CRC ANNUAL REPORT

1993 - 1994

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CRC Communications Research Centre
Centre de recherches sur les communications

Our Mandate

The Communications Research Centre:

- *develops and promotes communications technologies, systems and services;*
- *supports the efficient use and management of the radio spectrum;*
- *contributes to the development of national and international standards in communications technologies, systems and services;*
- *provides communications research and development services, advice and facilities;*
- *transfers technology to Canadian industry for exploitation;*
- *contributes technical expertise in support of government policy initiatives; and*
- *facilitates and participates in international research and development agreements.*

Our Mission is

to conduct strategic research and innovative engineering which contribute to the orderly development and accessibility of communications technologies, systems, and services for the benefit of all Canadians.

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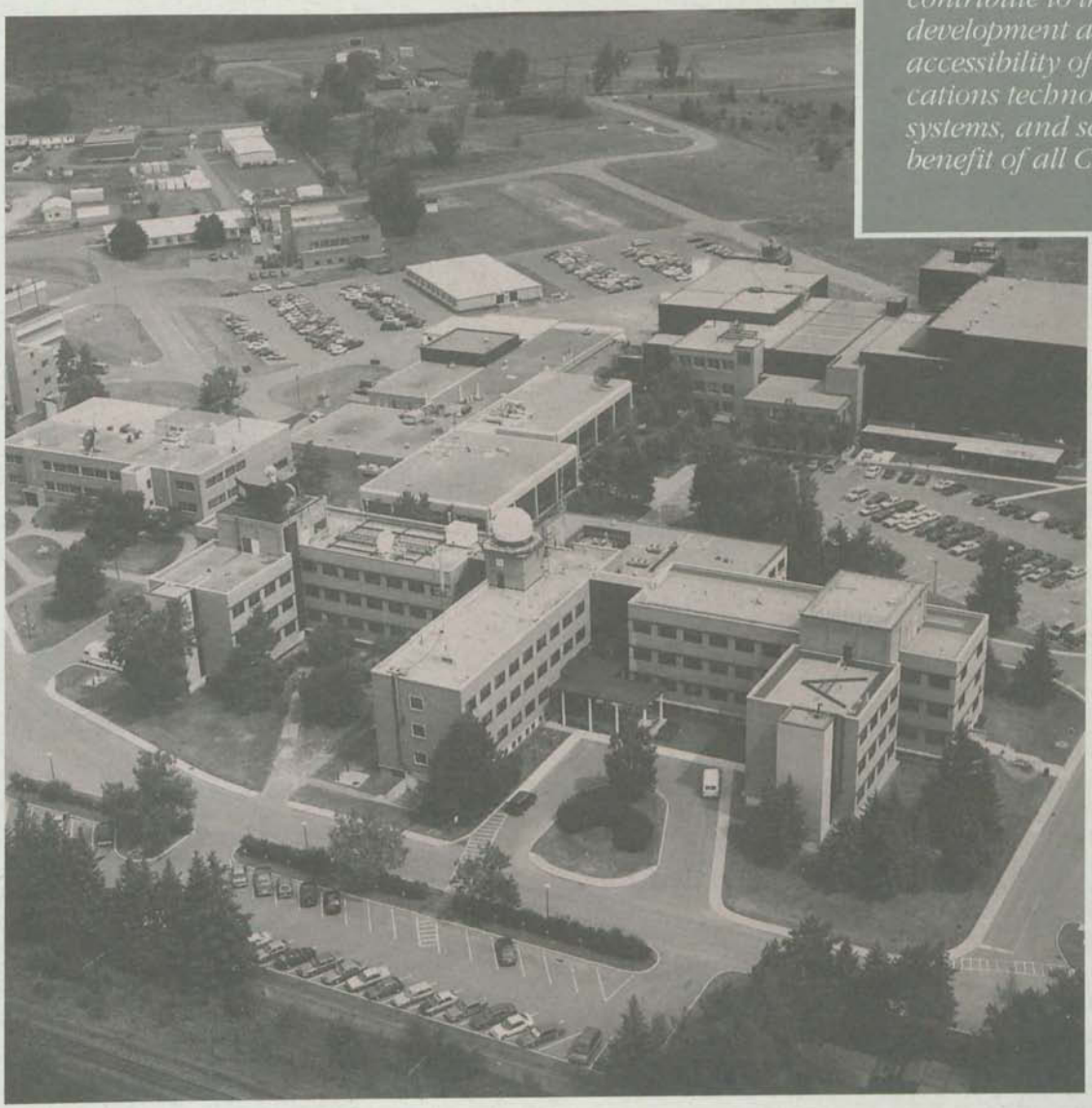


A word from our Chairman...

On behalf of the Board of Directors, I am pleased to present the Communications Research Centre's 1993-94 annual report. It covers the CRC's first year of operation under a new management structure that reports to a Board of Directors in addition to the Minister of Industry Canada.

The creation of CRC's Board of Directors enacted a key recommendation of the Lortie report on government-industry collaboration in science and technology. Publication of this annual report fulfils another Lortie recommendation: making federal government research more accessible and responsive to the Canadian public it serves.

Consisting of 20 volunteer members from across the country who represent academic, private sector and other institutional interests in the communications field, the Board provides general counsel and strategic direction to the Communications Research Centre. I am pleased that in our first year, the new Board has provided valuable advice on the strategic research plan and the inaugural business plan.

Federal government research has been ongoing at the Shirleys Bay research facility for more than 40 years. The CRC's operating philosophy and organizational structures have been adjusted to respond to the new challenges facing Canadian communications R&D in the 90s.

We have been able to regroup the research responsibilities into two key areas: Radiocommunications and Broadcast Research, and Communications Systems Research, each reporting to a vice-president. In addition, corporate functions and research services have been consolidated under an executive vice-president.

On the business development front, collaborative and licensing agreements between the CRC and industry are increasing. This has boosted the CRC's revenues, while advancing technology transfer to business for commercial development.

At the beginning of its 25th anniversary, the CRC is poised to embrace, with renewed purpose, the communications R&D challenges that are key to Canada's global competitiveness as we move toward a new century.

Bill Dunbar, Chairman

...and from our President

As President of the Communications Research Centre, it gives me great pleasure to present our annual report for the 1993-94 fiscal year.

This report covers a period of remarkable changes at the CRC, which have taken place almost 25 years after it joined the then new Department of Communications.

In June 1993, we said good-bye to our old department and joined Industry Canada—the federal government's flagship economic ministry. As a result of this reorganization, the CRC became a key R&D institute of Industry Canada, with a mandate complementary to the government's vision of economic renewal through an innovative economy.

Creation of a Board of Directors for the CRC has been beneficial, as we have adopted business-like management practices and instituted organizational changes to strengthen our core research.

The CRC has redefined itself in response to fiscal constraints and new marketplace realities. Over the last year we implemented a strategic research plan that is guiding our R&D efforts into the balance of the 1990s.

We have increased the emphasis on transferring technology to the private sector for development of commercial applications. In this regard, great progress was made over the year as the number of licensing agreements increased significantly.

As part of our thrust toward industry partnership, two new programs were developed during the year, the Broadband Applications and Demonstration Laboratory (BADLAB) and the Technology Incubator. Both programs help companies benefit from our unique facilities and from the expertise of some 200 scientists and engineers.

In any organization people make the difference and the CRC's reputation for excellence is due to the knowledge, skills and dedication of our staff. Many of our research and technical staff are reaching retirement age, after devoting an entire career to the CRC. To maintain a dynamic and innovative workforce, Industry Canada has supported our rejuvenation plan to fill in the ranks with a new generation of talented scientists and engineers.

This annual report reviews a year in the life of a vigorous CRC, with snapshots of our organization, numerous research highlights and a look at our new business development initiatives.

Jacques Lyrette, President

Radiocommunications and Broadcast Research

Radiocommunications Technologies

The rapidly expanding demand for wireless radio communication in Canada is creating privacy and congestion issues that require technical solutions. To find those solutions, this group researches terrestrial radiocommunications systems to meet both civilian and military requirements. Research is also conducted into radio networks and narrowband speech compression techniques.

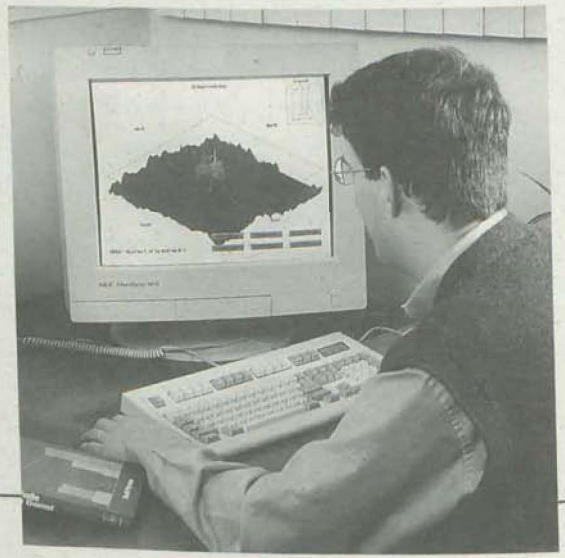
Radio Sciences

The CRC is the only organization in Canada conducting comprehensive research on the propagation of electromagnetic waves and the effects of noise, interference and other factors on the performance of radio communications. Research in radio sciences provides the basis for technical information and advice to help government and industry select the best systems and services for radio communications. CRC's research and advice also assist the government in planning for the efficient use of Canada's radio spectrum.

Bernard Breton studies computer simulation of radio propagation (pg. 4).
Skywave briefcase terminal undergoing testing (pg. 5).

Broadcast Technologies

Digital technologies will soon give consumers access to an unprecedented range of information and entertainment via television and radio services. Many international players are working toward creating this next generation of broadcast technologies. Canadians have a major stake in ensuring that future broadcast services evolve to meet our needs. In CRC's unique facilities, researchers are investigating advanced broadcast and related technologies to help define standards, manage the spectrum, and develop broadcasting and telecommunications policies.



Communications Systems Research

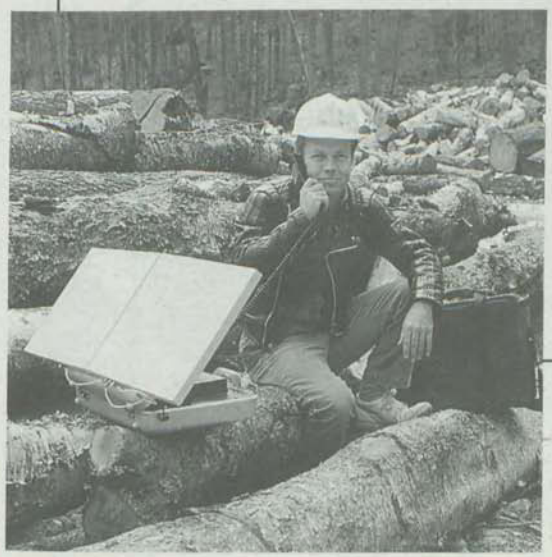
Satellite Communications Systems

Since the 1960s, the CRC has been Canada's primary research institute for satellite communications. Satellite communications complements terrestrial systems to provide Canada-wide telecommunications and broadcast services.

Over the years, the CRC has played a major role in developing Canada's world-leading satellite communications systems through technology and applications development, and major space flight programs. Early in 1995, MSAT will be launched, opening a new era of mobile communications services throughout Canada. This program was initiated by the CRC and later transferred to industry.

In collaboration with the Canadian Space Agency, the CRC has formulated long-term plans for the further development of satellite communications focusing on multimedia personal communications services.

Furthermore, CRC researchers face new challenges as the evolving information highway requires the application and integration of satellite services.



Microelectronics and Optical Technologies

CRC researchers in this area use their unique expertise and facilities to promote industrial capability in microwave and millimeterwave circuits and antennas, integrated electronics, optoelectronics and photonics—all key communications technologies. They give particular attention to emerging personal wireless communications using both satellite and terrestrial delivery systems.

In its well-equipped microelectronics fabrication facility, the CRC specializes in the integration and miniaturization of signal processing electronics using advanced technologies. Examples include small integrated antennas, and circuits operating at millimeterwave frequencies for wideband satellite communications and for within buildings. A current R&D thrust is the development and use of combinations of integrated microwave, digital, optoelectronic and photonic technologies.

Microcellular Land Mobile Communications

In collaboration with Canadian cellular providers, CRC directed a project for the measurement of radio propagation data on urban land mobile channels with microcell-style base stations. This data will help in designing microcellular communications cells (much smaller cells than currently employed for urban coverage) operating at frequencies close to 2 GHz.

With new electronic capabilities for handling fast signal switching among multiple microcellular base stations, such systems could provide a much needed answer to the demand for increased traffic capacity.

Improvements in Forgery Prevention

CRC staff developed a new technique to prevent forgery of valuable documents such as credit cards, passports and health care cards. Using a combination of image processing, public key encryption and error correcting techniques, the technology is an improvement over the current means of countering fraudulent documents.

Spectrum Management Software

Industry Canada is responsible for allocating and planning Canada's radio spectrum. In support of that function, the CRC developed unique spectrum management software that synthesizes radio broadcast coverage. A computer simulation of the multicarrier modulation was created to investigate the performance of proposed emission formats in the context of international standardization of digital radio. This software is being used by the broadcast industry to plan future digital radio service offerings.

L-Band Developments

The CRC conducted channel characterization measurements at a number of sites in Canada. The results were used to provide the International Telecommunications Union's Radiocommunication Bureau with technical data supporting the feasibility of establishing the new 1.5 GHz band (L-band) for digital radio broadcasting.

st Research Highlights

New Digital Television Standards

With North America on the verge of a 500-channel universe, the CRC's expertise in high definition television and digital compression techniques is highly sought. The CRC is under contract to Canadian and U.S. broadcast interests to examine digital broadcast emission techniques that improve service coverage.

The MPEG-2 family of digital video compression standards that are expected to be used widely for video broadcasting can now be fully simulated at CRC. The CRC also entered into a collaborative research project with Advanced Broadcasting Systems of Canada to select a single video compression standard for the Canadian broadcast industry.

Focus group rates high definition TV images.

Digital Radio on Internet

In December 1993, the CRC, in collaboration with the Canadian Broadcasting Corporation, began providing radio programming on demand over Internet. By January 1994, it was being downloaded in 39 countries. The next research phase will combine audio with complementary video pictures.

Communications Signal Processing

CRC researchers developed and successfully demonstrated at sea an experimental naval HF adaptive antenna system. This system incorporates a powerful new algorithm that cancels interfering signals several orders of magnitude stronger than the communications signal. Application of this technology to cellular communications systems is being studied.

Researchers have also developed an advanced HF equalization technique that counters the severe Doppler spreading experienced in Canada's North and offers the potential for increasing the data throughput on HF circuits.

Communications Systems Research

Satcom Extension of Networks

During this fiscal year, asynchronous transfer mode (ATM) emerged as a likely standard for broadband communications along the information highway. Researchers in this area began exploring ATM network interconnection via satellite links.

Satcom Technology Transfer

Technology transfer to Canadian industry is an important part of the CRC's ongoing R&D programs. During the past year, 11 satellite communications technologies were licensed to 9 Canadian companies. These include antenna technologies for future MSAT terminals and modem technologies meeting Inmarsat and MSAT standards. The CRC also contributed significantly to the development of aeronautical satellite communications.

On-board Signal Processing

Research into satellite on-board processing technologies and EHF terminal technologies has resulted in development of a prototype on-board processing system and an EHF briefcase terminal. These were tested this year using the European Space Agency's Olympus satellite.

The CRC initiated studies of a new advanced satellite communications system in collaboration with industry. A Spar Aerospace–led consortium completed the first phase of an integrated Ka/Ku band advanced payload which incorporates on-board signal processing and switching with a multiple-beam array antenna. On-board processing provides the satellite with the capability to switch between uplink and downlink signals without direct ground control.

Contract Services

Using its expertise in microwave and satellite technologies, the CRC has assisted several firms through collaborative R&D agreements. With Teleglobe, CRC has evaluated low earth orbit satellite systems, and with Inmarsat has contributed to the design of advanced personal satellite communications. Through these collaborations, the CRC has increased its expertise in non-geostationary mobile communications.

François Gouin tests an optoelectronic integrated circuit (pg. 9).

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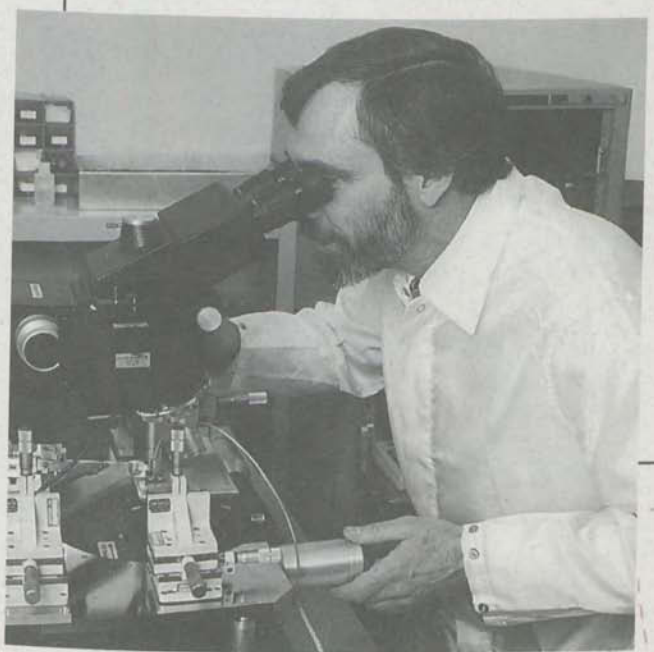
François Gouin tests an optoelectronic integrated circuit (pg. 9).

Highlights

Microwave and Millimeterwave Circuits and Antennas

Through collaborative R&D agreements and contracts exploiting our expertise in microwave technologies, the CRC assisted several Canadian industrial firms in developing new product capabilities.

Breakthroughs were made in aperture-coupled and dielectric resonator integrated antennas and arrays. A small active array for EHF satcom terminals and, a world first, a 20 GHz antenna/amplifier fully integrated on a gallium arsenide chip, were successfully demonstrated. CRC software for nonlinear analysis of MICs was used to design 20/30 GHz MMIC mixers and amplifiers. Researchers also completed tests on microwave amplifiers/filters using high-temperature superconductors.



Integration of Optical and Electronic Devices

This work focused on integrated components for broadband and high-speed applications. The CRC can fabricate optoelectronic integrated circuits from gallium arsenide–based material to final packaged subsystems, thus combining microwave and optical functions on single chips for use in satcom antennas, broadband switching and fibre-to-radio interfaces. With industry, R&D is being carried out on miniature hybrid MICs and multichip modules for combining RF and digital integrated circuits.

In collaboration with the Canadian Solid State Optoelectronics Consortium, good progress was made in the development of an eight-channel laser array integrated with advanced electronic driver circuitry. With it, future networks will carry a variety of signal sources along a single fibre.

Optical Components

Photosensitivity in optical fibre, discovered by CRC researchers in the 1970s, led to recent inventions of components for high-speed networks. For example, the transmitting wavelength of a solid-state laser can be controlled by writing "gratings" on the output fibre. An agreement has been signed to assist a British Columbia company to exploit this technology.

Building Partnerships to Develop Co

Defence Communications

The CRC has conducted a communications R&D program for the Department of National Defence (DND) on a cost-recovery basis since 1969. The program spans both research branches and provides salary and project funding for 20 percent of the CRC research staff. Program content is developed cooperatively with DND resulting in the cost-effective maintenance of the technology base necessary to meet both civilian and military requirements in emerging communications technologies.

In 1993-94, the CRC received approximately $6 million under this program to conduct R&D projects in networking, radio communications, satellite communications, electronic countermeasures, speech coding, propagation and microelectronics.

An important part of this program is a multinational NATO project to demonstrate the global interoperability of radio, satellite and wired multimedia networks. The CRC's role includes developing the network management architecture and the HF subnetwork in North America.

Advances in Business Development

Since becoming a research institute, the CRC has taken advantage of its new authorities to market its intellectual property and unique facilities more aggressively and to enter into collaborative R&D with industry, other government agencies and universities.

CRC's ability to retain money earned through contracting and licence agreements, has led to a significant increase in contracting activity and revenue generation over the year.

Testing HF adaptive antenna aboard Canadian naval vessel (photo: Andy Tenne-Sens).

mmunications Technology

VISTAR

In January 1994, the CRC signed a $14 million five-year collaboration agreement, the largest in its history, with VISTAR Telecommunications Inc. CRC and VISTAR will develop satellite technology and applications in wireless and personal communications and high-speed data networks.

Grand Alliance

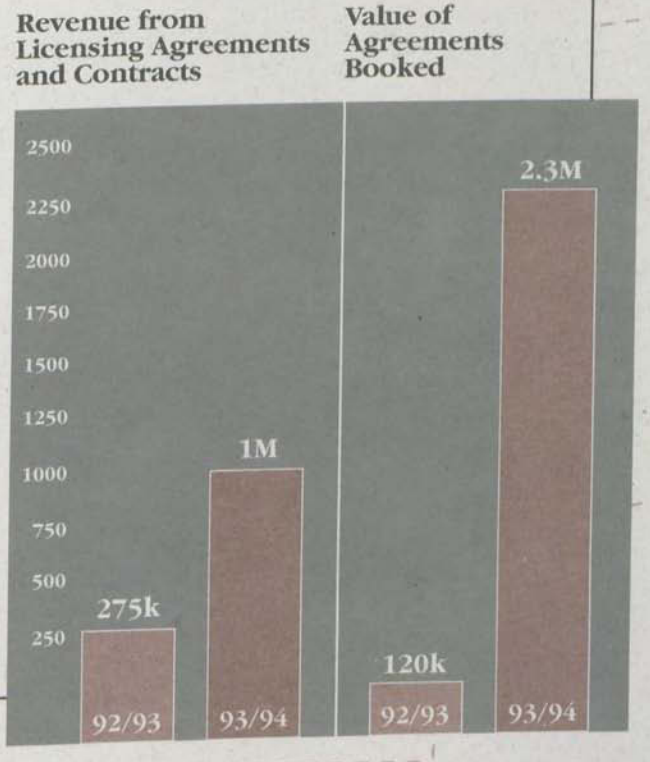
The CRC signed a $1.2 million service agreement with the Grand Alliance, a U.S. consortium developing a digital high definition television system. The CRC's Advanced Television Evaluation Laboratory will conduct subjective picture quality assessment tests to ensure that the system meets all requirements before being adopted as the HDTV standard for the United States and potentially for Canada.

Additional Contracts

- During this fiscal year, 50 revenue-generating research or technical services agreements, worth $2.3 million, were signed.
- Other contracts of note include a service agreement with the Electronic Industries Association, two contracts with Teleglobe Canada and three contracts with Canadian cellular operators, worth approximately $650 000.

Intellectual Property Agreements

- There were 135 active intellectual property agreements generating $222 000 over the fiscal year.
- Twenty-five technology transfer licences were granted to small and medium-sized enterprises.
- The CRC filed applications for 12 new patents.
- Two new U.S. patents were obtained.



Opening the Door to Business Oppo

In 1993-94, the CRC launched two initiatives to expand its working relationships with industry and other organizations: the Technology Incubator and the Broadband Applications and Demonstration Laboratory (BADLAB). It also initiated a feasibility study on developing a CRC research park.

Technology Incubator

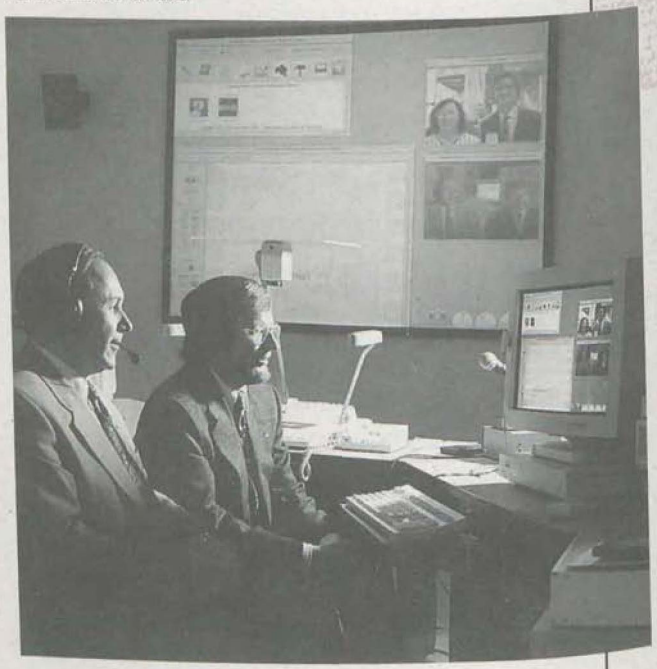
The Technology Incubator allows small and medium-sized companies and start-ups to reside at the CRC for a limited time to access CRC's expertise, technologies and unique facilities. The program will accelerate the exploitation of CRC's technologies and assist the development of innovative communications products and services. Companies will have access to furnished offices, lab space and technical support services. The Incubator will be open for business in the 1994-95 fiscal year.

BADLAB

The Broadband Applications and Demonstration Laboratory (BADLAB), was created to further the rapid development of Canada's information highway. In collaboration with Telesat, BADLAB is the first R&D facility in Canada to integrate satellite links with high-speed asynchronous transfer mode (ATM) networks to testand demonstrate information highway applications. Housed in a 335 m^2 space at the CRC, BADLAB is a part of the Ottawa Carleton Research Institute Network Inc. (OCRInet) ATM test network. The lab was linked to the network through a 90 Mb/s fibre optic cable in January 1994.

The first live test of a consumer application over OCRInet was held in BADLAB in March 1994. It demonstrated a travel agency application developed by MPR Teltech in association with Newbridge Networks Corporation.

Paul Wilker (left) and Bob Kuley experiment with BADLAB's multimedia worksation.



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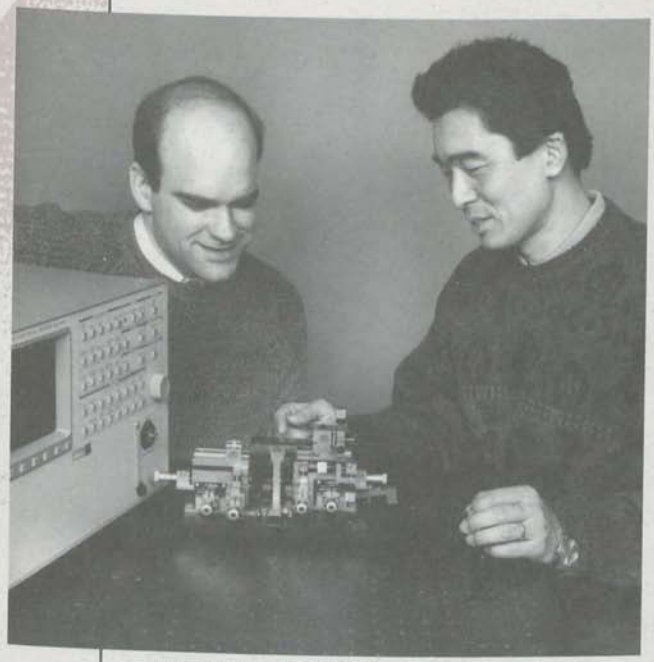


CRC's Bernard Malo (left) discusses photonics project with visiting Japanese scientist Taikshi Kitigawa.

BADLAB's mandate is to:

- test, demonstrate and license CRC-developed technologies relating to the information highway;
- test and demonstrate new multimedia applications in telemedicine and distance education over ATM fibre and satellite links; and
- provide non-competitive test and demonstration facilities to small and medium-sized communications R&D companies across Canada.

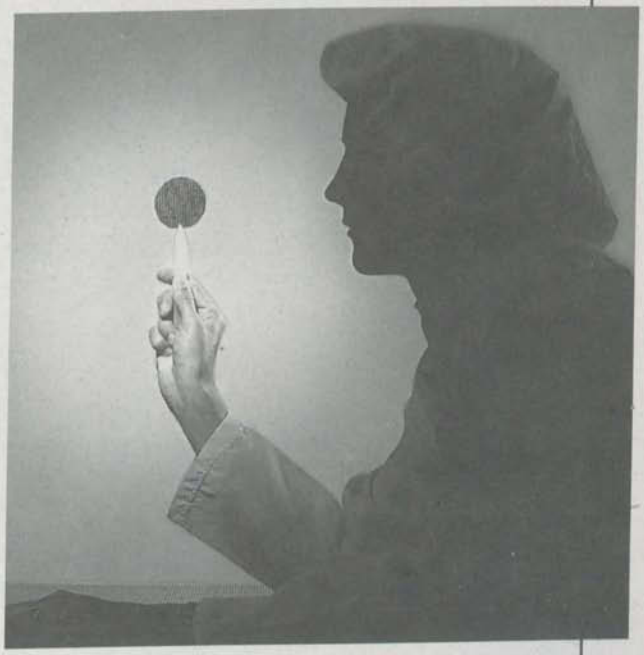
Research Park

The CRC's unique facilities, world-renowned expertise and proximity to a number of high-tech industries are compelling reasons to consider establishing a research park.

A consulting firm was hired to study the feasibility of building a research park at Shirleys Bay.

The study will provide detailed recommendations, which will be considered during the 1994-95 fiscal year.

Examining an integrated circuit.



Running CRC is like Operating a Sm

Essential Support

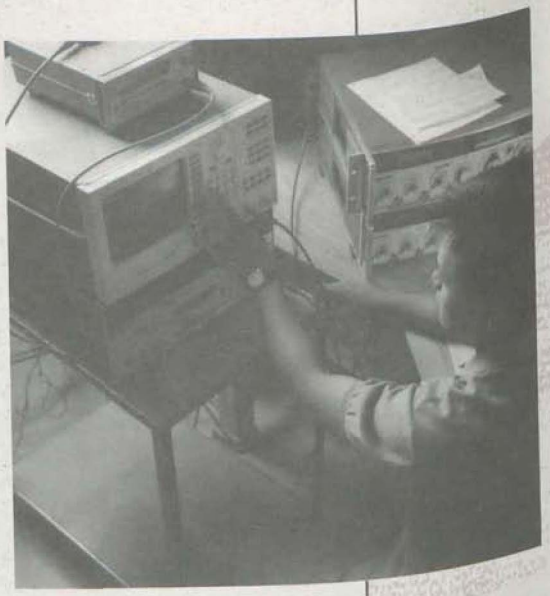
The research community at the CRC is supported by 190 staff who provide services and operate the site. Whether building integrated circuit boards or operating the central heating plant, much work is done behind the scenes to help maintain CRC's reputation as a world-class centre of excellence in communications R&D.

Energy Management

It costs about $2 million yearly to provide heat, light, water and sewer services to the CRC. Over the years, utility costs have risen faster than CRC's funding base. Aging buildings and infrastructure have made it necessary for the CRC to explore options for reducing energy and other operating costs. In the next fiscal year, energy management companies will be asked to submit proposals for retrofitting buildings to stabilize or reduce the operational expenses of running the site.

Pg. 14, top to bottom:
Minh Huynh performs instrument calibrations;
Commissionaire Bob Grenier greets visitors and staff at CRC main gate;
Denis Leduc adjusts heating controls.

Pg. 15, inset:
CRC exhibit at the Canadian Advanced Electronics Show;
centre: *Model Shop technicians install troposcatter antenna in High Arctic (photo: Capt. Isabelle Bergeron).*



all Town

Quick Facts

At 600 hectares in size, the site at Shirleys Bay, west of Ottawa, is larger than some small towns.

There are 72 buildings, 13 kilometers of road, and 400 permanent employees. The site was first used by the Defence Research Board in 1952. Today, National Defence and the Canadian Space Agency, with a combined staff of about 250, also occupy the site.

People Make the Difference at CRC

Rejuvenation Plan

In the fiscal year, Industry Canada approved CRC's human resources rejuvenation plan to ensure that long-term staffing needs are met. The plan identifies innovative recruitment methods to renew the scientific and technical ranks. It also creates a mentor program to ensure that research continuity is maintained between scientists.

Exchange Program

During 1993-94, a program was approved to provide new workplace opportunities for CRC employees and to foster cooperation between CRC and Canadian industries and universities through the exchange of employees.

This program will be implemented in the next fiscal year.

Pg. 16, top to bottom:

Librarian Carole Laplante helps Bob Deguire with computerized library catalogue;

Finance's Karen Tigbe-Scobie (l) and Audrey Honeywell;

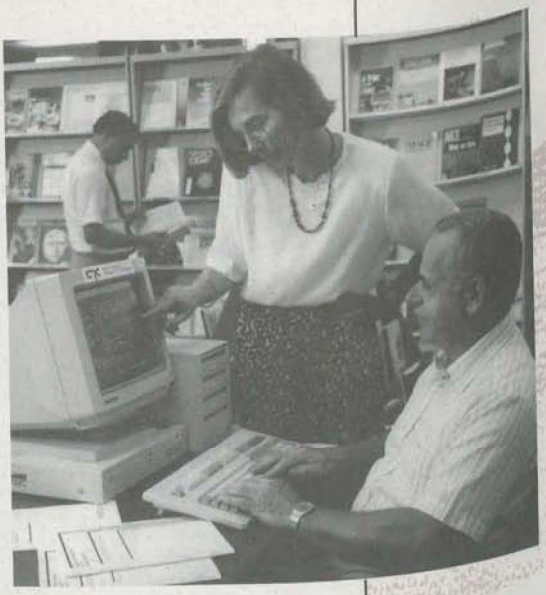
Informatics' Casey Van Oirschot makes network connections.

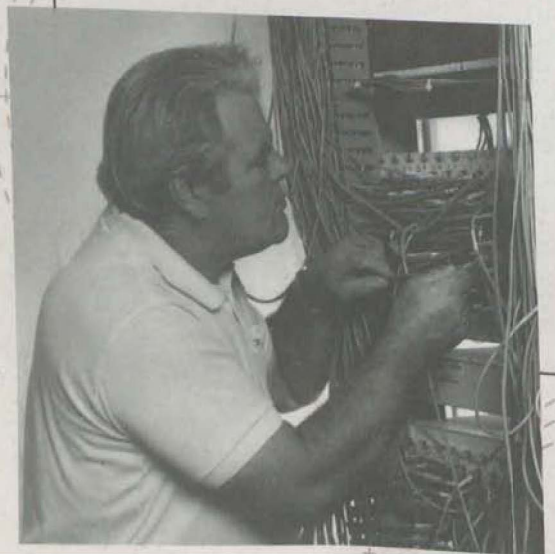
Pg. 17, inset, top:

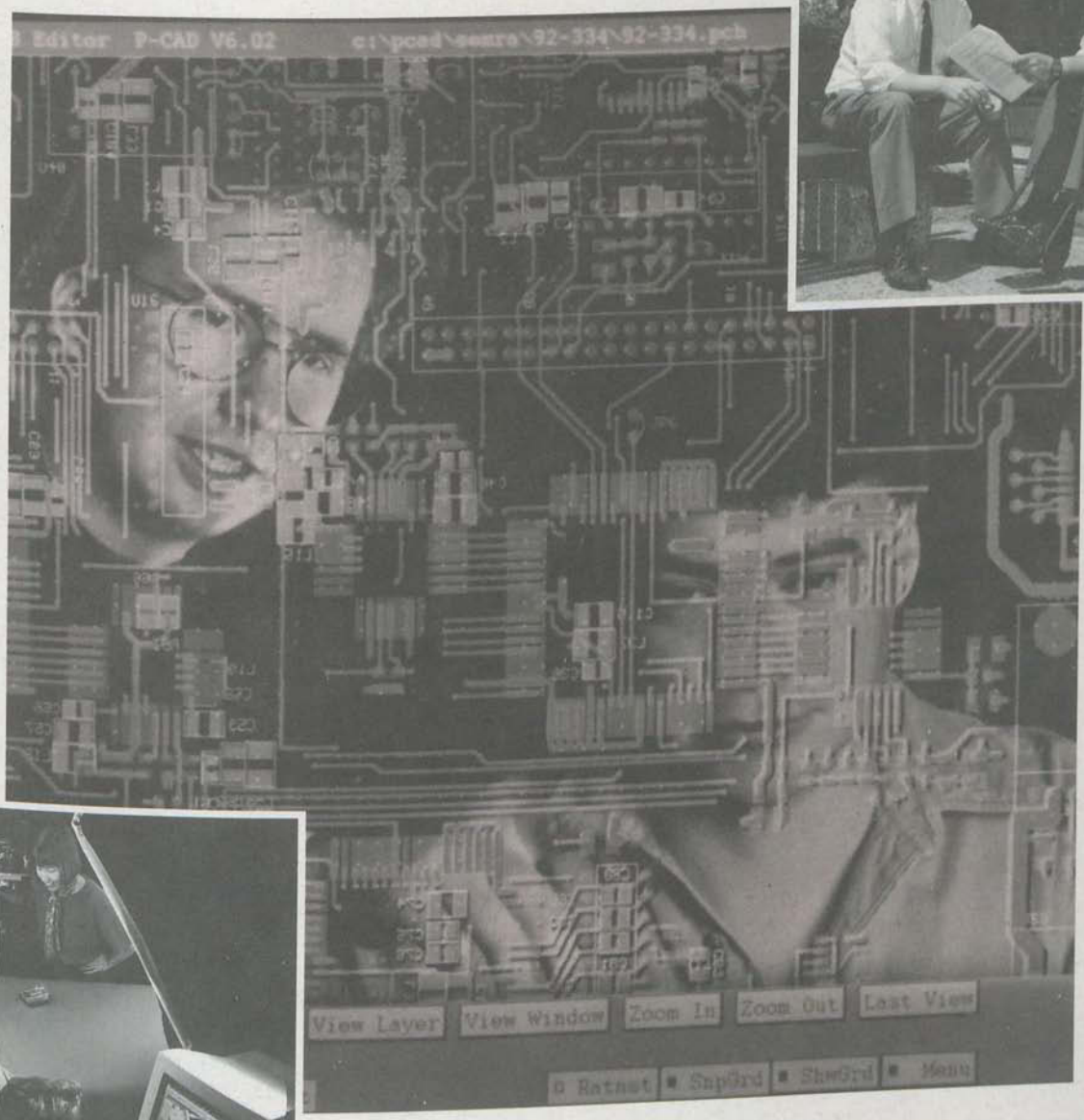
CRC Executive Vice-President Stu McCormick discusses strategic planning with Attilio Barcados;

centre: *prototype designers Peter Clark and Robert Macey examine a printed circuit;*

inset, bottom: *Creative Visual Services' Roberta Gal (l), Louise Casavant and Janice Lang (back) produce digital image.*



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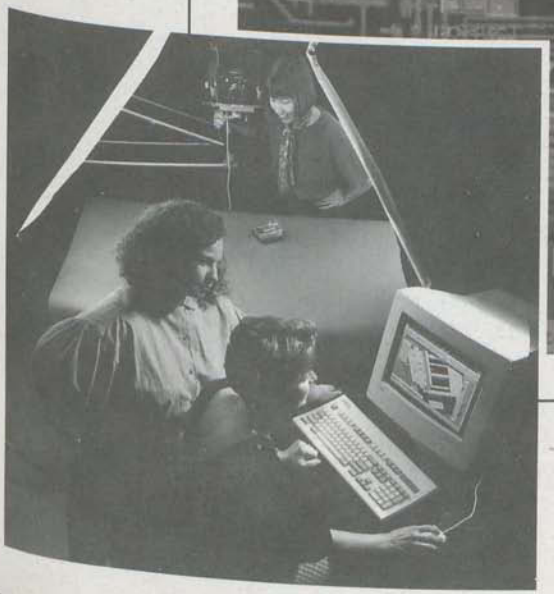
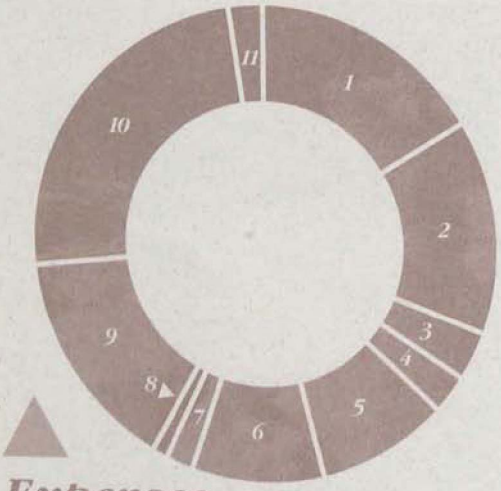


Revenues and Expenses



Expenses

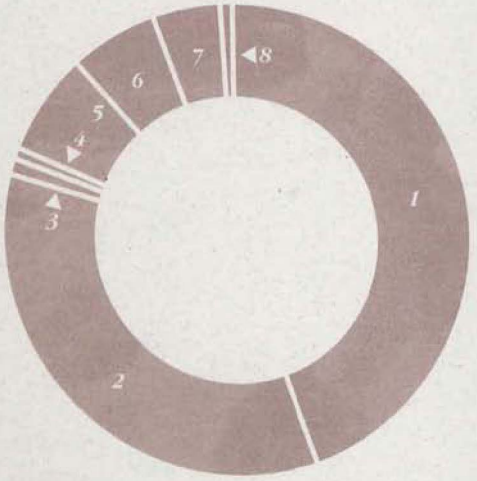
1993/94 ($Million)

Research Salaries:	
1 Radiocommunications and Broadcast	6.2
2 Communications Systems	5.5
3 Research Services	1.3
4 Administration	1.0
Research Operating Expenditures:	
5 Radiocommunications and Broadcast	3.5
6 Communications Systems	3.6
7 Research Services	0.6
8 Administration	0.3
Total Research	22.0
Site Services:	
9 Salaries	5.8
10 Operations	9.4
Total Site Services	15.2
11 Carry Forward (94-95)	0.7
Total	**37.9**

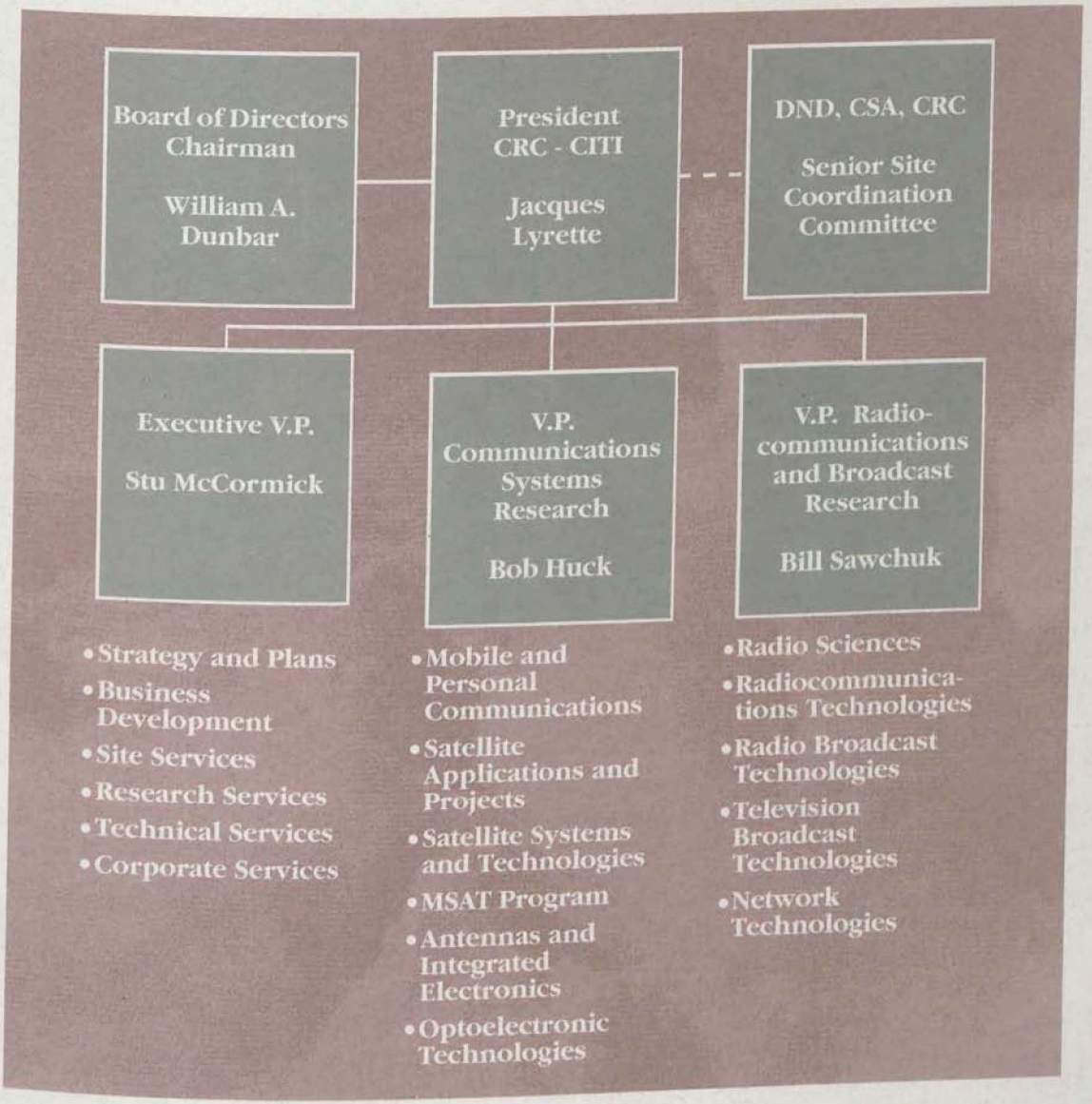
Revenues

1993/94 ($Million)

1 Parliamentary Appropriations (salaries and wages)	16.7
2 Parliamentary Appropriations (operating costs)	13.6
3 Intellectual Property	0.2
4 Industrial Partners	0.1
5 Other Gov't Depts. - Research	2.9
6 Other Gov't Depts. - Site Services	2.3
7 Industry Canada - Spectrum	1.9
8 Contracted Services	0.2
Total	**37.9**



The CRC Organization Chart



The Board of Directors

Morrel Bachynski
President
MPB Technologies Inc.

Larry Boisvert
President and COO
Telesat Canada

Jocelyne Côté-O'Hara
President and CEO
Stentor Telecom Policy Inc.

Gilles Delisle
Director
INRS Telecommunications

Roland Doré
President
Canadian Space Agency

William A. Dunbar (Chairman)
President and CEO, NorthwesTel Inc.

Martin Fournier
President and COO
Teleglobe World Mobility

Nick Hamilton-Piercy
VP Engineering and Technology
Rogers Cablesystems Ltd.

Jacques Lyrette
President
Communications Research Centre
Centre for Information Technology Innovation

Robert E. Olley
Consultant

Ken Peebles
Chief, Research and Development
Department of National Defence

Pierre Perron
President
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