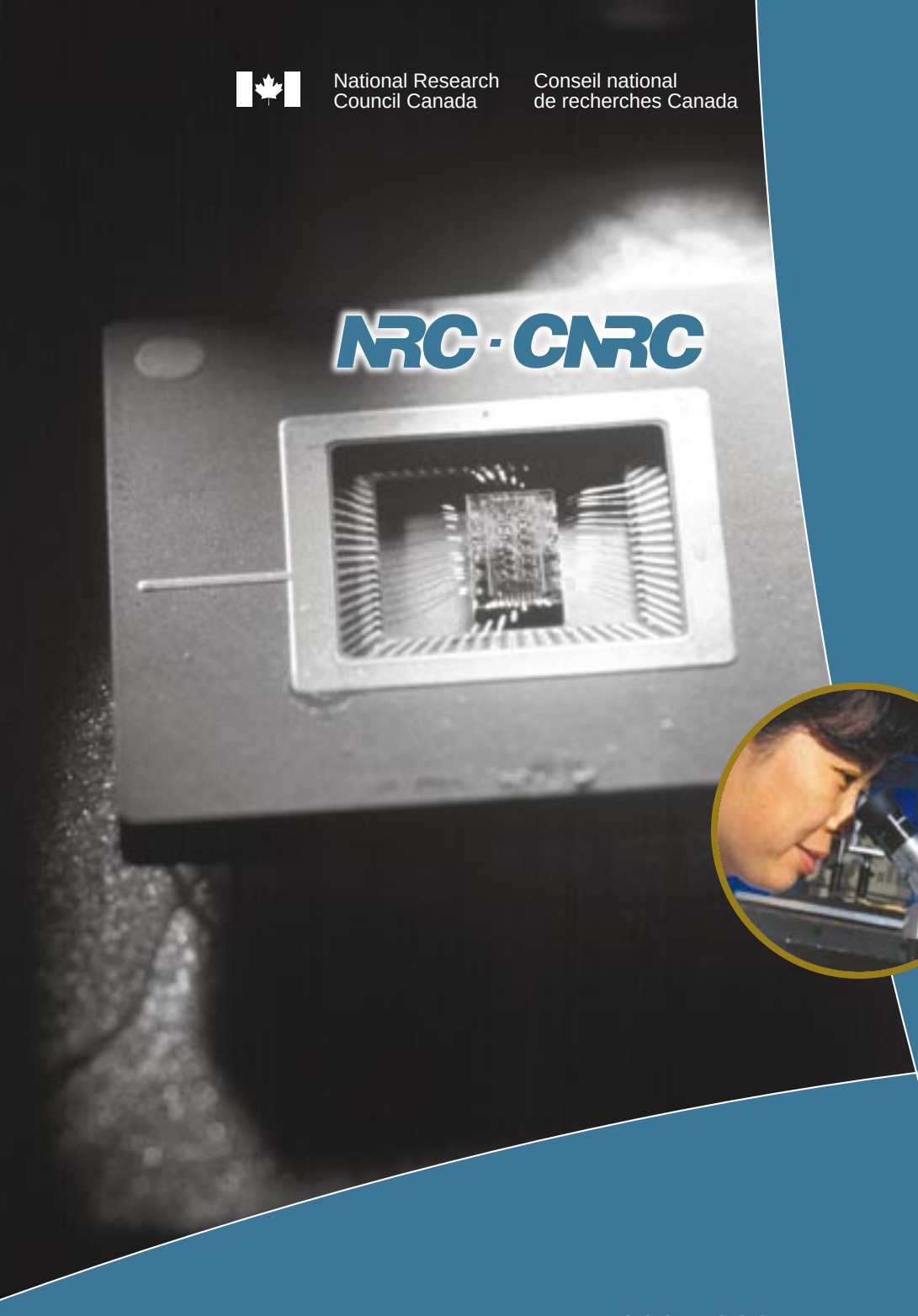
National Research Council Canada
Conseil national de recherches Canada

NRC · CNRC



ANNUAL REPORT 1998-1999

FOCUS ON THE Future

Canada

NRC – CNRC

NRC is a knowledge and innovation organization. The organization's primary business is R&D.

Since 1916, NRC's goal has been to promote scientific research for Canada, with a focus on industry. Working with other organizations, NRC provides a bridge between strategic research, economic growth and productivity.

With a workforce of 3,000 employees, NRC offers Canadian industry and the Canadian scientific community a wide variety of R&D support services. This support includes collaborative research programs, access to major facilities and installations, technical advice and expertise, hands-on training of high-quality personnel, licensing opportunities, testing, analysis, verification and calibration services and innovation activities, such as incubator facilities and access to S&T information.

In laboratories and offices coast to coast, NRC's specialized staff work in key technological areas supporting Canadian industries which have the potential to make an impact on Canada's competitiveness. NRC conducts research in three strategic technology areas: biotechnology, manufacturing and information and communications. In addition, NRC carries out research in the following areas: aerospace, construction, ocean technology, national measurement standards, surface transportation, and coastal and environmental hydraulics. NRC provides for the nation's astrophysical observatories and a number of national science facilities and continues to explore frontiers in molecular science research, which will lead to the next generation of scientific applications.

More recently, NRC has placed increased emphasis on innovation, transforming its know-how and technology into products and services for the marketplace. NRC works across the innovation spectrum to help build the Knowledge-Based Economy, strengthening innovation systems at the regional and national level by linking together all the players in innovation through targeted community innovation strategies.

NRC also supports innovation through its Industrial Research Assistance Program (IRAP). IRAP transfers knowledge, advice and technology to the SME community and delivers the Canadian Technology Network (CTN). NRC's Canada Institute for Scientific and Technical Information (CISTI) is Canada's largest resource for S&T and medical information.

Cover description:

Applying innovative, chemical sensor technology on a micro-scale, NRC has patented new functional materials that can be integrated with silicon chip circuitry. The result – smart, robust chemical sensors for gas and vapour detection.

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VISION

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 focused research, in collaboration with industrial, university and government partners, to develop and exploit key technologies;
- providing strategic advice 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.

AT NRC, TOMORROW IS TODAY – A MESSAGE FROM THE President

How do you accurately capture a 12-month snapshot of an organization that is working on tomorrow's research today? This is one of the interesting dilemmas NRC faces yearly at annual report time.

At NRC, tomorrow is today. From critical milestones like the first heart pacemaker to last year's vaccine for infant meningitis, an "overnight success" story based on 25 years of research, NRC continually distinguishes itself by the ability to mine the future for today's technological breakthroughs.

As you read this report, NRC's 16 research institutes and three technology centres are working on new technologies that Canadians will take for granted in the next decade. The fuel that drives us forward is innovation.

The Innovation gap

At NRC, we define innovation as the creation of ideas and the application of those ideas into new products and services. This complex, interactive, non-linear process can take years or even decades to bear fruit. Improving Canada's capacity to innovate is a key factor in increasing the country's productivity and, therefore, our economic growth and prosperity.

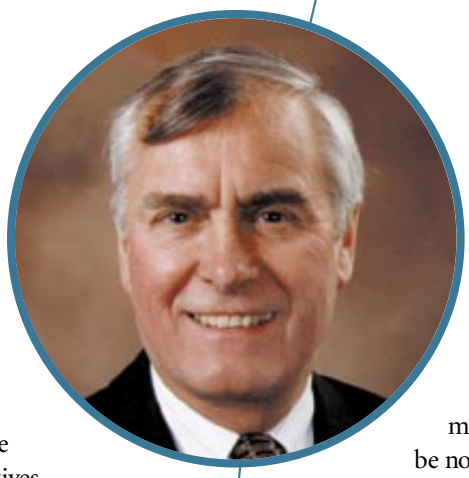
Historically, Canada has excelled at creating ideas and building its knowledge base, but has been less effective at transferring that knowledge into the marketplace. This "innovation gap" means that the path from breakthrough discovery to commercialization and financial pay-off often becomes a high-stakes gamble.

Both ends of the spectrum: a knowledge and innovation organization

NRC is shortening the odds and tackling the innovation gap by focusing on strategic R&D and technology transfer: investing in areas of potential economic return to the country, contributing to training the people and developing the links necessary to exploit these areas. We actively address both ends of the innovation spectrum to develop products and services through a full array of innovation activities geared for the marketplace.

From the knowledge creation end of the spectrum, this annual report describes how our Steacie Institute for Molecular Sciences (SIMS) has developed a model that solves a 3,000 year-old scientific mystery, while serving, at the same time, as a rich feeder stream for applied research conducted in other NRC facilities.

Meanwhile, at the application end of the spectrum, our Industrial Research Assistance Program (IRAP), the Canadian Technology Network (CTN), and the Canada Institute for Scientific and Technical Information (CISTI) continue to add tremendous value as springboards of technology transfer, commercialization and industrial innovation for small and medium-size businesses.



National scope – community presence

In the fertile medium found between these poles, NRC's innovative research partnerships, cooperative agreements, hands-on training initiatives, "incubator" facilities, and technology spin-offs all contributed substantially in 1998-99 to fill the country's innovation needs.

In a country like Canada, innovation must spring from more than one central source, if it is to succeed. NRC has developed a national infrastructure for R&D by putting high-quality jobs and first-class resources in Canadian communities across the country, linking the facilities and services that support universities, government and the private sector. The highlights of this report are conclusive: These links, nurtured by our institutes and programs, with businesses, universities, and governments at local and regional levels, are leveraging the critical mass necessary to create world-class centres of expertise that lead to economic growth.

Strategic pressure points

NRC continues to be guided by its Vision as our organization builds on past and present successes while shaping the future. Being on the leading edge means constantly looking ahead to identify opportunities for the development of future applications for Canadians. NRC, in consultation with industry and other partners, has identified five strategic initiatives, each critical to Canada's economic growth in the next century and is working with partners to define and implement them.

Clearly, the road to Canada's future level of productivity and prosperity is paved with the kind of innovation that spans a great many divides. And NRC is striving to be nothing less than the country's prime catalyst in the development of an innovative, knowledge-based economy for Canada through science and technology.

Closing the gap

When it comes to generating national wealth and economic growth, knowledge and innovation are as important as financial capital or natural resources. Canada has the opportunity to play a leading role in many areas of today's and tomorrow's knowledge-based global economy. The many successes, initiatives and innovations, highlighted in this report, demonstrate that NRC is well positioned to play a pivotal role in meeting that challenge.

Arthur J. Carty

Arthur J. Carty

TAKING OUR VISION INTO THE Future

NRC's Vision to 2001 is our commitment to play a leadership role in the development of an innovative knowledge-based economy through science and technology. The Vision statement emphasizes four elements:

- research excellence for the advancement of knowledge;
- focused research and partnerships in key technologies;
- entrepreneurship in knowledge and technology transfer and
- integration of Canada's system of innovation.

This Annual Report for 1998-99 highlights our successes in achieving these goals. It showcases the creativity and ingenuity of NRC researchers in discovering new scientific ideas and developing improved technological processes. The Report illustrates their determination to continually break new ground.

While the Annual Report focuses on accomplishments, these successes belong to all NRC employees. From research teams and administrators to the full range of support and corporate personnel who underscore their efforts – it is *people* who make possible our research excellence and our delivery of services and programs to clients across Canada.

"The NRC of today is dramatically different from what it was just five years ago, and, in another five years' time, will have undergone yet another metamorphosis to keep up with the relentless pace of change."

Dr. Arthur J. Carty
President

Building on the strengths of its people, NRC leverages its ability to fund new projects through partnerships with universities, the private sector, and other collaborators of public-sector research.

NRC has identified five strategic areas of opportunity, key to Canada's science and technology development and to its future prosperity:

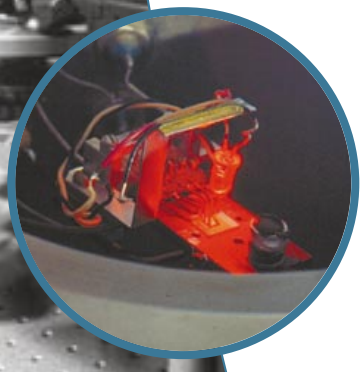
- Genomics
- Fuel cells
- Optoelectronics prototyping facilities, to serve researchers and small and medium-size enterprises (SMEs)
- Canada's aerospace research infrastructure
- The Scientific Knowledge Network.

NRC identified these strategic areas in consultation with industry and other partners. They are part of our ongoing effort to blaze the trail and to direct our investment in the national research infrastructure to new and emerging sectors, where Canada can become a world leader.

As we believe the following pages make clear, investment in S&T research and innovation pays off for all Canadians.

◀ Transistors undergo high frequency testing in the Device Physics Lab.

▼ A transistor is tested under illumination.



ADVANCING THE FRONTIERS OF Knowledge

"Knowledge is an unending adventure at the edge of uncertainty."

Jacob Bronowski
English historian and mathematician

NRC is first and foremost a research organization. Our core business is medium- to long-term research. Many of our major successes over the years spring from a long-term commitment to R&D in a key area of science and technology. Our world-class national facilities provide unique elements of the Canadian S&T infrastructure, in such fields as biotechnology, aerospace, ocean engineering and astrophysics.

Again this year, exceptional researchers in our institutes received recognition by their peers for blazing new pathways to understanding the world and the universe. As these developments are in areas of strategic importance, they feed directly or indirectly into future applications for products and services.

Among the highlights of 1998-99 are the following:

■ Researchers at the Steacie Institute for Molecular Sciences (SIMS) have solved a 3,000 year-old scientific mystery about how metal alloys form and what their properties are. Their theory allows researchers to predict what structures can exist for a given alloy compound (such as potassium and silver). This theory may have important applications in the design of new alloys for the aerospace industry and for other industries, where high strength and unique properties in manufacturing materials are required.

■ John Croll, a Research Test Pilot at the Institute for Aerospace Research's (IAR) Flight Research Laboratory was awarded the Canadian Aeronautics and Space Institute Trans-Canada (McKee) Trophy, for outstanding achievement in the field of air operations. He is especially noted for his role as one of the principal architects of the Canadian Runway Friction Index, which will lead to a major improvement in the safety of takeoffs and landings in poor weather conditions.

■ The Herzberg Institute of Astrophysics (HIA) led a collaboration with the Canadian Space Agency, Natural Resources Canada, the University of Calgary, and CRESTech, to connect Canadian-developed S2 recording systems to a global network of radio telescopes and a space antenna. HIA developed and operates a correlation centre that processes the data recorded from this network. The result is effectively a single radio telescope larger than the Earth. Capable of higher resolution than any other telescope, it is used for studies of the cores of active galaxies, pulsars and masers. The S2 system also precisely measures the separation of radio telescopes across Canada. The resulting national network of reference positions will support highly accurate GPS applications and contribute to the evaluation of earthquake hazard and the monitoring of global change.

■ Scientists from NRC's Steacie Institute for Molecular Sciences (SIMS) were honoured by the Royal Society of Canada. James K.G. Watson, Fellow of the Royal Society of Canada (FRSC), received the Henry Marshall Tory Medal (Chemistry) for outstanding research. Dr. Watson is especially noted for his original contributions to almost every aspect of molecular spectroscopy. Danial D. M. Wayner was awarded the Rutherford Memorial Medal (Chemistry) for outstanding research in his field. Dr. Wayner's research has had a broad impact on the entire fields of physical organic chemistry and electrochemistry. Dr. Robert Wolkow has been at the forefront of the increasingly important field of scanning tunnelling microscopy (STM) and atomic-scale surface processes for more than 10 years. Dr. Wolkow received the Rutherford Memorial Medal (Physics) for outstanding research in that field. This is the first time that these Physics and Chemistry medals have been awarded to individuals from the same research team in the same year.

◀ Downstream processing at BRI's pilot plant.

▼ Feed system at the pilot plant.

■ In 1999, the Royal Society of Canada named four NRC scientists as Fellows of the Royal Society of Canada's Academy of Science, bringing the total number of FRSCs at NRC to five. Among the new Fellows is Dr. James J. Beaudoin, of the Institute for Research in Construction (IRC), a recognized authority in the field of cement science. Dr. Beaudoin has gained international acclaim for his patented invention, electrically conductive concrete. He was the 1998 Copeland Award winner for outstanding contributions to cement science.

■ A second FRSC is Dr. James F. Whitfield, of the NRC's Institute for Biological Sciences (IBS), who has made outstanding contributions in life sciences research. One such contribution is Dr. Whitfield's pioneering work

on the importance of calcium and cyclic AMP in cell replication, and identifying differences in the regulation of proliferation in normal and cancerous cells. In 1998, Dr. Whitfield received a Gold Medal Award from the Professional Institute of the Public Service of Canada.

■ A third FRSC is Dr. Harold J. Jennings, principal researcher at IBS. Dr. Jennings has been recognized internationally for his outstanding achievements in the field of synthetic vaccine technology. His development of glycoconjugate vaccines for the prevention of bacterial infections in children has resulted in 13 U.S. patents, including the first conjugate vaccine to fight against group B meningoccocal bacteria. Dr. Jennings is a Fellow of the Academy of Science, the Chemical Institute of Canada, and the Infectious Disease Society of America. He was also presented with a Gold Medal Award by the Professional Institute of the Public Service of Canada (PIPSC) June 14, 1999. Dr. Jennings received high praise from the Senate for this award and for his efforts over the last 30 years.

■ The fourth Fellow is Dr. David Lockwood (IMS), an internationally recognized authority on the optical properties of solids. His outstanding work in optical emission due to quantum confinement in semiconductor nanostructures culminated in the definitive observation of the effect, whereas previous efforts throughout two decades had proved inconclusive. Dr. Lockwood has been appointed to many international committees and editorial boards. He is a Fellow in the American Physical Society.

■ Wing Sung, of IBS, received the Applied Research Award from the Ottawa Life Sciences Council, November 17, 1998. The award recognizes outstanding contributions to Ottawa's life sciences sector. Dr. Sung's contributions in developing advanced xylanase enzymes for the Canadian pulp and paper industry are incorporated into Iogen Corporation's technology for the bleaching of kraft pulp. Dr. Sung's collaboration with Iogen has been extended to engineering enzymes to produce an alternative fuel.

■ Jan Dubowski, Senior Research Officer at NRC's Institute for Microstructural Sciences was elected a Fellow to the International Society for Optical Engineering (SPIE) in 1998. Dr. Dubowski received this honour for his work in laser applications to materials and laser material interactions.

■ Dr. Norman Jones, a retired NRC researcher, became an officer of the Order of Canada April 14, 1999. Dr. Jones examined the use of infrared light for the analysis of molecules and, in 1955, co-wrote an article on the technique. The article became required reading for graduate students and organic chemists. While at NRC, Dr. Jones brought 37 post-doctoral graduates from overseas for two-year terms in Ottawa to work under his supervision.

■ Stephen Jones, Senior Research Officer at the Institute for Marine Dynamics (IMD), was presented with the 1999 Admiral Award by the city of St. John's. The award recognizes local citizens who have contributed to the economy of the city each year. Dr. Jones was instrumental in bringing the Offshore Mechanics and Arctic Engineering Conference to St. John's this year.

■ Researchers at the Plant Biotechnology Institute (PBI) made significant progress in altering secondary metabolic pathways in plants. Their research allows modification of several nutritional and performance characteristics of plants, with great potential for the agri-food industry. Modification of metabolic pathways through genetic engineering is a significant step towards improving, altering or enhancing various metabolites in higher plants, including compounds of nutritional value. For example, PBI has achieved excellent results in reducing antinutritional agents such as phytic acid and sinapine in canola seeds, to increase the nutritional value and digestibility of the canola meal.

■ The Biotechnology Research Institute (BRI) signed collaborative agreements with Gesellschaft für Biotechnologische Forschung, a key German research institute, for joint research in a number of areas. Areas include recombinant proteins, the impact of reactor environment on gene product quality and the production of labelled biomaterials for R&D purposes. These agreements also provide for personnel exchanges and training opportunities for graduate students.

■ Dr. Henry H. Mantsch, Head of the Spectroscopy Group at the Institute for Biodiagnostics (IBD) received the prestigious Ionnes Marcus Marci Medal from the European Society for Spectroscopy. The medal is given to a few select scientists who have made outstanding achievements in the field. Dr. Mantsch's achievements have been in the specific field of biomedical spectroscopy. As both researcher and research manager, Dr. Mantsch has advanced the knowledge of spectroscopy to the point where it is an important emerging modality for disease diagnosis.

International links

NRC is one of Canada's most effective links to science and technology (S&T) development bodies around the world. Through its vast international S&T networks, NRC levers its resources and accesses both information and the best minds and facilities in the world. We build bridges for introducing Canadian firms to investment and technology-based joint venture opportunities in new markets.

Again in 1998-99, NRC's International Relations staff, working with the Industrial Research Assistance Program (IRAP), the Canada Institute for Scientific and Technical Information (CISTI) and research institute staff and managers, played a key role in the management of NRC's S&T cooperation relationships with selected countries around the world. This work resulted in the formation of a number of technology-based joint ventures between Canadian SMEs and firms in Asia, including new venture financing. Examples include the CISTI-STIC (Taiwan's Scientific and Technology Information Centre) agreement and the IRAP/CTN-LIPI (Lemgaga Ilmu Pengetahuan Indonesia, Indonesian Institute of Sciences) initiative to establish a Canada-Indonesia Technology Network. In addition, new, high-quality collaborative research projects received joint funding in France, the UK, Taiwan and Singapore. These initiatives promote collaborative research in strategic areas of mutual interest, which in certain cases, include industrial participation on both sides.

In building these strong international S&T networks in other countries, NRC builds reputation, profile and credibility that facilitate other Canadians to develop business opportunities.

Here are a few European highlights:

- Revitalization of NRC's relationship with France's Centre national de la recherche scientifique led to the approval of 10 new joint projects of a total value of $10 million in the key sectors of biotechnology, information and communications technology, manufacturing technology and molecular sciences.

- The signing of an MOU with the Association pour la valorisation de la recherche (ANVAR) led to the creation of links and partnering between Canadian and French SMEs in the agro-food and biotechnology sectors. Two successful partnering meetings were held in Montréal and Toronto.

- With the British Council, NRC announced the first awards for Cooperative Research Projects and Researcher Exchange Awards. These awards, from a newly established joint S&T fund, were chosen from 15 proposals and total more than $1 million.

Also in 1998-99, NRC strengthened relationships through work under memoranda of understanding with various Asian partners, as follows:

- With the National Science Council of Taiwan, NRC expanded cooperation through a number of focused workshops on aerospace, next-generation Internet technologies and biomedical sciences.

- NRC/IRAP hosted a study session for a Taiwanese task force on the concepts of IRAP and CTN. As a result, the Taiwanese government has decided to develop an S&T extension service for SMEs, based on the IRAP model.

- NRC jointly organized with Taiwan a highly successful APEC Research and Development Leaders Forum on communications technology, which drew broad representation from APEC economies, and included government, industry and research institute representatives.

- NRC/IRAP organized and led a number of technology missions to South East Asia, including Korea, Singapore and China. In Singapore, NRC's Vice President of Technology and Industry Support, Mr. Jacques Lyrette, signed four cooperative research agreements on behalf of NRC on the occasion of the opening of Canada House by the Prime Minister of Canada. In addition, NRC led a number of Canadian companies to an industrial investment seminar, providing them with opportunities to form technology-based joint ventures and access venture financing.

- NRC/IRAP continues to help build and connect innovation support services in Indonesia along the lines of the Canadian Technology Network (CTN). At the same time, this network is being connected to CTN, its counterpart in Canada, to promote market access to mutually beneficial business ventures for both sides. The Canada-Indonesia Technology Network (CITN) receives financial support from the Canadian International Development Agency (CIDA). This project, which received special attention from the President of Indonesia, has been very successful and is held up as a model for other projects in Indonesia.

Collaborating

ON KEY RESEARCH AND TECHNOLOGIES

NRC conducts focused strategic research in areas with high potential for return on investment. Our research programs concentrate on fields in which companies require constant innovation to stay competitive, such as biotechnology, information and telecommunications, and manufacturing.

Canada has few large R&D-intensive firms in which the people engaged in medium- to long-term strategic research can interact with the people who develop products and services. Yet discussion and exchange between these two contributors are vital. They are the stuff of which innovation is made. In NRC's case, its national network of institutes and IRAP offices provides a wealth of opportunities for partnership with universities, industry and with other government agencies, at local, provincial and national levels.

Through these partnerships and links, we can cut costs and share risk, increase flexibility and responsiveness, seize opportunities, enhance exposure, pool resources, stimulate novel thinking, create synergies and realize new possibilities. Together, we leverage the critical mass necessary to create world-class centres of expertise.

"The most important thing we did was to bring diverse companies together, each one working on projects that were important to their commercial and business development, but all working collaboratively toward a common objective."

Alex Mayman
President of The Optical Processing and Computing Consortium of Canada (OPCOM)

Here are a few of the collaborative successes for 1998-99:

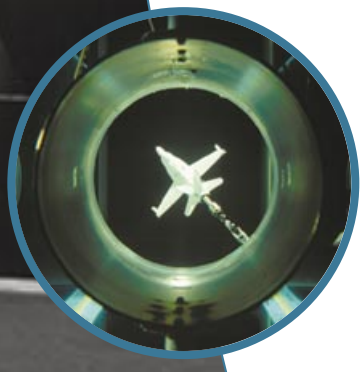
- The Biotechnology Research Institute (BRI), representing the federal government and NRC, joined the Québec government's Mineral Research Centre and the City of Montréal to implement the Montréal Centre of Excellence in Brownfields Rehabilitation (MCEBR). The centre promotes, supports and implements R&D and experimental programs in soil decontamination and site rehabilitation. A number of urban areas, such as Montréal, face soil contamination inherited from past industrial or commercial activities. MCEBR provides scientific and technical support and specialized infrastructures to partners in the private and public sectors who wish to develop and demonstrate new methods and technologies. These areas of knowledge are key to Canada's economic advancement.

- The Acoustical Standards Program, at the Institute for National Measurement Standards (INMS), collaborated with Rising Sun Productions Ltd. to develop the revolutionary Global Sound Microphone System (GSMS). Described as "brilliant" by motion picture and recording studio sound engineers, the surround-sound technology offers dramatic improvements in spatial authenticity and in the ease and cost of production.

- The Optical Processing and Computing Consortium of Canada (OPCOM), an NRC-led strategic precompetitive alliance of companies, has developed one of the most advanced, high-speed Small Area Networks (SAN) in the world, as well as new video applications which harness the potential of these bandwidths. The prototype fibre-optic network is being used to develop and test the next generation of photonic devices, and has already resulted in multiple patents, licensing agreements, and technology products for member companies, such as OPREL Technologies Inc.

◀ IAR acoustics researchers are working with de Havilland Inc. to reduce cabin noise in the Dash 8. Propeller noise simulations are generated by the bank of speakers.

▼ Aerodynamic testing in the IAR water tunnel.



■ The Institute for Research in Construction (IRC) has built the first Dynamic Roofing Facility (DRF) in North America. IRC undertook this project jointly with a consortium of manufacturers, trade associations, researchers, building owners and managers. DRF is expected to help reduce roof system replacement and insurance costs, increase efficiency of design and construction and help exporters meet international certification standards.

■ The Industrial Materials Institute (IMI), is launching a multi-partner research program, focused on the manufacturing of parts made of composite materials that use continuous-fibre thermoplastics. Among IMI's 11 partners are Bombardier, ADS Composites and Bauer.

■ The year 1998-99 was the 10th anniversary of Industrial Materials Institute (IMI)'s successful industry partnership program. In the program are 87 industrial and university partners, working in eight distinct areas, such as plastics blow moulding, polymer blending and surface technologies.

■ The Institute for Aerospace Research (IAR) is working on an international project, with Bell Helicopter Textron of Fort Worth, Texas and Stewart-Hughes Ltd. of the UK. The focus is on a worry-free handling system, which would employ tactile cueing through the controls, to assist the pilot in handling the aircraft within its performance limits. Funded in part by the Department of National Defence and by the U.S. National Aeronautics and Space Administration, the project includes fundamental research and prototype testing, using NRC's Bell 412 HP helicopter.

■ Polymer researchers at the Institute for Chemical Process and Environmental Technology (ICPET) have developed specialized polymers for biomedical applications that are biocompatible and water-soluble. These characteristics, together with strength, durability and flexibility of design, make these "star-shaped" polymers ideal for cell therapy applications. Such synthetic materials are being investigated as methods to promote human organ regeneration and as new drug delivery mechanisms. The work is carried out under the NRC/NSERC Research Partnership Program, with the University of Victoria and two Québec-based companies, Organogel Canada and Polymer Source Inc.

■ The Institute for Marine Biosciences (IMB) collaborated with Kinetek Pharmaceuticals Inc. to study the rapidly growing field of proteomics and to discover drugs which target protein kinases that have been shown to play a causative role in cancer and diabetes.

■ The Institute for Biodiagnostics (IBD) and the Institute for Biological Sciences (IBS) collaborated with Astra Canada and the Universities of Manitoba and Calgary and Memorial University on novel pharmaceutical compounds for the treatment of stroke. Researchers at IBD are using MRI technology to distinguish between damaged and undamaged brain tissue, to determine the effectiveness of novel compounds and speed the drug development process.

■ The Integrated Manufacturing Technologies Institute (IMTI), Regal International in Windsor and Siemens Automotive found a novel approach to develop the tools wanted by Siemens for a particular purpose. In the words of Paul Daly, Siemens' Director of Technology, Powertrain and Air Induction, the approach Siemens adopted constituted a "paradigm shift". Normally, Siemens, as a need generator, would assess various ready-made products and buy from a technology provider the tool required to meet this need. In this case, Siemens approached NRC and several tool companies with a hypothetical question: "What if there were a tool (technology) that could (perform x and y)? " Siemens then chose NRC and Regal to design and make a tool that would meet its need. With this approach to problem-solving, Siemens became not only the party to generate the need for a technology but also, with the help of NRC and Regal, the party to provide it.

PERFORMANCE DATA – 1998-1999

Collaboration

Formal Collaborative Agreements	684
Formal Collaborations with National Organizations	252
Formal Collaborations with International Organizations	116
Participation in National Committees	545
Participation in International Committees	640
New Collaborative Agreements signed during the year	344
Dollar value of new agreements	$85.6 million
Cash contributions of partners in new agreements	$26.9 million
In-kind contributions of partners in new agreements	$37.9 million

TRANSFERRING KNOWLEDGE TO

a New Generation

OF ENTREPRENEURS

Information and knowledge are the new currencies upon which value-added jobs and high standards of living are built. NRC focuses not only on the creation and application of knowledge, but also on the transfer of technology. We facilitate the dialogue between the creators of knowledge and those who apply that knowledge.

NRC's impact and successes are based within its system of networks – regional, national and international – providing national reach and presence in local communities. Through research institutes and IRAP, NRC is a catalyst in communities across Canada, providing substantial federal visibility and support for regional and local economic development.

NRC offers support mechanisms for innovative firms, including technology diffusion and commercialization. We offer risk capital and financing for new enterprises. Entrepreneurship at NRC is about finding new commercialization strategies for the knowledge and technology we develop in our labs. It is about pursuing those strategies for the benefit of Canada. One avenue for commercialization is spin-off firms, created by NRC employees or others, for the purpose of exploiting technology from NRC. The rate of creation of spin-offs has risen from an average of one per year to five per year.

"The National Research Council is ... ideally positioned to bridge the gap between the basic research undertaken in universities and the development and commercialization in industry."

Report No. 19 of the Standing Committee on Industry, June 1999

Company (No. of employees)	**Business Area**
AmikaNow!™ (4)	'Seamless messaging'
Crosslight Software Inc. (5)	Specialized software
Diaspec Holdings Ltd.	Non-profit holding company
EDM Co. (2)	Electrical motors
IatroQuest Corp. (7)	Ultra-high throughput sensing/ diagnostic systems
IMRIS (12)	MRI systems and magnetic resonance for veterinarians
IRIDIAN Spectral Technologies Inc. (5)	Thin film technology for the telecommunications industry
Nir-Vivo (3)	Infra-red spectroscopy med-devices
Nova-Science Pharma (4)	Biocalorimetry services
Occell Inc. (3)	Anti-tumour agents/compounds
Pharma Laser Inc. (4)	Laser-induced plasma spectroscopy
SiGe Microsystems Inc. (22)	Semiconductor devices for RF applications
Sussex Research Laboratories (4)	Diagnostic chemicals/targets
Toth Information Systems Inc. (2)	Products/services for maintaining crystallography databases
Visimag Inc. (4)	Laser scanning services
Vitesse (Re-skilling) Canada Inc. (2)	O-Vitesse program expansion nationwide
VLN Advanced Technology Inc. (5)	Ultrasonic pulsed waterjet systems/applications

◀ Dimensional Metrology: A complex jet engine component is assessed using the Institute for National Measurement Standards (INMS) coordinate measuring machine.

▼ A bank of optical discs is coated with multi-layer thin films in NRC's Optical Component Laboratory of INMS.

To transfer technology and deliver services to clients more effectively, NRC continues to develop a more entrepreneurial corporate culture. A recent collaborative agreement with Inno-centre of Montréal provides new NRC spin-off companies with mentoring, market analysis and business planning support. Inno-centre, a Montréal-based consulting group, specializes in coaching entrepreneurs who have scientific backgrounds.

The following examples provide evidence of NRC's continued support for entrepreneurship:

- IRAP increased its total contributions to SME projects to more than $75 million, up from $68 million last year, and spent close to $120 million in support of the innovation activities of Canadian firms.

- An IMI spinoff company, Tecnar Automation Ltd., will commercialize a second IMI technology. DPV 2000 is a quality-control instrument for use in the thermal spray industry. The technological advances are undergoing tests at several universities and private research organizations for eventual transfer to industry. Earlier, the company commercialized IMI's arc-welding process and exports the technology to several countries.

- Thanks to advice and early financial assistance from NRC, including IRAP, and to the practical scientific advice of IMB's Dr. James Craigie, Acadian Seaplants Limited (ASL) has evolved into a technology-rich, award-winning Maritime company. ASL employs about 130 full-time staff and 1,000 to 1,100 seasonal workers. The company produces sea vegetables and seaweed extracts, used in feed lots and by the brewing industry. Company sales, world wide, are estimated at $15 to $20 million annually. Dr. Craigie received NRC's 1998 Industrial Partnership Award, while Federal Partners in Technology Transfer (FPTT) named him Innovator of the Year.

- NRC's Institute for Information Technology (IIT) and GIE Technologies Inc. captured the Association de la Recherche Industrielle du Québec (ADRIQ) award for technology transfer for the Laser Vision System (LVS). The system uses laser-based technology to obtain accurate, quantitative data about surface conditions of roads and highways.

- In interactive technology, the Institute for Information Technology (IIT) licensed CLUSTIFIER™ to PC Docs/ Fulcrum Technologies, a recent acquisition by Hummingbird Communications Limited, a North York, Ontario-based international company, as an advanced component of its Knowledge Network product. Licensed to Tetranet Inc. of Kanata is IIT's EXTRACTOR™.

- Two former employees of the Institute for Biological Sciences (IBS) created the IatroQuest Corporation to develop ultra-high throughput sensing and diagnostic systems for commercial and military applications. Their work is based on a patented technology, arising from a series of NRC and non-NRC platform technologies.

- Using the licensed technology they had developed at the Institute for Microstructural Sciences (IMS), two former NRC scientists started a company, IRIDIAN Spectral Diagnostics Ltd. After only one year of operation, the company is already a success.

- A researcher at IIT launched AmikaNow!™, while a technology developed at the Industrial Materials Institute (IMI) was used to start Pharma Laser Inc., a fast-growing Montréal-based company.

PERFORMANCE DATA – 1998-1999

Entrepreneurship

Patents Held	1,070
Patents Issued	61
Patent Applications	88
Licences Issued	56
Licencing Revenue	$1.7 million

BUILDING Innovation CAPACITY

An innovative economy demands a strategy that mobilizes new combinations of people, capital, resources and ideas.

We need new partnerships and relationships to capture the changing ways in which R&D happens, both in Canada and around the world. The growth of the economy of today and tomorrow depends on the ability of economies to coalesce around clusters of firms and centres of research and innovation. Supporting these centres is an entire infrastructure of people, institutions, programs and public policies – all promoting the transfer of knowledge and technology.

To these elements, we add the public and private partnerships that support and finance innovation and a pool of skilled human resources.

NRC is experienced in helping build innovation systems, especially at the community level. In 1996, we, with the Government of Saskatchewan, formed a steering committee that drew together leading individuals from the private sector, from federal, provincial and municipal governments and from universities and financial institutions. The objective: to develop a blueprint for mobilizing Saskatchewan's R&D strengths into a new innovation system that would take the province into the next century. Two years of study and research later, committee members organized an innovation forum of more than 250 people, from companies, universities, technical institutes, governments and financial institutions. Following further research and consultation, the committee delivered a blueprint to build Saskatchewan's innovation system, one that will guide the province in achieving its economic and social goals in the next century.

Canadian researchers generate knowledge at a rate comparable to that of their colleagues in other countries. Yet the fact that Canada is much slower to apply that knowledge effectively is one of the reasons that the growth rate of productivity in Canada lags behind that in the U.S. Productivity is linked to innovation, which is linked to investment in R&D. Creating ideas is only the first step. It is equally important to develop ideas into innovative products and to help companies launch these into the marketplace.

"Innovation is the central issue in economic prosperity."

Michael Porter
economist

"Innovation is not something you 'fix'. It is something you must invest in continually. And investing in innovation is a key requirement in improving Canada's productivity."

Industry Minister John Manley
in an April 22, 1999 speech to the Canadian Institute of Advanced Research

NRC provides leadership and expertise in bridging the innovation gap. Through national facilities and networks, we support and expand Canada's innovation infrastructure. We provide scientific, medical and technical information through the Canada Institute for Scientific and Technical Information (CISTI), and offer both start-up and ongoing support through the Industrial Research Assistance Program (IRAP). Incubator facilities associated with institutes serve as fertile breeding grounds for technology transfer and aid the creation of vital, new companies.

One of the ways IRAP stimulates innovation is by funding pre-competitive R&D in companies. The fact that SMEs receive venture capital in the early stages of a project encourages them to embark on the risky quest to translate research into commercial products or processes. IRAP delivers the Canadian Technology Network (CTN), a Canada-wide network of related government labs and agencies, universities, community colleges, industry associations, technology centres and economic development agencies. CTN's more than 1,000 members and 250 advisors provide additional resources in technology, finance, marketing and training.

◀ Air discharge tubes are adjusted prior to testing the thermal conductivity and condensation of windows.

▼ IRC's multidisciplinary approach to fire research allows it to develop fire safety solutions that consider other important issues, such as sound transmission, indoor air quality and the environment.

Together, IRAP and CTN function as a *virtual multinational*, offering SMEs single-window access to S&T research, financing and related business services.

Here are a few more innovation-building highlights in 1998-99:

■ NRC launched Vitesse (Re-skilling) Canada Inc. This is a new, national, not-for-profit organization, which has evolved from the Ottawa Venture in Training Engineers and Scientists in Software Engineering (O-Vitesse) program. Although national in scope, Vitesse-Reskilling is adapted to local community needs. In collaborating with local universities and industry, the program retrains science graduates from a variety of disciplines as software engineers. A combination of coursework and work placements prepares the graduates in just 16 months.

■ Kautex-Textron, a Windsor-based company, worked with the Industrial Materials Institute (IMI) specialists to perfect a mould for a plastic gas tank for the automotive industry. With the help of IMI researchers and IMI's unique blow moulding simulation software, Kautex can produce a lighter product that, in using less material, reduces production cost.

■ *Virtual Environment Technologies* (VET) Centre, developed by the Integrated Manufacturing Technologies Institute (IMTI) with the collaboration of SGI Canada and Electrohome Diesel, fosters the adoption of visualization by Canada's manufacturing industry. The VET Centre enables companies to design, prototype, test and fabricate new concepts, increasing productivity by eliminating the need for making costly physical prototypes. This capability supports the industrial need for fast introduction of new products to the marketplace.

■ The Biotechnology Research Institute (BRI) continues to support Montréal's leadership role in the biotechnology sector, as more companies lease space in its recently opened incubator wing, where they benefit from the contact with BRI researchers and leading-edge technological equipment. Among these companies are: Advanced Bioconcept, Base4 Bioinformatics, Bioniche, Biophage, Caprion Pharmaceuticals, Conjuchem, DSM Biologics, Hukabel Scientific, Intellivax, Lallemand, Neuroscience Pharma, NIM Biomedical, Phenogen Therapeutics, PROCREA BioSciences, ProMetic BioSciences and Theralipids.

■ The Industrial Partnership Facility (IPF), a new NRC incubator that focuses on the information and telecommunications sector, opened in 1998. Within just a few months, the IPF made an excellent start. IPF's close proximity to NRC's experts in this industry sector is a big drawing card for the spinoff and start-up companies who are its clients.

■ The Institute for Aerospace Research (IAR) is now home to the new Office of Collaborative Technology Development, jointly sponsored by the Aerospace Industries Association of Canada (AIAC) and NRC. The office will facilitate the initiation of multi-client collaborative research programs in aerospace, to be performed by industry, university and government laboratories.

■ NRC is an important partner in the construction and operation of Canadian Light Source (CLS), a long-awaited national Synchrotron Radiation Facility, at the University of Saskatchewan. Once completed, the facility will help Canadian pharmaceutical companies engineer new drugs. CSL will also help the mining sector to use advanced analysis techniques and will enhance micro-fabrication of miniature components.

■ The broad range of clients of the Canada Institute for Scientific and Technical Information (CISTI) reflects the Institute's vital importance to Canadian innovation. In many cases, only CISTI can provide large corporations, small start-up firms, universities, hospitals and independent researchers with the information on which they depend.

■ CISTI enlarged its regional presence by opening two new information centres, one in Vancouver and the other in London, Ont. The library expanded its list of services to include competitive intelligence, economic and marketing information that will enable small companies to assess technology opportunities and the appropriate climate for developing those opportunities.

The Research and Technology Development Program

NRC's Research and Technology Development Program encompasses NRC's responsibilities for performing research and development in strategic areas. The Program is organized to address key technological and industrial areas of the economy in which NRC has mandated roles and responsibilities and sufficient research and technology competencies to create a demonstrated impact on innovation. These technological and industrial areas include a number of Technology Groups and Institutes:

Technology Groups

■ The Biotechnologies Group: As federal leader in biotechnology, NRC offers facilities and expertise in key sectors of the Canadian economy, such as health, medical technologies, agriculture, aquaculture, natural resources and the environment. In this group are five NRC Institutes, the Biotechnology Research Institute, the Institute for Biodiagnostics, the Institute for Biological Sciences, the Institute for Marine Biosciences and the Plant Biotechnology Institute.

■ Information and Communications Technology Group : Since 1996-97, the Group has played a central role in producing a coordinated view of the R&D activities in the Industry Portfolio, a group of research-based agencies reporting to the Minister of Industry. The Group strongly supports regional innovation programs which target the National Capital Region, British Columbia, New Brunswick, Manitoba and Alberta. And because the Group's direct economic impact derives primarily from collaborative R&D projects, one of its important activities is to monitor and analyse technology and market trends that are critical to its strategic R&D directions. Members include NRC's Institute for Information Technology and Institute for Microstructural Sciences, which, although they share a coordinated strategy and marketing approach, operate as separate business units.

■ Manufacturing Technologies: NRC's Manufacturing Technologies Group was created in 1996 to respond more efficiently to the strategic information needs of Canadian industry in these technologies. The program is based on the following common strategic objectives:

- contribute to the competitiveness of Canadian industry through innovation and the application of technology;
- develop core competencies relevant to the long-term technology needs of Canadian manufacturers;
- support the development of a national system of innovation in manufacturing technologies and
- encourage an entrepreneurial management culture which is efficient, effective and responsive.

In this Group are NRC's Industrial Materials Institute, Institute for Chemical Process and Environmental Technology and Integrated Manufacturing Technologies Institute (London, Ont. and Vancouver, B.C.) respectively.

Since 1998, IRAP has offered precommercialization assistance through its joint venture with Industry Canada's Technology Partnerships Canada (TPC). The IRAP-TPC Precommercialization Assistance is designed to help small and medium-size firms develop or significantly improve technological products, processes, or services. The initiative, funded at $30 million annually, has enabled IRAP to help firms develop their technologies from the initial concept all the way through to the finished product. In 1998-99, 40 projects, representing all provinces and technology sectors, were approved for assistance. Seventy per cent of these involved IRAP clients.

A Saskatoon biotechnology company was the first in Canada to receive funding under the joint initiative. In October 1998, MicroBio Rhizogen Corp. received a $500,000 repayable investment to develop a novel biotechnology product for the agriculture industry. In May 1999, Biomedical Implant Technology Inc., with operations in St. Catharines, Ont. and St. John's, Nfld., received a $448,000 repayable contribution to design a dental implant system.

Together, IRAP and the Canadian Technology Network (CTN) function as a virtual multinational, offering SMEs single-window access to S&T research, financing and related business services.

STATEMENT OF Operations BY ORGANIZATION

FOR THE YEAR ENDING MARCH 31, 1998

(Dollars are in thousands)

FY1997/1998

Organization	Expenditures [1]	Income
Research Institutes	$285 184	$50 297
Industrial Research Assistance Program	102 305	53
Scientific and Technical Information	36 048	14 895
Technology Centres	8 821	6 945
Corporate Branches	91 145 [2]	5 127
Total	**$523 503**	**$77 317**

FOR THE YEAR ENDING MARCH 31, 1999

(Dollars are in thousands)

FY1998/1999

Organization	Expenditures [1]	Income
Research Institutes	$296 538	$51 273
Industrial Research Assistance Program	121 772	293
Scientific and Technical Information	38 445	17 754
Technology Centres	9 028	8 478
Corporate Branches	89 795 [2]	3 863
Total	**$555 578**	**$81 661**

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

2 Expenditures include construction projects for research institutes, managed centrally, and resources for a new Council-wide information system.

THE INSTITUTES/ PROGRAMS

BRI	Biotechnology Research Institute (Montréal)
CISTI	Canada Institute for Scientific and Technical Information
CTN	Canadian Technology Network
HIA	Herzberg Institute of Astrophysics (Victoria, 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)
INMS	Institute for National Measurement Standards (Ottawa)
IMTI	Integrated Manufacturing Technologies Institute (London, Vancouver)
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)

Technology Centres

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

"DSM Biologics and BRI enjoy a unique and successful partnership, working together to offer industrial clients a one-stop shop for both development and cGMP manufacturing needs [and] ... provides our clients with a streamlined, adaptive process that works."

Helen Paparis
Project Manager, DSM Biologics

Pilot plant, microbial fermentation.

BRI Biotechnology Research Institute (Montréal, Québec)

BRI laboratory programs respond to the changing needs of the pharmaceutical, natural resource and biotechnology communities that arise from rapid research advances in molecular biology and genetics. Established 10 years ago, BRI is the largest laboratory site in Canada dedicated to biotechnology R&D. Scientists work in three major areas, in Pharmaceutical biotechnology, Environmental biotechnology and Bioprocess sectors.

The Pharmaceutical Biotechnology Sector applies knowledge gained from molecular biology, genetics, protein chemistry and bioinformatics research to the creation of new therapeutics for the pharmaceutical and biotechnology industries.

The Environmental Biotechnology Sector develops biologically based processes for cleanup and monitoring of contaminated soils, waters and air. Research scope includes a range of activities from pollutant identification through remediation process design and development to monitoring and risk evaluation.

Facilities in the Bioprocess Sector are used for testing and optimizing pre-production microbial and mammalian cell culture processes. Scientific and engineering staff design equipment and carry out applied molecular biology research, primarily for an industrial clientele.

SCALING UP SUCCESS FOR CANADIAN BIOTECHNOLOGY

BRI's Bioprocess Sector has carved out a special niche. By leveraging its expertise in producing recombinant organisms and products through microbial, insect and mammalian systems, the Bioprocess Sector helps Canadian and international biotechnology and biopharmaceutical companies develop and scale up their bio-products and processes. The Sector provides timely, customized, high-quality, low-cost services, which help attract foreign investment and foreign companies to Canada.

The Bioprocess Sector has established a Pilot-scale Biosafety Level-2 facility. This handles the biomaterial products from Adenovirus vectors, recombinant proteins, and membrane-bound receptors. These are products used for drug screening, structural analyses and gene transfer studies.

Clients here find a wide range of services: process development, scale-up, optimization and production of purified bulk materials. The client list includes Aqua-Health Ltd., Lallemand, Merck Research Laboratories (US), Merck-Frosst Centre for Therapeutic Research (Montréal), Pfizer, and Proctor & Gamble.

The Bioprocess team entered into a working relationship with its close neighbour, DSM Biologics (previously Biointermédiaire), a fully operational Good Manufacturing Practices (cGMP) facility. When DSM needs to optimize a fermentation process, the pilot plant handles the research portion of the work. The technology is then transferred to DSM for validation and production.

"BiblioNet meets the needs of information technology and telecommunications sectors in finding information rapidly and efficiently to support both business and research communities."

Hon. Ronald Duhamel
Secretary of State for Science, Research and Development

Biblionet is a unique web-based service for researchers in the fields of information technology and telecommunications. It offers hard-to-find research results, industry information, personal service from a technical information specialist, and more.

CISTI Canada Institute for Scientific and Technical Information (Ottawa, Ontario)

This year, CISTI celebrates its 75th anniversary, proudly positioned as the largest, most comprehensive library of scientific, technological, engineering and medical information in North America. CISTI is also Canada's leading publisher of scientific journals and books.

Canadians access CISTI information services through a national network of NRC information centres, staffed by highly trained specialists. The centres help researchers and advance national R&D within such specialized fields as plant biotechnology, marine biosciences and astrophysics.

CISTI has expanded its world-wide client base to increase revenues. These additional annual revenues help CISTI develop innovative services and invest in leading-edge technologies. For example, a newly launched Product Help Desk enhances service to all clients and increases the efficiency of CISTI's internal operations.

CISTI's publishing program, NRC Research Press, offers scientists and engineers international, peer-reviewed journals and monographs for scholarly and research communication. Each year, NRC Research Press publishes 14 international research journals, as well as several books and conference proceedings. It provides online access to the 14 journals and is currently exploring new developments in value-added online technology, such as access to new databases and full-text publications.

CISTI LAUNCHES NEWEST ONLINE INNOVATION, BIBLIONET

BiblioNet, CISTI's latest Web-based research tool, integrates vast amounts of research material and database resources into a single location. In addition to the electronic information provided by BiblioNet, members enjoy links to NRC experts, the reference services of a technical information specialist and related sites approved by CISTI.

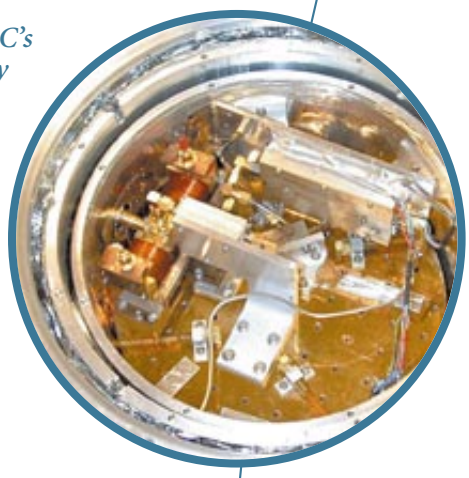
As the first online service designed for specific industry sectors, BiblioNet signifies a departure for CISTI. First to benefit are researchers and workers in information technology and telecommunications. CISTI plans to introduce a series of similar online services, targeted to specific sectors of technology, science and medicine.

BiblioNet furthers CISTI's growing expertise in the virtual library environment. This expertise grew from NRC's need to improve client services and eliminate duplication of resources.

The launch of BiblioNet moves CISTI one step closer to the development of its Scientific Knowledge Network, the world's best R&D information system and largest scientific virtual library.

"I'm very impressed with NRC's Receiver A3. It tunes very quickly and reliably. There have been no problems whatsoever associated with the instrument."

Dr. Wayne Holland
JCMT Staff Astronomer
(entered in the observing log during the initial test period)



Interior of a test cryostat used to cool very sensitive radio receivers.

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

HIA operates all astronomical observatories established by the Government of Canada and ensures the Canadian scientific community appropriate access to these facilities. The Institute is responsible for the Dominion Astrophysical Observatory (DAO) in Victoria, B.C., and the Dominion Radio Astrophysical Observatory (DRAO) in Penticton, B.C.

Through HIA, NRC is an international partner in the 3.6-m Canada-France-Hawaii optical Telescope (CFHT) and the 15-m James Clerk Maxwell Telescope (JCMT) for short-wavelength radio emission, both located in Hawaii. HIA is also an international partner in the Gemini twin 8-m optical telescopes. The Gemini-North telescope is scheduled to begin regular observing in mid 2000, while Gemini-South is under construction in Chile. These international partnerships enable Canada to be a major player in international astronomy. Indeed, a recent survey identified Canada as third in the world, behind only the U.S. and the UK in its contributions to astronomy. The partnerships give astronomers from the university community and from HIA access to large telescopes in the world's best observing locations. On high mountains in certain regions, cloudy weather is infrequent and the atmosphere is steady, permitting sharp images. Due to the absence of water vapour in the Earth's atmosphere at these high, dry, 4-km-high Hawaiian and Chilean sites, astronomers can also find great transparency to infrared and radio waves.

HIA is known internationally for the quality of the research performed by its astronomers, engineers and software specialists, and for the development of competitive and innovative technological instruments and user-oriented software. HIA is allied very closely with the academic astronomy community in Canada and works increasingly with industrial partners to help generate economic benefits from the technologies and software systems that it creates and develops.

HIA CAMERA TUNES INTO STAR-FORMING CLOUDS

Thanks to a new camera, astronomers are peering deep into the cores of star-forming clouds in our own Milky Way and to galaxies beyond.

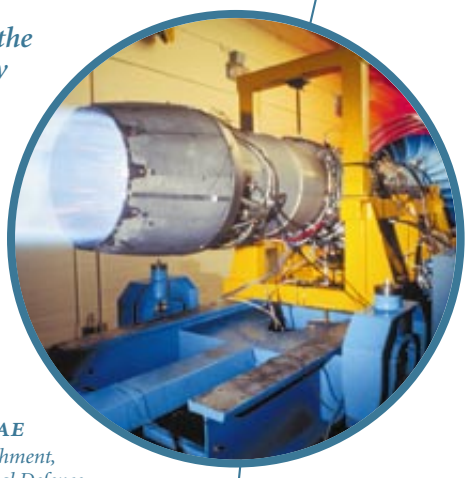
Developed by HIA's JCMT group for the James Clerk Maxwell Telescope in Hawaii, Receiver A3 is the most sensitive spectral line detector at the telescope. The camera tunes instantaneously to observe spectral lines emitted by the more than 100 different chemicals known to exist in space.

At the heart of this new receiver is a tiny superconducting electronic switch, so small that 50 switches, set side by side, would span the width of a human hair. The HIA specialists, working with skilled machinists in the Administrative Services & Property Management Branch shop, designed and built the intricate structures that house the device. The specialists assembled the supporting components into an instrument that stands about one metre tall and weighs 250 kg.

Cooled in a bath of liquid helium to a temperature of -269° C., this tiny detector is sensitive to the long wavelength infrared radiation, emitted by the vast clouds of cold, dense gas between the stars. These clouds, some containing a mass equivalent to 100,000 suns, are regions of new star and planet formation.

"(We) anticipate that the certification methodology and repair schemes will be transferred to the life cycle managers of other engine fleets, further increasing the already substantial savings to DND. And the successful certification of the novel repairs has greatly increased Orenda's competitiveness in the gas turbine industry."

K.I. McRae
Acting Head/Air Vehicles Research Detachment, Department of National Defence.



IAR works with DND and industry to develop and demonstrate technology for life extension and better maintenance for F404 turbofan engines.

IAR Institute for Aerospace Research (Ottawa, Ontario)

IAR supports the needs of the Canadian aerospace community and maintains strong ties within the international aerospace sector. The Institute assists and promotes research and development in the design, manufacture, performance, use and safety of aircraft and related vehicles. IAR interacts extensively with the manufacturing industry, with repair and overhaul companies, air carriers, defence agencies and universities to ensure its research remains relevant to current and emerging needs. Experienced staff back up the Institute's unique testing capabilities in three laboratories: Aerodynamics, Flight Research, and Structures, Materials and Propulsion.

The Aerodynamics Laboratory performs research on the aerodynamics and flight dynamics of aircraft, and aerodynamics of surface vehicles and ground-based structures. The Flight Research Laboratory studies flight mechanics and avionics and performs complex airborne research experiments. The Structures, Materials and Propulsion Laboratory supports the Canadian aerospace community, in areas affecting the design, strength, durability, structural integrity and performance of aircraft, gas turbine engines and space structures.

IAR 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-DEVELOPED METHODOLOGY SAVES ON COSTS

IAR is making history as the first research institute to develop comprehensive guidelines for engine operators to certify novel repairs on high-cost gas turbine engine components.

The use of repaired components extends the aircraft's useful life, lowering operating costs.

A successful collaboration, with the Mississauga-based Orenda Aerospace Corporation and the Chief, Research and Development of the Department of National Defence, won the NRC-IAR team an NRC 1998 Industrial Partnership Award.

The Qualification of F404 Component Repairs Team of IAR, with government and industry partners, provided engine operators with a methodology, a world first, to carry out the certification. Innovative repairs were developed for the F404-GE-400 engine and subjected to a battery of rigorous certification tests at NRC to ensure durability and flight safety. The accelerated flight endurance test at NRC was the first of its kind performed in Canada for the Canadian Forces.

The results showed the useful life of high-cost components in both civil and military gas-turbine engines can be extended, for greater cost savings. For the Forces, these were estimated at more than $60 million for the F404 alone. At Orenda Aerospace, the technology translated into improved competitiveness. Orenda's application of the technologies to other military and civil engines further enhances the company's ability to compete.

"MRIs can decrease surgery and patient hospital stays. Adding this state-of-the-art technology to the Health Sciences Centre greatly benefits patient care in our province."

Darren Praznik
Minister of Health for Manitoba

IBD's collaboration with the Health Sciences Centre in Winnipeg resulted in the joint acquisition of an MRI system, facilitating closer interaction between research scientists and the medical community.

IBD Institute for Biodiagnostics (Winnipeg, Manitoba)

IBD conducts research and develops leading-edge, instrumentally based, non-invasive medical diagnostic technologies. The Institute performs its research in partnership with medical schools, universities, other research organizations and industry. Partnerships help IBD improve growth and diversification opportunities for Canadian companies and fuel the Institute's ability to provide more effective diagnosis and treatment monitoring for diseases which significantly affect Canadians. The Institute also supports training for physicians and technologists in the use of new instruments and techniques.

IBD encompasses four core research groups. The Biosystems Group uses non-invasive techniques, such as magnetic resonance (MR) and infrared (IR) spectroscopy. Major projects focus on cancer, heart disease and stroke. The Informatics Group develops and adapts methods for analysing and monitoring complex biomedical data. The resulting software products are then commercialized. The Magnetic Resonance Technology Group develops magnetic resonance techniques and instruments to diagnose human disease. The group also creates protocols in applying 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 COLLABORATION BENEFITS MANITOBA HEALTH CARE SERVICES

Manitobans benefit from improved patient care and medical research, thanks to a newly installed Magnetic Resonance Imaging (MRI) scanner at Winnipeg's Health Sciences Centre.

The Centre's new MRI wing houses the $4.2 million scanner, funded by NRC-IBD, provincial and federal governments, and other scientific and medical organizations. Non-invasive MRI imaging equipment enhances Western Canada's capabilities in diagnosing and treating injuries and diseases, such as brain tumours, strokes and heart disease.

In addition to an initial contribution of $1 million, IBD finances annual operating costs associated with any IBD-conducted research activities at the new facility. The site supports technological development in a real, clinical environment and provides opportunities for the Institute to test, spotlight and market the latest medical technologies that IBD researchers develop. The Institute expects that these technologies will attract international investment to Western Canada, as have other IBD successes in magnetic resonance imaging, bioinformatics and optical spectroscopy.

"Whatever the application, the clever tethered enzyme system represents a significant advancement in this methodology, making the future for complex glycans a sweet one indeed."

THOMAS G. WARNER
in Nature Biotechnology,
Vol. 16, No. 8, August 1998

Breakthroughs by IBS teams in the Institute's glycobiology laboratory, like the discovery described below, are the result of leading-edge research.

IBS Institute for Biological Sciences (Ottawa, Ontario)

The Institute for Biological Sciences (IBS) conducts innovative research in neurobiology and immunochemistry of importance to the health and pharmaceutical sectors. IBS carries out research programs with partners in industry, university and hospital settings and with fellow R&D organizations.

IBS encompasses two major research programs. Cell Biology focuses on applications related to therapies for neurodegenerative disorders. These are pursued in three research groups: Apoptosis, Cellular Neurobiology, and Receptors and Channels. The Immunochemistry Program conducts molecular level research, leading to the development of improved diagnostic agents, vaccines and immunotherapeutics. These are pursued through the Glycobiology, Novel Antibodies, Pathogenesis and Vaccine Design research groups.

TETHERED ENZYMES FACILITATE LARGE-SCALE PRODUCTION OF KEY CARBOHYDRATES

A breakthrough by an IBS team could permit large-scale, cost-effective manufacture of carbohydrates for consumer products and therapeutics.

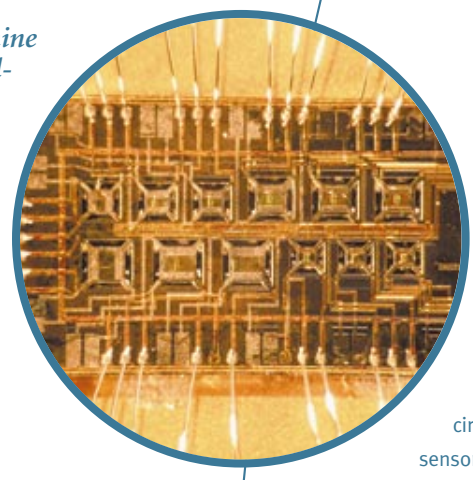
IBS and Cytel Corp. of San Diego, California, collaborated to provide a low-cost, high-yield technology the company required, in order to manufacture complex carbohydrate drugs and other commercial products, in a rapid, cost-effective way.

The company used the technology to scale-up a bioactive carbohydrate, found in breast milk, for potential addition to infant formula.

Group leader Dr. N. Martin Young and a team of IBS scientists ventured to fuse, or tether, two bacterial enzymes into a single molecule, to produce sialyl lactose. This is a component of human breast milk with potential as an infant formula additive. While scientists have used the strategy of fusing proteins, until IBS' accomplishment, the strategy had never before been applied to the synthesis of complex carbohydrates. The journal, *Nature Biotechnology*, hailed the fused enzyme strategy in its August 1998 edition. The company, using the technology, began scale-up production, with marked success.

"ICPET is a gold mine for Canadian industry, a world-class facility that provides a wealth of resources and gets results. They deliver."

Don Segall
Vice-president of Technology and Resources
The Armstrong Monitoring Corporation



Applying innovative, chemical sensor technology on a micro-scale, NRC has patented new functional materials that can be integrated with silicon chip circuitry. The result – smart, robust chemical sensors for gas and vapour detection.

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

ICPET develops chemical process technologies to help Canadian industry improve the commercial viability of their products, reduce costs, manage environmental performance and increase the efficiency of process operations.

ICPET's chemical process expertise is built on five core competencies: *functional materials development* – such as new polymers, chemically-based sensors and high performance energy materials for batteries and fuel cells; *cleaner production technologies* for manufacturing applications involving chemical use, chemical recycling, pollution reduction and improved industrial spray systems; *advanced diagnostics* for measuring and analysing material surfaces or combustion processes; *separation processes* – membrane-based technology for industrial processes such as wastewater treatment, agri-food processing, effluent reduction, and petrochemical gas and vapour treatment; and *simulation and design capabilities* with applications to air quality modelling, computational fluid dynamics and reactive flows, chemical process design and simulation, and environmental management.

MANUFACTURER INCORPORATES ICPET TECHNOLOGY IN DESIGN OF MONITORING EQUIPMENT

An NRC/NSERC research partnership arrangement among ICPET, Concordia University and Ottawa-based Armstrong Monitoring Corporation is advancing the commercialization of superior gas- and vapour-monitoring equipment.

The work encompasses the development of new chemical sensor materials and the use of thin film technology to deposit this material onto micro components. Concordia University has designed and developed a micro-machined "hot-plate" to contain the sensor. ICPET researchers have developed a patented, sensor material to perform reliably in harsh environments and at high temperatures. The combination of these research advancements is leading to the successful integration of sensor and silicon technologies.

The Armstrong Monitoring Corporation will be the first manufacturer to incorporate these new sensors in the design of commercial industrial and personal monitoring equipment. This equipment will minimize interference in less-than-ideal conditions, to reliably measure a specific gas or a variety of gases simultaneously.

"The NRC's IIT group has been an invaluable R&D resource to Tetranet. Their technology has given us a competitive advantage that we could not have replicated on our own."

Michael Weider,
CEO Tetranet Software Inc.

Mike Weider, CEO of IIT licensee Tetranet, demonstrates software to the Hon. John Manley, Minister of Industry.

IIT Institute for Information Technology (Ottawa, Ontario)

IIT's main research objective is to position itself not only as a credible collaborator in information and telecommunications but also as a key player in strengthening this sector. IIT assists industries across Canada to improve competitiveness through excellence in information technology, the development of innovative solutions to industry problems and the identification of business opportunities. Through cost-shared collaborative R&D projects, IIT helps Canadian companies turn ideas into technologies and products by bringing opportunities in software and systems to Canadian industry.

Research competence at this institute is in software engineering, digital 3-D imaging, interactive access to information, user communication in heterogeneous networked environments, human interaction with computer systems and the application of advanced information technologies in decision-making within complex environments. IIT focuses on real-world challenges while sustaining a broad research perspective.

IIT LENDS TETRANET THE COMPETITIVE EDGE

No time to read lengthy reports or detailed analyses? New software developed by the Institute for Information Technology can summarize for you: reports, analyses, proposals and memoranda, whether in English, French or Japanese.

EXTRACTOR™ is the software module that can summarize any document by scanning the text to choose several, short phrases that best describe the topics discussed. Designed for inclusion into products in a wide variety of applications, EXTRACTOR is already licensed to three companies, while 25 more have submitted formal expressions of interest.

Tetranet Software Inc., ranked by Information Week as the 16th fastest-growing independent Windows software vendor in North America, has incorporated EXTRACTOR into several of its products, including Metabot, a web page management program. An IIT researcher joined Tetranet, to smooth both the technology transfer and the development process.

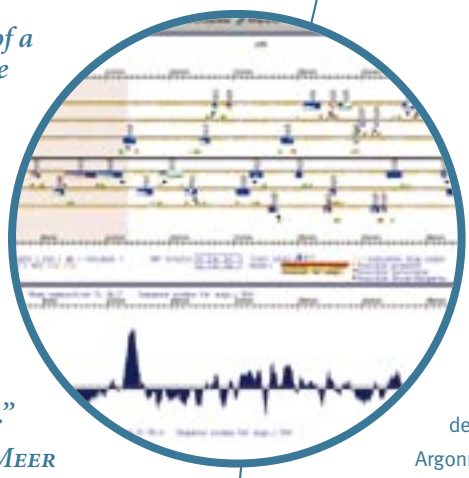
Strategis, Industry Canada's business information Internet site, uses EXTRACTOR to help organize vast quantities of information and has helped to develop the French version. Tetranet funds development of German and Spanish versions, while Gogurue Development Ltd. is sponsoring a Korean version.

In another domain, AmikaNow!™ Corporation's first product, AmikaFreedom, is incorporating EXTRACTOR to summarize the contents of lengthy E-mail messages for transmission to portable wireless devices, like pagers.

EXTRACTOR demonstrates how advanced information technologies can simplify information retrieval for busy decision-makers.

"It is certain that the existence of a credible and comprehensive Canadian bioinformatics infrastructure is an important incentive (or ingredient) in attracting researchers and biotechnology companies to set up activities in Canada. In the words of one senior pharmaceutical executive: it is as important a part of our national infrastructure as the highways."

Dr. John P. van der Meer
Director of Research, IMB



CBR provides access to unique bioinformatics software programs, such as MAGPIE, an automated genome sequence analysis and annotation system developed by IMB in collaboration with Argonne National Laboratory.

IMB Institute for Marine Biosciences (Halifax, Nova Scotia)

IMB's biotechnology research focuses on the growth and diversification of Canada's aquaculture industry and the development of genomic technologies.

The Institute's aquaculture research is primarily in the areas of fish health and nutrition, alternative species development for finfish, shellfish and seaweed and consumer food safety. IMB's Aquaculture Research Station is an ideal environment in which to undertake hatchery studies and fish feed improvement research. Molecular biology, seafood safety and therapeutant research are conducted in the Oxford Street laboratory.

The genomics program includes large-scale, high-throughput DNA sequencing, advanced protein sequence analysis (protoemics) and the development of unique bioinformatics software. On behalf of NRC, the Institute operates and manages the Canadian Bioinformatics Resource, a national facility dedicated to providing Canadian researchers with convenient, effective access to biotechnology-related databases and bioinformatic software tools.

IMB has a significant impact on economic growth, particularly in Atlantic Canada through its interactions with clients in the private, academic and government sectors. Helping create and sustain this impact are the Institute's multi-disciplinary teams and state-of-the-art facilities and instrumentation.

CBR ENABLES SCIENTISTS TO RECORD AND PARSE THE GENE SEQUENCE

Mark Ragan, a leading evolutionary biologist at IMB, wanted to shed light on the evolution of life on earth. The challenge: to compare every gene of 10 different organisms in order to discover how a number of species evolved and at what point, long ago, they may have shared ancestors.

To perform the staggering number of calculations on thousands of pieces of complex genetic information, Dr. Ragan required an advanced computer and informatics tools that could record and parse the gene sequences found in DNA, the building block of proteins and enzymes.

A group of IMB-led researchers met the challenge. Working with Sun Microsystems, they developed the Canadian Bioinformatics Resource (CBR). The first phase, CBR-I, was developed two years ago as an Intranet site, reserved for NRC research performed in partnership with the private sector. Last year, CBR-II was launched to provide access to Canadian researchers in industry, universities and hospitals.

CBR is a high-speed, distributed network, with connections to computers at NRC and associated sites. All international genetic databases are downloaded regularly to the CBR system.

CBR will aid research in health care, gene therapy, genetic diseases, cell function, agriculture, forestry, fishery, the environment and more.

"The work IMD is undertaking enhances our understanding of ice-ship interaction, thereby lowering the cost of total field development."

GEORGE VANCE
Technical Integration Group Leader, Petro-Canada

A scale model of an offshore tanker passes a "bergy bit" in experiments at IMD to investigate the interactions of vessels and small icebergs. NRC's partners in the three-year study are Petro-Canada, Mobil Oil Canada Properties and the Panel on Energy Research and Development.

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

As Canada's national centre for ocean technology research and development, IMD's mission is to provide innovative solutions and engineering expertise related to the world's oceans. In collaboration with industry and university partners, the Institute pursues programs of research 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 has been applied to a wide range of Canadian and international projects, from high-performance naval vessels to offshore oil and gas platforms.

The Institute's facilities include the world's longest ice tank, 90 metres in length, an offshore engineering basin and a 200-metre towing tank. IMD's specialized equipment includes a marine dynamic test facility for evaluating vessels in six degrees of freedom of motion, a planar motion mechanism for studying manoeuvring characteristics, a yacht dynamometer and a cavitation tunnel.

IMD offers a combination of expertise and world-class facilities to address the needs of large multi-national companies, of small ventures and of consultants. To its work with offshore firms and research organizations, IMD brings an international reputation for the excellence of its research. The Institute acts as a conduit to Canada for international technology. Long-term collaborative research projects provide the investment in knowledge that permits Canadian industry to compete in the global marketplace of the 21st century.

IMD RESEARCHES INTERACTION OF SHIPS AND 'BERGY BITS'

Results of IMD's Investigation of the hydrodynamic effects of the impact of bergy bits, as they hit ocean vessels, have provided the oil industry's marine shipping operations with valuable information.

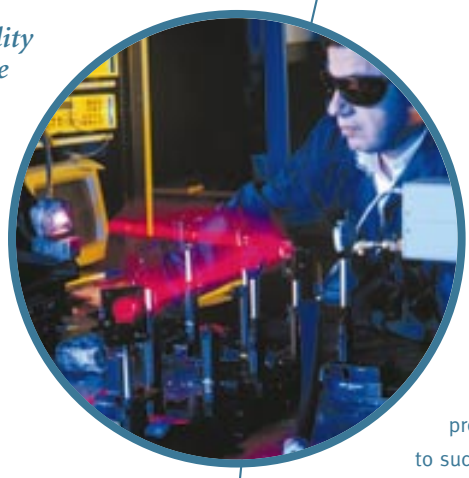
Each spring, off the coast of Newfoundland and Labrador, glacial ice threatens vessels working in the North Atlantic. Bergy bits (small pieces of ice that crumble from icebergs) represent the greatest risk. These, unlike icebergs and growlers (larger broken chunks), are difficult to detect on radar and can be concealed by waves, fog or darkness.

IMD has simulated varying impacts in its towing tank, using a 1:41 scale model vessel and "ice pieces" represented by various sizes of spheres, cylinders and pyramids. Experiments to gauge the impact of the "ice" as it strikes the vessel at different angles and under distinct water conditions, have advanced the knowledge of ice-ship interaction, to the great benefit of IMD industrial partners in their Canadian offshore operations.

IMD's partners include The Panel on Energy Research and Development, Petro-Canada (as operator of the Terra Nova project) and Mobil Oil Canada Properties (on behalf of motor tanker Kometik owners Mobil, Chevron and Murphy Oil). Petro-Canada and Mobil Oil jointly contribute $100,000 in each of the first two years.

"With the quality of its infrastructure and the talent of its team, NRC helped us jump-start the R&D aspects of our product and let us concentrate on the business side of our new venture."

Simon Béchard
President, Pharma Laser Inc.



Using a pulsed laser and real-time spectroscopy, this IMI technology can be used to analyse materials onsite and without any contact or sample preparation. This technology will be applied to such diverse fields as pharmaceutical quality control and in-mine material analysis.

IMI Industrial Materials Institute (Boucherville, Québec)

IMI promotes the growth and competitiveness of Canadian industry, through research and development activities related to materials processing technologies. The Institute has received international recognition for its work with scientific collaborators from industry, universities, government departments and agencies and R&D centres. IMI works with raw materials producers, instrumentation and equipment suppliers and with semi-finished and finished-product manufacturers, in a variety of significant collaboration and partnership arrangements, focused on key industrial sectors.

R&D projects at IMI include: developing computer simulation models and experimental techniques for validation and process optimization; developing and perfecting processing technologies involving metals, polymers, ceramics and their composites; and developing and using process control systems, such as optical and ultrasonic sensors.

Thanks to IMI, industries such as plastics, steel-making, transportation, aerospace, energy, telecommunications, electronics and information technologies, benefit from more efficient production processes and the development of more cost-effective, higher-quality products.

IMI-DEVELOPED TECHNOLOGY PROMISES SUCCESS FOR PHARMA LASER

A year-old agreement between IMI and a new Québec-based business, Pharma Laser, Inc., is expected to yield exciting results.

The focus of the agreement is a laser-plasma spectroscopy technology, developed by IMI specialists to analyse the composition of a material, in this case, pharmaceutical pills. A forthcoming commercial version could signal a breakthrough in the global pharmaceutical and biotechnology marketplace. The technology enables rapid and continuous on-site evaluation of a material and provides manufacturers production-line correction and real-time modification of the manufacturing process. The result: a greater degree of product quality control.

Pharma Laser hopes to conclude a partnership agreement with a manufacturer to fabricate the equipment. An additional, strategic-alliance agreement with a partner will see world-wide distribution of the product.

Pharma Laser is located at IMI, while both collaborators optimize the technology in application to the pharmaceutical and biotechnology industry. Later, as part of a cooperation agreement with Merck-Frosst, the equipment will undergo trials under real conditions. In association with Merck-Frosst, IMI will conduct a major R&D program to explore other potential uses of the laser-plasma spectroscopy technology. And, as the developed technology is generic, IMI will continue to pursue applications to the mining industry, notably with Québec's Centre de recherche minérale (CRM) and Noranda, Inc.

"IRIDIAN is a good example of IMS' capability to commercialize technology and create economic benefit."

Dr. Peter Dawson
President, IRIDIAN Spectral Technologies

An IMS researcher displays a substrate holder used in the ion plating process to create high quality telecommunication filters.

IMS Institute for Microstructural Sciences (Ottawa, Ontario)

IMS keeps Canada at the leading edge of technologies that will drive the information revolution within the next decade. IMS works in collaboration with industry and universities to provide national leadership in the development of a strategic base for information technology. The Institute encourages industrial innovation and assists economic development through enabling technologies related to future hardware requirements for: information acquisition, processing, transmission, storage, and display.

The core competencies of the Institute's five major programs include: device design and simulation, epitaxial growth, semiconductor processing, microlithography, thin film deposition, interface physics, nanostructures, optical characterization, electronic properties and physical and psychological 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.

IMS' THIN FILMS LABS SPIN OFF HIGH-PRECISION SUCCESS

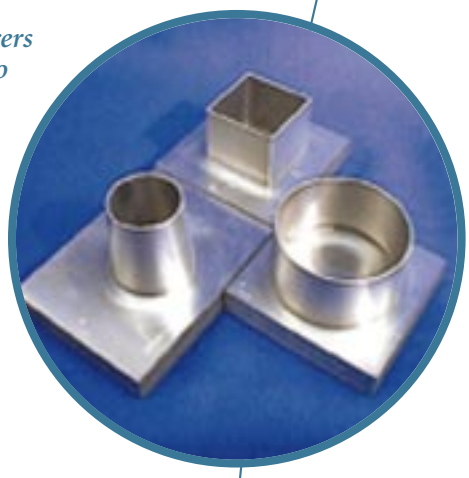
A major success for IMS' Thin Films Labs is the successful spin-off in June 1998 of IRIDIAN Spectral Technologies.

IRIDIAN is a supplier of leading-edge products that use optical thin film technology. The company designs and manufactures complex optical thin film components to match the transmittance or reflection requirements in a particular spectral range. These films may incorporate 100 or more varying layers of material, each deposited with very high precision. The main applications of the company's products are in filters for fibre-optic communications. IRIDIAN has proprietary process control technology, licensed from NRC. The company's location, in NRC's Industrial Partnership Facility, at close proximity to IMS, enables IRIDIAN to enjoy access to a variety of deposition processes, including advanced, high-rate sputtering and ion plating systems.

The company started with two employees, both former NRC staff members, and today employs 11. President Peter Dawson said: "...the relationships with NRC have played a critical role in (our company's) success ...Continuing R&D collaborations with IMS are important for our future and help to provide a small company with an unusual strength in research."

"Canadian manufacturers must constantly find new ways to cut costs, add value or reduce production times. IMTI demonstrates leading-edge R&D in the rapid tooling field."

Hon. Ronald Duhamel
Minister of State for Science Research and Development



Laser consolidation makes possible production of fully functional metallic components directly from CAD models.

IMTI Integrated Manufacturing Technologies Institute (London, Ontario and Vancouver, British Columbia)

IMTI promotes the international competitiveness of Canadian manufacturers by focusing its research and development on leading-edge technologies for discrete product and equipment manufacturing at the design and production levels. The Institute works with manufacturers and other technology providers to address manufacturing challenges through joint research projects.

IMTI's research areas are: Virtual Manufacturing; System Modelling and Simulation; Concurrent and Distributed Manufacturing Technologies; Intelligent Production Systems; Industrial Laser Processes and Systems and Solid Freeform Fabrication. The research laboratories are located in a state-of-the-art facility in London, Ontario (IMTI East) and in the NRC Innovation Centre in Vancouver, B.C. (IMTI West).

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

As it completed its third year, IMTI rapidly gained an international reputation for its advanced research in laser micromachining, laser consolidation and in rapid tooling.

IMTI COLLABORATION ACCELERATES AUTO PARTS PRODUCTION

An IMTI collaboration with Siemens Automotive and Regal International underscores the growing importance of manufacturing research and development in the automotive sector.

The collaboration began with Siemens Automotive's wish to reduce the time spent developing functional engine intake manifolds. The company chose IMTI and Regal of Windsor to speed the mould-manufacturing process for this purpose. IMTI combined its research in rapid mould making of plastic parts with a materials-addition process called "Selective Laser Sintering" to fabricate the world's first 100-lb. mould insert prototype. No other organization conducting similar research has successfully created a mould weighing more than 25 lbs.

This significant breakthrough is instrumental in the production of faster, cheaper auto parts. With Siemens' and Regal's full support, IMTI is now focusing its state-of-the-art technology on developing methods to reduce the time and cost of making durable, precision production tools.

"Realization of the potential of the system will benefit a host of important commercial activities conducted by our customers, including drug discovery and biotechnology development where sensitivity and high sample throughput play a key role."

Bill Davidson
Vice President, Research, MDS SCIEX

Coupling ion mobility spectrometry with mass spectrometry shows great potential in the area of chemical analysis, particularly in the health sciences sector.

INMS Institute for National Measurement Standards (Ottawa, Ontario)

INMS' core mission is to serve as Canada's primary reference centre for the accuracy, validity and traceability of physical measurements and appropriate chemical measurements. The Institute's physical metrology programs develop, maintain, improve and disseminate standards for the basic units of mass, length, time, electricity, temperature, and luminous intensity, and for a number of derived measurement standards. The chemical metrology program develops and maintains world-class capabilities, in selected areas of organic and inorganic trace analysis, and provides certified reference materials.

The ability to trace all measurement in Canada back to these standards provides the basis for fair trade, development in science and technology, the achievement of product quality, and demonstration of conformance to international quality standards.

INMS also supports the development of competencies and technology in selected areas of optical science, technology and measurements, as well as in selected areas of photonics technology related to high-performance computers.

INMS SCIENTISTS REFINE PHARMACEUTICAL ANALYSIS TECHNOLOGY

A world-first discovery by INMS scientists sheds new light on the benefits of coupling ion mobility spectrometry with mass spectrometry. The technique shows great potential in the area of chemical analysis, particularly in the health sciences sector.

Institute researchers have devised a way to focus and trap ions at atmospheric pressure using high-field asymmetric waveform ion mobility spectrometry (FAIMS). The INMS prototype capably separates ions with minimal ion transmission loss, making it an ideal input device for mass spectrometry (MS).

This discovery, of considerable potential importance to the pharmaceutical and biochemistry fields has led to a collaboration between INMS and MDS SCIEX, a Canadian manufacturer of mass spectrometry instrumentation. As part of a two-year agreement, SCIEX provides INMS with $500,000 in human resources, equipment and legal assistance for patent applications. In return, INMS is developing the first electrospray/FAIMS/MS instrument in the world. Current electrospray MS instruments produce a "background" of ions which often renders difficult the detection of specific ions. FAIMS dramatically reduces this background, enabling detection at much lower ion concentrations.

"Without IRAP, we would not have been able to develop the diverse components that comprise the IVS platform. IRAP support was the shot of adrenaline we needed to take an enormous technological risk, given the size of the company at the time. IRAP expertise allowed us to test our ideas against theirs. This process resulted in even better solutions than we had imagined at the start."

Ahmed Aïna
Executive Vice President, MediaSoft Telecom

MediaSoft's award-winning software platform enables developers to build, run and manage large-scale interactive computer telephony Web solutions integrating voice, fax, Web and multimedia.

IRAP Industrial Research Assistance Program

IRAP's mission is to connect innovative Canadian small and medium-size enterprises (SMEs) with the information, resources and financial support they need to turn good ideas into commercially viable products and services. For more than 50 years, IRAP has helped SMEs create and adopt innovative technologies which yield new products, create high-quality jobs and make industry more competitive. IRAP's support stimulates R&D within Canadian firms and helps them build their technical knowledge and expertise.

IRAP operates a national network of more than 250 Industrial Technology Advisors (ITAs) who work with about 12,000 firms annually, in all regions of the country and in all industrial sectors. IRAP offers direct access to the latest technological advances, expertise, facilities and resources, and cost-shared financing of innovative technical projects. In 1998-1999, IRAP strengthened its link with the Federal Partners in Technology Transfer (FPTT). This link has expanded the resources available to IRAP by providing them with easy access to the rich and varied talents and expertise of the 15 science-based federal government departments and agencies that form FPTT's membership. IRAP also helps clients access expertise in the business end of innovation, such as marketing, financing, and production through the Canadian Technology Network (CTN).

QUÉBEC COMPANY LEADS THE MARKET WITH IRAP HELP

The remarkable progress of a Québec-based company shows that working with IRAP can help lead to success.

MediaSoft Telecom was first introduced to IRAP in the early 1980s, when the company, as Bachal Technologies, developed diverse applications for videotext for Bell Canada. In 1989, as MediaSoft Telecom, the company began to develop software that would build, run and manage large-scale interactive computer telephony and Web solutions for integrating voice, fax, web and multi-media technologies.

In 1992, MediaSoft Telecom again sought IRAP's help to develop its flagship product, the Interactive Voice System (IVS). With IRAP support, the company developed the IVS platform (the IVS Builder and IVS Server). These enable developers to build computer telephony applications in a Windows environment, in which applications can run on UNIX and NT-based IVS Servers. Additional IRAP support enabled the company to launch its next-generation development product, the IVS Studio, which heralds a new era of telephony development.

Today, MediaSoft Telecom is a manufacturer of award-winning software for computer telephony and web solutions. Staff numbers have risen from 10 in 1993 to 50 today. The latest company to strike a partnership with MediaSoft Telecom is industry giant Microsoft.

"The Centre establishes a benchmark for the best the market can deliver ... There are immense learning opportunities for the construction industry and for home buyers."

Tim Mayo
General Manager of The Canadian Centre for Housing Technology

The goal of the Canadian Centre for Housing Technology, a partnership between NRC, Canada Mortgage and Housing Corporation and Natural Resources Canada, is to improve the quality, affordability, and environmental sustainability of Canadian housing thereby supporting domestic and global market opportunities.

IRC Institute for Research in Construction (Ottawa, Ontario)

IRC works with partners in industry and government in conducting research programs in:

- indoor environments, to improve acoustics, thermal comfort, lighting use and air quality; in all types of buildings;
- building envelope and structure, to optimize the both the envelope performance and structural safety of both new and rehabilitated buildings, while extending their life span and enhancing their energy performance;
- urban infrastructure rehabilitation, to improve technologies for the design, construction, operation and maintenance of buried services, such as sewers and water mains, and surface structures, such as roads and bridges;
- fire risk management, to provide sophisticated tools to assess the risks and costs of fire safety options for buildings, while developing economical and effective methods of fire resistance, detection and suppression.

In addition, IRC provides:

- a national evaluation service that establishes the suitability of innovative products and technologies for their intended use;
- research and technical support critical to the development of the National Building Code and other national model codes, which form the basis of construction regulation across Canada.
- knowledge and technological information that the IRC transforms into forms suitable for construction practitioners and disseminates it to them.

PARTNERSHIP SPEEDS DEVELOPMENT OF NEW HOUSING TECHNOLOGIES

NRC, Canada Mortgage and Housing Corporation and Natural Resources Canada are partners in a unique research project, The Canadian Centre for Housing Technology (CCHT).

Located on the grounds of NRC's Ottawa campus, the Centre consists of two identical research houses and an Infocentre for the demonstration of innovative products and technologies. The focus is on sustainability, material and energy efficiency and marketability.

Founded on the premise that the house is a system, CCHT uses its research houses to evaluate the impact of innovative products and alternative construction techniques on total house performance. The Centre is dedicated to accelerating the development and acceptance of new technologies for the housing industry and to supporting market opportunities for Canadian housing products and services.

With close links to product-certifying agencies and world-class government laboratories, the Centre works to bring promising ideas and innovative products to the attention of builders, housing professionals, consumers and foreign visitors.

"This strategic alliance is an obvious step to link PBI's expertise and our commercial interests in research to improve canola quality and productivity."

David Dzisiak
Business Leader, Plant Genetics, Dow AgroSciences Canada

The Transgenic Plant Centre, a specialized unit within PBI, was established to provide expertise and facilities for the production and assessment of plants developed through collaborative projects.

PBI Plant Biotechnology Institute (Saskatoon, Saskatchewan)

PBI's biotechnology research benefits agriculture and industrial innovation through research with crops and crop products. Strongly linked to the local agro-biotech community, PBI maintains competitive research and enables the commercialization of new technologies and discoveries.

The Institute is a world leader in the genetic engineering of wheat and in seed oil modification of Brassica. PBI is committed to the improvement of crops that are of primary importance to the Canadian economy. PBI's main areas of research include Brassica technology, cereal biotechnology, legume biotechnology, gene expression, growth regulation, promoter technology and seed oil modification. Transgenic plant and DNA technologies contribute to PBI's ability to develop novel systems for the analysis and manipulation of genes, leading to state-of-the-art technologies and crop development.

PBI-DOW AGROSCIENCES AGREEMENT TURNS IDEAS INTO SOLUTIONS

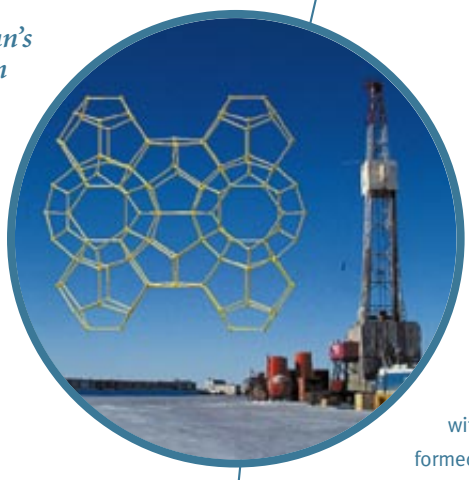
A $10 million, five-year research agreement between PBI and Dow AgroSciences Canada Inc. (DASCI) is turning innovative ideas into solutions that benefit Canadian agriculture.

The agreement focuses on the development of better ways to genetically improve canola and other Canadian crops, and to tackle problems caused by insects and disease. Canadian farmers can expect solutions to reduce costs, increase crop production and increase their ability to compete internationally.

Around the world, research in agricultural biotechnology continues to evolve. Through strong strategic alliances such as this, PBI and DASCI assure Canada's status as an international leader in enhanced crop development and production.

"Canada is by far Japan's preferred partner for research on the extraction of hydrates as a natural resource. SIMS' expertise on clathrate hydrates has been instrumental to our success to date."

Statement from Japan Petroleum Exploration Company (JAPEX)



The hydrate recovered at the Mallik 2L-38 drill site, Mackenzie Delta, Northwest Territories is mainly structure I hydrate (shown in overlay) with methane molecules in the cages formed by hydrogen-bonded water molecules. (photograph by S. R. Dallimore).

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

SIMS' mission is to undertake long-term interdisciplinary research, in selected areas of molecular science with the potential to have an impact on key sectors of the Canadian economy. SIMS works in partnership with researchers, inside and outside NRC, to develop innovative technologies in areas such as therapeutics, diagnostics, advanced electronics, telecommunications, precision manufacturing, optoelectronics, information sciences and advanced materials.

The Institute offers expertise in chemical synthesis, material characterization, understanding the chemistry of biological processes, the prediction of material properties and the use of femtosecond lasers in optics and telecommunications research applications.

Research programs have been established in functional materials, molecular spectroscopy, neutron program for materials research, femtosecond science, chemical biology, molecular interfaces and theory and computation.

CLATHRATE RESEARCH TAPS INTO NEW ENERGY SOURCE

Imagine freeing up a new, untapped source of natural gas that consists of some 50% of the world's current hydrocarbon deposits? What if this substance, through Canadian expertise that is unique in the world, could provide a bountiful supply of clean energy for Canada's future and for resource-poor countries like Japan and India?

Thanks to the advanced research being conducted by SIMS' Functional Materials Program team on the intricate structures of clathrate (natural gas) hydrates, these breakthroughs are distinct possibilities. What's more, Canada has tremendous reserves of these clathrate hydrates and the expertise needed to extract them.

Found in settings like permafrost and the ocean floor along the continental margin, clathrate hydrates are naturally formed when "guest" hydrocarbon molecules are trapped in the "cages" of hydrate (water-based) structures, under specific combinations of temperature and pressure.

The natural gas is trapped in solid form, and to date no technology exists to extract it. SIMS researchers are helping pinpoint where these deposits can be found, how to estimate the resource, and how to anticipate difficulties related to gas recovery, through their research on clathrate structures, precursor states, formation and inhibition.

As a scientific first, the Geological Survey of Canada led an international consortium to recover hydrates from a site in the high Canadian Arctic. In performing the excavation, Canadian workers developed the necessary expertise. The Mallik Research Well Project (US$10M) was funded primarily by the Japanese, and used NRC's expertise in molecular-scale characterization to analyse core materials recovered. The work is a prelude to a hydrate drilling project offshore Japan in late 1999.

CHC Canadian Hydraulics Centre (Ottawa, Ontario)

CHC is Canada's largest hydraulics and coastal engineering laboratory. CHC operates as a cost-recovered NRC Technology Centre. It offers physical and numerical modelling and analysis services to the Canadian and international engineering community in the general field of hydraulics. The Centre specialises in coastal engineering, environmental hydraulics and cold regions technology. Facilities 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 moorings, beaches and shoreline protection, near and offshore fixed and floating structures, scour and deposition of sediments, ice forces on structures and river and estuary hydraulics.

CHC also develops and applies advanced numerical models of wave propagation, motions and forces of both intact and broken ice covers, interacting with structures, coast environmental management, water resources, rivers and watersheds, sediment transport, pollutants, oil and chemical spill fate, water quality, environmental production and decision support systems.

TTC Thermal Technology Centre (Ottawa, Ontario)

TTC is a cost-recovered NRC Technology Centre, consisting of a highly qualified team of engineers, researchers and technologists, with broad experience in R&D in thermal engineering systems and advanced process heat transfer equipment. This group has worked extensively with industry and acquired specialized expertise in the application of alternative refrigerant technology. This high level of technical competence is combined with the operation of a range of special-purpose, state-of-the-art facilities.

TTC offers its services to clients in the commercial refrigeration, air-conditioning, heat pump and process heat transfer equipment manufacturing industries. Applied R&D projects are also conducted in collaboration with government departments and agencies with a focus on energy and environment.

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

CSTT operates as a cost-recovered NRC Technology Centre and offers its clients 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 modelling and analysis, field tests, climatic simulation and vehicle performance.

Some highlights of CSTT's recent work include developing methodologies to improve Canadian safety standards for tank containers carrying dangerous goods, conducting performance evaluations and developing improvements for introducing North American freight railway technology and equipment to the UK, developing improved lubrication methods for numerous types of industrial and transportation equipment bearings and conducting performance evaluations to improve aircraft de-icing fluids.

Design: Herrera Berman Communications Inc

NRC'S GOVERNING COUNCIL

(as of 31 March 1999)

Dr. Richard F. Ablett	Executive Director PEI Food Technology Centre, Charlottetown, Prince Edward Island
Dr. John ApSimon	Associate Vice-President, Research Dean of Graduate Studies Carleton University, Ottawa, Ontario
Mr. A. Wayne Clifton	President Clifton Associates, Regina, Saskatchewan
D[re] Auréa Cormier	Moncton, New Brunswick
Dr. Otto L. Forgacs	President O.L. Forgacs & Associates, Vancouver, B.C.
Dr. Jacques-Yves Guigné	Chief Executive Officer Guigné International Ltd., Paradise, Newfoundland
Dr. H. Clarke Henry	Manager, Products and Chemicals Division Imperial Oil, Sarnia, Ontario
Dr. Peter Nicholson	Senior Vice-President, Corporate Strategy BCE Inc., Montréal, Québec
M. Gilles Ouimet	Président et Directeur général Pratt & Whitney Canada, Longueuil, Québec
Dr. Ted Rhodes	Halifax, Nova Scotia
Dr. Indira Samarasekera	Centre for Metallurgical Process Engineering University of British Columbia, Vancouver, B.C.
Dr. Patricia Shewen	Department of Pathobiology University of Guelph, Guelph. Ontario
Dr. Claudine Simson	Vice-President Global External Research and Intellectual Property Nortel Inc., Nepean, Ontario
Dr. Douglas Stairs	Department of Physics McGill University, Montréal, Québec
Dr. David Strong	President and Vice-Chancellor University of Victoria, Victoria, British Columbia
Ms. Kim Sturgess	President Revolve Technologies Inc., Calgary, Alberta
Dr. Eva A. Turley	Department of Cardiology Hospital for Sick Children, Toronto, Ontario

NRC Senior Officers

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