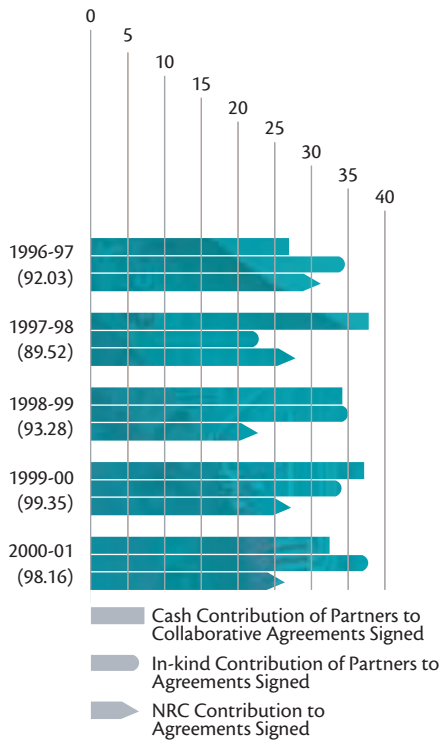
NRC Partnerships & Agreements



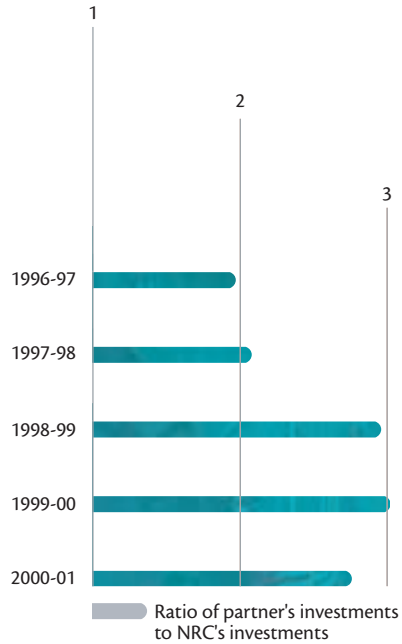
NRC : Value of Formal Collaborative Agreements ($ millions)



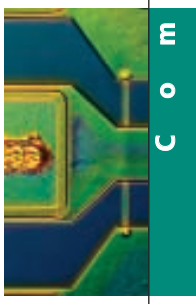
Contributions to NRC Agreements ($ millions)



Leverage Impacts of NRC Investments



NRC's new High-Throughput Screening facility is an important component of collaboration and partnership with the Canadian pharmaceutical industry. The facility uses robotics and automation to help smaller biotech companies overcome severe bottlenecks in the drug discovery process – providing the capacity to screen compound libraries quickly, and at reasonable cost.



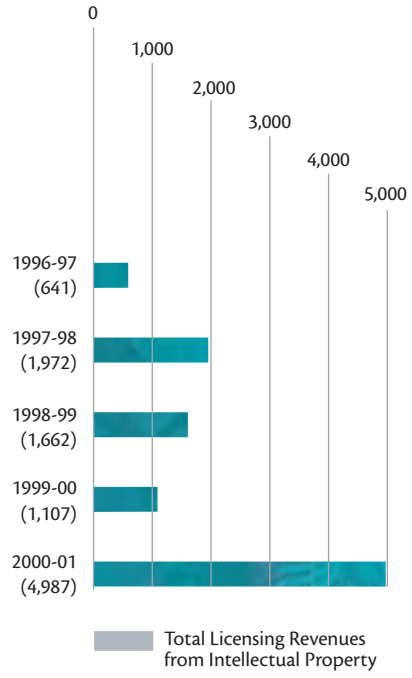
Licensing

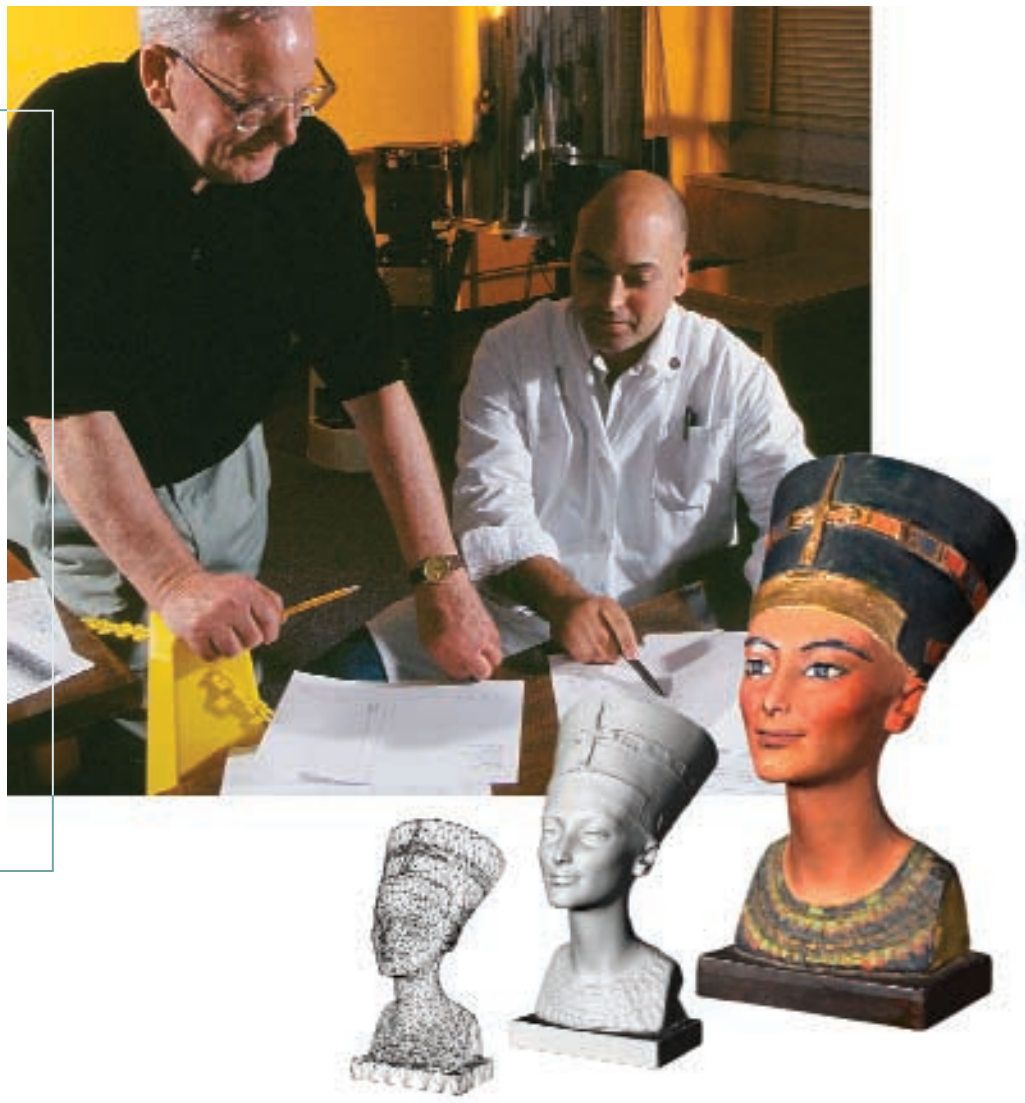
NRC seeks industrial firms best positioned to exploit NRC-developed technology. License agreements are generally granted in return for up-front payments and/or royalties based on sales. Often, licensing agreements arise from collaborative research; in such cases the terms of the agreement reflect a client's contribution in developing the technology. A single technology may also be licensed to several clients for different fields of application. In all cases, licensing revenues flow back to NRC – to the researchers and research groups responsible for the initial development and commercialization of the technology. By reinvesting in its research programs, NRC is able to continue the cycle from discovery, to innovation, to market.

NRC's licensing revenue has grown significantly. In 2000-2001 alone, an NRC vaccine technology generated a single royalty payment of almost $3 million. This represents the highest individual royalty payment ever made to a federal government organization. Since 1996-97, licensing revenues have grown from just over half a million dollars annually to $4.9 million in 2000-2001.

The following are a few examples of the NRC collaborations and licenses that created value for Canada in 2000-2001.

NRC Licensing Revenues
($ thousands)





World-leading 3D Scanning Technology

The investment by NRC in 3D digital imaging and colour 3D digitizing technology has resulted in a number of scientific and economic successes. One of these is the most precise colour 3D scanning technology in the world. The company commercializing the technology – Arius 3D – has grown in one year to more than 10 times its original size.

Toronto-based Arius 3D was founded in 1998 on the basis of NRC's 3D colour imaging technology and in 1999 obtained a license to commercialize it. With offices in the United Kingdom, the United States and Ottawa, Arius 3D has grown from five employees to approximately 60 in May 2000. The company, already generating revenues from a global base of customers, is planning further expansion in Europe and Japan and is developing complementary technologies.

"You can design in the virtual world and create high-resolution replicas of real world objects or products without the expense of having to experiment with the real thing. If you make a mistake or want to change something in the product design, you can do it in the virtual world, on the computer screen, and save a lot of money. We can transform the manufacturing process. There are many millions of products that don't have CAD [computer-assisted design] data and Arius can digitally capture those objects and create the data necessary for the manufacturing process."

Rick Camuleri
CHIEF EXECUTIVE, ARIUS 3D

Based on NRC research, the technology licensed to Arius 3D is the only one that captures the true colour and geometry of an object, at near microscopic levels, with perfect registration, independent of ambient light. The technology produces photo-realistic, 3D digital copies of real world objects that can be used for a variety of applications, including the wired and wireless Web, video games, multimedia, film, advertising, product design, education, manufacturing and heritage.

Arius 3D established a revolutionary viewing technology to complement the capture technology of NRC. Among recent applications are a collaboration with Cosmoda Corporation and Hudson's Bay Co. that will let online shoppers see realistic 3D content, and a collaboration with Macromedia and Intel that uses Arius 3D's technology to support new 3D content and playback technology included in Macromedia Director 8.5, Shockwave Studio and Shockwave Player.

NRC-ALviva Biopharmaceuticals Inc. – Rescuing Nerve Cells

NRC's Institute for Biological Sciences and Saskatoon-based ALviva Biopharmaceuticals Inc. have signed a two-year collaborative agreement focusing on both basic and applied research in the area of apoptosis. In diseases such as Parkinson's, Alzheimer's, Huntington's, ALS and stroke, nerve cells in parts of the brain die. This progressive dying is called programmed cell death or apoptosis. ALviva has a large library of drugs that are potentially anti-apoptotic – they can interrupt and block this process

"This collaboration with its mix of basic and targeted research, coupled with the applied sequential development program, is a perfect match. I hope and expect to extend this collaboration…"

Dr. Alan Boulton
PRESIDENT AND CEO,
ALVIVA BIOPHARMACEUTICALS INC.

and "rescue" those nerve cells that would otherwise die. By combining ALviva's library of unique drugs, leading edge chemical synthesis, and *in vitro* screening program with NRC's expertise in stroke research and advanced methodologies for target identification, lead drugs could be potentially identified for Alzheimer's, stroke, Huntington's, ALS and even cancer.

Electrically Conductive Concrete – Not at All Shocking

Electrically conductive concrete (ECC) is an NRC-patented construction material receiving keen interest worldwide. Its many applications impact everything from de-icing and snow melting to low-cost electronic security in buildings. Through licensing arrangements, a Canadian company is now set to market the technology around the world.

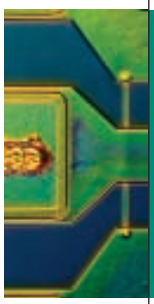
ECC is an innovation that has created, in effect, a new class of construction materials. This material has the physical strength of regular concrete combined with electrical properties that make it suitable for countless new applications. The material is intended for use as a critical component in various operating systems. For this reason, the Institute for Research in Construction also developed preliminary system designs that incorporate ECC, to both protect the technology and to clearly demonstrate its commercial potential. Patent coverage has been granted in five countries, with others pending. Given the many possible applications for ECC, and the size of the North American concrete industry alone ($20 billion annually), the market for the product promises to be very significant.

ECC represents, as well, a significant technical development. No other construction material can duplicate its properties. The centrepiece of the transfer of the technology was a 400-page document detailing the recommended procedures and guidelines for manufacturing and using conductive concrete. To date, over 600 enquiries have come from industry and government about the technology and its applications in the areas of electrical heating, de-icing/snow melting, electromagnetic shielding, electrical grounding and cathode protection.

NRC-Foragen Technology Ventures Inc. – An End to "Hamburger Disease"

In August 2000, NRC signed an agreement with Foragen to take the next steps in testing a vaccine against *E.coli 0157* – the bacterium that causes so-called "hamburger" disease. This particular strain of *E.coli* causes serious illness in humans, especially young children and the elderly. Infections from the bacterium are directly associated with water contamination. Humans are infected by *E.coli*, principally through eating undercooked meat or by drinking water contaminated by *E.coli* from cattle feces.

The NRC vaccine is expected to trigger an immune response in cattle against *E.coli 0157* through the production of protective anti-bodies that prevent the growth of the bacterium in the animal. If proven effective, this simple, inexpensive vaccine could provide an effective solution to the elimination of the bacterium at the source. Eliminating *E.coli 0157* from cattle could go a long way toward preventing the disease outbreaks in humans. If the cattle evaluations are successful, action will be taken to commercialize the vaccine.



"The Monte Carlo code developed at the National Research Council will be a key part of MDS Nordion's treatment planning systems, which will help doctors provide better, more accurate treatment of their cancer patients in clinics and hospitals around the world. As well, NRC's application will help us solidify our position as a global leader in a competitive global market."

Ken Johnson,
SENIOR V.P., MDS NORDION

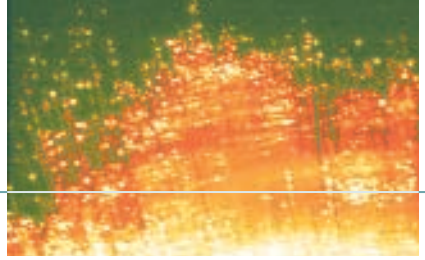
NRC-MDS Nordion – Cancer Treatment Software

In December 2000, a breakthrough in radiation therapy research at NRC resulted in the licensing of new technology to MDS Nordion that will significantly improve the speed and accuracy of radiation therapy treatment planning for cancer patients around the world. The new technology, the Monte Carlo Code, was developed by NRC to help doctors provide better health care and help ease treatments for cancer patients. Though the use of electron and photon radiation is a well-established practice, this new technology holds the potential for improved efficiency in the delivery of radiation therapy.

Incubators/Co-location

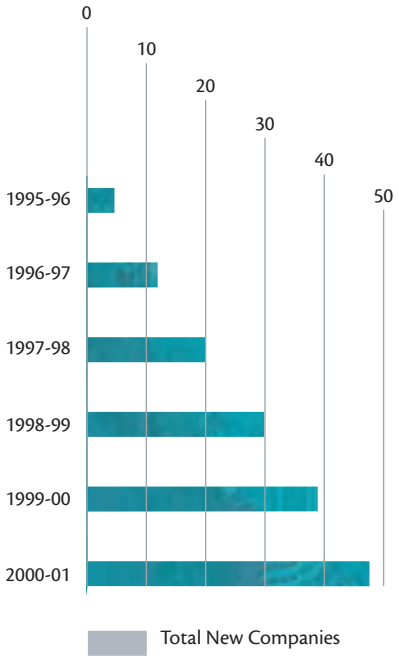
Most of NRC's research institutes have the means to incubate new, small, technology-based firms. By co-locating with NRC, firms have direct access to NRC facilities, the expertise of its researchers, its extensive national networks and its other knowledge resources.

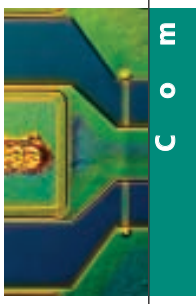
In 2000-2001, 75 companies were incubating at NRC. New incubators are being built in Montréal, Saskatoon and Atlantic Canada. Such facilities will be an integral part of any new NRC research facility in future.



Trillium Photonics, a spin-off from NRC launched in September 2000, is developing fibre-optic amplifiers that will help eliminate bottlenecks that can slow networks to a crawl.

NRC Spin-offs 1995-2001





Spin-offs and Start-ups

Often the fastest and most effective way to commercialize a new technology or product is to create a new Canadian company. That venture can either be a start-up company (created by non-NRC principals) or a spin-off (formed by NRC employees). Since 1995-96, NRC technology has generated the creation of 49 companies.

"Once again, IBD and its spin-off companies are demonstrating innovation and providing value-added solutions to clinical imaging problems. I look forward to additional collaborations with NovaDAQ and NRC."

Dr. Wilbert Keon
DIRECTOR GENERAL, OTTAWA HEART INSTITUTE RESEARCH CORPORATION

In 2000-2001, nine new companies started up from NRC:

- NovaDAQ Technologies Inc.
- ParaTecH Therapeutics Inc.
- Digital Light and Sound Inc.
- SYNTHESARC Inc.
- Groupe Minutia Inc.
- Optenia Inc.
- Metro Photonics Inc.
- Trillium Photonics Inc.
- Image Tree Inc.

These companies have already begun to create value for Canadians.

NovaDAQ Technologies Inc. – Coronary Surgery Tools Offer Hope

It is estimated that 18,000 bypass surgeries are performed annually in Canada, with some 900,000 performed annually around the world. NRC's Institute for Biodiagnostics (IBD) spin-off NovaDAQ Technologies Inc. has developed a laser-based technology that allows surgeons to check the quality of their by-pass grafts at the time of surgery. The technology allows surgeons to pinpoint the exact location of the blood vessel to be bypassed. After surgery, the system helps assess the viability of the graft before the patient leaves the operating room, greatly reducing the need for repeat surgeries. NovaDAQ received an infusion of $2 million

in venture capital from a private Winnipeg-based firm, James Richardson & Sons, Ltd. in 2000.

ParaTecH Therapeutics Inc. – Treatment for Osteoporosis

This NRC spin-off from the Institute of Biological Sciences is a drug development company focused on bone-related disorders. Its lead compound is about to enter clinical trials for the anabolic treatment of osteoporosis. Osteoporosis is an age-related disease, often called the silent epidemic because bone loss occurs without symptoms. One in four women and one in eight men over the age of 50 have osteoporosis. Between 100 and 200 million people worldwide are at risk of osteoporotic fracture.

ParaTecH has formed strategic alliances with NRC and CroMedica, to develop and commercialize medical research from NRC. The company's lead compound – Ostabolin-C™ – produces bone of normal or supranormal mechanical strength, at lower doses than other treatments and without the risks of hypocalcaemia.

Optenia Inc. – Multiplying Capacity/ Slashing Costs for Networks

In January 2001, NRC and Mitel announced the creation of a new company, Optenia Inc., to produce photonics components for the high growth optical network market. These components are designed to boost the performance and slash the cost of fibre-optic networks.

Optenia began operations as a 26-person firm, with a dozen people each from Mitel and NRC and two from Nortel Networks. The company is forecasting a workforce of about 100 within one year.

Optenia is developing semiconductor chips to make faster and cheaper fibre-optic telecommunications networks. The firm has already developed prototypes and plans to ship its first chips in July 2001.

Mitel and NRC started working together four years ago on the technology Optenia will commercialize, announcing in August 2000 the first dense wavelength division multiplexing (DWDM) prototype chips.

Trillium Photonics Set to Flower

Trillium Photonics, a spin-off from NRC launched in September 2000, is developing fibre-optic amplifiers that will help eliminate bottlenecks that can slow networks to a crawl. Most existing optical amplifiers are designed for so-called "static" networks that transmit data without making any alterations based on the amount and type of traffic.

"This new company is another example of the NRC energizing innovation in Canada by transferring technology to the private sector."

Dr. Gilbert Normand
SECRETARY OF STATE, SCIENCE, RESEARCH AND DEVELOPMENT

Trillium's product can be used in dynamic networks in which signals can be rerouted to avoid congestion, and as a result, travel without interruption. When used on massive networks like the Internet, dynamic fibre-optic amplifiers can also support the addition of features such as video-on-demand and, in the process, make Web surfing a more user-friendly experience.

Metro Photonics Inc. – Ottawa Start-up Boosts Fibre-Optics

NRC spin-off Metro Photonics Inc. landed $62.5 million in a single round of financing to support its push to develop fibre-optic gear for the metropolitan-level network market. Based on its research in DWDM, which increases streams of data traffic on a single strand of glass fibre up to 160 times or more, Metro Photonics is working to tap the emerging metropolitan-level market for fibre-optic technology.

Metro Photonics plans to challenge the market by producing photonics integrated circuits that are one-twentieth the size of anything presently available. It will put integrated circuits onto indium phosphide, an advanced conducting material that will support both passive and active networking gear.

"Canada will become a country that, within the limits of our resources, takes maximum possible advantage of international opportunities in support of advancing scientific research, industrial innovation, and improvement in the quality of life of Canadians."

PRIME MINISTER'S ADVISORY COUNCIL ON SCIENCE AND TECHNOLOGY

At Work on the World Stage

Canada, like other countries, must respond to the effects of globalization of trade that favours a shift to innovative, knowledge-based economies. Strong, knowledge-based economies depend on a successful innovation system. Along with industry and universities, government R&D organizations like NRC are essential components for Canada's success in the global economy:

- To more effectively integrate government, university, and industry strengths across the innovation system
- To encourage increased flows of knowledge and technologies to industry
- To help companies deal with international competitive pressures and barriers to trade, including national science-based standards and codes.

Global Reach for Canadians

NRC has developed invaluable international networks of technological and scientific intelligence of strategic importance to Canada. This knowledge and expertise is used not only to transfer S&T information to Canadian firms and universities, but also to leverage new innovation opportunities for Canadian industry internationally.

NRC has fostered the development of international networks, collaborations and strategic alliances that benefit Canada and Canadian industry:

- S&T agreements – hundreds of bilateral organization-to-organization and multi-lateral agreements, as well as 42 formal collaboration agreements with 22 countries – which open doors for Canadians
- Membership in international S&T organizations such as the International Council for Science and a host of international measurement standards bodies
- Technology alliances – including industrial research alliances and collaborations and international workshops for technology diffusion
- Targeted research alliances that focus on countries and fields where there is great potential for Canada and Canadian industry innovation and commercialization benefits
- Development and harmonization of international measurement standards, the foundation of international trade and the removal of significant barriers to trade for Canadian businesses
- Showcasing of Canadian systems and products along with the supporting research, technical and regulatory infrastructure as a means of gaining access to new international markets such as Japan, Russia and Chile for Canadian construction products
- Financial support for international research collaborations through research fellowships, travel grants, and joint project funding
- Programs to reduce administrative barriers and facilitate cooperation
- Training and visiting worker programs in NRC labs
- Leading SME missions abroad and helping in the development of innovation support systems modeled after NRC's IRAP and CTN approaches
- Developing/participating in international S&T knowledge and information networks and systems through partnership agreements undertaken by NRC's CISTI.

These activities contribute to levering significant resources and expertise, to new knowledge and its commercialization, to the recruitment, training and retention of human resources for Canada, and to building networks that will serve Canada well as it moves to the future.

Highlights of NRC's 2000-2001 International Work

In 2000-2001, NRC made contributions in a number of international fields that created value for Canada, including helping build a more effective innovation system, facilitating access to R&D, knowledge and facilities, providing opportunities for Canadian firms and building new research and technology alliances.

In Europe

- NRC renewed its Memorandum of Understanding with the British Council. Seven new projects were funded for a three-year period, bringing the total of funded projects under this scheme to thirteen.
- NRC renewed its MOU with France's Conseil national de la recherche scientifique. This MOU, valued at $1 million/annum will lead to a call for new proposals in the fall of 2001 and the funding of new projects after the completion of the ten current ones.
- NRC's Integrated Manufacturing Technologies Institute signed an MOU with Italy's Institute of Industrial Technologies and Automation (ITIA). This has led to a number of workshops and is expected to lead to joint collaborative projects.
- NRC undertook a successful mission to Spain representing not only NRC, but also profiling Canada as an innovative high tech nation. The result – a letter of intent between NRC and the Consejo Superior De Investigaciones Científicas (CSIC) to conduct four joint workshops, the first to be held in Ottawa in October 2001. The mission is also expected to result in joint collaborative projects in future.
- NRC continued its involvement in the CERION (Canadian-European Research Initiative in Nanostructures) project with the European Union (EU). CERION provides a critical link in nanotechnology between Canada and the EU through exchange visits, joint projects and annual workshops. The research activities under the project are three to ten years ahead of industrial needs and cover new process technologies for next generation chips, optoelectronic components, microsystems, solar cells, sensors and new design technologies for systems on a chip.

APEC R&D Leaders Forum

NRC successfully organized an APEC Forum on *Growing and Nurturing Technology-Based SMEs and Spin-offs* in September 2000, attended by representatives from 15 APEC economies and over 200 private and public sector leaders. The Forum provided participants with unique networking information and business opportunities. One of the highlights for delegates was the launch of NRC spin-off Trillium Photonics.

In Taiwan and Singapore

- NRC has 12 collaborative research projects with some of Taiwan's best researchers in a variety of fields including: nanoelectronics, semiconductor technologies, biomedical sciences, manufacturing technologies, aerospace and advanced molecular sciences.
- In addition, 12 workshops have been held to foster R&D collaborations and there is a constant flow of students, post-doctoral fellows and staff between Taiwanese and NRC laboratories.
- With Singapore, NRC has six ongoing projects in plant biotechnology, advanced materials science, biotechnology and manufacturing, and has helped companies join in the collaborations.

Access to the Universe

In January 2001, NRC and the U.S. National Science Foundation signed a letter of intent setting out the principles for cooperation in developing plans for the Atacama Large Millimetre Array (ALMA). ALMA will be an array of large radio antennas constructed at 5,000 metres altitude in the Atacama Desert in Chile. When completed, it will be the world's most powerful radio telescope operating at millimetre and sub-millimetre wavelengths. ALMA will produce breakthroughs in our understanding of how planets and stars form in our own galaxy and how galaxies themselves formed in the early history of the Universe.

The letter of intent defines how Canada can join the ALMA partnership – an international partnership between the U.S. National Science Foundation (NSF) and the European Southern Observatory. In return for investing in the project, Canada will have full partnership status. Participation in the project demonstrates NRC's leveraging strategy on behalf of the Canadian astronomy community.

The NRC-NSF letter was complemented by a separate agreement between NRC and the U.S. National Radio Astronomy Observatory to form the North American Partnership for Radio Astronomy (NAPRA). Under this NAPRA agreement, NRC will seek funding to develop and produce a new bandwidth signal correlator for the Expanded Very Large Array (EVLA) project – a technology that will dramatically enhance the sensitivity of the EVLA telescope. Canadian astronomers will gain access to all major U.S. radio astronomy observatories on the same basis as U.S. astronomers.

Setting the World's Standards

NRC's Institute for National Measurement Standards (INMS) continued its contribution to international trade-related collaborations and arrangements that break down technical barriers to trade and enhance the competitiveness of Canadian products in the global marketplace. INMS represented Canada's interests in five cooperation efforts, including the North American Calibration Cooperation under NAFTA, the Inter-American Metrology System, and the Mutual Recognition Arrangement sponsored by the Comité international des poids et mesures. INMS also participated in 63 networks of comparisons of measurement standards, at the worldwide and regional levels, and participated in the activities of 163 international and 46 national metrology-related committees.

INMS also continued its work in support of accreditation of secondary calibration laboratories, a shared responsibility with the Standards Council of Canada (SSC), through its Calibration Laboratory Assessment Service (CLAS). In November 2000, the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement was signed in Washington, D.C., by Canada and 27 other countries, opening the way for recognition of CLAS-assessed, SSC-accredited labs. This new agreement should have a major impact on reducing the need to test goods and services twice (in both importing and exporting countries). This will save time and money by reducing the need for duplicate accreditations and duplicate calibrations and tests, while increasing market acceptance of Canadian products.

"An innovative economy is driven by research and development… To secure our continued success in the 21st century, Canadians must be among the first to integrate new knowledge and put it to use."

Speech from the Throne
JANUARY 30, 2001

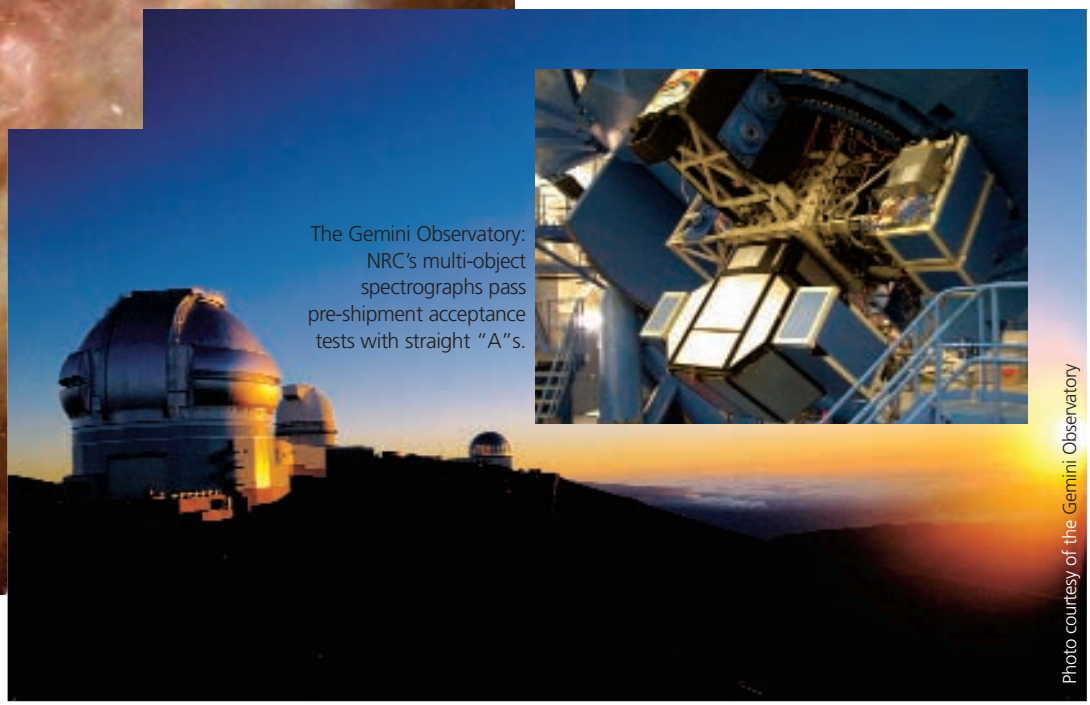
Frontiers R&D – at the of Knowledge

Leading-edge research and development is at the very heart of NRC's contributions to creating value for Canada and all Canadians.

NRC pursues research and development – from fundamental sciences and engineering, to emerging and cross disciplinary fields such as photonics, genomics, nanotechnology, bioinformatics and biocomputing – to help build Canada's technology capacity, improve its R&D performance and position in the world, support the needs of Canadian industry in emerging opportunity areas and lay the research foundation for Canada's future growth.

Mapping the Milky Way: Midplane of the Milky Way near the constellation Persius, seen in the Eastern Sky.

Photo courtesy of the Canadian Galactic Plane Survey



The Gemini Observatory: NRC's multi-object spectrographs pass pre-shipment acceptance tests with straight "A"s.

Photo courtesy of the Gemini Observatory

Advances in the Basic Sciences

Astronomy and Astrophysics – Our Gateway to the Stars

NRC's Herzberg Institute for Astrophysics (HIA) conducts leading-edge research in astronomy and astrophysics, and provides access to major astronomical facilities in Canada and internationally to the Canadian astronomy community. HIA is also a world leader in the development of astronomy instrumentation and works to transfer the technologies and knowledge it develops in astronomy to other unrelated disciplines.

World-leading instruments for Gemini

The first of two multi-object spectrographs for Gemini (GMOS-N) passed pre-shipment acceptance tests with straight "A"s in all categories and is now ready for final acceptance tests on the telescopes in Hawaii. The GMOS-N is expected to be the first facility-class instrument to be accepted by the Gemini Observatory.

Next Generation Space Telescope

The Canadian Space Agency (CSA) funded major studies by HIA and university students of instrumentation for CSA's participation in the Next Generation Space Telescope (NGST) mission. HIA is central to Canada's participation in this flagship space astronomy mission.

Charting the Stars

Phase I of the Canadian Galactic Plane Survey, a highly successful NRC-university collaboration to map the Milky Way Galaxy, was completed in 2000-2001. Phase II of the project has attracted new partners and renewed funding from the Natural Sciences and Engineering Research Council (NSERC). The project has also attracted international collaborators, bringing new telescopes into the study, which has transformed it into the International Galactic Plane Survey. The Project, to date, has provided significant new insights into the physics of the interstellar medium in the Milky Way Galaxy, including publication of more than 40 refereed papers, as well as numerous doctorate and masters' theses.

Neptune and Venus – on Earth

HIA led the conceptual design of the proposed data handling and archiving systems for the NEPTUNE (international) and VENUS (domestic) oceanographic projects. These projects target the establishment of an undersea observatory, capable of operating for more than 25 years, in the straits of Juan de Fuca, off the coast of British Columbia. HIA's contributions build upon the application of data handling techniques initially developed for astronomy. The projects also benefited from the expertise and experience of the Canadian astronomy community in setting up international collaborations.

A 400-fold Increase in Knowledge

HIA published a new standard measurement system containing more than 18,000 stars, based on 15 years of observations. The work represents a 400-fold increase in the number of fainter stars available to calibrate observations made with 8-metre telescopes. The data is available online and will lead to increased efficiency in large telescope utilization, improved accuracy of stellar photometry, and potentially, to the establishment of a new international standard for calibration of astronomical measurements.

New Coating Technology Patented

A sol-gel anti-reflection optical coating technology developed by HIA received its first patent, recognizing its novelty and its capacity to reduce the losses at air-glass interfaces by a factor of three or more over the entire optical spectrum. This new technology has wide potential applications in the optical industry, as well as for astronomical instrumentation.

Molecular Sciences: Small Scale – Big Impact

NRC's Steacie Institute for Molecular Sciences (SIMS) pushes the frontiers through long-term, interdisciplinary research in the molecular sciences that has the potential to generate breakthroughs which will provide the foundation for the technologies of tomorrow. Nano-science, bioscience, and optical science are three overarching areas of strategic focus for SIMS research.

Molecular-Scale Wires

Researchers at SIMS developed ways of studying the interactions between metal atoms and biological molecules in the gas phase, opening the way to a better understanding of electron transfer and development of new experimental and theoretical methods, an important step in providing new insights into biological functions that could lead to the development of molecular wires.

Self-directed Growth of Organic Nanostructures

SIMS researchers have achieved the first demonstration of self-directed growth of organic nanostructures on surfaces – opening new approaches to the growth of molecular scale interconnections between nanodevices on semi-conductor surfaces – a breakthrough that could impact on the burgeoning nanoelectronics and biochip industries.

World's Shortest Laser Pulses

Ultrashort-pulse lasers are the fastest probes available for tracing transitions between different states of matter. They provide access to fundamental physical, chemical and biological processes on a microscopic scale – in real time. They permit taking snapshots of atomic, molecular or condensed matter dynamics at instants following excitation by a pump pulse.

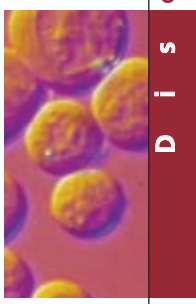
In collaboration with the Technical University of Vienna, SIMS researchers have produced the world's shortest laser pulses – 1.8 femtoseconds – a world record and a demonstration of world leadership in laser science.

To move to even shorter pulses – in the 100-attosecond range – two problems have to be overcome. The first – establishing a reliable and simple method of measuring the temporal structure with a resolution of approximately 100 attoseconds – has been overcome as a result of this collaboration. The second – improved control of laser pulses that generate the attosecond pulses – is well on the way to being solved through a collaboration of SIMS and INMS.

Just as femtosecond pulses allow the motion of atoms in molecules to be followed, attosecond pulses will allow researchers to trace electron motion and relaxation, such as atomic inner shell dynamics. Attosecond science will produce laser fields strong enough to modify electron dynamics, well enough controlled to control electron dynamics, and well enough synchronized to attosecond pulses to allow sub-laser cycle measurements.

Neutron Scattering Exposes Viral Structures

Researchers have demonstrated a method to investigate structures of viral peptides and membranes in biologically relevant conditions, by neutron scattering. This provides new insights about the mechanisms of viral attack on cells, which could lead to control of diseases or new pharmaceutical treatments.



Disruptive Technology – Opening New Vistas

Researchers at SIMS have written low-loss wave-guides and other refractive index structures inside transparent dielectric materials. This is a potentially disruptive technology, opening the way to new methods of fabricating photonics devices and leading to improvement of the competitive position of Canadian industry.

Nano-scale Lithography

Using light, SIMS researchers have formulated a theory for the control of the alignment and orientation of polyatomic molecules, advancing the knowledge of light-matter interaction and the exploitation of molecular manipulation using light. One possible application of this research is nano-scale lithography.

"Direct laser writing to fabricate optical circuits in three dimensions will represent a major step forward, allowing multiple devices on differing planes of the same substrate with arbitrary interconnection. A thorough understanding of the underlying mechanisms in forming wave-guide structures with femtosecond pulses is essential to its successful exploitation in device formulation…SIMS is pioneering this understanding and their ability to transfer this expertise to Canadian industry can have a major impact for integrated optics here in the future."

Dr. Simon Boothroyd
VICE PRESIDENT, R&D
TRILLIUM PHOTONICS

Advances in the Science of Measurement

NRC's Institute for National Measurement Standards is not only Canada's primary centre of reference for the accuracy, validity and traceability of physical measurements and appropriate chemical measurements, it also supports the development of competencies and technologies in selected areas of optics and photonics. In 2000-2001, INMS research broke new ground in a number of fields.

Screening for Drugs of Abuse

NRC researchers have developed a sensitive, reliable method for rapid throughput screening of drugs of abuse in human urine – a development that will be useful for forensic and clinical labs, drug enforcement and customs agencies, pharmaceutical industries and others.

Fully Automated Diagnostic System

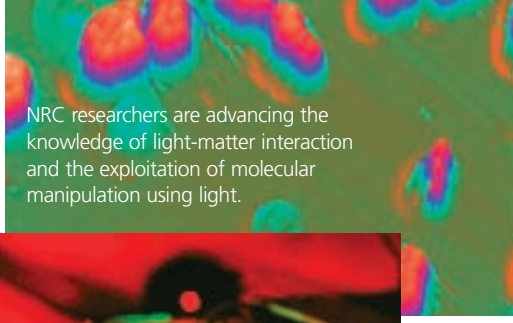
The INMS team developed a fully automated measurement system for measuring the polarization and depolarization properties of dielectric materials. The technique can be used to assess the operating conditions of electrical insulation of high voltage apparatus. Small and large utilities alike will be able to get more information about the condition of their equipment and will be able to better plan replacement schedules.

Toxic Metal Detection

Researchers at INMS have developed a technology for the speciation of organometallic pollutants that will streamline capabilities for detection of these organometallic compounds in contaminated sediments. This will not only enhance the measurement reliability vis-à-vis toxic metals, but will also increase the capability for detection of environmental mercury pollutants in air, soil and water.

Low Temperature Primary Standard

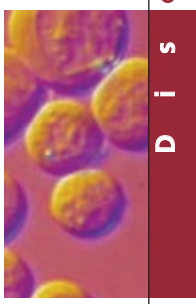
Low temperature research was completed on the triple point of deuterium and on the hydrogen triple point relevant to cryogenic and aerospace industries worldwide, and has led to INMS



NRC researchers are advancing the knowledge of light-matter interaction and the exploitation of molecular manipulation using light.

participation in a collaborative research project with the EU and five national measurement institutes to develop a portable temporary primary standard, known as MULTICELLS, for all low temperature triple points. This work enhances the propagation of standards at the highest level, improves fixed points and calibration processes, and will lead to improvements in cryotechnologies and processes in the aerospace, shipping, power generation and health care industries.

NRC researchers in SIMS and INMS have produced the world's shortest laser pulses – 1.8 femtoseconds – a world record, and a demonstration of world leadership in laser science.



Advances in Biotechnology

Biotechnology is one of the most important fields of R&D in Canada and a major research area for NRC. NRC's five biotechnology institutes form a strategic force for Canada, working with each other and with universities and industry, to tap the potential of a field that is forecast to have a significant impact on Canada's Gross Domestic Product within the next decade.

Individually, collectively and in collaboration with outside public, academic and private industry organizations, the NRC biotechnology team made many major R&D breakthroughs in 2000-2001.

New Targets for Anti-fungal Drugs

Researchers at NRC's Biotechnology Research Institute have fabricated DNA microarrays for the human pathogen *Candida albicans* that enable the analysis of the global pattern of gene expression for this organism. These patterns of expression can be monitored to identify genes whose expression is linked to virulence, providing information valuable in identifying new targets for the development of anti-fungal drugs.

New Approach for Drug Discovery

Researchers at BRI have developed a new algorithm for the development of drugs. This novel method produces a general library of compounds with a high probability of being drugs or drug candidates without specifying target diseases or molecules. This approach enables the discovery of new applications for existing commercially available drugs.

Accelerating the Drug Discovery Process

A new transient transfection technology for high-level expression of recombinant proteins has been developed at BRI. This technology allows for the rapid production of active proteins in mammalian cells that are suited to HTS and structural analyses. In the short term, the technology will help accelerate the structure, function, and characterization of new proteins and help accelerate the drug discovery process.

Meningitis Vaccines Hold Hope

Baxter HealthCare Corp. produced three million doses of the NRC's IBS-developed Group C meningococcal conjugate vaccine for the immunization program of the United Kingdom. This Group C vaccine was shown to have the highest potency rate among all vaccines used in the U.K. vaccination program. This is the first commercially available vaccine against the disease for infants.

"The fruits of Baxter's partnership with NRC ripened in 2000 as NeisVAc-C® was part of a concerted campaign which ultimately reduced the incidence of meningococcal C disease in the U.K. by 60 to 80 per cent across all age groups over the previous year. Moving forward, this vaccine will provide health officials with a very safe and highly effective weapon to continue the fight against meningococcal disease."

Serge Messerlian
BAXTER CANADA

There are 13 different N*usseria meningitides* serogroups, but close to 90 per cent of cases in the U.K. and North America are a result of serogroups B and C. There is no effective vaccine in the world for the prevention of meningitides B, the bacteria responsible for most cases of meningitis in developed countries since the 1940s. NRC's licensed vaccine for Group B is undergoing Phase I trials with partner Baxter Health Care. If successful, this synthetic vaccine would be the only one available to treat Group B meningitides.

Quick, Painless Diagnosis for Rheumatoid Arthritis

"Infrared spectroscopy shows tremendous potential as an effective diagnostic tool for RA. It will help us detect early and subtle changes to the joints before significant damage occurs. In addition, it may provide a means of objectively assessing response to therapy which is very important as we look at treatments for inflammatory arthritis."

Dr. Jan Canvin
RHEUMATIC DISEASES UNIT
HEALTH SCIENCES CENTRE
WINNIPEG

The IBD team, in collaboration with the University of Manitoba, has developed a method to diagnose rheumatoid arthritis (RA) rapidly and non-invasively. The technique is based on infrared spectroscopy of the joints of the hand. Currently there is no "gold standard" for diagnosing RA and no way to predict which cases of RA are aggressive and require acute – and potentially harmful – treatment.

Better Treatment for Brain Disorders

Researchers at IBS have validated two novel, single-domain antibody species for their *in vivo* brain vectoring properties. Using a combination of phage-display, genomics and proteomics approaches, antigens recognized by these antibodies have been identified and partially characterized. After evaluation, these antibodies will be optimized into commercial vectors for delivering therapeutic peptides and genes into the brain. The result will be better treatment modalities for treating brain disorders.

Rapid Test for PSP Toxins

In collaboration with Jellet Biotek Ltd., scientists at NRC's Institute for Marine Biosciences developed a rapid field test kit to detect paralytic shellfish poisoning (PSP) toxins in shellfish. The kit has generated interest worldwide because these toxins are a global problem. The new kit is faster (users know results within 20 minutes) and more cost-effective than existing test methods and can be used in a non-laboratory setting without specialized training (much like a home pregnancy test). Shellfish farmers can pre-screen their product before harvesting and, if contaminated shellfish are found, they can be left in the water to detoxify naturally – eliminating losses sustained when crops found to be contaminated after harvesting have to be destroyed. The kit also has potential in plankton monitoring and as a quality control tool in processing plants. The use of this kit will increase the safety of shellfish products going to market and reduce production costs. The kit is going through international regulatory approvals and should be available on the market by the summer of 2001.

Fertilizers Clean Up Oil Spills

BRI researchers, in cooperation with Fisheries and Oceans Canada, the U.S. Environmental Protection Agency and several Canadian and U.S. universities, have demonstrated that biostimulation through the addition of fertilizers may help minimize environmental damage caused by oil spills and promote habitat recovery in sensitive freshwater and saltwater wetland environments. The on-going research is expected to generate information to improve environmental guidelines and regulations as well as monitoring programs. Wetland environments are important wildlife habitats that provide nursery support for coastal fisheries, mitigate flooding and contribute to wastewater treatment and water quality enhancement.

Nurturing the Biotech Industry

A novel technology for cell-based assays to monitor intracellular proteolyic activities has been successfully implemented by BRI using protein engineering and gene expression technologies. This will be a proprietary technology, licensable to companies interested in drug development, and will support new collaborations on specific enzyme targets with the pharmaceutical industry.

Seeing Tumours in a New Light

Researchers at IBD have developed a method to visualize tumours *in vivo*, using fluorescent imaging. This method determines if anti-body based drugs bind to their targets and assess the efficacy of other anti-cancer agents.

Rare Gene Sequences Form Library

In collaboration with SignalGene Inc., IBS scientists involved in neuro-degenerative diseases have created a library of rare gene sequences selectively expressed in lesions from the brains of Alzheimer's and Parkinson's disease sufferers. These libraries will serve as a source for discovering novel targets and future therapies and drugs for neuro-degenerative diseases and dementia.

On the Case of Poultry Poisoning

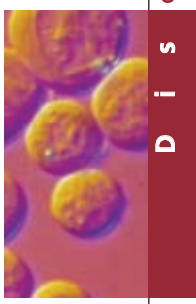
Contaminated poultry, bearing *C.jejuni*, is the leading cause of food poisoning in North America. IBS researchers have generated DNA chips covering 97 per cent of the *C.jejuni* genome and concurrently, a comprehensive map of the proteins expressed by this bacterium. These results provide proof-in-concept of the approach to profile and link together the entire genomic and proteomics complement of *C.jejuni* on DNA chips and 2D electophoretic maps to study the pathogenesis of this organism. In turn, this will provide the basis for detection and elimination of this serious food-borne pathogen.

Healthy Halibut and Haddock Diet

In haddock and halibut nutrition, IMB researchers completed a study on inorganic requirements and established that feed proteins satisfy a substantial part of haddock energy needs. They developed a feed formulation that does not cause the fatty liver disease resulting from high lipid diets, and subsequently created a commercial feed for halibut reared in re-circulation systems. These advances not only reduced feed costs for producers, but also increased the health of cultured haddock and provided an opportunity for Canadian firm Scotian Halibut to make new feeds.

NRC researchers have developed a method to visualize tumours *in vivo*, using fluorescent imaging.

NRC's library of rare gene sequences will serve as a source for discovering future therapies and drugs for neuro-degenerative diseases.



Skin Cancer Shows Up Under Light

IBD scientists developed a means to diagnose skin cancer rapidly and non-invasively using infrared spectroscopy of skin lesions. The technology has been licensed to nir-vivo inc., an NRC spin-off. Currently, skin cancers are verified via biopsy. NRC's technology allows point-of-care assessment, without biopsy, with the potential for immediate treatment planning.

Increasing Canola Oil Content

Canola is valued at $2 billion annually to the Canadian economy. A major focus of Canola research is on developing Canola lines with increased oil content, while not affecting the growth or development of the plant or making it more susceptible to disease or insects.

PBI researchers are meeting the challenges through investigation of the genes involved in the Kennedy pathway – the metabolic pathway involved in oil production. The genes that encode enzymes in seed oil synthesis have been identified and characterized. PBI researchers have used this knowledge to develop genetically modified lines that produce a significantly higher amount of oil.

Advances in Manufacturing

Manufacturing remains one of Canada's major economic forces, touching virtually every sector of the economy. NRC's research and development programs in manufacturing are focused on:

- Helping the manufacturing community improve its global competitiveness
- Improving the commercial viability of products and services
- Creating, responding to and adapting new technologies, materials and processes for application across the sector
- Meeting environmental responsibilities.

The highlights of NRC's manufacturing research and development in 2000-2001 demonstrate how it has delivered on these objectives for the industry and for Canadians.

Ultra-precision Micro-machining System

NRC researchers at the Integrated Manufacturing Technologies Institute (IMTI) developed a new, ultra-precision micro-machining system, based on XYZ piezoelectric translation stages and control algorithms. They have used the system to develop a prototype sensor for neurological research. Neuronal signals (both electronic and sound) from rats have been recorded using the prototype. If successful, this advance will result in a major improvement in neurological devices and can be used for development of applications in the area of micro-feature generation in moulds and dies – a major industry opportunity.

From the Four Corners of the Earth They Come

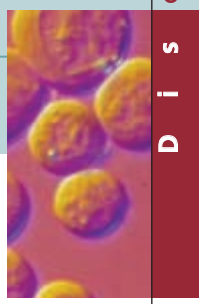
To be successful in responding quickly to customer needs, geographically dispersed design teams must be able to work together in a collaborative design environment. NRC has developed a new approach to automatically track design changes, in just such an environment, using a data change tracking model based on the relationships between product specifications, functions, working principles, design objects, assemblies and components. The new methodologies and tools, developed at IMTI, will help product designers manage and reuse design knowledge, analyse early design alternatives, and evaluate the impact of design decisions during the early stages of product development, helping bring products to market faster, cheaper and with less work and travel. IMTI has developed a software prototype and is testing it with the help of real-life case studies taken from Canadian manufacturers.

"Our partnership in the development of virtual technologies with the Industrial Materials Institute continues to benefit our company by helping to reduce development times and improve part quality. Recently, IMI helped us become a privileged fuel systems supplier to two large international auto manufacturers by providing state-of-the-art predictive technology and know how. Furthermore, with the constraint of a tight schedule, IMI developed a new 3D virtual capability that helped us develop a new process for producing automotive parts at lower cost."

Haile Atsbha
CAE MANAGER
KAUTEX-TEXTRON

A Supplier of Choice for the Auto Industry

Kautex-Textron is an auto fuel systems manufacturer with clients that include Daimler-Chrysler, Toyota, Honda and General Motors. The company has been a long-time collaborator with NRC in using virtual reality technologies to predict the quality of parts and to optimize their production by using advanced moulding techniques. The company entered into a new phase of collaboration with IMI to develop virtual reality technologies and applications in order to take advantage of the strengths of the technology in rapid evaluation of different designs, under different operating conditions, while avoiding long and expensive trials and prototyping processes. The company was able to find the ideal form of moulds and the best processes for making parts to meet the cost and performance requirements of its clients. Kautex-Textron gained the designation of preferred supplier – the second in 18 months for the company – thanks in large part to the expertise and technologies of NRC.



"Thanks to the expertise and resources of NRC's IMI, we are now using a plasma laser spectroscopy technology to ensure the treatment of noxious elements in liquid wastes at our factories. In this regard, the success of this leading-edge method and its potential advantages have exceeded our original expectations. As a result, we are counting on being able to use this same technology for magnesium transformation and the continuous analysis of zinc fusion."

Valmont Samuel
DIRECTOR, COPPER AND RECYCLING
NORANDA INC.

Better Environmental Controls

NRC's Industrial Materials Institute and Noranda, a major metals producer of zinc and copper in Canada, are developing leading-edge technologies to measure the levels of pollutants in effluents from the company's factory operations. These facilities produce potentially harmful gas, solid and liquid wastes that must be treated to neutralize any environmental effects. The new technology allows for more accurate, real-time monitoring of harmful liquid wastes, while considerably reducing the costs of controlling wastes. In effect, it replaces the need for off-site sampling and laboratory testing. The system uses a plasma laser to analyse the light rays emitted from the material being produced. The characteristics of the light rays identify the elements in the material – the brighter the light, the more the material contains the elements being monitored. Using this approach, the quantity of potentially harmful pollutants can be identified and modified – in real time, during production.

Fully Functional Production Tools – in Two Weeks!

IMTI has moved its research forward with development of a ceramic shell mould casting process. They have developed reinforcing technologies and pattern burning procedures that overcome major technical challenges of mould cracking and warping for fine features during the pattern burning-off stage. The process rapidly produces intricate metal

parts of various castable alloys with good accuracy. This process, combined with high-performance machinery, can potentially produce fully functional production tools in two weeks, an order of magnitude better than conventional means, with a 256 cubic foot capacity. This fits the dimensions of many consumer products, at much lower costs than existing technologies.

CANSTEP Takes New Step

The Canadian Centre for STEP (International Standard for the Exchange of Product Model Data) located at NRC's Integrated Manufacturing Technologies Institute in London, created a software tool called STEPThrough targeted to facilitating supply chain communications in the automobile and aerospace industries. STEPThrough eliminates geometry translation and errors, meaning that manufacturers using the program will reduce the cost and time associated with using a supply chain involving several suppliers. The positive impact has already been seen at Bristol Aerospace and Pratt & Whitney Canada.

More Agile, Responsive and Reusable Manufacturing Systems

NRC's research team at IMTI has devised a new framework for modeling and design of reconfigurable manufacturing systems. A new hybrid, parallel-Cartesian machine tool prototype was developed and demonstrated by the team. The capabilities being developed through this research ultimately will help Canadian manufacturers organize and design production systems that can respond to changes, with minimal costs for retooling, changeover and ramp-up.

Nanocomposites – The Next Revolution Is Here

Researchers are now learning to build materials and machines at the molecular level – the same scale at which nature itself builds. This represents nothing less than a new frontier for science. The ability to manipulate matter at so primary a level has an inherent potential for innovation as vast as the imagination itself.

Nanotechnology, even in its infancy, has enabled great strides already in the materials sciences. NRC's Industrial Materials Institute is at the centre of efforts in the development of new "super polymers" – called polymeric nanocomposites (PCNs) – and is working to bring their almost unbelievable benefits to the marketplace.

PCNs are essentially polymers – like those used in pop bottles, injection moulding, nylon and PVCs – to which nanoscale particles of another material have been added. For example, adding nanoparticles of common clay to an ordinary plastic makes a material that is very strong, light and fire retardant. Adding only 0.64 per cent by volume of clay nanoparticles to a plastic results in a reinforcement equivalent to adding 35 per cent by volume of conventional glass fibre, and the clay nanoparticles increase density by only 0.88 per cent, as compared with 65 per cent in the case of glass fibre.

Another promising discovery is that adding 2 per cent PCNs by volume to plastic reduces permeability a thousand-fold without affecting visibility, a fact that will revolutionize the food packaging industry.

PCNs have environmental and safety benefits too, including: less waste due to reduced food spoilage; less landfill because PCNs are directly and easily recyclable; and increased flame resistance, making for safer homes, workplaces and transportation.

Polluters Beware – NRC Technology Measures Emissions

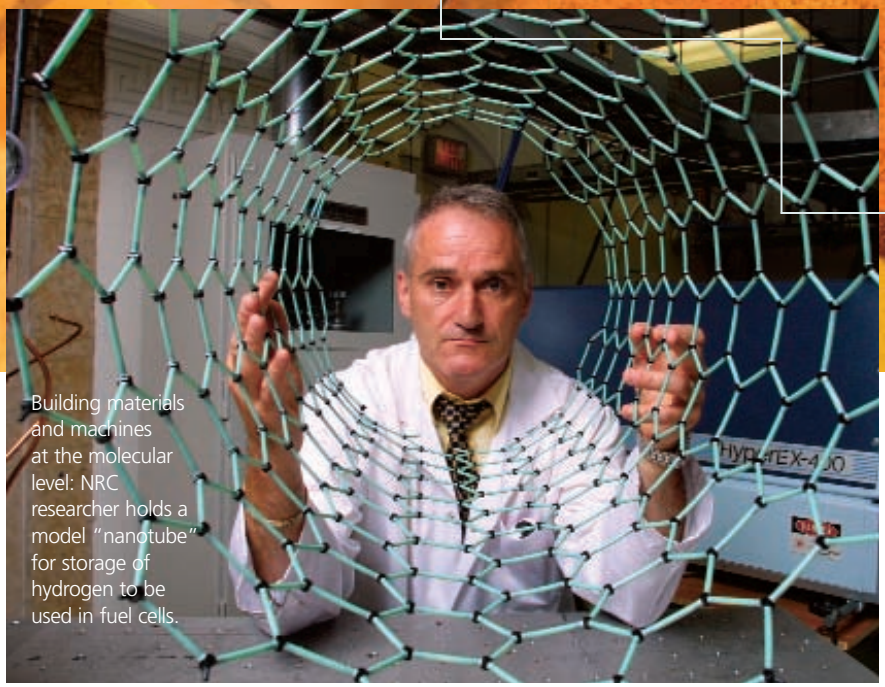
NRC researchers at the Institute for Chemical Processes and Environmental Technologies (ICPET) have developed a simple, highly effective diagnostic instrument that performs real-time measurements of particulate emissions and soot concentrations produced by gasoline and diesel-powered engines. Current technologies, while suitable for high concentrations of relatively large particles, are time consuming and often inaccurate when applied to modern low-emission engines. Laser-induced incandescence (LII) is a non-intrusive, optically based diagnostic technique well suited to emissions monitoring and measurement on cleaner vehicle engines. ICPET is now working with Artium Technologies Inc. to develop a portable unit for roadside monitoring.

Advancing Fuel Cells Technology

The Innovation Centre (IC) in Vancouver, B.C. is the coordinator of the NRC National Fuel Cells Program that supports the emerging fuel cell industry in Canada. In 2000-2001, IC researchers completed projects such as:

- The design of a micro-fuel cell powered sensor system. Fabrication of the fuel cell/battery hybrid system will eventually lead to more advanced products for a host of consumer electronic products and opportunities for Canadian industry
- The development of a multi-variable fuel cell control test station. A 1-KW fuel cell controls-and-test station was built and is being used in a Canadian fuel cell company to develop a fuel cell powered bicycle. Eventually, this research will contribute to the development of fuel cells for different industrial applications and will make fuel cells more economical.

The IC also coordinates and administers the NRC Intramural Fuel Cell Research Program and deploys funds to other NRC institutes for strategic projects in fuels cell related technologies. Among NRC's



Building materials and machines at the molecular level: NRC researcher holds a model "nanotube" for storage of hydrogen to be used in fuel cells.

institutes, ICPET is a key player in the delivery of fuel cell R&D activities, with 13 projects ongoing in-house, or in partnership with universities, the private sector and other NRC institutes. ICPET researchers made a number of R&D advances in 2000-2001 relevant to the emerging fuel cells industry that will affect the production, operation and efficiency of fuel cells being developed:

- A method for coating interconnects in multi-stack Solid Oxide Fuel Cell (SOFC) assemblies that reduces corrosion while maintaining conductivity. This method could lead to the development of less expensive and easier to manufacture metallic interconnects for the fuel cell industry
- Using a microwave synthesis process that allows control of the oxidation state of mixed transition metal oxides, researchers fabricated and produced new cathode materials. This technology offers possibilities for new, higher performance materials for both the fuel cell and battery industries
- Developments in oxide and bi-metallic alloy coatings for electrodes used for organic acid and direct methanol oxidation hold out promise for improved performance in the electrochemical removal of organic pollutants and of direct methanol fuel cells.

Fuzzy Sensor Fusion Engine – Cornerstone for Vision-guided Robotics

A generic fuzzy sensor fusion engine for combining individual sensor measurements in a generic manner has been developed by Innovation Centre researchers. The engine is applicable in any system where discrete sensors are deployed – as in fuel cell powered sensors – and offers the potential to improve the success rate of such sensors. The initial design and testing have been completed. The technology has application in automation, fuel cells and virtual reality fields, and lays a cornerstone for research in vision-guided robotics and wireless sensing systems.

3D Sensing System – Saving Money, Time and Materials

The manufacturing research team at the NRC Innovation Centre has developed a low-cost, online 3D sensing system for materials handling and industrial inspection applications. Of potential value to the forest products and fuel cells industries alike, the system offers saving of materials and reduced production times, coupled with high measurement accuracy, improved productivity and reduced waste.

"It's a sawmiller's dream. For example, we can run the same bunch of logs and cut them hypothetically in different ways to find out what is the most efficient yield. We can change cutting patterns. We can find bottlenecks and problems before they occur. The new technologies development was made possible through the support of the National Research Council (Innovation Centre in Vancouver). The modeling and simulation program called ForeSite™ will help revolutionize not only the way mills can be planned and run, but also will change the way employees are trained."

Barry Comes
PRESIDENT
PURE LOGIC TECHNOLOGIES

"Chopsaw" Model Reduces Waste, Increases Productivity

Innovation Centre researchers developed a primary and generic "Chopsaw" model to run production schemes over the Internet to forecast the results of scheduling decisions for sawmill operators. The model targets the needs of secondary wood product manufacturers and rough mills to help avoid excess waste or low recovery on raw materials. Tests demonstrated that there was a 10 to 20 per cent improvement in operations just by better schedules, without the need for capital investments.

Advances in Information and Communications

The information and communications technologies (ICT) sector is vital to the growth of the Canadian economy and will continue to be for the foreseeable future. Contributing $52 billion (1992 dollars) to Canada's gross domestic product in 2000, the sector accounted for 6.6 per cent of Canadian GDP – with over 25 per cent of actual GDP growth from 1999 to 2000 coming from this sector. The numbers tell the story: positioning Canada to excel in the ICT sector worldwide is critical to Canada's success and the prosperity of all Canadians.

As information and communications technologies continue to permeate all aspects of the economy, NRC's research institutes are playing an increasing vital, cross-sectoral role. In 2000-2001, major advances across this sector were made in 3D imaging and modeling, hardware, software, information processing and management technologies, and fundamental enabling and next generation technologies.

Speech Extractor

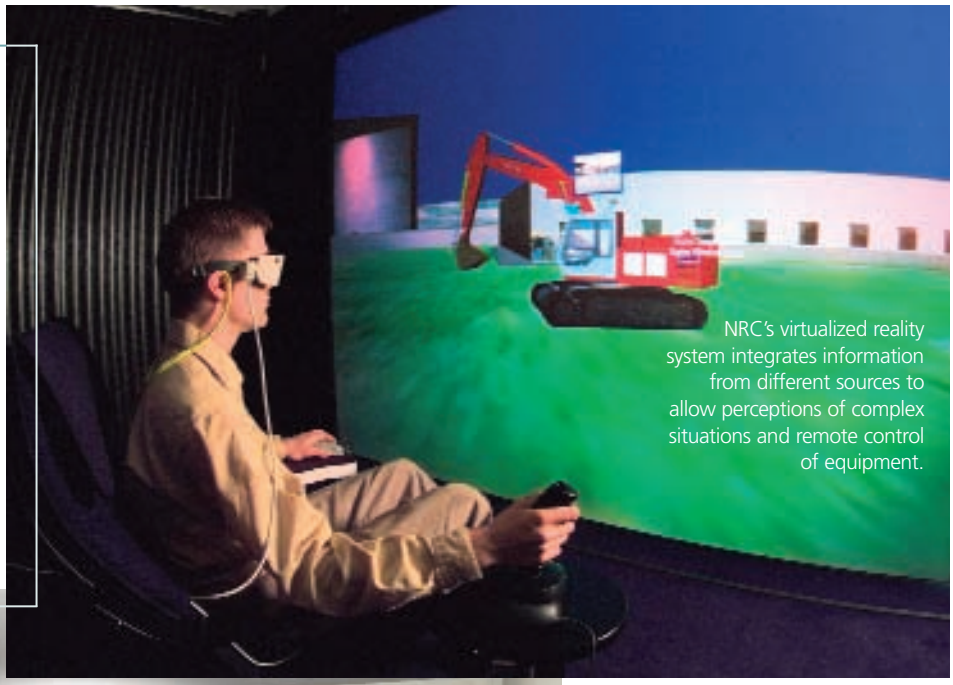
Researchers at NRC's Institute for Information Technologies (IIT) developed a prototype version of Speech Extractor, capable of extracting key phrases from spoken documents of variable audio quality – a tool that will be particularly relevant in broadcasting, video conferencing, video-on-demand, and other applications where capture of spoken audio is needed.

BioMiner

In collaboration with NRC's Institute for Biological Sciences, IIT continued to research and develop data mining tools, techniques and methodologies for application in genomics and biochip research. IIT researchers designed the architecture for BioMiner software and began its implementation. Three of the building modules for data pre-processing were completed and moved to the test stage. Technologies like these have the potential to revolutionize medical screening, improve primary prevention, and contribute to more effective treatments in areas like pharmacogenomics and toxicogenomics.

ADAM

IIT also completed the development of a prototype (ADAM) that allows the analysis of aircraft sensor data for aerospace data mining. The overall goal of the tool is early detection of abnormal behaviour and avoidance of defects, resulting in decreased costs, more effective management and maintenance of aircraft fleets, and increased air safety.



NRC's virtualized reality system integrates information from different sources to allow perceptions of complex situations and remote control of equipment.

Laying the foundation for future e-commerce and online shopping activities: NRC's 3D object management tool allows for automated product database updates.

Online Shopping

IIT developed a new concept for user-friendly e-commerce for online shopping based on NRC's 3D object management tool. The new tool allows for automated product database updates, a major step from actual manual or text-based technologies. This demonstrated prototype and other technologies are laying the foundation for future e-commerce activities.

ROSA – The Next Foothold in Space

Having successfully launched the CANADARM 2, MD Robotics and the Canadian Space Agency have set their sights on Canada's next generation in space with the ROSA (Remote Operations with Supervised Autonomy) project. ROSA is designing the framework to allow operation of space-based robotic systems by operators on the ground, relieving astronauts of time-consuming work. NRC's IIT is supplying its advanced vision technologies expertise – an essential component that will allow robots to "see" in space, giving them a higher degree of autonomy.

The VR Toolkit

IIT has produced and licensed to a start-up company, Digital Light and Sound Inc., a virtualized reality system that integrates information from different sources to allow perceptions of complex situations and remote control of equipment. The tool has application in a broad range of sectors from mining and space exploration to virtual tourism, museums and collaborative work in manufacturing.

Bright Blue Organic Light

Since the discovery of polymer conductivity, organic materials have been the subject of intense study for their application in the field of photonics and electronics. Organic light emitting diodes are seen as the most advanced technology with potential to penetrate and displace existing technologies in the flat panel and disposable display market. In 2000-2001, researchers at NRC's Institute for Microstructural Sciences moved the bar up in this field, developing:

- Very bright, efficient and stable blue emitters
- Application of an integrated shadow mask technique to spun-off polymers
- The first organic transistor and soft photography gratings.

Advances in Aerospace

Canada is considered among the top five countries in the world for the manufacturing of regional and business aircraft, commercial helicopters, gas turbine engines, landing gear, flight simulators, and aircraft guidance and control systems. Aerospace sector sales in 2000 reached $20 billion, including exports of nearly $15 billion, and direct employment approached 90,000.

NRC's Institute for Aerospace Research (IAR) supports this industry through research, innovation support and assistance for the development, commercialization and adoption of leading-edge technologies that help improve the industry's competitiveness. In 2000-2001, NRC made a number of key R&D contributions to this vital sector.

Understanding Climate Change

Under the Canadian Climate Action Fund, IAR developed a capability to measure the vertical flux of N_2O associated with spring melt over agricultural lands. N_2O has 310 times the warming potential of CO_2. This development will provide a basis for a better understanding of climate change through the use of improved numerical climate change prediction models.

New Codes – Smoother Flying

NRC's IAR team is developing improved Computational Fluid Dynamics (CFD) codes and applying them to address problems with fixed wing aircraft and helicopters. This work is at the leading edge of computational methods, and a powerful combination of numerical and experimental methods can be brought to bear in aerodynamic design – improving the effective operation, cost-effectiveness and safety of aircraft and air transportation.

Faster Aircraft Modeling and Design

Work continued at IAR to develop the world's first near real-time aircraft aerodynamic modeling capability for rapid use on existing aircraft. This work will greatly accelerate flight test projects and help companies that need flight mechanics models for simulator development. Its ultimate impacts are increased competitiveness for Canada's aerospace industries, and advanced design and manufacturing processes.

Into the Eye of the Hurricane

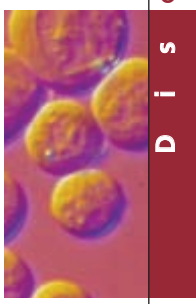
A team from NRC's Flight Research Laboratory flew the first deliberate flight by a Canadian research aircraft into a hurricane (Michael) off Newfoundland in November 2000 to measure the local environmental conditions. The data gathered will be used to help improve predictive capabilities regarding hurricane trajectories and effects.

Enhanced Synthetic Vision System – Saving Lives

The IAR team flew again, in January 2001, for the first time with the Enhanced Synthetic Vision System. This new system increases the capability of Search and Rescue crews to fly in poor visual conditions brought on by bad weather. The result, ultimately, will be improved flight safety and superior search and rescue operations.

Environmentally Friendly Aircraft Coatings

IAR, working with National Defence and 20 private companies, continued its leadership in the development of environmentally friendly coatings for aerospace applications, focusing on alternatives to chromium and cadmium. Reducing the use of toxic materials and plating solutions used in manufacturing aircraft will provide healthier factories for aerospace workers.



Advances in Ocean Engineering

NRC's Institute for Marine Dynamics works with marine regulatory bodies, marine systems designers, constructors and operators and the defence community to ensure that Canada's ocean engineering businesses and operations are safe, competitive and environmentally benign.

IMD provides industry with a unique concentration of knowledge, facilities and technologies to solve engineering challenges related to operations in Canada's ocean environment. NRC made a number of key ocean engineering contributions in 2000-2001.

Offshore Evacuation System Performance Research

IMD is conducting a study of Offshore Evacuation System Performance to provide basic information to support a transition in offshore regulations from prescriptive to performance-based. The work is a collaboration between Transport Canada, Natural Resources Canada and the Canadian Association of Petroleum Producers, as well as NRC. The project will identify and quantify the performance and success of marine evacuation of offshore oil installations. It will evaluate lifeboat evacuation capabilities (as a function of weather conditions) and develop and refine measures of performance useful in the development of goal-based regulations. In future phases of this three-year project, several other evacuation systems will be studied and experiments will be conducted with installations in damaged conditions.

AUV Takes to Water for the First Time

IMD continued its participation in a five-year project with Memorial University of Newfoundland (MUN) to develop technologies for autonomous

underwater vehicles (AUVs) for application to offshore environmental monitoring. The project will result in technologies for using AUVs for monitoring the impact of pollutants and toxicants from rock cuttings and drilling muds, as well as bringing

opportunities for firms to build AUVs. AUVs have potential applications in iceberg profiling, pipeline and hydrographic surveys, and mine detection and countermeasures. IMD is developing the vehicle with MUN. In 2000-2001, the AUV passed its first major milestone, operating in water for the very first time.

Thruster Propeller "Wash" Model Developed

Following an issue raised during model trials of the Terra Nova FPSO (Floating Production, Storage and Offloading) vessel, IMD developed an improved numerical model for heavily loaded thruster propellers to predict the effects of downstream wash from the propellers on the flexible marine risers that carry oil up from the sea floor. The numerical work not only provided the capacity to predict wash effects, but also resulted in substantial improvements in panel method numerical models for propellers operating under heavy loads such as those found in Dynamic Positioning Systems.

Scaling Down Reality for Model Reliability

In collaboration with Transport Canada, IMD participated in the trials of the U.S. Coast Guard icebreaker Healy. IMD's efforts were concerned with the physical characteristics of the ice and the performance of the ship given variable ice conditions and properties. IMD gained access to a comprehensive set of full-scale data on the behaviour of a modern vessel in ice, and as a result, will carry out a series of model experiments to correlate with the full-scale trials. Such correlations are critical to validating physical modeling of ship performance in ice and provide proof positive that model tests are properly representative of reality.

Advances in Construction

The Canadian construction industry is one of Canada's largest, encompassing over 125,000 companies and employing some 750,000 people. It is highly fragmented and comprises primarily small companies. Consequently, innovation in this sector poses special challenges: codes and standards are vital to lowering transaction costs, facilitating technology diffusion and reducing trade barriers in an increasingly globalized market.

The construction industry in Canada is an industry in transition. NRC's Institute for Research in Construction (IRC) made significant contributions in its research and innovation work to the industry in 2000-2001, complementing the accomplishments of the Institute in its five-year project to develop national integrated, performance-based building and fire safety codes for Canada.

WeatherSmart – Helping Extend Building Life

IRC researchers have devised a user-friendly computer tool – WeatherSmart – to generate indoor and outdoor moisture references for hygrothermal calculation and design. The tool enhances the reliability of models to assess long-term thermal and moisture performance of building envelopes. Ultimately, it will help extend the life of existing and new buildings, and lower the risk of building failures due to moisture and leaking.

A Mouldy Measure

IRC researchers have developed a new test to measure mould growth on wood and wood-based products subjected to higher relative humidity under lab conditions. The new test allows for detection of moulds at early stages, reducing the need for expensive repairs and creating healthier buildings and improved indoor environments for occupants.

Better Window Performance

A new test developed by IRC researchers to determine the levels of krypton and argon gas concentrations in insulating glass units is offering the window industry in Canada a new way to determine levels in their units with an inexpensive, non-destructive approach. The test will help manufacturers improve the quality and performance of their products, improve energy efficiency and ultimately help reduce greenhouse gases through reduced energy use. Future adoption of the test may also allow for low-cost in-use testing in homes and commercial buildings.

Innovation for the Canadian construction industry: an NRC researcher checks instrumentation mounted on a full scale wall assembly being evaluated for water penetration under static and dynamic wind loading.

Water Main Management and Renewal Tool

The IRC team developed new methods for the management of water mains, including the development of a prototype software tool – Water Mains Renewal Planner (WARP). This work will allow municipalities to better plan the maintenance/replacement of their water distribution systems and budget for downstream costs associated with repair and replacement. It also reduces the risks to health and business disruptions due to water main failures.

Big Dollar Savings for Cities and Towns

Eight new techniques have been developed at IRC to characterize asphaltic materials, including compatibility tests to evaluate the effect of construction on material behaviour, a superior method for analyzing road bases, and a comprehensive method for analyzing the performance of urban roads. The use of these techniques will result in longer service life for urban roads and less need for repairs – offering major cost savings, in the hundreds of millions of dollars annually, to municipalities across Canada. And, as an added bonus, the knowledge created may have applications for roofing materials.

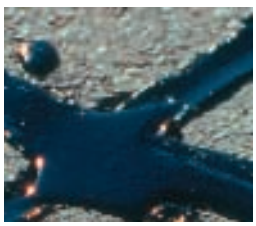
Insulating Houses Against Aircraft Noise

New software developed by IRC researchers allows designers to calculate the noise inside homes generated by passing aircraft above. A simulation of the indoor and outdoor noises enables the assessment of the effectiveness of noise reduction treatments and the development of measures to lower the costs for new or retrofit designs.

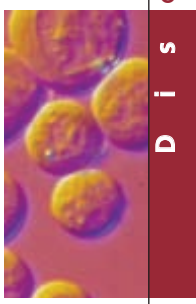
Big Savings by Reducing Office Space and Keeping Employees Satisfied

Working with leading building operators and manufacturers of office products, multi-disciplinary experts at IRC have developed software that assists the decision-making process in office remodeling. The software allows designers to reduce office space, while avoiding the pitfalls of poor indoor air quality, degraded lighting, higher noise levels and lower employee satisfaction – all of which can lead to decreased productivity.

Sealing Cracks for Longer Life and Big Savings



New technical guidelines issued by IRC on crack sealant installation hold the promise of significantly improving the performance of sealants on roadways, resulting in extended life for roads of between one to three years. This represents savings to municipalities, provinces, contractors and others in Canada of some $300 million annually through reduced costs of rehabilitation, less wear and tear on vehicles and reduced pollution.



STATEMENT OF OPERATIONS BY ORGANIZATION

For the Year Ending March 31, 2000

(DOLLARS ARE IN THOUSANDS)
FY 1999/2000

Organization	Expenditures [1]	Income
Research Institutes	$316,397	$60,100
Industrial Research Assistance Program[2]	137,549	21,581
Scientific and Technical Information	42,668	21,578
Technology Centres	9,831	9,398
Corporate Branches	92,103 [3]	5,425
Total	$598,548	$118,082

For the Year Ending March 31, 2001

(DOLLARS ARE IN THOUSANDS)
FY 2000/2001

Organization	Expenditures [1]	Income
Research Institutes	$357,597	$63,991
Industrial Research Assistance Program[2]	145,299	28,215
Scientific and Technical Information	45,738	24,125
Technology Centres	11,905	13,400
Corporate Branches	94,139 [3]	4,605
Total	$654,678	$134,336

(1) Expenditures shown above include both appropriation and income-based expenditures.

(2) Includes amounts received and expended under IRAP/Technology Partnership Canada Pre-Commercialization program (1999-2000, $20.636M; 2000-2001, $27.381M)

(3) Expenditures include construction projects for research institutes managed centrally.

BRI	Biotechnology Research Institute (Montréal)
CISTI	Canada Institute for Scientific and Technical Information (across Canada)
HIA	Herzberg Institute of Astrophysics (Victoria and Penticton)
IAR	Institute for Aerospace Research (Ottawa)
IBD	Institute for Biodiagnostics (Winnipeg)
IBS	Institute for Biological Sciences (Ottawa)
ICPET	Institute for Chemical Process and Environmental Technology (Ottawa)
IIT	Institute for Information Technology (Ottawa)
IMB	Institute for Marine Biosciences (Halifax)
IMD	Institute for Marine Dynamics (St. John's)
IMI	Industrial Materials Institute (Boucherville)
IMS	Institute for Microstructural Sciences (Ottawa)
IMTI	Integrated Manufacturing Technologies Institute (London)
INMS	Institute for National Measurement Standards (Ottawa)

NRC Institutes / Programs

IRAP	Industrial Research Assistance Program (across Canada)
IRC	Institute for Research in Construction (Ottawa)
PBI	Plant Biotechnology Institute (Saskatoon)
SIMS	Steacie Institute for Molecular Sciences (Ottawa and Chalk River)
IC	NRC Innovation Centre (Vancouver)

NRC Technology Centres

CHC	Canadian Hydraulics Centre (Ottawa)
TTC	Thermal Technology Centre (Ottawa)
CSTT	Centre for Surface Transportation Technology (Ottawa and Vancouver)

Improving the health of Canadians and their environment

BRI promotes, assists and performs leading edge R&D in biochemical engineering and molecular level biology closely linked to the needs of industries in the pharmaceutical and natural resources sectors.

The BRI research program has three sectors: Pharmaceutical Biotechnology, Environmental Biotechnology, and Bioprocess.

The Pharmaceutical Biotechnology sector is active in the development of new strategies for the treatment of cancer and infectious diseases, such as research at the molecular level, the use of receptors and signal transduction, and the use of proteases and protease regulation.

The Environmental Biotechnology sector's work is centred on prevention and pollution control, including technology and process development; identification and behaviour of pollutants; monitoring and ectoxicological risk evaluation; green technologies and sustainable development; production of non-pollutant products and exploration of ways to reuse organic wastes and turn them into value-added products.

The Bioprocess sector is engaged in the identification and integrated development of new bioprocesses; optimization of bioprocesses; scale up of fermentation processes to industrial levels; recovery and purification of biotechnology products; production of research materials and training of industrial personnel.

BRI is also involved in two major Centres:

- The Montréal Centre for Excellence in Brownfields Rehabilitation, in cooperation with the Government of Québec and Canada Economic Development
- The National Joint Centre for Structural Biology – providing a focal point for protein engineering research in the region – with the University of Montréal, McGill University, Merck Frosst Canada Inc. and Boehringer-Ingelheim (Canada) Ltd.

Biotechnology Research Institute (Montréal, Québec)

BRI and Qbiogene Inc. to develop adenoviral libraries

BRI and Qbiogene Inc. have negotiated a $3.8 million collaborative research project for the development of adenoviral libraries. Genetically engineered adenoviruses show great potential for applications in gene therapy. Studies show that the introduction of a specific adenovirus vector into prostate tumors may help fight prostate cancer.

"...This new collaborative research project will provide [Qbiogene] with the next-generation viral vector production platform. BRI has been a valuable partner and I am extremely pleased to have been able to expand our business relationship..."

Dr. Garth Cumberlidge

PRESIDENT AND CHIEF EXECUTIVE OFFICER
QBIOGENE

Knowledge and information for the new economy

CISTI is North America's largest, most comprehensive provider of scientific, technical and medical (STM) information, as well as Canada's leading publisher of scientific journals and books. As the global economy evolves from resource to knowledge and innovation-based, CISTI is increasingly considered a key strategic component of Canada's S&T information infrastructure.

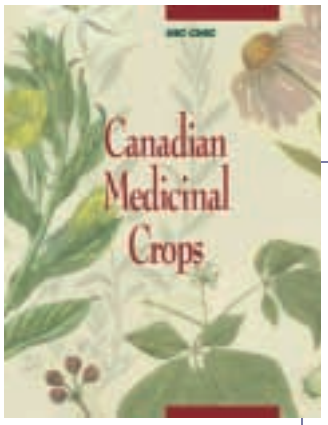
Canadians access the information resources of CISTI and of the world through CISTI's Web-based catalogue and state-of-the-art document delivery service. Fast turnaround times and electronic document delivery ensure that Canadians have access to the STM information they need when they need it. CISTI resources benefit researchers, innovators, students, librarians and medical workers in industry, universities, government, hospitals and libraries across Canada and throughout the world.

A national network of NRC Information Centres, staffed by highly trained specialists, brings vital information resources and expertise to local innovation communities. These centres help researchers and innovators in fields of strategic importance, including biotechnology, biosciences, molecular sciences, astrophysics and specific industry sectors.

CISTI's publishing program, NRC Research Press, offers scientists and engineers 14 international, peer-reviewed journals and a growing list of monographs and conference proceedings.

CISTI strengths include :

- 17 NRC Information Centres
- Close links to NRC institutes, IRAP and networks – ensuring CISTI is known and used by all sectors and interest groups
- Consortia agreements with university libraries – extending its information links and dissemination strengths across Canada
- International networks and agreements – access for Canada to the STM resources of the world and for the world to Canada's STM resources
- NRC Research Press and support to the peer review system.



Canada Institute for Scientific and Technical Information (across Canada)

Canadian Medicinal Crops

NRC published Canada's first comprehensive guide to medicinal plants to meet the need for accurate, detailed information on medicinal crops in Canada. The book, published by the NRC Research Press, serves the needs not only of the public, but also those working in agriculture, health care and the pharmaceutical industries in Canada.

Canada's gateway to the stars

HIA operates all astronomical observatories established by the Government of Canada and ensures that the Canadian scientific community can access these facilities. The Institute is responsible for the Dominion Astrophysical Observatory (DAO) in Victoria, B.C., the Dominion Radio Astrophysical Observatory (DRAO) in Penticton, B.C. and the Canadian Astronomy Data Centre in Victoria, B.C. The Centre receives data from national and international telescopes, including, with support from the Canadian Space Agency, the Hubble Space Telescope.

Through HIA, NRC is an international partner in the Hawaii-based 3.6-m Canada-France-Hawaii optical Telescope (CFHT) and the 15-m James Clerk Maxwell Telescope (JCMT) for short-wavelength radio emission. HIA is also an international partner in the Gemini twin 8-m optical telescopes, one in Hawaii, which began operations in 2000, and the other in Chile, which will be completed in 2001. These collaborations leverage Canada's investment in astrophysics, providing researchers with new opportunities and positioning Canada as a major player in international astronomy.

HIA also develops advanced scientific instrumentation for astronomical observatories and operates other elements of the national astronomy infrastructure, including a major data archiving and distribution service for clients in Canada and around the world. Other services include daily measurements of the level of solar activity that are used in countries worldwide.

HIA is known worldwide for its astrophysics research, as well as for its development of advanced scientific instrumentation, innovative technologies, and data management, mining, and manipulation technologies, including:

- Optical design and coating procedures
- Optical and infrared detector technology
- Multi-object spectroscopy
- Adaptive optics
- Data processing, archiving, distribution and data mining
- Antenna design
- Signal processing
- Sub-millimetre instrumentation
- Phase monitoring for radio interferometry.

HIA works closely with Canada's academic community and a growing number of industrial partners to transfer the technologies and knowledge it develops in the demanding realm of astronomy to other unrelated applications. HIA also helps train students in astronomy and engineering, and supports a major program of public outreach for astronomy.

Herzberg Institute of Astrophysics (Victoria and Penticton, British Columbia)

Institute for Aerospace Research (Ottawa, Ontario)

Taking Canadian aerospace research to new heights

IAR's vision is to be recognized as Canada's foremost centre for aerospace research and as the leader in aerospace innovation through R&D programs, partnerships and collaborations with stakeholders.

IAR develops and maintains the core competencies and knowledge base critical to the needs of the Canadian aerospace community. It fosters innovation in the design, manufacture, performance, use and safety of aerospace vehicles and supports the development, commercialization and implementation of leading-edge technologies through world-class research, technologies and networking, nationally and internationally.

IAR focuses on six strategic areas of critical importance to Canada's aerospace industries:

- Development and use of national aeronautical facilities
- Advanced design and manufacture
- Transportation safety
- Aerospace and the environment
- Human resources development
- International programs and strategic intelligence.

IAR provides the major national facilities used to design, develop and certify Canadian aerospace products, and the core competencies to maintain and develop the facilities and interpret the data they supply. The Institute's facilities include seven wind tunnels, air compressor/exhauster facilities, engine test cells, a full-scale structural fatigue rig, aeroacoustics chambers, a Flight Data Recorder Playback Centre and a fleet of research aircraft.

IAR is also responsible for the new Aerospace Manufacturing Centre announced in November 2000, to be built on the campus of the University of Montréal. In 2000-2001, IAR:

- Received government approval to proceed with detailed planning of the new Centre
- Selected a site for the centre and signed an MOU with the University of Montréal
- Procured the first item of capital equipment for the centre and hired its first employees.

2000-01 project highlights for IAR include:

- Receiving government approval to proceed with detailed planning of the new Aerospace Manufacturing Centre to be built on the campus of the University of Montréal
- Completion of the Aurora Aerodynamics Loads Program
- Beginning the active test portion of the CF-18 International Follow-on Structural Test Program
- Completing the first flight of the Advanced Systems Research Aircraft in the computer controlled fly-by-wire mode.

Improving Canadian patient care and medical diagnostics

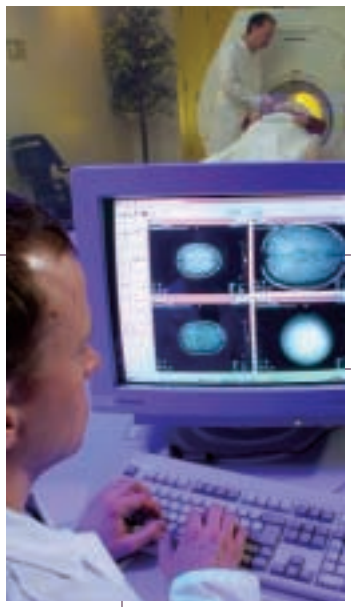
IBD conducts research and develops leading-edge instrument-based, non-invasive medical diagnostic technologies. The Institute performs its research in partnership with medical schools, universities, other research organizations and industry to foster socio-economic development through R&D and commercialization of its advanced medical devices.

IBD has four core research groups:

- The Biosystems Group uses non-invasive investigative techniques, such as magnetic resonance (MR) and infrared (IR) spectroscopy, and is primarily focused on cancer, heart disease and stroke
- The Informatics Group develops and adapts methods to analyze and monitor complex biomedical data and helps bring the resulting software products to market
- The Magnetic Resonance Technology Group develops magnetic resonance techniques and instruments to diagnose human disease, and creates protocols to apply these techniques to solve medical and biological problems
- The Spectroscopy Group uses optical methods, including the development of infrared imaging, to pursue goals similar to those of the MRT Group.

IBD also operates a prototyping facility – to take science from the proof-of-concept stage and develop it to the point where it can be transferred directly to industry.

Institute for Biodiagnostics (Winnipeg, Manitoba)



Satellite facilities in Calgary and Halifax

In 2000-2001, IBD inaugurated two satellite facilities – one in Calgary at the Calgary Foothills Hospital and one in Halifax, to help in the development of a Brain Repair Centre. These complement the two satellite laboratories at the Health Sciences Centre and the St. Boniface Hospital in Winnipeg. IBD will also extend its reach and competencies through R&D efforts using the facilities of the new Virtual Reality Centre in Winnipeg announced in the fall of 2000, as they become available.

Other 2000-2001 research highlights for IBD include:

- New diagnostic tests for colorectal cancer, skin cancer, prostate cancer, breast cancer, kidney rejection, arthritis, functional imaging of the spinal cord and Crohn's disease
- Progress in assessing tissue viability and the severity of burns with spectroscopic imaging
- Creation of a new, reagent-free clinical chemistry analyzer
- Creation of a novel coil for MRI-based breast cancer detection.

Institute for Biological Sciences (Ottawa, Ontario)

Easing the effects of debilitating diseases

IBS conducts innovative research in neurobiology and immunochemistry of importance to the health and pharmaceutical sectors. IBS carries out its research programs with partners in industry, universities, hospitals, and other R&D organizations. IBS research focuses on:

- Neuro-degenerative diseases, such as stroke, Alzheimer's, Parkinson's and epilepsy
- Osteoporosis
- Vaccines and immunotherapies against infectious diseases
- Therapeutic cancer vaccines.

IBS encompasses two major research programs. The Cell Biology program develops applications related to therapies for neuro-degenerative disorders through its three research groups, Apoptosis, Cellular Neurobiology, and Receptors and Ion Channels.

The Immunochemistry program conducts molecular-level research, through a multidisciplinary team, that leads to the development of novel vaccines and immunotherapeutics. These are pursued through the Bioanalysis, Carbohydrate-Protein Systems, Vaccine Design, Infection and Immunity, Molecular Pathogenesis and Pathogen Genomics Research groups.

IBS has a strong track record for transferring technology and knowledge to multi-national, small and medium-sized Canadian firms. IBS is also closely involved with the development and activities of three Canadian Centre of Excellence Networks: Bacterial Diseases, Arthritis and Stroke.

"This agreement links NRC's outstanding scientific expertise with GlycoDesign's unique technology platform for discovering, developing and delivering new drugs from glycobiology. The collaboration significantly expands GlycoDesign's programs in infectious diseases and complements our existing programs in cancer, cardiovascular disease and inflammatory diseases."

Dr. Jeremy Carver

PRESIDENT AND CHIEF EXECUTIVE OFFICER
GLYCODESIGN INC.

Attacking ulcers at the source

Toronto-based GlycoDesign Inc. focuses on the treatment of diseases that have a fundamental basis in glycobiology (the study of the role of carbohydrates in biological systems). IBS' expertise in carbohydrate chemistry and glycosyltransferases made for the ideal partnership match. The combined efforts of GlycoDesign and IBS should lead to improved treatments for such diseases as peptic ulcers. The collaboration will characterize new glycobiology drug targets from several medically important bacteria, including Helicobacter pylori – considered to be a causative organism for peptic ulcers and stomach cancers, and estimated to infect two out of three people worldwide.

Supporting industry – protecting the environment – through technology

As part of NRC's Manufacturing Technology Group, ICPET develops chemical process technologies and value-added materials to help Canada's industry sectors increase their commercial viability and the efficiency of their processing operations, while improving their environmental performance and sustainability.

The Institute's core R&D capabilities are concentrated on:

- Process technologies: electrochemical and interfacial technologies for industrial processes involving chemical use and recycling, such as waste water treatment, agri-food processing, pulp and paper/mining effluent reduction, and petrochemical gas and vapour treatment
- Functional materials: new polymers, nanostructured materials and other advanced materials for use in fuel cells, micro devices, high performance batteries and tissue engineering applications
- Modelling and design expertise in the area of air quality, computational fluid dynamics, numerical simulation and visualization, and in environmental management.

ICPET's current R&D priorities are to:

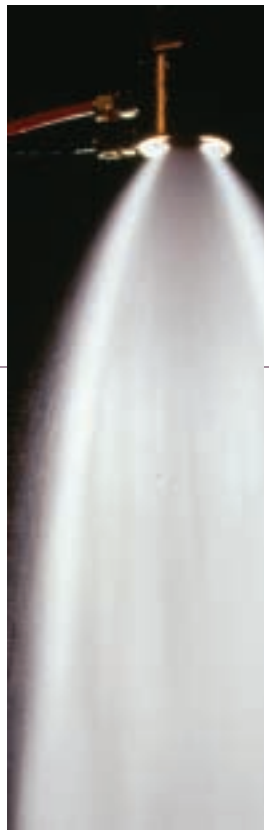
- Develop competencies in nanotechnologies, virtual manufacturing and sustainable technologies research
- Enhance its fuel cells research
- Support the development of technology clusters in Alberta oil sands and the Ottawa life sciences and electronics sectors.

Institute for Chemical Process and Environmental Technology (Ottawa, Ontario)

Oil sands technology moves East

NRC's ICPET, in collaboration with Syncrude Canada Ltd., has developed a proprietary spray nozzle technology for use in refining and petrochemical processes. NRC has granted a license to Imperial Oil Ltd. to apply this technology in its single coker reactor (thermal conversion unit) located in Sarnia, Ontario.

Based on previous success in two operational coker units at Syncrude in Ft. McMurray, NRC will migrate this technology to a retrofit of the coker



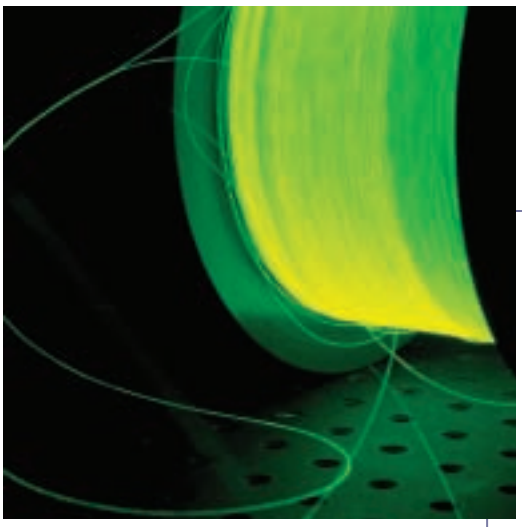
at the Imperial Oil refinery. Imperial will install the nozzles in a residuum thermal conversion unit where low quality heavy feed streams are converted to lighter, more-valued petroleum products. Expectations are that this technology will improve the conversion of residuum to liquid products, and reduce the quantity of recycled residue in the process.

The foreseen success at the Sarnia site is expected to extend the interest of Imperial Oil and its affiliates (Exxon-Mobil) to negotiate world-wide licensing with NRC for many more refineries.

Strengthening Canada's leadership in information and telecommunications

IIT creates and commercializes new software and systems technology, strengthens software engineering practices in the private sector, and communicates, educates and consults to help Canada prosper in the information age and knowledge economy. With information technology permeating all sectors of the economy, IIT is playing an increasing role in sectors other than technology, including manufacturing, biotechnology and electronic business.

IIT collaborates in information and telecommunications technologies, with business, universities, and government agencies, as a key player to strengthen this sector. IIT helps industries across Canada improve their competitiveness in information technology, develop innovative solutions to industry problems, and identify new business opportunities.



IIT's main research areas include:

- Interactive information: focused on creating new models to communicate information, tools to help acquire and distribute knowledge, and tools to find, organize, summarize and navigate through information
- Software engineering: to devise tools and techniques to help Canadian software companies improve both products and development processes
- Integrated reasoning: concentrated on automating and improving aspects of corporate decision-making, helping companies use innovative information technologies to enhance their business objective
- Network computing: research in highly connected computing and communications systems
- Visual information technology: to lead the way for innovation in 3D imaging, 3D information management and virtualized reality, with applications in manufacturing, heritage, anthropometry, medicine, road inspection, space and entertainment.

Along with the Institute for Microstructural Sciences, IIT operates an Industry Partnership Facility (IPF), which helps small and medium-size business exploit emerging technologies by providing a supportive working environment and access to NRC expertise.

Institute for Information Technology (Ottawa,Ontario)

e-business technology cluster

One of IIT's major achievements in 2000-2001 was to lead NRC efforts in establishing the e-business institute in Fredericton, along with satellite facilities and operations in Saint John, Moncton and Miramichi. This new institute will be the focal point for the development of the province's e-business technology cluster, moving the province to a position where it can successfully compete at the global level.

Leadership in aquaculture and genomics research for Canadians

IMB's targeted, innovative and strategic biotechnology research in aquaculture and genomics focuses on diversifying Canada's aquaculture industry and on developing genomics technologies.

Its mission is to serve Canada by developing and applying new knowledge and technology in key areas of marine and genome science, as a world leader in R&D in fish health and nutrition, marine toxins and genomic technologies.

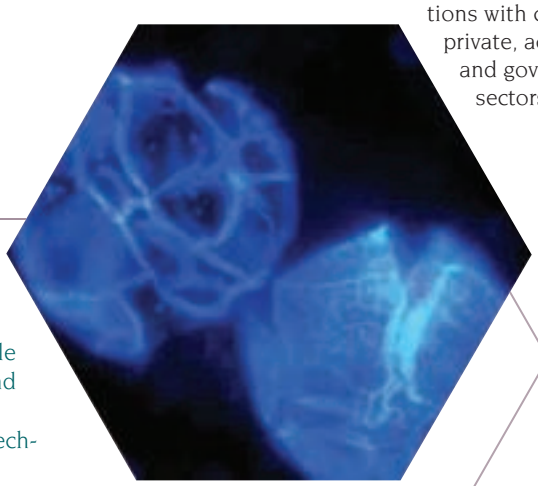
The Institute's aquaculture research is primarily concentrated on: fish and shellfish health and nutrition; developing alternative species of fish, shellfish and seaweed for aquaculture; and producing standards and reference materials used to ensure seafood safety.

The genetics research program targets the development of platform technologies in genomics – high throughput DNA sequencing, unique bioinformatics software development and proteomics (protein sequence analysis) – that apply to aquaculture, and other areas relevant to Canada.

On behalf of NRC, IMB operates and manages the Canadian Bioinformatics Resource (CBR), a national facility dedicated to providing Canadian researchers with convenient, effective access to biotechnology-related databases and bioinformatics software tools. CBR is a key component of the Canadian Heart Network, a Network Centre of Excellence. IMB is also a member of AquaNet, the Network Centre of Excellence dedicated to aquaculture development. CBR now also has several associate member nodes in other government departments and at universities.

IMB significantly influences innovation and economic growth in the region through its interactions with clients in private, academic, and government sectors.

Institute for Marine Biosciences (Halifax, Nova Scotia)



Halifax Life Sciences technology cluster

Of key importance in 2000-2001 is IMB's role in the development of the infrastructure and community consensus needed to drive the development of the Halifax Life Sciences technology cluster. IMB played host to the first Halifax life sciences community Round Table in September 2000, which led directly to the development of the Life Sciences Development Association. IMB's efforts were central in mobilizing the community on this initiative, a key component of NRC's Atlantic Canada Cluster Development Initiative and the Government of Canada's Atlantic Investment Partnership.

Responding to marine challenges

IMD works to enhance Canada's competitiveness by providing expertise, innovative solutions and technologies in ocean engineering. The Institute collaborates with industry, universities and government to anticipate and respond to challenges and opportunities to improve the industry's capacity to generate wealth in Canada.

In collaboration with industry, government and universities, the Institute pursues research programs in ship technology and offshore engineering, focusing on such areas as ship and underwater vehicle dynamics, ice effects on marine systems, mooring and towed body simulation, wave-current interaction, and wave impact analysis. IMD research supports a wide range of Canadian and international projects, from high-performance naval vessel operations to offshore oil and gas exploration.

The Institute's facilities include the world's longest ice tank (90 metres), an offshore engineering basin, and a 200-metre towing tank.

IMD's specialized equipment includes a marine dynamic test facility to evaluate vessel manoeuvring characteristics, a yacht dynamometer and a cavitation tunnel. IMD facilities provide an essential infrastructure targeted to meet the needs of industry and support leading-edge R&D.

IMD combines expertise and world-class facilities to address the needs of large multi-national companies, small ventures and consultants. It brings an international reputation for research excellence to its work with offshore firms and research organizations. The Institute acts as a Canadian conduit for international ocean engineering technology. Long-term collaborative research projects invest in development of the knowledge that will permit Canadian industry to compete in the 21st century's global marketplace.

IMD has also launched Oceanic Consulting Corporation, in collaboration with Memorial University, as its primary vehicle for commercialization of IMD performance prediction technologies. In 2000-2001, this company carried out some 20 national/international client projects, while its staff grew from 20 to more than 30.

Institute for Marine Dynamics (St. John's, Newfoundland)

In the movies

IMD was the home of the Newfoundland film industry for one weekend in 2000-2001, as producers used the Institute to film scenes from an upcoming feature film, "Rare Birds." The spin-off benefits were substantial for the community – employment for local actors and crews, as well as a large contingent of personnel from outside Canada.

Working with industry to improve materials processing

Industrial materials and processes permeate every sector of the economy. IMI promotes the growth and competitiveness of Canadian industry through research and development activities related to materials processing technologies. The Institute works in a number of sectors, including metal, polymer, aerospace, automotive and bio-medical sectors, as well as in virtual fabrication, advanced instrumentation and environmental technologies.

In support of this mission, IMI strives to:

- Be the leader in developing competencies and knowledge related to the creation and development of industrial materials
- Be a partner-of-choice with industry in the diffusion of knowledge and the adoption of strategic technologies
- Be a catalyst for innovation and a magnet for future technologies of relevance to industry.

IMI offers multidisciplinary expertise focused on the next generation of technologies and high-performance systems necessary to produce new materials and manufacture the products that consumers in the 21st century will demand. R&D efforts are centred on two fields of activities:

- Design of Materials Processing through the understanding of science principles to optimize the formulation and the behaviour of material in the process-structure performance continuum
- Virtual Technologies and Intelligent Control through 3D modeling, simulation, visualization and real-time sensing, high-performance computational methods and information processing.

The Institute has received international recognition for its work with scientific collaborators as well as for its active involvement in technology transfer to industry.

Industrial Materials Institute (Boucherville, Québec)

New advanced coatings extend industrial life

The new company SYNTHESARC is firmly committed to the fight against industrial wear. Coatings developed with Alpha 1800 cored wire, its flagship product, are five times more erosion resistant and 25 times more abrasion resistant than steel. Founded on research work conducted at IMI, the company specializes in products and services in the field of part and component coatings. Thanks to its involvement with the Industrial Materials Institute, the company had a strong launch and was very successful from its first year of operation. Its products will help a multitude of companies extend the useful lifespan of their facilities, thereby opening up a number of potential markets to SYNTHESARC.

"The Industrial Materials Institute helped launch our company, not only by welcoming us into an innovative scientific environment but also by participating in joint R&D work necessary to develop a technology company such as ours."

Serge Dallaire

PRESIDENT
SYNTHESARC INC.

Leading the information technology revolution

The mission of IMS is to provide leadership, in collaboration with Canadian industry and universities, in the development of the strategic base for information technology, that is, in the development of emerging and enabling technologies related to future hardware requirements for information processing, transmission, acquisition and display.

IMS collaborates with Canadian industry to provide national leadership in developing this strategic base – creating the enabling technologies needed by the industry to take a leading place in the emerging IT markets in the global economy.

IMS partners with industry to exploit the technological advances that result from research and to reduce the risk to industry by investing in those alternative technologies which, if achieved, would represent a paradigm shift and major opportunity areas for the future of the sector.

The Institute's core competencies include: photonic device design and fabrication, semiconductor process development (organic and inorganic), thin film technology, nanotechnology, and acoustics.

IMS applies its expertise in novel materials and components to solve problems posed by the need for advanced hardware through both national and international initiatives.

Institute for Microstructural Sciences (Ottawa, Ontario)

IMS looks ahead to solve technology challenge

IMS helped its partner Mitel Semiconductor to develop a prototype semiconductor that could double data transmission capacity more cheaply and effectively. The new semiconductor increases the number of light channels on a glass fibre from 16 to 40. The product uses Echelle gratings, which bounce light signals off a silicon chip structure to create new channels. These gratings, known since the 19th century, have been the subject of recent research interest in the U.S., Canada, Sweden and Japan, but NRC and Mitel were the first to discover how to make the technology work at high channel counts. The results have been amazing – not the least of which was the creation and launch of IMS spin-off, Optenia Inc. – in a joint effort with Mitel. At launch, the company had 26 staff and was gearing up to produce its first chips for market by the summer of 2001.

Breaking new ground for Canadian industry

IMTI is a leader in the research and development of integrated technologies for the manufacture of products and equipment. It carries out focused, innovative and strategic research in collaboration with industrial, university and government partners in virtual manufacturing and precision freeform fabrication to give Canadians access to new products that cannot be created by conventional technologies.

IMTI programs focus on two fields:

- System simulation and control research – to provide manufacturers with the tools they need to speed up the product development cycle by working in a collaborative, virtual environment; sharing and evaluating design and manufacturing information in real time with customers, suppliers and collaborators
- Production technologies research – to provide manufacturers with novel production processes to deliver the best products for clients, taking full advantage of material properties, making shapes or features that are difficult or impossible to produce using conventional processes.

IMTI's research, conducted with collaborators in key industry sectors such as aerospace, automotive, tooling, medical devices and electronics, is breaking new ground for Canadian industry.

Integrated Manufacturing Technologies Institute (London, Ontario)

Laser consolidation for manufacturing rotary cutting dies

A successful collaboration in 2000-2001 involved the application of IMTI's novel laser consolidation process to manufacture net shape functional components directly from computer aided design files. IMTI is collaborating with Rotoflex International on the development of the laser consolidation process for manufacturing rotary cutting dies. Major benefits include significantly enhanced wear resistance and increased life cycle. Two rotary cutting dies have been produced and are being tested in the production environment. They have successfully cut more than 180,000 metres of labels without requiring re-sharpening.

"We can use simple steel for the base and build up the blades with an extremely strong alloy. As a result, the blades are sharper, last longer and the whole die is much less expensive."

Dr. Andrew Weiczorek
ROTOFLEX INTERNATIONAL

Institute for National Measurement Standards (Ottawa, Ontario)

Ensuring Canada measures up

INMS provides the recognized primary centre of reference in Canada for the accuracy, validity and traceability of physical measurements and of appropriate chemical measurements, and plays a leading role in the Canadian national systems of physical and chemical measurement, to facilitate increased competitiveness of Canadian industry and serve public needs.

The activities of INMS have vital importance throughout the economy including resources industries such as pulp and paper, manufacturing industries such as automotive, the electrical power industry and high-tech industries such as aerospace and telecommunications. Metrology is a key component of ensuring product quality and the interoperability and exchangeability of components. It is also essential for consumer and environmental protection and in the health sciences. Central to INMS is the need to achieve international recognition of Canada's measurement standards as a key element in the reduction of technical barriers to trade, an issue vital to Canada where over 40 per cent of GDP is dependent on

exports – a level five times greater than in the United States.

INMS is a fundamental enabling element in the Canadian government infrastructure. Its role is to support Canadian industry and the Canadian public by:

- Facilitating Canada's global trade and global co-manufacturing by providing the necessary national primary measurement standards and calibration-related services, and by ensuring that those measurements standards and services are internationally competitive, thereby contributing to the reduction of technical barriers to trade
- Strengthening the competitiveness of Canadian companies by facilitating, through a viable national measurement system, the traceability of their measurements to those national measurement standards and services
- Ensuring that Canadian companies exploiting emerging advanced technologies are supported through the timely development of appropriate new measurement standards and services
- Addressing health and environmental issues through chemical metrology services that create appropriate measurement standards and certified reference materials.

Calibration measures up

It is a challenging task for the laboratories of INMS to meet the calibration needs of Canadian measurement users. In 2000-2001, the Institute performed calibrations for 1,637 clients, but this is only a small fraction of the calibrations performed in Canada that are traceable to the international system of units (SI) through INMS laboratories. Public and private sector calibration labs provide the majority of calibration services. It is through CLAS/SCC calibration laboratory accreditation that NRC standards are disseminated to a vast, multi-level group of consumers. In a survey held in 2000-2001, 17 of 25 labs responding identified they had issued a total of 87,505 calibration reports – just one indicator of the importance of Canada's national measurement standards and their relevance to industry and to Canada's trade.

Building capacity in the Canadian innovation system

IRAP has evolved over the last 60 years, focusing more on the needs of Canadian SMEs. IRAP works with other government programs in a common mission to help firms enhance their innovation capabilities through research and development. Today, IRAP represents a key component of Canada's system of innovation, serving as a federal catalyst that links a diverse network of people, institutions, organizations and programs to help SMEs develop and exploit technology in a competitive, knowledge-based economy.

As a national program with strong regional presence, IRAP helps build local and national economic systems and technology clusters. Through its expertise and advice, as well as financial assistance, IRAP provides customized solutions for the increasingly complex projects undertaken by about 12,000 client firms, in Canada and abroad, each year.

The backbone of the network is IRAP's 260 Industrial Technology Advisors (ITAs) located in over 140 centres across the country. IRAP ITAs perform two main functions. The first, and the most important and effective, is providing advisory services to firms – ITAs help assemble a mix of expertise, information and resources tailored to the individual needs of their client firms. The second is their involvement in IRAP's contributions to firms' activities. In addition, ITAs advise clients on their proposals, review requests for assistance, and monitor contribution agreements once approved.

Since 1997, when Industry Canada's co-sponsorship ended, IRAP has led the Canadian Technology Network (CTN), building a strong national network of member organizations contributing business, financial and marketing expertise and services that complement IRAP's technology focus. With over 1,000 public and not-for-profit organizations, CTN members work together to provide integrated innovation services and support to SMEs. CTN is in the business of supporting community-centered innovation in the broadest sense. It makes the suite of services needed by SMEs to innovate more accessible and provides SMEs with sources of technology advice, expertise and intelligence, as well as business, financial and marketing services. CTN benefits IRAP, and other member organizations, through: networking opportunities to enhance awareness of services; access to expertise and resources; identification of opportunities for synergy and alliances between member organizations; free initial assessment of client needs; client referrals for solutions to problems and challenges; and supporting communications services.

Industrial Research Assistance Program (across Canada)

More efficient heat sources for Canadians

Thanks to IRAP's expertise in research and marketing, and its financial support, Wirsbo Canada, a Regina-based producer of radiant in-floor heating systems for residential, commercial and industrial applications, is now expanding its investment in R&D, positioning itself as a leader in Canada's electrical control manufacturing industry. The company's development of a more efficient, lower-cost electronic control device to link their systems' various components, allowed them to penetrate the mid-range housing market.

"IRAP was a tremendous support to us. First, they helped us do an international technology-and-patent search, which confirmed this was indeed a new idea. Then they helped us with a marketing feasibility study, to determine if this would be material to growing our business. From that point, with funding from IRAP, we went forward with research and development."

Wade Peterson

PRESIDENT & MANAGING DIRECTOR
WIRSBO CANADA

Safe, durable, comfortable – at home, at work, on the road

IRC develops and maintains the core competencies and the knowledge base critical to the needs of the Canadian construction industry, supports the development, commercialization and implementation of leading-edge technologies, and fosters the provision of safe and sustainable built-environments through the development of codes and standards.

Key program areas include:

- Indoor environments: improving acoustics, thermal comfort, lighting use and air quality in all types of buildings
- Building envelope and structure: optimizing envelope performance and structural safety of both new and rehabilitated buildings
- Urban infrastructure rehabilitation: improving technologies used to design, construct, operate and maintain buried services and surface structures
- Fire risk management: providing sophisticated tools to assess the risks and cost of fire safety options for buildings, and developing economical and effective methods of fire resistance, detection and suppression
- A national evaluation service that determines the suitability of innovative construction products and technologies
- A national code centre that supports the development of the National Building Code and other national model codes on which construction regulation across Canada is based
- The production of practical technical information the IRC disseminates to construction practitioners.

Institute for Research in Construction (Ottawa, Ontario)

2000-2001 highlights of IRC's contributions to Canadians and industry include:

- IRC produced the Québec Construction Code 2000, a major service provided on behalf of the Québec government. It will allow users to consult all building code requirements adopted by Québec in a single source. Uniform codes lower transaction costs for industry and minimize trade barriers
- As part of a CIDA/CHMC project to promote Russian acceptance of Canadian housing products, IRC signed a joint declaration with Russia that paves the way for recognition of Canadian conformity assessment organizations – opening doors in Russia for the Canadian construction industry
- Working with leading organizations in the field of roofing, IRC conducted research that led to a new test protocol for assessing the performance, condition and durability of roofing membranes. This new protocol holds the promise of less wind damage to roofs, better durability, and reduced repair and replacement costs.

Better crops – better markets for Canada

PBI is the major research centre for plant biotechnology in Canada, with expertise in transformation, promoters, gene expression, genomics, metabolic pathways, DNA sequencing and biochemistry. PBI performs, assists and promotes strategic research in plant biotechnology to improve and diversify Canadian industry and to improve Canada's competitive position in the global agricultural marketplace.

PBI research is organized in three domains important to the development of agricultural biotechnology in Canada:

- Strategic technologies: the development of platform technologies to support plant biotechnology research and provide Canadian industry and institutions with freedom to operate strategies
- Crop Metabolic Modification: the study and development of strategies to modify plant metabolism to improve nutritional and utilization potential and value
- Crop Performance: modification of plant performance in response to environmental and biological stresses, improving crop productivity and efficiency.

PBI's main research areas include: Brassica technology; cereal biotechnology; legume biotechnology; gene expression; growth regulation; promoter technology; and seed oil modification. Transgenic plant and DNA technologies help the Institute develop novel systems to analyze and manipulate genes, leading to state-of-the-art technologies and crop development.

PBI's continuing work in plant genomics and improved understanding of plant growth and development set the stage for the introduction of a host of new products with unlimited potential. Products resulting from this research, such as insect-resistant and herbicide-tolerant crops, are already available in the marketplace.

Under PBI's Cell Technologies Program, discoveries are made about the molecular processes that regulate cell growth and about the molecular biology of plant development. Basic aspects of plant cell growth, division and development are fundamental to understanding the cellular process that defines the utility, value and performance of all crop plants.

Plant Biotechnology Institute (Saskatoon, Saskatchewan)

Plants and robotics come together

NRC and CRS Robotics Corporation (CRS) announced a collaboration to bring the latest technologies in robotics and computer software to PBI to rapidly sequence genes and determine gene functions. The collaboration will enable PBI to use genomics data to understand and improve the genetics of wheat, barley and canola crops, to increase their productivity, quality and pest resistance.

"This cooperative effort between NRC's Plant Biotechnology Institute and CRS enabled our company to bring together expertise in computer hardware and software with expertise in molecular biology for CRS to expand into new markets."

Ralph Steedman

PRESIDENT AND CEO
CRS ROBOTICS CORPORATION

The fundamental things apply

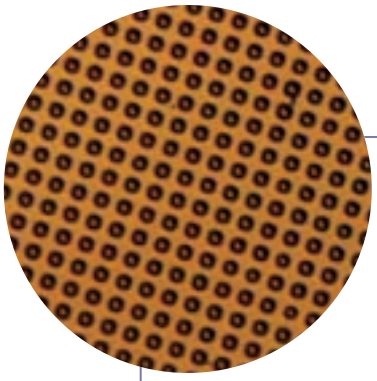
SIMS carries out long-term interdisciplinary research in selected areas of molecular science that can potentially impact entirely new or emerging sectors of the Canadian economy. SIMS focuses on moving the frontiers of molecular-scale sciences and technology out of the lab and into the marketplace.

SIMS investigates topics in molecular sciences that have the potential to generate and transform the technologies of the future. Nanoscience, bioscience, and optical science are three overarching areas of strategic focus for SIMS.

With research partners both inside and outside NRC, SIMS helps develop innovative technologies across a wide spectrum including: therapeutics, diagnostics, advanced electronics, telecommunications, precision manufacturing, optoelectronics, information sciences, and advanced materials. SIMS works with other NRC Institutes to determine how interdisciplinary science can support Canada's manufacturing, information and communications, biotechnology and other sectors.

SIMS teams offer expertise in chemical synthesis, material characterization, understanding the chemistry of biological processes, predicting material properties, and using femtosecond lasers in optics and telecommunications research applications.

SIMS has established research in functional materials, molecular spectroscopy, neutron program for materials, femtosecond science, chemical biology, molecular interfaces, organometallic and cluster chemistry, and theory and computation.



Steacie Institute for Molecular Sciences (Ottawa and Chalk River, Ontario)

New diagnostic tools for health care on the horizon

SIMS researchers successfully demonstrated micron-scale photo patterning of organic molecules on silicon surfaces, opening the door to the manufacture of advanced DNA and protein microarray devices. This could lead to new diagnostic tools, advances in proteomics and genomics research, and ultimately to better, more personalized health care and disease management.

A catalyst for innovation

The NRC Innovation Centre (IC) is the gateway to innovation focusing on B.C.'s critical technology needs, and is a hub where research programs, laboratories, scientific and technical expertise, networking and financial assistance converge. The IC offers R&D co-location opportunities and is home to important NRC resources such as IRAP and CISTI.

The mission of the IC is to develop core competencies relevant to long-term strategic technology needs of Canadian industry, with particular emphasis on integration with other players in the B.C. innovation community. The IC realizes this mission by:

- Being a fuel cell "flag ship" for Canada – an international showcase for Canadian fuel cell technologies, and an active player in the implementation of the hydrogen economy
- Using the Centre's core competencies in manufacturing systems technologies to improve the efficiency and effectiveness of the manufacturing sector
- Being a champion to link fuel cell regional clusters into a Pan-Canadian fuel cell cluster
- Being NRC's ambassador and link with all NRC strengths in B.C.

The Centre supports regional innovation and cluster development, provides support to mature and developing industries and provides a platform for collaborative research between government, universities and the industry and business communities. It uses its core competencies in fuel cell and manufacturing system technologies to meet challenges in fuel cell, hydrogen, energy and resource sectors.

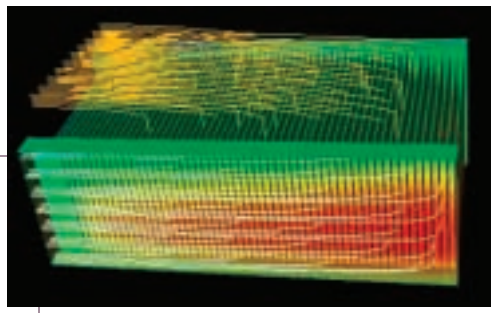
The Centre has five research groups: fuel cell technologies, sensors, controls, surface technology and manufacturing systems engineering. Approximately 80 per cent of the Centre's research and collaboration focuses on fuel cell technology development, with the remaining 20 per cent of collaborations involving manufacturing and processing sectors in projects related to wood products, value-added energy resources, process equipment and plant machinery.

The IC is the administrative home to the NRC National Fuel Cell Program, the National Fuel Cell Technology Centre (FCTC) and the partnership with Fuel Cells Canada (FCC), is the national leader of the NRC Fuel Cell Program and a leader of the Canadian fuel cell effort.

NRC Innovation Centre (Vancouver, British Columbia)

Fuel Cells Canada – NRC partnership pays dividends

The Innovation Centre's partnership with Fuel Cells Canada (FCC) has made available over one million dollars in funding for 2500 sq. ft. of specialized code-compliant laboratory space to be built in the NRC Innovation Centre. It has also extended the reach of the Centre's research program through FCC and has augmented IC's training and education efforts. In addition, this partnership has consolidated NRC's relationships with the provincial government and local industries. From FCC's point of view, NRC's support and their location in the Innovation Centre have benefits beyond the provision of services – the partnership enhanced the credibility of the organization – a factor contributing to the success of FCC's initial membership drive.



"One of the major projects in which Fuel Cells Canada is collaborating with NRC is the construction of the hydrogen-ready lab space at the Innovation Centre. This facility will be extremely beneficial to new companies entering the fuel cell technology sector, as well as those already in the field that require additional lab space for special projects."

Christopher Curtis

VICE PRESIDENT
FUEL CELLS CANADA

CHC – Canadian Hydraulics Centre (Ottawa, Ontario)

CHC is Canada's largest hydraulics and coastal engineering laboratory. It operates on a cost-recovery basis, providing physical and numerical modeling and analysis services in the general field of hydraulics to Canadian and international engineering communities. CHC specializes in coastal engineering, environmental hydraulics and cold-regions technology. CHC facilities available to industry include three large wave basins, two wave flumes, a cold room and an ice basin, which are used for physical model studies of: breakwaters, harbours, ship mooring, beach and shoreline protection, near and offshore fixed and floating structures, scour and depression of sediments, ice forces on structures, and river and estuary hydraulics.

CHC also develops and applies advanced numerical models of: wave propagation (motion and forces of both intact and broken ice covers interacting with structures) coastal environmental management; water resources; rivers and watersheds; sediment transport; pollutants; oil and chemical spill fate; water quality; environmental protection; and decision support systems.

TTC – Thermal Technology Centre (Ottawa, Ontario)

TTC engineers, researchers and technologists offer R&D services related to thermal engineering systems and advanced process heat transfer equipment to clients working in fields such as: commercial refrigeration, air-conditioning, and heat pump and process heat transfer equipment manufacturing. Working on a cost recovery basis, TTC combines its specialized technical competencies and experience with state-of-the-art test facilities, in collaboration with industry, and government departments and agencies that are particularly focused on energy and the environment.

NRC Technology Centres

CSST – Centre for Surface Transportation Technology (Ottawa, Ontario and Vancouver, British Columbia)

CSST operates as a cost-recovery NRC Technology Centre, offering clients its unique expertise and facilities to improve the productivity, competitiveness, reliability and safety of rail and road transportation equipment and systems. CSTT's expertise includes vehicular engineering research and development, computer modeling and analysis, field testing, climatic simulation and vehicle performance.

CSST methodologies have improved Canadian safety standards for tank containers carrying dangerous goods. The Centre is developing improvements to introduce North American freight rail technology and equipment in other parts of the world and designing performance evaluation methodologies to improve such things as aircraft de-icing fluids.

Mr. Wayne Clifton	President, Clifton Associates, Regina, Saskatchewan
D^{r} André Gosselin	Professeur titulaire Centre de recherche en horticulture, Université Laval, Ste-Foy (Québec)
Dr. Jacques-Yves Guigné	Chief Executive Officer - Guigné International Limited, Paradise, Newfoundland
Mr. Peter Harder	Deputy Minister Industry Canada, Ottawa, Ontario
Dr. Clarke Henry	Manager of Research - Products and Chemicals Division, Imperial Oil, Sarnia, Ontario
Dr. Ross McCurdy	Chief Executive Officer InNOVAcorp, Dartmouth, Nova Scotia
Mme Pascale Michaud	Consultant McKinsey & Company, Montréal, Québec
Mr. Gilles Ouimet	President and Chief Executive Officer Pratt & Whitney Canada, Longueuil, Québec
D^{r} Louise Proulx	Vice-présidente Développement des produits thérapeutiques BioChem Pharma Inc., Laval (Québec)
D^{r} René Racine	Professeur émérite - Département de Physique , Université de Montréal, Montréal (Québec)

NRC's Governing Council on 31 March 2001

Dr. Indira Samarasekera	Vice-President, Research - University of British Columbia, Vancouver, British Columbia
Dr. Patricia Shewen	Chair, Department of Pathobiology University of Guelph, Guelph, Ontario
Dr. Claudine Simson	Vice-President Disruptive Technology, Network and Business Solutions, Nortel Networks Inc., Ottawa, Ontario
Dr. David Strong	Victoria, British Columbia
Ms. Kim Sturgess	Calgary, Alberta
Dr. Eva Turley	Senior Scientist - London Regional Cancer Centre, London, Ontario

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Ms. Lucie Lapointe	Secretary General
Dr. Peter A. Hackett	Vice-President, Research
Mr. Jacques Lyrette	Vice-President, Technology and Industry Support