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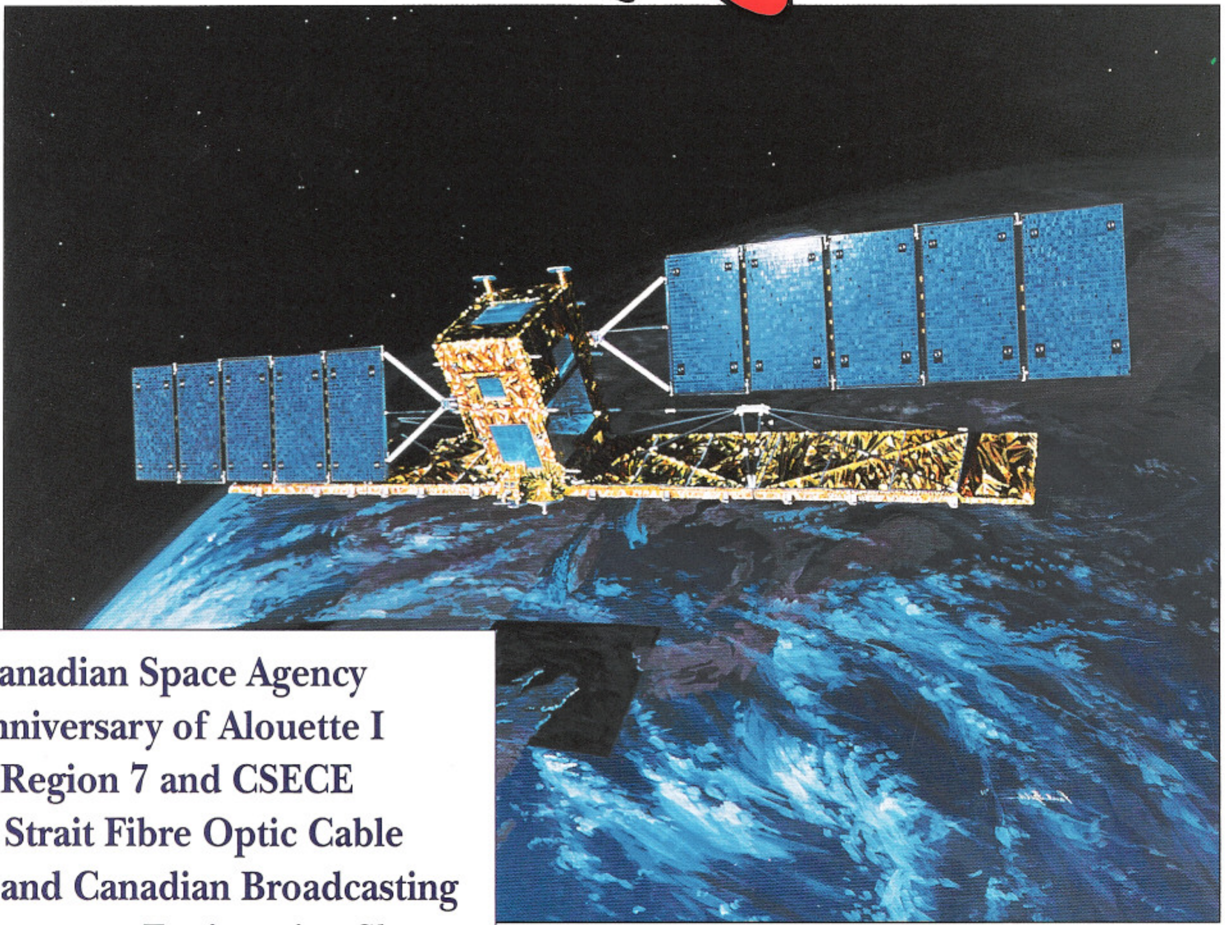

The Canadian Space Agency
30th Anniversary of Alouette I
IEEE, Region 7 and CSECE
Cabot Strait Fibre Optic Cable
Digits and Canadian Broadcasting
The Spectrum Engineering Show
E&C Engineering - a Report

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IEEE Canadian Review General Information

The *IEEE Canadian Review* is published three times per year - Spring, Fall and Winter. The *IEEE Canadian Review's* principal objective is to project an **image** of the Canadian electrical, electronics, communications and computer engineering professions and their associated academic and business communities to :

(i) Canadian members of IEEE;

(ii) Canadian members of the profession and community who are non-members of IEEE;

(iii) the associated academic (i.e. universities, colleges, secondary schools), government and business communities in Canada.

In this context, the *IEEE Canadian Review* serves as a forum to express views on issues of broad interest to its targeted audience. These issues, while not necessarily technologically-oriented, are chosen on the basis of their anticipated impact on engineers, their profession, the academic, business and industrial community, or society in general.

To ensure that the *IEEE Canadian Review* has the desired breadth and depth, Associate Editors are responsible for identifying issues and screening articles submitted to the *IEEE Canadian Review* according to the following general themes:

1- National Affairs
2- International Affairs
3- Industry
4- Education
5- Power
6- Communications
7- Computers

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- The Managing Editor

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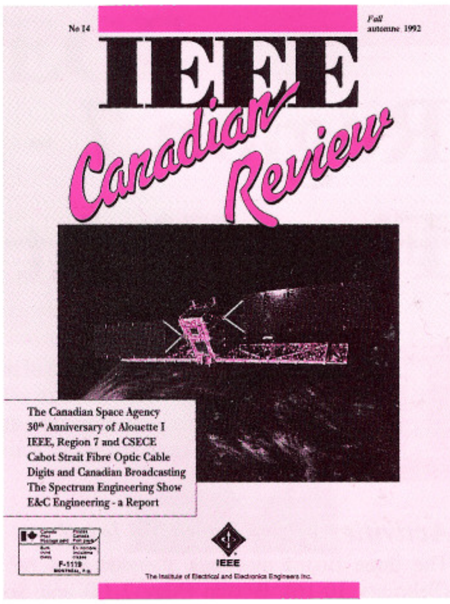

Cover picture

Our cover picture shows an artist's view of RADARSAT tracking over Canada, courtesy of Canadian Space Agency. (*Illustration: Paul Fjeld*)

Tableau couverture

Le tableau de la page couverture donne une perception artistique de RADARSAT survolant le Canada, gracieuseté de l'Agence spatiale canadienne. (*Illustration: Paul Fjeld*)

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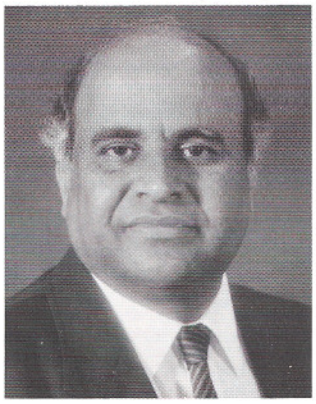
Region 7 - A Report on the First Eight Months

by Dr. Vijay K. Bhargava
Director, IEEE Canada



It is hard to believe that one third of my two-year term is already finished. Our regional committee will meet next month, the first and only time this year. However, since this is the last issue of 1992, I would like to share my activities during the last eight months with you.

Activities at the Institute level

The three Board meetings attended thus far have been in Vancouver (February 10-16), Boston (May 7-14) and Sparks (July 29- August 4). Although the IEEE Board meets for only two days, there are numerous other meetings. The ones with which I am involved are Regional Activities Board, Educational Activities Board, Transnational Committee and the IEEE Audit Committee. These meetings have been fascinating. A third of million members, one IEEE and 140 countries. A large number of volunteers and staff make it work in the most amazing way.

During May 16-17, I attended the Region 8 (Europe, Middle East and Africa) Meeting to learn how they serve their members. This was a fascinating experience. A report written by me is available from your Section chair.

Activities within Canada.

I arranged two conference calls of your full Executive Committee and Operating Committee chairs, to set goals and to get going.

At the three Council meetings (CCC - Peterborough, April 4-5; ECC - Trois Rivières, April 11-12 and WCC - Calgary, April 25-26), I made presentations on several IEEE organizations (BOD, RAB, Field Services, etc.)

At the Executive Committee Meeting (Toronto - June 13), we received reports from all Operating Committee chairs, and made plans for the Region Committee Meeting. In the rest of this report, I would like to provide you with a summary of Region 7 activities in various areas.

Forward Planning Committee: This committee is developing future plans for the region, provides input to the budgetary process and is looking at means of generating additional revenues, other than by increasing the regional assessment. The three-member committee, chaired by immediate Past Director, Dr. **Tony Eastham**, Region 7, includes Treasurer Mr. **Micha Avni** and Mr. **Bill Kennedy** of WCC.

IEEE Region 7 / CSECE Blue Ribbon Committee: I urge you to give careful consideration to the accompanying IEEE/CSECE article by Drs. **B. John Plant** and **Tony R. Eastham**. This may be an old issue but the philosophies of the Engineering Institute of Canada and that of IEEE have changed considerably over the past few years. We have an historic opportunity here.

IEEE Canadian Foundation: Senior Past Director Dr. **Bob Alden** has been spearheading efforts in this direction. As we go to press, it is very close to becoming a reality.

IEEE Canadian Review: It is doing very well, and Managing Editor **Ted Wildi** and his impressive slate of Associate Editors have ensured a regular flow of timely articles by top-notch authors.

Finance: This has been a source of concern at the Institute level and within Region 7. I regret to inform you that there will be a basic dues increase of U.S. $4 in 1993. In *addition*, the Region 7 assessment will increase by U.S. $3. Our regional assessment at U.S. $15 is now the highest among all non-U.S. regions in the IEEE (compared to U.S. 11$ for Region 8, and $4 for Regions 9 and 10). I have requested Region 7 Treasurer Mr. **Micha Avni**, to look at our budget carefully and devise plans to create a reserve. We will report to you on the 1993 budget (now approaching $300,000) in the next issue of the IEEE Canadian Review.

Student Activities: We now have some 3321 student members in 62 schools. The total number of student branches stands at 51, and 35 percent of these can be reached by electronic mail. Training workshops have been scheduled. A Region 7 student paper competition was held in conjunction with the 1992 Canadian Conference on Electrical and Computer Engineering.

Conference Activities: The 1992 Newfoundland Conference on Electrical and Computer Engineering was held on May 1, 1992. This successful conference was sponsored by the section and is a good model for others. The Conference was co-chaired by Mr. **Ken Butt** and Dr. **John Quaicoe**.

During June 25-26, Region 7 played host in Vancouver to 282 conference delegates from 28 countries, attending the IEEE International Conference on Selected Topics in Wireless Communications. The Conference was chaired by Dr. **Norman Toms**, while the Technical Program was co-chaired by Dr. **Vijay Bhargava** and Mr. **Mike Callendar**. Region 7 will be hosting several other conferences during the remainder of 1992.

Awards and Recognition: The Committee, chaired by Dr. **Greg Stone**, has completed its work. In addition to Regional and Council awards, our members have won several other IEEE awards. We will continue to inform you about these winners.

Membership Development: Compared to last year, Region 7 membership increased by 1.44% to 14 782. The Membership Development Committee, chaired by Mr. **David Kemp**, has set definite goals regarding new members, member retention and member upgrading. I challenge the sections and councils to attain these goals.

Public Awareness and Educational Activities: To date, these have been low profile activities within the region. I hope to report on them more fully at a future date.

Sections/Chapters co-ordinator: Dr. **T. Aaron Gulliver** has been appointed to this new position.

Finally, I would like to hear from you. I can be reached c/o Department of Electrical & Computer Engineering, University of Victoria, POB 3055, Victoria B.C. V8W 3P6; Telephone (604) 721-8617, FAX (604) 721-6048; e-mail: Bhargava @ sirius. uvic. ca. ■

IEEE, Region 7 and CSECE

Is a merger desirable and feasible?

During the last Canadian Conference on Electrical and Computer Engineering in Quebec City in September 1991, the incoming Director of IEEE Canada, **Vijay Bhargava**, got together with the incoming President of CSECE, **Jean-Remi Giroux**, to discuss matters of mutual interest. Conversation soon turned to the relationship between the two societies. They decided to ask the outgoing Director of IEEE and the outgoing President of CSECE, the authors of this article, to form a "blue ribbon committee" to review the relationship between IEEE Region 7 and CSECE, and to bring forward first a discussion paper for consideration by the Executives of the two societies and then to develop specific recommendations for consideration by the membership. We deliberated upon our assignment for about six months, and identified three options:

Option 1. Maintain a clear separation between the two societies, with each pursuing its own program for the benefit of its own members.

Option 2. Develop collaboration and engage in cooperative programs and ventures. Specific examples are cosponsorship of the Canadian Conference on Electrical and Computer Engineering, joint medal banquet and prize presentations, joint student paper competitions, and reciprocal invitations to each society's Executive Meetings.

Option 3. Amalgamate to form one organization to better serve the needs of Canadian electrical engineers.

We recognized that Option 1 is highly undesirable and that, as a result of an evolving cooperative relationship, we are now effectively operating under Option 2. We recommend consolidation of this mode of operation with further cooperative ventures in the near term.

We are convinced that Option 3 is the right objective for the mid term. Why? Because we believe that one strong society is best able to represent the technical and professional needs of electrical engineers in Canada. Let's first review the current situation:

IEEE Region 7 (also known as IEEE Canada):

- is the Canadian Region of transnational IEEE, with approximately 13 000 full members, grouped in 20 Sections and 3 Councils across Canada,
- has approximately 4 500 student members, with branches in 48 institutions across Canada,
- maintains a Regional Office in Thornhill, Ontario,
- publishes the IEEE Canadian Review,
- members receive Spectrum and The Institute, and can subscribe to a wealth of Society and other technical publications,
- has an annual fee (1992) of $73 U.S. (basic dues) + $12 U.S. (regional assessment). In Canadian funds, the basic dues plus regional assessment amount to $105.

Canadian Society of Electrical and Computer Engineering (CSECE):

- is the national EE society, with approximately 850 members,
- has very few student members,
- is a member society of the Engineering Institute of Canada (EIC),
- publishes the archival Canadian Journal of Electrical and Computer Engineering,
- organizes and sponsors the Canadian Conference on Electrical and Computer Engineering,
- has an annual fee of $85.

There are clearly a number of questions which must be answered before amalgamation could take place. Discussions must be held with IEEE and EIC, and both organizations must be convinced that a merger between IEEE Canada and CSECE would be in their interests and in the best interests of their members.

B. John Plant
Past President, CSECE
Principal,
Royal Military College of Canada
Kingston, Ontario K7K 5L0

Tony R. Eastham
Past Director, IEEE Region 7
Professor, Electrical Engineering
Queen's University
Kingston, Ontario K7L 3N6

Cet article passe en revue les relations qui existent entre les deux sociétés scientifiques au service du génie électrique au Canada; il s'agit de l'IEEE, Région 7 et la Société canadienne de génie électrique et informatique (SCGEI, CSECE). La collaboration s'est accrue ces dernières années. Nous recommandons un pas vers la fusion de telle sorte que la nouvelle société résultante bénéficie de la reconnaissance à la fois de l'Institut canadien des ingénieurs et de l'IEEE.

Another obvious question is what will it cost persons who are presently members of only one of the organizations. Clearly, there can be economies with the elimination of duplicate services. What happens to the IEEE Canadian Review, to News 7, and to the CSECE Journal? We recognize that a proposal has to be presented in detail before any decision can be made.

Our thoughts are that the membership fees for an integrated CSECE (IEEE Region 7) organization should be paid in Canadian funds to a Canadian address. A certain amount would be transferred to IEEE headquarters for IEEE basic dues and the remainder would be retained for Canadian activities. We believe that the membership fee should be the same as that which Canadian IEEE members currently pay.

We presented our discussion paper to the Executive Committees of the CSECE and IEEE Region 7 at their Spring Meetings in May 1992. Both organizations responded very positively to our thoughts, and both passed motions to the effect that a move towards amalgamation be approved in principle, pending consultation with the membership and a detailed analysis of the financial and operational impacts of the proposed merger.

This article is part of the consultation process. We hope that it will stimulate discussion at the Section and Council levels. We plan to bring forward our recommendations for discussion at the Regional Meeting of IEEE Region 7 and at the Annual Meeting of CSECE, both of which will be held during the week of the Canadian Conference on Electrical and Computer Engineering in mid-September 1992, at the Delta Chelsea Inn in Toronto.

Our recommendation is that we move towards amalgamation to form one technical society that is recognized by EIC as the Canadian Society of Electrical and Computer Engineering and by IEEE as Region 7. When? Perhaps a decision could be taken in the Fall of 1993 for implementation on January 1, 1994.

We would appreciate your thoughts and comments.

The Canadian Space Agency

A *brief history.*

In December 14, 1990, the Canadian Space Agency was officially established by an Act of Parliament, with the following mandate:

- to promote the peaceful use and development of space;
- to advance the knowledge of space through science; and
- to ensure that space science and technology provide social and economic benefits for Canadians.

Dr. Larkin Kerwin, former President of the National Research Council of Canada, was the first president of the newly-established Canadian Space Agency. He was succeeded in May 1992 by **Dr. Roland Doré**, former Principal and Chairman of École Polytechnique de Montréal.

Canada's experience in space began in 1962, with the launch of **Alouette I, a** research satellite. Canada was the third country in the world, after Russia and the United States, to design and build its own satellite. With the launch of **Anik A1** in 1972, Canada became the first country in the world to have its own commercial, domestic, geostationary communications satellite. In 1976, a Canada-U.S. cooperative effort led to the launch of the **Hermes** communications satellite, which subsequently served as a prototype for direct broadcast satellites.

In 1981, Canada confirmed its position as a world leader in space robotics technology with the development of the **Canadarm** or **Shuttle Remote Manipulator System (SRMS)**, which is used to deploy and retrieve satellites in space from the Space Shuttle. The ***Canadarm*** was used for the first time aboard the U.S. Space Shuttle **Columbia** in 1981. A few years later, in October 1984, Dr. Marc Garneau became the first Canadian in space when he conducted the **CANEX-1** series of experiments.

More recently, in January 22, 1992, **Dr. Roberta Bondar** became Canada's second astronaut and first Canadian woman in space when she participated in the first **International Microgravity Laboratory** mission (**IML-1**) aboard the **Spacelab** on Space Shuttle **Discovery**. A few months earlier, in September 1991, Canada had provided the **WINDII** instrument, or **Wind Imaging Interferometer**, as part of NASA's **Upper Atmosphere Research Satellite** (**UARS**) program, designed to study global ozone change.

The Canadian Space Agency brings together the larger part of the existing space activities of the federal government. It coordinates all elements of Canada's Space Program and manages major space-related activities in Canada. Its headquarters are temporarily located in Montreal, pending completion of the new headquarters under construction in St-Hubert, a suburb of Montreal. The $72.2 million complex will be set on 40.7 hectares of land in St-Hubert. With occupancy scheduled for mid-1993, it is designed to provide work areas, laboratories and other facilities for Agency personnel and visitors from institutions, companies and other partners of the Canadian Space Agency.

The Canadian Space Agency is also maintaining and upgrading the ***David Florida Laboratory*** (***DFL***) in the Ottawa area, which is dedicated to the assembly and testing of space hardware, satellites and remote sensing equipment.

MSS Canada: Robotics for the Space Station

The **Mobile Servicing System** (**MSS**) is Canada's contribution to the international Space Station *Freedom*. This next generation of the **Canadarm** is a crucial component of Space Station. Designed to play the predominant role in the assembly and maintenance of the Space Station, the **MSS** will be used to help move equipment and supplies, release and capture satellites, service instruments and other payloads attached to the Station, and support astronauts working in space. It will also be used for berthing the shuttle to the Space Station and then loading and unloading materials from its cargo bay.

The **MSS** will be a roving space robot, able to travel the full length of the Space Station on its rail-mounted base. The first elements of the **MSS** are scheduled to be flown to Space Station orbit in the mid-1990s, aboard one of the first Space Shuttle missions dedicated to the Station's assembly. The rest of the equipment will be delivered on several shuttle flights throughout the four years it will take to make Space Station permanently habitable. Space Station *Freedom*, 450 km above Earth, along with the **MSS**, will have an expected working life of thirty years.

A major component of the **MSS** will be the **Space Station Remote Manipulator System** (**SSRMS**). About the same size as **Canadarm**, but over three times as strong, it is being designed to handle loads as big as the Shuttle as it approaches to resupply the Space Station. The **SSRMS** will also be able to detach itself from its movable base and crawl hand-over-hand to different points of the Station's structure to service hard-to-reach objects. When operated by astronauts, the **MSS** will be an extension of their own senses – able to see and touch. Artificial intelligence will even give it an I.Q.

by Dr. Roland Doré, P.Eng.
President, Canadian Space Agency

This article is an overview of the Canadian Space Agency's main programs and activities. The Canadian Space Agency brings together the larger part of the existing space activities of the federal government. It coordinates all elements of Canada's Space Program and manages major space-related activities in Canada. Thus, it administers projects such as RADARSAT – *a remote sensing satellite to be launched in 1995; the Mobile Servicing System (MSS) – Canada's contribution to Space Station Freedom; the David Florida Laboratory – A spacecraft testing facility; the Astronaut Program; the Space Science and Space Technology Programs; as well as Canada's cooperation with international partners such as NASA, the European Space Agency (ESA) and other foreign space agencies.*

Le présent article constitue un aperçu des principaux programmes et activités de l'Agence spatiale canadienne. L'Agence spatiale canadienne regroupe la plupart des activités spatiales du gouvernement fédéral. L'Agence coordonne l'ensemble des éléments du Programme spatial canadien et gère les principales activités liées au secteur spatial au Canada telles que : RADARSAT – *un satellite de télédétection qui sera lancé en 1995; le Système d'entretien mobile (SEM) – la contribution du Canada à la station spatiale Freedom; le Laboratoire David Florida – une installation de mise à l'essai d'engins spatiaux; le Programme des astronautes; les Programmes des Sciences et de la Technologie spatiales; ainsi que la coopération du Canada avec ses partenaires internationaux comme la NASA, l'Agence spatiale européenne (ESA) et les autres agences spatiales étrangères.*

The second element of **MSS**, a smaller, more sophisticated robot, is called the **Special Purpose Dextrous Manipulator** (**SPDM**). Equipped with two arms, each two metres long, the **SPDM** will perform more delicate jobs such as cleaning surfaces, replacing faulty components and working on the Station's electrical circuits, fuel lines and cooling systems. The **SPDM** will be able to work as a companion to the main arm (connected to its end), or singly (attached to the Station's truss structure).

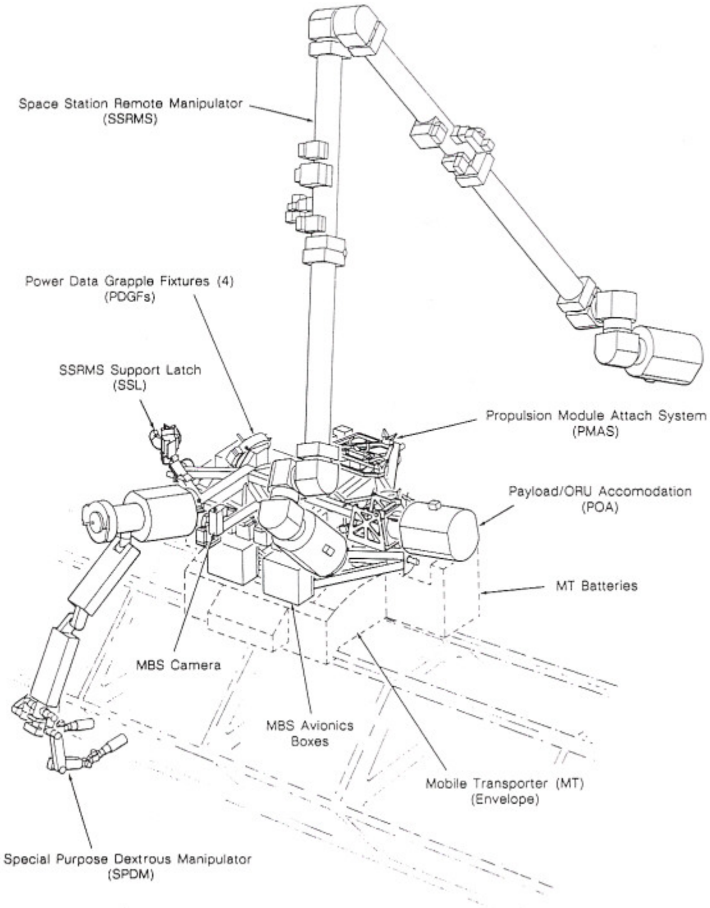
The **MSS** program will continue to involve and benefit Canada throughout Space Station's 30-year life via the **STEAR** Program (**Strategic Technologies for Automation and Robotics**). Its objective is to encourage Canadian companies, universities and research organizations to develop advanced automation and robotic technologies which offer potential for integration in the evolutionary design of the **MSS. STEAR** also has a mandate to encourage the spin-off of robotic technologies into manufacturing, service and resource industries.

Microgravity Program

The Microgravity Program involves the study of physical and biological processes in a weightless environment. Microgravity research also allows for the processing of purer materials (such as glasses and lenses with improved optics), better pharmaceuticals, and stronger plastics.

In this regard, the **User Development Program** (**UDP**) has been established to ensure that Canadian industries, universities, and researchers take full advantage of the Space Station's microgravity environment.

In the meantime, **UDP** currently promotes microgravity research by providing flight opportunities on NASA's special KC-135 aircraft, which achieve short periods of microgravity; the **CSAR** (**Canadian Space Agency Rocket**) **Microgravity Rocket**, carrying five Canadian experiments aboard the Canadian-made **Black Brant** rocket, and the National Research Council T-33 and Falcon 20 jets.



Space Station Remote Manipulator System (SSRMS) and its base (MSS) with Special Purpose Dextrous Manipulator (SPDM). The SPDM incorporates the most advanced automation and robotics technologies. The combination of the SPDM and the main manipulator arm (SSRMS) will enable the MSS to do many kinds of work around the Space Station, from handling massive satellites to carrying out the most delicate repair jobs.

A Word from the President

For most people, the idea of space exploration conjures up the image of astronauts like Roberta Bondar or Marc Garneau. Others see satellites or orbiting space stations. Space shuttle and rocket launches have become a part of our lives but continue to stimulate our imagination. These events, however spectacular they are, reflect a desire to challenge the unknown and to better understand our world and the universe. They are also the result of long and arduous research conducted by dedicated scientists and engineers all around the world who are determined to find elusive answers and are not inclined to accept defeat. Research is the basis of space exploration; it is the desire to discover the unchartered territory that is space and to better understand and know our home world, planet Earth. The advancement of science has to remain a priority for mankind. Space science and exploration hold a promise of a better future for humanity.

The Canadian Space Agency's mission is, of course, to contribute to space exploration and to promote the peaceful use of space. But the Agency's goal is also to encourage research and to increase scientific knowledge for the benefit of mankind – economically and intellectually.

Dr. Roland Doré graduated from École Polytechnique de Montréal with a degree in Mechanical Engineering in 1960. He obtained a Ph.D. from Stanford University in 1969. He devoted his career to engineering education and to research in the fields of nuclear power plants and biomechanics of the human body. Formerly Principal and Chairman of the Board of the École Polytechnique de Montréal, Dr. Doré was appointed President of the Canadian Space Agency on May 4, 1992.

Earth Observation: RADARSAT

The RADARSAT satellite, scheduled for launch in early 1995, will represent a leap forward in the technology of remote sensing. Unlike most current remote sensing satellites which rely on capturing reflected sunlight from the Earth, RADARSAT will transmit and receive radio signals through darkness and clouds using a powerful microwave *Synthetic Aperture Radar* (*SAR*) System.

From its circular polar orbit 800 km above the Earth, RADARSAT will gather data from which high-resolution images will be produced to survey natural resources, monitor pollution, track ice movement, and generally provide tools for more efficient management of the environment and Earth's resources. RADARSAT will scan the Earth in a variety of swath widths, up to 500 km-wide. This will permit frequent coverage of the northern latitudes. Because its SAR enables the measurement of soil moisture and vegetation, RADARSAT has the potential to greatly improve crop management, and forestry operations. RADARSAT data will also benefit geological exploration, fisheries management, marine transportation and offshore drilling.

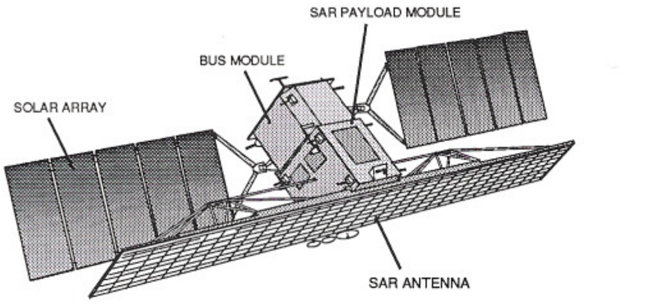
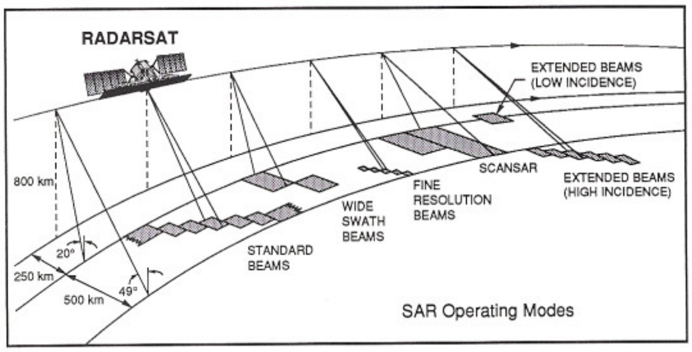


Illustration of the RADARSAT satellite.

RADARSAT is a Canadian-led project in partnership with nine provinces and the United States. Four provinces have contributed directly to the cost of implementing the system while the remaining five have pre-paid for data from the satellite. NASA is contributing by launching RADARSAT in exchange for data.



RADARSAT SAR Operating Modes.

RADARSAT SAR CHARACTERISTICS

Frequency / wavelength	5.3 GHz / C-band 5.6 cm
RF bandwidth	11.6, 17.3 or 30.0 MHz
Transmitter power (peak)	5 kW
Transmitter power (average)	300 W
Maximum data rate	85 Mb/s (recorded) – 105 Mb/s (R/T)
Antenna size	15 m × 1.5 m
Anttenna polarization	HH

SPACECRAFT CHARACTERISTICS

Launch mass (total)	2750 kg
Array power (EOL)	2.5 kW
Batteries	3 × 48 Ah (NiCd)
Design lifetime	5 years

ORBIT CHARACTERISTICS

Altitude (local)	793 to 821 km
Inclination	98.6°
Period	101 min
Ascending node	18:00
Sun-synchronous	14 orbits per day

COVERAGE ACCESS USING MAXIMUM SWATH WIDTH

North of 70° N	Daily
North of 48° N	Every 4 days
The Whole Earth (north of 80° S)	Every 6 days

A consortium of private investors has formed *RADARSAT International Inc.* (*RSI*), a company which will market and process RADARSAT data for domestic and international users.

Canadian Astronauts

The **Canadian Astronaut Program** was established in 1983 after the United States invited Canada to fly an astronaut aboard a Space Shuttle mission.

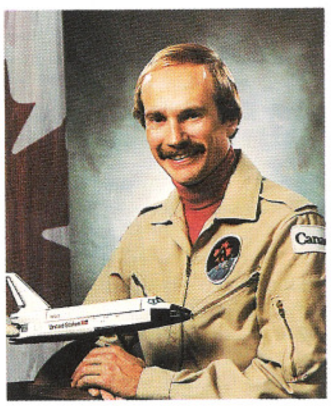
In October 1984, **Dr. Marc Garneau** became the first Canadian in space when he conducted the **CANEX-1** (**CAN**adian **EX**periments-**1**st series) experiments on board the **Challenger** Space Shuttle. In January 1992, this close cooperation with NASA continued with **Dr. Roberta Bondar** participating in the first **International Microgravity Laboratory** mission (**IML-1**), on board the Space Shuttle ***Discovery***. Dr. Roberta Bondar was prime Canadian payload specialist during her eight-day flight. She conducted more than forty sets of experiments, including life sciences experiments developed by Canadian scientists. Called **Space Physiology Experiments** (**SPE**), they were developed by Canadian scientists to help them understand common health problems for space crews, such as back pain (possibly caused by elongation of the spine in microgravity) and space motion sickness which affects more than half of all astronauts. In addition, **SPE** data provided information on the cardiovascular system's adaptation to weightlessness, the nutritional needs of astronauts, and the phase partitioning de-mixing of liquids in a process that could be used to separate blood cells. Knowledge gained from this research may be applied to medical problems on Earth.

Dr. Roberta Bondar became Canada's second astronaut and first Canadian woman in space when she participated in the first International Microgravity Laboratory mission (IML-1) aboard the Spacelab on Space Shuttle Discovery.

Dr. Bondar also performed materials sciences experiments from a dozen countries. Materials sciences cover a broad range of activities exploring the fundamental physics involved in materials behaviour and processing in a weightless environment. Discoveries in this field may have a wide range of applications on Earth in the areas of pharmaceutical research, computer and laser technology and the development of optical and electrical equipment.

In the Fall of 1992, Canada's third Astronaut in space will see **Dr. Steve MacLean** perform the **CANEX-2** set of experiments as a follow-up to **CANEX-1**. Dr. MacLean will evaluate an experimental **Space Vision System** (**SVS**) for the **Canadarm**, developed by the National Research Council of Canada. During the mission, he will also carry out experiments in materials processing and space science, and report on his own adaptation to weightlessness as part of Canada's continuing research into human adaptation to spaceflight.

The **SVS** experiment will assist in the design of the Machine Vision System being developed for Canada's contribution to Space Station *Freedom*, the **Mobile Servicing System** (**MSS**). This vision system will help guide the **Canadarm** or the **MSS** in assembly and maintenance tasks, unloading cargo and capturing, berthing and deploying satellites.



Dr. Steve MacLean, Canada's third Astronaut in space, will perform the CANEX-2 set of experiments in the Fall of 1992.

A Canadian World-Class Facility For Spacecraft Testing

The **David Florida Laboratory** (**DFL**) is a facility for the assembly, integration and environmental testing of space hardware and satellites. Located at Shirley Bay on the outskirts of Ottawa, it includes three large "clean" rooms which offer a dust and contaminant free environment for the assembly of satellites and other space hardware; a range of thermal vacuum chambers and an infrared testing system for verifying the thermal design and workmanship of spacecraft. Vibration as well as modal analysis for the qualification of structural aspects and launch simulation can also be performed. Furthermore, anechoic chambers, shielded rooms, and antenna ranges allow for the evaluation of antennas and radiofrequency payloads. Additional facilities provide for the measurement of spacecraft mass moments of inertia and the provision of static and dynamic balancing.

The DFL is owned and operated by the Canadian Space Agency. The facilities are available on a fee-for-service basis to both the Canadian and international aerospace and communications communities. The **Anik E** satellites were tested there in 1990-91. The facilities are currently being improved and upgraded, primarily through the extension of the large anechoic chamber and the addition of a new static load test facility in order to meet the upcoming integration and test requirements of the RADARSAT, **MSAT** and **MSS** Programs.

Science: Passport to Space

The *Space Science Program* provides opportunities for Canadian scientists and engineers to participate in quality national and international space projects. Through this Program, the Canadian Space Agency supports the activities of Canadian researchers in space by contributing in the development of scientific instrumentation packages, and working in cooperation with international partners to launch Canadian packages.

Most of Canada's ongoing science projects in space are cooperative. For example, in 1987, Canada had contributed an ultraviolet camera aboard the Swedish satellite **Viking**. The camera was used to take pictures of the Earth's aurora oval for studies of auroral morphology. Today, as part of its long-standing study of the *Aurora Borealis* (Northern Lights), Canada has joined with Sweden to provide two scientific instruments to the **FREJA** satellite, to be launched from the Jiuquan Satellite Launch Centre in China in 1992. Also in 1992, Russia will launch its **Interball** satellite, which will carry the ***UVAI*** instrument, a Canadian imager to study the *Aurora Borealis.*

Meanwhile, Canada's **Suprathermal Ion Mass Spectrometer** (**SMS**) instrument on board the Japanese satellite **Akebono** (formerly known as **EXOS-D**), launched in 1989, continues to add to knowledge and understanding of the aurora phenomenon.

NASA has selected a Canadian instrument, *Measurement of Pollution in the Troposphere* (*MOPITT*), to fly on the A-series **Earth Observation System** (**EOS**) Polar Platform. The ***EOS*** will unite scientific efforts to concentrate on global environmental problems and, to investigate the factors contributing to the deteriorating quality of the Earth's air and water.

Other Canadian space science programs include the **WINDII** (**Wind Imaging Interferometer**), a Canadian optical instrument placed aboard NASA's **Upper Atmosphere Research Satellite** (**UARS**), launched in September 1991. It is one of 10 major instruments on **UARS** which will provide new measurements of the physical and chemical processes acting within and upon the stratosphere, the mesosphere and the lower thermosphere. **UARS** will monitor the stability of the stratospheric ozone, the protective layer that screens out the harmful ultraviolet radiation of the sun.

Astronomers are seeking effective ways to explore the extreme ultraviolet range of the electromagnetic spectrum. Canada is participating with Russia, Switzerland, the United States and France in the **Ultraviolet Imaging Telescope Array** (**EUVITA**) astronomical experiment, to be carried aboard Russia's **Spektrum-X-Gamma** satellite. Launch is planned for late 1994.

Another long-range astronomy project is the **Lyman Far Ultraviolet Spectroscopic Explorer** (**FUSE**) telescope, to be launched in the year 2000. The Lyman/FUSE telescope will allow scientists to view phenomena visible in ultraviolet light, which is otherwise blocked by the Earth's atmosphere. At NASA's invitation, Canada is participating in this project by designing and building the light baffle assembly, and components of the fine guidance system.

Other Canadian space science programs include the **Canadian Auroral Network for the Observation of Plasma in the Upper Atmosphere in Space**, (**CANOPUS**) and **WISP**, a joint Canada-U.S. experiment to study **Waves In Space Plasma**.

Space Technology

The development of advanced technology for space applications is a central function of the Canadian Space Agency. This includes research and development within the Agency, and the promotion of technical cooperation and exchange of information with industries and universities, and space organizations in other countries. Space technology activities provide technical support and advice to major space projects such as RADARSAT, the **MSS** and other Canadian Space Program projects such as **MSAT**, a mobile communications satellite to be launched in 1994.

International Partnerships

As demonstrated earlier, Canada's Space Program has long-standing ties to the **National Aeronautics and Space Administration** (**NASA**). The Canadian Space Agency's largest single project is its participation in the international Space Station *Freedom.* NASA is a partner in Canada's RADARSAT Program and our major partner in space science programs.

Canada's international relations in space also feature its role as a cooperating state in the **European Space Agency** (**ESA**). In 1989, a new 10-year cooperation agreement was reached with ESA. Also, in 1991, new arrangements were established regarding Canada's participation in new programs: two remote sensing satellites – **ERS-1** and **POEM**; a communications satellite – **ARTEMIS**; the European space plane – **Hermes**, and various preparatory programs, such as the **Earth Observation Preparatory Program** (**EOPP**).

The Canadian Space Agency is a key participant in the **European Remote Sensing** (**ERS-1**) satellite program. The **ERS-1** mission is designed primarily to observe the oceans and sea ice with a number of microwave instruments, including a Synthetic Aperture Radar (SAR). The information

GLOSSARY OF SPACE ACRONYMS

CANEX-1	CANadian EXperiments-1st series
CANOPUS	Canadian Auroral Network for the Observation of Plasma in the Upper Atmosphere in Space,
DFL	David Florida Laboratory
EOPP	Earth Observation Preparatory Program
EOS	Earth Observation System
ERS-1	European Remote Sensing (ESA satellite)
ESA	European Space Agency
EUVITA	Ultraviolet Imaging Telescope Array
FUSE	Lyman Far Ultraviolet Spectroscopic Explorer
IML-1	International Microgravity Laboratory
ISY 1992	International Space Year
MOPITT	Measurement of Pollution in the Troposphere
MSAT	Mobile Communications Satellite
MSS	Mobile Servicing System
NASA	National Aeronautics and Space Administration
RADARSAT	Radar Satellite (Canadian remote sensing)
SAFISY	Space Agency Forum for ISY
SAR	Synthetic Aperture Radar
SARSAT	Search and Rescue Satellite
SMS	Suprathermal Ion Mass Spectrometer
SPDM	Special Purpose Dextrous Manipulator
SRMS	Shuttle Remote Manipulator System
SSRMS	Space Station Remote Manipulator System
SVS	Space Vision System
UARS	Upper Atmosphere Research Satellite
WINDII	Wind Imaging Interferometer
WISP	Waves In Space Plasma

provided by **ERS-1** will have a profound effect on our understanding of oceans, polar ice caps and climate.

The **ERS-1** satellite was launched in 1991, and Canada currently collects data for most of the North American continent at two receiving stations located at Gatineau, Quebec and Prince Albert, Saskatchewan. The European Space Agency expects to launch the **ERS-2** satellite in the mid-1990s.

The expertise developed by Canadian firms in the **ERS-1** and **ERS-2** projects will help in the production of Canada's more advanced RADARSAT satellite, slated for launch in 1995. Canada's **ERS-1** ground stations will also form part of the RADARSAT network. The experience gained from the reception, processing and use of the **ERS-1** data will prove helpful for Canadian users when RADARSAT becomes operational.

Canada also participated in the development of an international search and rescue program, **COSPAS-SARSAT**. Canada, the U.S. and France developed **SARSAT** (**Search and Rescue Satellite**) in conjunction with the Soviet Union's **COSPAS** satellite. Canadian companies have provided payloads and major ground terminals worldwide for this system. Since then, the program has saved 1800 lives from aviation, maritime and land distress situations.

International Space Year 1992

The **International Space Year** (**ISY 1992**) is a worldwide celebration of humanity's future in space. In this context, and under the auspices of the **Space Agency Forum for ISY** (**SAFISY**), an organization made up of 25 international space agencies, the Canadian Space Agency is contributing to two major international projects: **GEOSCOPE**, and the **Ozone Hole Project**.

GEOSCOPE is a computerized software encyclopedia that incorporates the wealth of information that has been gathered by remote sensing satellites over the last two decades. GEOSCOPE can generate a combination of photos, satellite images and animated graphics on a personal computer screen. It will enable the user to compare images over various periods of time in order to assess the impact of environmental change. GEOSCOPE will become an invaluable education tool for schools, universities, museums and other learning institutions.

The GEOSCOPE encyclopedia will be available in the Fall of 1992.

The Ozone Hole Project aims at improving the understanding of changes in polar stratospheric ozone by combining space observations with measurements from ground-based and balloon-borne equipment. This Arctic investigation program began during the winter of 1991-1992 and the second part will take place during the winter of 1992-1993. The project is conducted by the *Atmospheric Environment Services* (Environment Canada) with a financial contribution from the Canadian Space Agency.

Conclusion

As we look to the future, space offers limitless opportunities for all humanity in agriculture, medicine, industry and many other fields such as the development of new energy sources, the protection of the environment, and the creation of new technologies that generate employment. In order to maintain its strong position within the global space market, Canada must also encourage young people to pursue the scientific and engineering qualifications that are the key to space. The scientific and technological advances resulting from space research will continue to benefit all Canadians and all mankind.

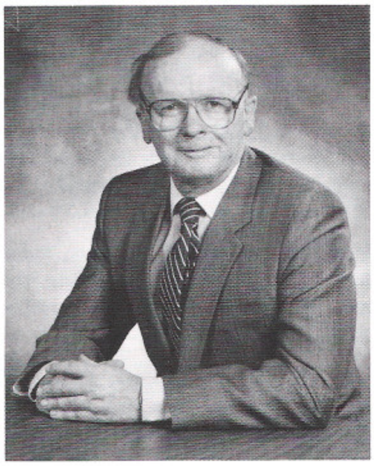
Michael Valentine O'Donovan named 1992 IEEE McNaughton Gold Medallist

Michael Valentine O'Donovan (Val) qualified as a professional engineer and received his Higher National Certificate in Electrical Engineering from the Cambridge College of Technology, U.K., in 1959. Mr. O'Donovan has been a member of IEEE and the Microwave Theory and Techniques Society since the early 60's and is also a member of the Association of Professional Engineers of Ontario and the American Institute of Aeronautics and Astronautics.

His career started in England with Pye Telecommunications as a Microwave Engineer. Mr. O'Donovan emigrated to Montreal in 1963 to work for RCA. He was promoted in 1965 to Group Leader, Microwave Devices and Sub-Systems. Under his guidance, the RCA team successfully developed microwave components and subsystems for the Canada Wide (CNCP) Radio Relay Network, and the first generation of satellite earth terminals in Canada at Mill Village, Nova Scotia. Continuing his career with RCA he became Supervisor, Microwave Payloads, Space Systems Group and, subsequently, Manager of the Satellite Transponders Department in 1971. Between 1971 and 1974 Mr. O'Donovan's team developed the microwave payload flown on HERMES, the joint Canada-U.S. high power communications technology satellite. They also conceived and designed the payload for the first 24 channel C-Band Communications satellite. When launched in 1976, this RCA SATCOM was the first operational U.S. domestic satellite.

In 1974 he left RCA and became President of COM DEV, a company which grew from 5 people in 1974 to more than 500 in 1992. COM DEV is Canada's largest exporter of spaceborne equipment for communications and remote sensing satellites. Over the past 15 years it has supplied flight subsystems for 130 spacecraft including payload equipment for all INTELSAT satellites contracted for since 1975, and all the TELSAT ANIK satellites with the exception of ANIK A. COM DEV is currently providing payload equipment for the INTELSAT VII and VII A, INMARSAT 3, HISPASAT and TELSTAR series of satellites. The company is also building a number of spaceborne scientific payloads and is supplying a substantial part of the radar for RADARSAT.

In 1985 COM DEV EUROPE was established in England and more recently, COM DEV Atlantic was formed in Moncton, New Brunswick.



Mr. Michael Valentine O'Donovan – winner of the 1992 McNaughton Gold Medal, bearing the citation: *for sustained leadership in the development of space technology and for transforming a fledgling company into a significant international player in the field of satellite communications.*

Mr. O'Donovan lives in Cambridge with his wife Sheila. Outside of COM DEV he is interested in gardening and good wine. Prior to developing expertise in these extra-curricular activities, he contributed to a number of key publications in the microwave field and in 1974 co-authored the book "Microwave Filters for Communication Systems". Under his guidance, COM DEV has become one of the leading 40 corporations in Canada in terms of R&D expenditures, with more than 50 patents. When the Canada Awards for Industrial Excellence were introduced in 1984, COM DEV was the gold medal winner for "Innovation in Satellite Technology". In 1991 COM DEV received the Canadian Export Award and COM DEV Europe received the Queen's Award for Export Achievement.

As Chairman of the Board and Chief Executive Officer of COM DEV, Val O'Donovan has given sustained leadership in the development of space technology and has transformed a fledgling company into a significant international player in the field of satellite communications.

30th Anniversary of Alouette I

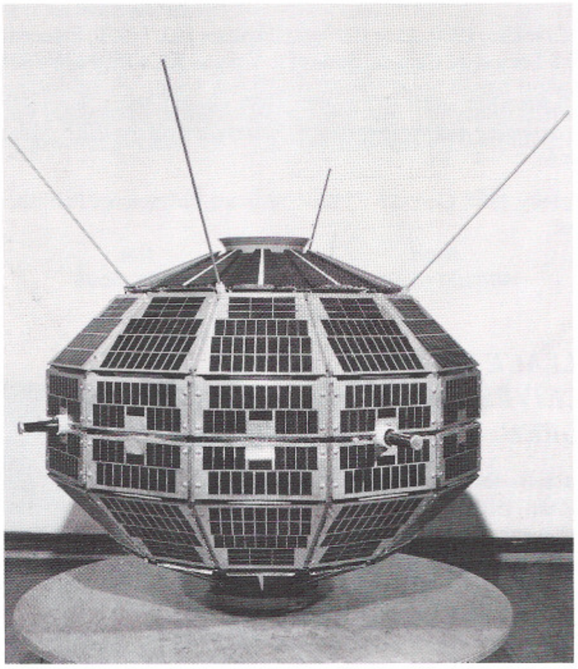
A milestone of electrical engineering

by John Palimaka
Senior Mission Analyst
Telesat Canada

Exactly thirty years ago, on September 29, 1962 the Canadian-built Alouette I satellite was launched into orbit aboard a Thor-Agena launch vehicle from the U.S. Pacific Missile Test Range in California. It was the first satellite launched into space which was built entirely by a country other than the U.S. or the U.S.S.R.

The Alouette/ISIS Program consisted of four satellites and associated ground-based data analysis equipment. After the successful launch of Alouette I, Alouette II was launched in 1965, ISIS I in 1969 and ISIS II in 1971 (ISIS is an acronym for "International Satellite for Ionospheric Studies"). Both Alouette satellites were used for ten years, and the ISIS satellites were used until 1984, when the program was concluded. Japan was authorized to use the ISIS satellites and continued to do so until the late 1980's. By 1980, over 1100 papers and reports were published, and data continued to be received from the two ISIS satellites – more than 20 years after the start of the program.

Early in the history of space exploration, Canadian researchers in space science concentrated on the study of the earth's upper atmosphere and the ionosphere. This was due to the need to understand the characteristics of radio communication in the Canadian North. This area of study was not as predominant a component of the space science efforts of other countries and therefore the Alouette/ISIS Program was able to make a major and unique contribution.



A view of the Alouette satellite showing the four telemetry antennas and two of the four STEM (Storable Tubular Extendible Member) sounding antennas which were deployed on orbit. The satellite is about one metre in diameter.(Crow*n copyright photo reproduced with permission from the Canadian Department of Communications*)

Canada entered into the Space Age thirty years ago with the launch of the Alouette I satellite. Early success in the field of space science lead to strong Canadian programs in satellite communications and remote sensing, through the cooperative effort of government and industry.

Le Canada a fait son entrée dans l'ère spatiale il y a déjà trente ans, avec le lancement du satellite Alouette 1. Les succès initiaux dans le domaine des sciences de l'espace ont permis la mise sur pied de solides programmes canadiens de communications par satellites et de télémétrie, ce, grâce aux efforts concertés du gouvernement et de l'industrie.

This effort lead to the realization that a satellite communications system would be the best way to provide a communications infrastructure for all of Canada, including the North. A very concrete result of this was the launch by NASA for Telesat Canada of Anik A1, a telecommunications satellite designed to satisfy Canada's domestic communications requirements [1].

John H. Chapman

The Alouette/ISIS Program was initiated by **Dr. John H. Chapman**, who at his untimely death in 1979 at age 58, was the Assistant Deputy Minister for Space in the Canadian Department of Communications.

At the end of 1958, a proposal was submitted by Canada to NASA for a scientific satellite to act as an ionospheric topside sounder to study the effects of the ionosphere on radio communications in the North, from an orbital altitude of approximately 1,000 km. As Canadian coordinator of the Alouette Program, John Chapman was instrumental in the successful launch of the Alouette I satellite [2].

In June 1969, a special issue of the Proceedings of the IEEE was devoted entirely to topside sounding of the ionosphere and the great majority of papers in this issue sprung from the analysis of data from the Alouette satellites [3].

John Chapman was convinced of the need to develop the capability to design and build space hardware in Canadian industry and to move away from the practice of relying solely on the expertise of the government laboratories. As a result, Alouette II and the ISIS satellites were built, with steadily increasing participation by Canadian industry.

Telecommunications Satellites

In 1967, a report was produced by a committee chaired by John Chapman, which recommended a redirection of Canada's effort in space from space science and toward telecommunications and land survey.

This photograph was taken in 1974 and shows the Alouette/ISIS tracking antenna (on the right), a yagi array antenna of the earlier generation and a dish antenna of later design (on the left). (*Crown copyright photo reproduced with permission from the Canadian Department of Communications*)

The culmination of this was the launch in 1972 of Anik A1. With the successful placement of this satellite on station, approximately 36,000 km above the equator, Canada became the first country to have a domestic geostationary communications satellite system. The Anik A series of satellites was built by Hughes Aircraft Corporation of the United States.

The Alouette/ISIS Tracking Antenna

As a reminder of the Alouette/ISIS Program, an effort is being made to preserve an 18-metre diameter tracking antenna at the Shirley Bay Research Centre near Ottawa, Ontario. This antenna was used to receive data from the Alouette II, ISIS I and ISIS II satellites. The site of the antenna is occupied by three agencies of the Canadian Federal government: the Communications Research Centre, the Defence Research Establishment Ottawa and the David Florida Laboratory of the Canadian Space Agency.

The three agencies have jointly undertaken a feasibility study of the restoration and interpretation of the Alouette/ISIS tracking antenna. The agencies propose to create an interpretation centre at the entrance to the Shirley Bay Research Centre, along a major regional road just west of Ottawa. This relocation of the antenna will increase the antenna's visibility and permit public access to the display.

During the past year, the IEEE Ottawa Section has submitted a nomination to the IEEE Centre for the History of Electrical Engineering to have the Alouette/ISIS Program designated as a Milestone of Electrical Engineering. That designation is expected to be awarded soon.

The Alouette/ISIS Program had previously received recognition in Canada as an engineering achievement. In 1987, the centennial year of engineering in Canada, the Engineering Centennial Board selected Alouette I as one of the ten greatest achievements in Canadian Engineering in the past century.

Doris Jelly, Curator of the new "Canada in Space Exhibit", which has recently opened at the National Museum of Science and Technology in Ottawa, writes that: "The success of the Alouette/ISIS Program led to the growth of satellite technology in Canadian industry, and the further development of satellite systems for communications, meteorology, resource surveys and other related programs during the 1970's. Communications satellites soon became the most important application of space technology. Their introduction resulted in a communications revolution, the effect of which has been likened to the airplane on transportation." (4)

It is hoped that the Milestone designation and the preservation of the Alouette/ISIS antenna will promote a wider knowledge about the accomplishments of Canadian researchers and satellite hardware manufacturers in the early years of the Space Age.

About the author

John Palimaka studied Engineering Science, Physics and Astronomy at the University of Toronto, receiving a B.Sc. degree in 1976. He received an M.Sc. degree in Physics (Radio Astronomy) from Queen's University at Kingston in 1979. Now at Telesat Canada, he specializes in the analysis of techniques for satellite attitude determination and control. He is a Past-Chairman of the IEEE Ottawa Section (1991 - 92).

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2) C.A. Franklin, 1980, *John Herbert Chapman 1921-1979*, Proceedings of the Royal Society of Canada, Series IV, Volume XXVIII, Page s 68-72.

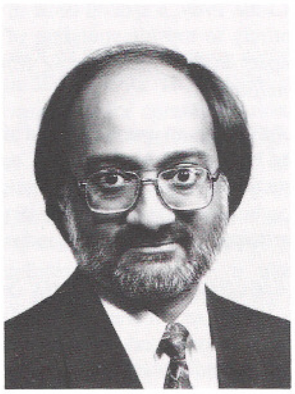
3) E.R. Schmerling and R.C. Langille, 1969, Guest Editors, *Special Issue on Topside Sounding and the Ionosphere*, Proceedings of the IEEE, Volume 57, Number 6.

4) Doris Jelly, 1988, *Canada - 25 Years in Space*, Polyscience Publishers Inc., Montreal.

DR. PATEL NAMED FELLOW OF IEEE IN 1992

Rajnikant V. Patel, M76, SM80, F92, Professor, Electrical and Computer Engineering, Concordia University, Montreal, Quebec, was named Fellow of IEEE in 1992 for **numerical analysis and design of control systems.**

We regret the omission of Dr. Patel's name in the Spring issue of the IEEE Canadian Review.



WALLACE S. READ RECEIVES HONORARY DEGREE

Wallace S. Read, President of the Canadian Electrical Association (CEA), was recently honoured by the Technical University of Nova Scotia where he received a Doctor of Engineering Degree (Honoris Causa). A Fellow of the IEEE, Mr. Read has received numerous awards, including IEEE's General A.G.L. McNaughton Gold Medal for competent and dedicated leadership in the field of electrical engineering.

Digits Define the Future for Canadian Broadcast Services

by Michel Durocher
Associate Director of the Standards and Technology Development Department
Canadian Broadcasting Corporation Engineering Headquarters, Montreal, Canada.

The compression of audio and video data for both conventional and high-definition television, the compression of audio data for radio, combined with digital transmission techniques for terrestrial, satellite and cable services, will enable planning and coverage strategies leading to spectrum re-development. These innovations will positively impact the viewers and listeners in terms of broadcast services, quality, and access. The convergence between the technologies for radio, television and computers indicates that interoperability with the different delivery media is becoming more important than compatibility with conventional NTSC systems.

La compression de l'information numérique audio et vidéo aussi bien pour la télévision traditionnelle que pour la télévision à haute définition, ainsi que la compression audio pour la radio, permettront une meilleure planification et des stratégies plus rationnelles de réutilisation du spectro, lesquelles auront des retombées positives sur les auditeurs et les téléspectateurs en ce qui a trait à la qualité des services de radiodiffusion et à leur accès.La convergence des technologies qui intègrent radio, télévision et informatique, indique que la possibilité d'échange de l'information entre les différents systèmes de distribution devient plus importante que la compatibilité avec les systèmes NTSC classiques.

Conventional broadcast services are based on analog technology which was first developed in the days of vacuum tubes. In recent years, significant advances in the field of integrated circuits have opened the door to the development of high-speed digital processors.

Digital signals

Digital signals have important advantages which enable the improvement of their quality. Thus, noise and distortions, introduced by non-linear circuits, can be filtered out of the system because digital signals have only two discrete voltage levels defining their "zeros" and "ones". If not too distorted, the digital signal can be fully restored to a perfect shape. However, there is a price to pay. Digital signals occupy a much larger bandwidth than their analog equivalent.

In the studio

Bandwidth is not a too severe constraint in studio signal distribution because the signals are normally carried over relatively short distances; however, digital recording is bandwidth limited. Nevertheless, the immunity to noise of the digital signal is so attractive that digital tape recorders were developed with the bandwidth required for digital audio and digital video. These developments will result in major quality improvement of the studio sound and pictures, as digital equipment gets installed.

The natural question then becomes: how can we make the general public benefit from these advances?

Transmission

By transmitting the sound and image signals using digital technology, it becomes possible to dream of perfect delivery. Perfection is still only a dream, however, because the bandwidth available for transmission is very limited. It is at this critical point that the technical advances mentioned in the introduction begin to play their critical role.

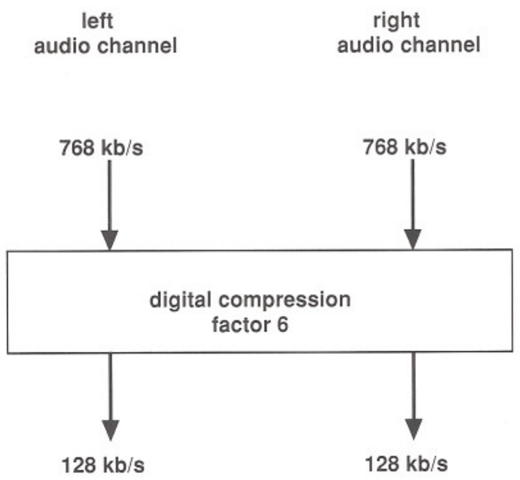


Figure 1.
Example of audio compression, showing its order of magnitude.

Compression of digital signals

By using very fast digital processors it is now possible to manipulate the large number of bits in digital video and audio signals in real time. The implication is that the original signal can be analyzed and then transformed into a compressed signal which contains fewer bits, therefore requiring less transmission bandwidth. The algorithms used for compression are very complex and are the subject of intensive studies in many laboratories around the world. Describing their details is not possible here; however, it can be said that their basic principle relies on removal of the information redundancy which is contained in natural music and image signals, taking into consideration the psycho-perceptual processing of the human brain.

Digital radio

A digital audio signal in its pure uncompressed form has a rate of 768 kb/s, based on a sampling rate of 48 kilosamples per second and 16 bits per sample. For a stereo signal this should be doubled to 1.536 Mb/s. Using compression as described previously, an approximate reduction factor of 6 is possible, with its associated bandwidth savings. This results in a compressed audio rate of 128 kb/s for each audio channel (see Figure 1). In order to get such a

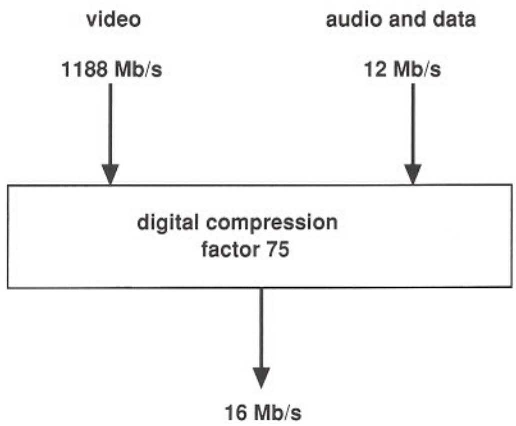


Figure 2.
Example of television compression, showing its order of magnitude.

signal to the general public it is necessary to modulate it on an R.F. channel. At the February 1992 World Administrative Radio Conference held in Málaga-Torremolinos, Spain, the radio spectrum from 1452 MHz to 1492 MHz was reserved for the transmission of digital radio. This will be a new radio band, in addition to the current AM and FM bands.

Digital television

An HDTV (High Definition Television) digital signal in its uncompressed form has a rate of 1188 Mb/s, based on a sampling rate of 74.25 megasamples per second, using 8 bits per sample for the luminance information and as much information for the two colour signals. In addition, when considering the required sound and data signals, the entire television program represents a total bit rate of approximately 1200 Mb/s. This requires an enormous bandwidth. Again, the compression techniques can help reduce this rate by a factor of approximately 75, to a more manageable 16 Mb/s (see Figure 2). Using R.F. modulation techniques like 16 QAM (Quadrature Amplitude Modulation) it is possible to broadcast such a digital signal in the conventional 6 MHz television channels that are not currently utilized (see Figure 3).

The FCC (Federal Communications Commission) formed an advisory committee on "Advanced Television Service" to obtain a recommendation on the digital terrestrial broadcasting technology that should be adopted for the U.S.A. Canadians are participating in the selection process. Four systems are under consideration:

> The Advanced TV Research Consortium (NBC, Thomson of France, N. A. Philips and the David Sarnoff Research Centre) proposed a system called ADTV (Advanced Digital TV).

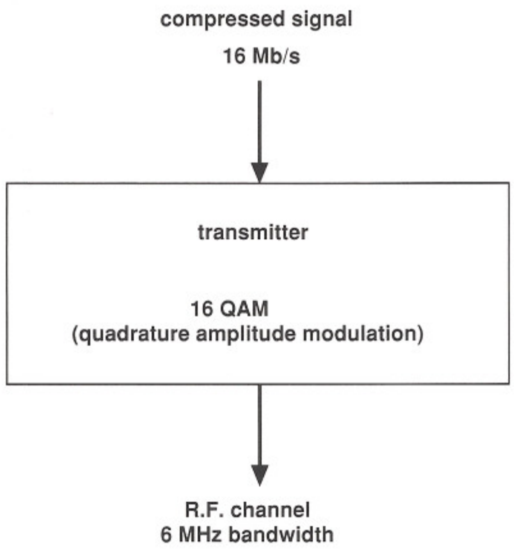


Figure 3.
TV digital modulation with an example of transmission configuration.

> The American Television Alliance (General Instrument and MIT) proposed two systems, called Alliance Interlaced (formerly DigiCipher) and Alliance Progressive.

> Zenith and AT&T proposed a system called DSC-HDTV (Digital Spectrum Compatible).

These four ATV (Advanced TV) systems are based on a wide aspect-ratio home display. They also all have the capability of producing beautiful pictures in the home. Hence, for the FCC advisory committee to make a recommendation, complete testing of the systems is required. Three specialised laboratories were set up – ATTC, CableLabs and ATEL:

> ATTC (Advanced Television Test Centre) is located in Alexandria, Virginia. Here, *objective* tests are being carried out, under laboratory conditions, for the *terrestrial transmission* of the ATV signals. Video tapes are being prepared for ATEL evaluation. The test centre is funded by its members, by a contribution from CableLabs and by test fees paid by the ATV systems proponents. Its members are broadcasters like ABC, CBS, NBC, PBS, etc. and organizations like the NAB (National Association of Broadcasters), EIA (Electronic Industries Association), etc.

> CableLabs (Cable Laboratories Inc.) are located in Boulder, Colorado and occupy a part of the space at ATTC. Here, *objective* tests are being carried out, under laboratory conditions, for the *cable transmission* of ATV signals. Video tapes are being prepared for ATEL evaluation. The laboratory is funded by its members who are the major U.S.A. and Canada cable operators.

> ATEL (Advanced Television Evaluation Laboratory) located in Kanata, near Ottawa, Canada. Here, *subjective* tests are being carried out, showing the ATV pictures to members of the general public, for their assessment. The laboratory is funded by test fees it receives from ATTC, by the DOC (Canadian Department of Communications) in the form of direct expenses and personnel, by canadian industry, mainly in the form of equipment loans and by the CBC in the form of equipment loans and technical support personnel.

A key date is December 1992 for the advisory committee to present the results of these tests to the FCC. In addition, PBS (Public Broadcasting Service) will be responsible for the overall management of ATV **field testing** which is currently planned to be conducted in Charlotte, North Carolina. June 1993 is the target date for the FCC selection of an ATV standard.

Computers

Again using digital signal compression techniques, it is now possible for computers to store audio and video signals. The latest computers also have enough speed to do some manipulation of the sounds and images. These capabilities are just beginning to be implemented, but progress is extremely rapid.

About the author

Michel Durocher studied at École Polytechnique de Montréal and graduated with a Bachelor of Applied Sciences degree and with an Engineering diploma (Electrical) in 1976.

He joined CBC Engineering in 1976 in the Transmission Systems Department where he worked in spectrum management, and on special projects. In 1986, he assumed the position of Assistant Director in the Strategic Engineering Department, responsible for standards, emission and studio, including new technologies, in particular advanced TV (ATV) systems. Mr. Durocher is currently Associate Director of the Standards and Technology Development Department at the Canadian Broadcasting Corporation Engineering Headquarters in Montreal, Canada.

Convergence

When looking at future services that will be offered to Canadians, it becomes obvious that a wide variety of digital signals will reach the home. They emanate from digital radio transmitters, from digital television transmitters, from cable services, from satellite services, from compact disks for sound, from video disks, from data services to computers and more. All these various pieces of equipment will have to interconnect and it will be very important that each understand the "bits" of the others. Conventional NTSC (National Technical Sub-Committee) television will then play an ever decreasing role. The convergence between the digital technologies for radio, television and computers indicates that interoperability with the different delivery media is becoming more important than compatibility with conventional NTSC systems. From that point of view, the new systems themselves can be considered revolutionary. However, as implementation is done at a relatively slow pace, their introduction in the marketplace will be perceived as being evolutionary.

Conclusion

Sophisticated digital processing technology enables taking a modern approach to advanced broadcast systems. The future looks bright when considering the high quality of the digital radio and television services which will be offered to the Canadian audience.■

Report on Electrical and Computer Engineering

Assessing the Health of the Discipline

by Dr. Alan Aitken,
President, Canadian Semiconductor Design Association
and
Dr. Hans Kunov
Director, Institute of Biomedical Engineering,
University of Toronto,

This article is a summary of a "Health of the Discipline" report which was prepared on behalf of the NSERC operating grant committees, Communications, Computers and Components Engineering and Electromagnetics and Electrical Systems Engineering. It is used to inform NSERC of the activities of the university research community and to highlight major issues and changes in the discipline. The report also attempts to demonstrate the contribution of the field to Canadian industry and economic development.

Cet article constitue une synthèse du rapport intitulé "Health of the Discipline", une étude réalisée pour le compte de plusieurs comités du CRSNG responsables de l'octroi de subventions pour dépenses courantes: plus précisément ceux de génie: communications, ordinateurs et composants; génie: électromagnétique et systèmes électriques.

L'objectif de ce travail est de renseigner le CRSNG sur les activités de recherches au sein des universités et d'identifier les problèmes et les changements dans ces disciplines. Le rapport cherche aussi à mettre en évidence la contribution de ces spécialités au développement de l'industire et de l'économie canadienne.

In a Canadian economy which is dominated by the exploitation of natural resources, the electrical engineering community has played a major role in changing the Canadian economy to one which can compete internationally through intelligence-based products. Of all Canadian R&D, 35 percent is performed in information technology industries. Furthermore, 13% of its sales are reinvested in R&D and over 60% of the shipments of the resulting high value-added product is exported.

The environment in which the electrical engineer is working is rapidly changing. Product development, which previously had a 5-10 years timescale, now has to be completed in 1-3 years. This situation is reflected in the evolution of concepts such as "concurrent engineering" and "flexible manufacturing". Within the university community, EE departments are now called Electrical and Computer Engineering (ECE) departments, reflecting the move towards intelligence-based systems.

Importance of Electrical Engineering Disciplines in Canada's Regions

Each region of Canada benefits from ECE activities in a different way.

In **British Columbia**, a 1988 Science Council of British Columbia report on science and technology predicted that at the current rate of growth of 25 to 30 percent annually, the province's information technology industry would, by the end of the century, approach that of forestry, B.C.'s top industry. The B.C.Telephone and B.C.Hydro have spawned major research centres whose developments will result in new industrial activity to add to that of the 600 companies that presently employ over 12,000 people.

In **Alberta**, ECE is at the heart of the province's effort to diversify its economy, with the establishment of the Alberta Microelectronics Centre, the Electronics Test Centre, the Laser Institute and TRLabs. The ECE industry has built on its core activity, which originally supported the energy, transportation and natural resources sectors, to expand into telecommunications, instrumentation and control systems for export markets.

In **Saskatchewan**, the ECE manufacturing industry includes approximately 20 firms employing about 500 people. A significant part of that employment has resulted from spin-offs from the universities. An increase in university-industry interaction is anticipated now that TR Labs has established an R&D program in Saskatchewan through the support of SaskTel.

In **Manitoba**, the electronic industry is characterized by small home-grown specialized companies building on unique expertise or applications which originated in the province. Manitoba Hydro is an important contributor to R&D in the universities, providing support and an initial market for many new developments. Quantic Laboratories Inc. and Manitoba HVDC Research Centre are examples of companies which had roots in university research programs.

Ontario accounts for 60% of shipments of manufactured electrical goods, mainly for telecommunications and computers. Approximately 65% of Canadian ECE R&D is carried out in this province. The large multi-national companies such as Northern Telecom and IBM are complemented by small and medium-sized locally-founded companies characterized by very large investments in R&D and a high level of exports, typically 80% of sales. The Ontario Premier's Council established a fund to stimulate cooperative research between universities and industry through the formation of seven Centres of Excellence, including ITRC, TRIO and OCMR which have a strong ECE interest.

Québec accounts for approximately 20% of the Canadian research in Information Technologies, electrical products and power. It also accounts for 30% of Canadian shipments of electrical and electronic products, with close to 800 companies employing over 40,000 people. Its strongest sectors are telecommunications, avionics and simulators, the majority of whose products go to export markets.

In the **Atlantic Provinces**, small pockets of activity have developed to benefit from local situations and subsequently to export products to the rest of Canada and internationally. In Halifax/Dartmouth, Hermes Electronics has established an international position in Sonobuoys, and has acted as a seeding ground for new electronics enterprises in the region.

In **Newfoundland**, Memorial University is a key source of expertise for new enterprises in the field of instrumentation and radar .

Current strengths and weaknesses

Diversity is a major strength of university research throughout the country. All levels of government have recognized the importance of funding university-based research work, and most provinces have introduced special funding initiatives. The strengths, however, lead to weaknesses in that the breadth of work is not always matched by depth. Small research teams which are recognized internationally for the originality of their work, are often not large enough to compete with the comprehensive programs of larger national or industrial programs.

Federal and provincial initiatives for Networks of Excellence are intended to bring individual researchers together to improve the depth of the research and develop the knowledge base required by key sectors of industry to improve their competitiveness. There is, however, duplication of goals between federal and provincial initiatives.

Many of the more established fields of research such as Electric Power have, over many years, established strong links with the industrial base. In the fields of computer and telecommunications, however, the rate of change is so rapid and unpredictable, that very strong partnerships must be established between industry and universities. Strong links enable university researchers to maintain their standing with their international peers and permit industry to incorporate their work in innovative and competitive new products for the very dynamic international market.

The Canadian ECE community can point to many successes in which university research has played a major role. The university ECE research can be divided into seven broad categories:

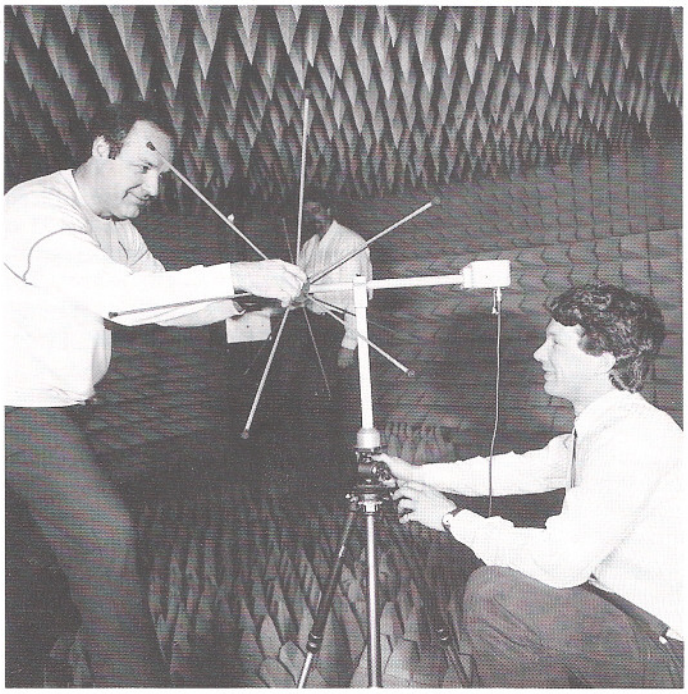
1) **COMMUNICATIONS –**
COMMUNICATIONS, including IMAGE AND SIGNAL PROCESSING is by far the largest category, in terms of the number of NSERC operating grant applications to the ECE Operating Grant Selection Committees. The traditional Canadian strengths which started with the invention of the telephone were matched with the need for long distance communication services resulting in the first Western domestic satellite system, the first national digital data communications service and the first rural optical fibre network. The telecommunications industry has typically spent 17% of its total revenues on research and development. This compares favourably to the average of 9.4% spending on R&D by the twelve largest world-wide telecommunications companies.

The entire communications industry is entering a phase of change which will radically alter and expand the uses of the communications infrastructure. This is due to the deployment of systems which remove the bandwidth and wired access constraints, thus stimulating new commercial and social opportunities such as distance education and a wider variety of entertainment services. Broadband systems are receiving the strongest focus, ranging from network to component research. The academic community has received strong support from industry and government through funding of centres of excellence such as CITR, TRIO, TRLabs, NWCRF, ASI, INRS and ITRC. Thus, the communications industry is able to develop the strong core expertise which is required for success in international markets.

2) **POWER ENGINEERING –**
The character of research in POWER ENGINEERING, which has the second-highest number of NSERC ECE operating grant applications, has fundamentally changed over the last decade This is witnessed by the application of advanced electronics and software for control and system modelling, and in the development of improved insulator technology to meet the needs for more reliable utility operations. Canada has achieved many firsts in high voltage engineering, such as the first 765 kV transmission system, and the first 500 kV submarine cable system. The EMTP (Electromagnetic Transient Program), pioneered in Canadian universities, has enabled utilities worldwide to improve their real time network simulation capability, and consequent system reliability.

3) **ROBOTICS –**
There is a growing activity in ROBOTICS AND CONTROL SYSTEMS including associated computer vision studies. There is presently little industrial robotics enterprise in Canada, but the country enjoys prominence in niche areas such as space robotics (the Canadarm and the future Space Station Service Module). Among the prominent areas of current robotics research focus are: path planning techniques, visual feedback using sensors, and intelligence techniques for integrating robot sensor information. A focal point for robotics research in Canada has recently been provided by the formation of IRIS, a federally funded network of Centres of Excellence in robotics.

4) **ELECTROMAGNETIC SYSTEMS –**
Canadian strengths in ELECTROMAGNETIC SYSTEMS research include: electromagnetic compatibility studies, monolithic microwave integrated circuits (MMICs), scattering and diffraction studies, antenna design and characterization, numerical evaluation techniques for electromagnetic systems, radar and navigation applications, ionospheric and other propagation studies, bio-medical effects of electromagnetic radiation, electrostatics, and radio astronomy. Many new opportunities have opened at millimetre wavelengths for wireless telecommunications within buildings and imaging of complex targets. Foreseeable developments in the merging of optical techniques with millimetre wavelength technology should result in extremely powerful, small size adaptive array antennas for personal communications. The importance of electromagnetics to new developments in telecommunications, particularly in the 1 GHz frequencies and above, is highlighted by the participation of a Laval University research group in CITR and the McMaster Communications Research Laboratory in TRIO.



Mesuring antenna characteristics, in a joint venture of TRIO and the University of Ottawa. It typically represents the R&D being carried out by universities throughout Canada.

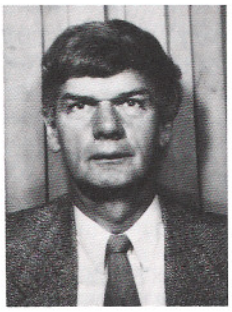
5) MICROELECTRONICS AND PHOTONICS –
Many of the successful innovations in MICROELECTRONICS AND PHOTONICS commercialized by industry originated in research work conducted at a number of universities. Examples are switched capacitor filter technology (Carleton and Toronto), digital filtering for telephones (Calgary) and CCDs for imaging arrays (Waterloo). The Canadian Microelectronics Corporation has played a unique role in providing the university community with access to integrated circuit design and fabrication facilities to implement and prove-in their concepts on silicon.

There is a strong growth in the development of optoelectronic components linked to future gigabit per second communication networks. This sector has benefitted from the establishment of consortia such as Micronet, TRIO, ITRC, TR Labs, SSOC and CSDA which have brought together the device, circuit and system engineers to develop new applications for semiconductor technologies.

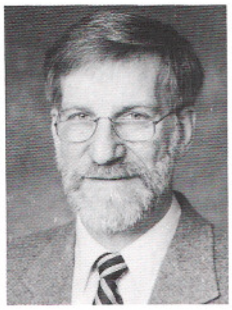
6) COMPUTER ENGINEERING –
COMPUTER ENGINEERING covers a broad spectrum of information technology, from Microelectronics to Virtual Reality. There is an ever increasing interdependence in industry between computer engineering and other disciplines. In a recent speech, Mr. Serge Fournier, Vice President of Bell-Northern Research, stressed the growing mutual importance of distributed computing and telecommunications networks. The most notable structural developments are the working relationships that are growing between existing collaborative groupings. One such is the Telepresence project, sponsored by the Ontario Technology Fund, to study the use of multimedia technology for interactive working between distant locations and jointly undertaken by industry, the ITRC and TRIO Centres of Excellence, and consortia in Europe.

7) BIOMEDICAL ENGINEERING –
The BIOMEDICAL ENGINEERING profession has several components; rehabilitation engineering (aids for the handicapped), clinical engineering (management of technology in hospitals), research in physiological systems, diagnostic and therapeutic instrumentation. While Canada has a strong research reputation in all areas of biomedical engineering research, there is substantial room for expansion, underscored by the fact that we import ten times the amount we export in medical devices. As part of a Strategic Initiative to increase industrial activity in this field, ISTC in early 1991, held a workshop to analyze the potential for the medical device industry. In addition to the instrumentation work, a considerable proportion of biomedical engineering effort goes into the safe and cost effective delivery of health care.

About the authors



Alan Aitken received his B.Sc. and Ph.D. in Applied Physics from the Universities of Edinburgh (1964) and Strathclyde (1969), respectively. His research interests have been in the area of semiconductor technology development at Bell-Northern Research and Mitel, where he was also responsible for the semiconductor operations. Since 1985, he has been President of the Canadian Semiconductor Design Association and an independent consultant to the electronics industry.



Hans Kunov received his M.Sc. and Ph.D. in Electrical Engineering from the Technical University in Copenhagen, Denmark, in 1963 and 1966, respectively. He has been a member of IEEE since 1961. He joined the University of Toronto in 1967, where he is now Professor and Director of the Institute of Biomedical Engineering. He holds appointments in the Departments of Electrical Engineering and Otolaryngology at the University of Toronto. His research interests include biomedical acoustics, sensory communication, and cost-effective health care technology.

GLOSSARY OF ACRONYMS

ASI	BC Advanced Systems Institute
CCD	Charge Coupled device
CITR	Canadian Institute for Telecommunications Research
CSDA	Canadian Semiconductor Design Association
CRIM	Centre de recherche informatique de Montréal
DEC	Digital Equipment Corporation
IBM	International Business Machines
INRS	Institut national de la recherche scientifique Telecommunications (Joint centre of INRS and Bell-Northern Research)
IRIS	Institute for Robotics and Intelligent Systems
ISTC	Industry, Science and Technology Canada
ITRC	Information Technology Research Centre
NWCRF	National Wireless Communications Research Foundation
NSERC	Natural Sciences and Engineering Research Council
OCMR	Ontario Centre for Materials Research
SSOC	Solid State Optoelectronic Consortium
TRIO	Telecommunications Research Centre of Ontario
TRLabs	A Cooperative Applied Research Institute affiliated to the Universities of Alberta and Calgary

Emerging Trends

With the emergence of the microprocessor in the mid 1970s, a strong trend emerged: electrical engineering increasingly became the "integrative" technology in processes and instrumentation in all areas of engineering. In Canada and in other countries advanced high-speed computing and multimedia communication networks are being planned to facilitate meetings and collaboration among participants. Within the industrial environment, there is a strong trend towards standards which have become a technology in their own right. Unless research indicates a major advance in the state-of-the-art, many new techniques will not be applied if they are not compatible with international established standards.

Among the major engineering disciplines in Canada, Electrical Engineering has the largest number of full-time graduate students. From 1985 to 1989, the number of enroled full time masters students and full-time Ph.D. students in Electrical Engineering grew by 32% and 69%, respectively.

As the faculty ages, Canada will have to train large numbers of prominent researchers to maintain the quality of university teaching and research. Two NSERC initiatives to alleviate the growing problem are the NSERC/ Industrial Research Chairs program, and a program to encourage women to join the engineering profession .■

Cabot Strait Submarine Fibre Optic Cable System

by Nels Mitchell, P. Eng.
Senior Engineer, Transmission Technology Department
Newfoundland Telephone Co. Ltd.

In 1991, Newfoundland Telephone Co. installed a fibre optic cable across the Strait of Belle Isle to supply long distance communication to the province of Newfoundland. The cable, when installed, was the longest repeaterless submarine fibre optic cable in the world, and represents the first phase of a project that will see all of Newfoundland tied to a cross-Canada fibre optic link. It currently handles traffic at the rate of 135 Mbit/s and will be upgraded to 622 Mbit/s in the near future.

En 1991, la compagnie Newfoundland Telephone Co. procédait à l'installation d'un câble constitué de fibres optiques pour traverser le Détroit de Belle-Isle, dont l'objet était de fournir un lien de communication interurbain avec la province de Terre Neuve. Le câble, une fois installé, devenait le plus long lien optique sans répétitrice au monde et cette opération constitue la première étape d'un projet qui vise à intégrer Terre Neuve dans un lien optique pan-canadien. Présentement il supporte un débit de 135 Mbit/s, que l'on doit porter à 622 Mbit/s dans un très proche avenir.

In the late 1980s, it became apparent that Newfoundland Telephone could not meet customer demands for high quality voice and data services with the mix of analog and digital technologies in its telecommunications network. In particular, it was decided that another route to handle off-island traffic was needed.

At the same time, fibre optics was rapidly becoming the dominant technology for long distance telecommunications transmission for several reasons. Despite the high initial cost, the incremental growth cost is minimal compared with alternatives such as microwave radio. Another major benefit is the ability of fibre optics to easily support future services such as High Definition Television (HDTV) and the Integrated Services Digital Network (ISDN). It was therefore decided that a fibre optic cable across the Cabot Strait from the Island of Newfoundland to Cape Breton Island would be installed.

The benefits of fibre optic technology were also being considered at this time by New Brunswick Telephone (NBTel) and Nova Scotia's Maritime Telephone and Telegraph (MT&T). NBTel had a requirement for a second fibre optic route because of its commitment to Teleglobe Canada, Canada's overseas long distance carrier, and would require a fibre optic cable laid across the Bay of Fundy. It was decided by MT&T to extend fibre optics to Prince Edward Island across Northumberland Strait, thereby improving services to Canada's smallest province.

The three companies decided to jointly purchase and install these three cables, thereby reducing mobilization and installation costs, and to share common spare parts after the installation was complete. With this goal in mind, the Atlantic Provinces Optical Cable System (APOCS) was formed, a jointly managed project which would oversee the installation of the three fibre optic cables.

Feasibility studies were conducted throughout 1988-89, resulting in a Request for Tender being issued in February, 1990. The contract was awarded to a joint venture between British Telecom Marine and Alcatel-Submarcom in August of that year. Installation of the Cabot Strait cable commenced in August of the following year, and on October 31, 1991, the Cabot Strait fibre optic cable went in service.

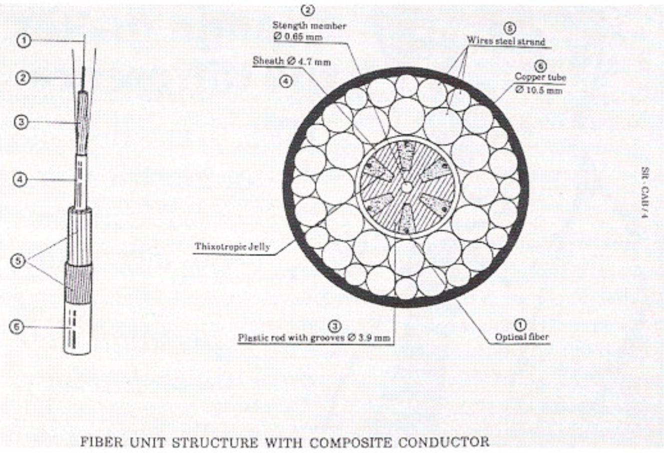


Figure 1. Fibre Optic Cable.

The fibre optic cable

The Cabot Strait cable stretches from Cape Ray, Newfoundland, to Sydney Mines, Nova Scotia, a distance of 175 km. This cable, when laid, was the longest repeaterless underwater fibre optic cable in the world. Currently, the cable is driven at either end by asynchronous terminal equipment at a data rate of 135 Mbit/s. In 1993 this will be upgraded to Synchronous Optical Network (SONET) compatible equipment operating at 622 Mbit/s, providing the equivalent of roughly 8000 voice circuits.

In order to send an optical signal over such a long distance without repeaters, it was necessary to provide cable with extremely low loss. The cable is single mode pure silica core fibre with a loss of 0.18 to 0.20 dB/km at a light wavelength of 1550 nm. By comparison, typical land cables are specified with 0.28 dB/km loss at the same wavelength.

The cable incorporates six pairs of fibres inserted in jelly-filled v-grooves in a central plastic rod extruded around a steel strength member (Figure 1). The jelly permits some movement of the fibres in the cable without damage. All this is protected by a high strength steel wire vault whose elongation at break is lower than the combination of slack in the fibres and their screen test elongation. In simple terms, the cable is designed to break before the fibres do. A copper tube is formed on the steel vault, then seam-welded and bound to the wire strands, providing a power supply for those instances where repeaters are used, and also acting as a hydrogen barrier. In this case, the copper sheath is lightly energized, providing an effective means of determining when the cable is damaged. Over all this, a five millimetre abrasion-resistant polyethylene layer is laid.

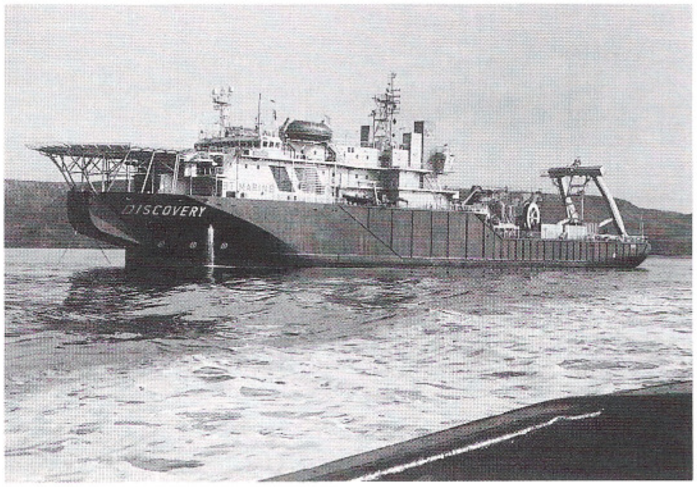


Figure 2. The cable ship *MV Discovery.*

In order to protect the cable from damage after it is laid, two means are used: armouring and ploughing. Single armour was used for 162 km of the cable's length where the cable is in deeper water and relatively less susceptible to damage. Single armour is formed by winding galvanized steel wires in a long pitch helical configuration around the cable core. The entire cable is then covered with polypropylene yarn. Where the cable was more susceptible to damage at the shore terminations, double rock armouring was used. In this case, the single armoured cable is covered again with a layer of steel wires, this time in a normal pitch. This layer is then again covered with a final layer of polypropylene yarn.

Installation procedures

The ship used in the Cabot Strait cable installation was the MV Discovery, operated by BT Marine, Southampton, England (Figure 2). Specially designed for this type of work, the ship features a diesel electric propulsion system capable of exerting a pull of 100 tonnes and tracking against a side current of 3 knots. It also has a dynamic positioning system with specialized software for both cable laying and diving operations.

To minimize interference with local fishing activity, and further to protect the cable from damage, the cable was ploughed into the sea floor using a remote submersible plough operated off the Discovery. The plough (Figure 3) is controlled from the ship via the control umbilical. It features power steering capability, allowing a high degree of route control on the seabed and enabling the plough to avoid obstacles while maintaining sufficient cable tension. An additional feature is the plough's ability to "fly" over seabed obstacles while maintaining directional control. Sophisticated telemetry and video data recording are featured in the control and monitoring system, giving the operators a comprehensive view of the cable laying operation.

Initial analysis of the cable route indicated that approximately 12 km., or about 7%, of the cable would not be ploughed, owing to the sea floor conditions. In fact, it was later found that 98% of the cable was buried, in depths ranging from 200 mm to 1.5 m.

The cable installation was not without its problems, however. The installation started at Cape Ray, and soon after starting to lay the cable, it became apparent that there was excessive signal loss along the cable, indicating that it had been damaged while being laid. Analysis of the problem using an Optical Time Domain Reflectometer indicated that the problem lay approximately one km offshore. It was decided that the entire cable would be installed before attempting to investigate the problem.

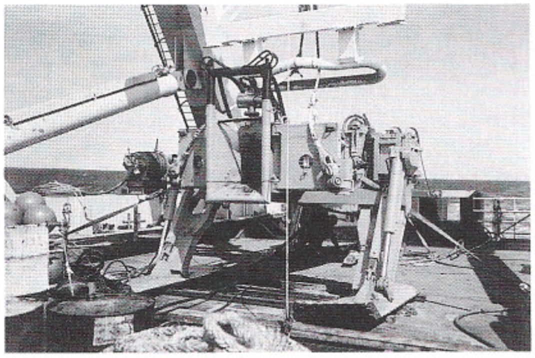


Figure 3. View of the cable plough.

At the 35 km point, the plough damaged the cable. At this point, it was decided to take up the cable and repair the damage before proceeding. The cable was removed from the water, repaired, and replaced. The splice took approximately two days to complete.

At this point, Mother Nature intervened to delay the installation still further. Originally, the Discovery was to have installed the Bay of Fundy cable before the Cabot Strait cable. However, because of the approach of Hurricane Bob, the Fundy cable was delayed and the Northumberland Strait and Cabot Strait cables were installed. Now a crucial window was approaching for the Bay of Fundy; if the window were missed, the cable might not be installed until the following year. It was decided to cut the Cabot Strait cable at the 50 km point, install the Fundy Bay cable, and return to finish the job.

Cutting the cable was a delicate operation, because the ship, upon its return, had to retrieve the end without damaging the cable. The cable was cut at an existing splice to help minimize splice losses. At the end was attached 200 m of rope, followed by 20 m of heavy metal cable. With tension applied to the rope, the cut end was carefully laid on the sea floor; when all the rope has payed out, the final piece of cable was let go.

Upon the ship's return, the sophisticated positioning equipment allowed the crew to position her over the exact point where the cable had been cut. A grapnel was lowered and the rope fished out of the water. It is an indication of the accuracy of the equipment, and the skill of the crew, that the cable was retrieved on the first pass.

Now the cable installation could proceed. No more problems were encountered with the installation, and the remaining 120 km of cable was laid in four days of continuous operation.

There was one remaining problem, however - the damage at Cape Ray. It was eventually decided to cut the cable at a point past the damage, splice in a new section, and float that section to shore. When this was done, the cable was anchored, brought to a manhole, and the Cabot Strait installation was complete.

Conclusion

The Cabot Strait Submarine Cable System is the first phase of a four-part project undertaken by Newfoundland Telephone to upgrade long haul communications. The second phase of this project, an extension of the fibre optic cable to Corner Brook on the island's west coast, has already been completed; the third phase, which will see fibre run as far as Clarenville on the island's east coast, is scheduled to be completed this fall. When phase four is complete, Newfoundland Telephone will give customers in St. John's access to a fibre optic system which stretches across the entire country.

The greatest advantage of fibre optic transmission technology is that its capacity is currently limited only by the terminal equipment attached at either end. The carrying capacity of fibre optic cable is increasing all the time, as data rates of the terminal equipment increase. Because of this, the Cabot Strait submarine cable should handle Newfoundland Telephone's off-island growth requirements for some time.

About the author

Nels Mitchell received his Bachelor of Engineering Degree in Electrical Engineering from Memorial University in St. John's, Newfoundland in 1974. His career has included planning, project management, design and provisioning of a broad range of switching, and transmission facilities projects dealing with the telecommunications industry. He has worked with Newfoundland Telephone since graduation and is presently Senior Engineer Transmission.

The Spectrum Engineering Show

Helping People to Discover Engineering

by Ian Marshall
Graduate Student
University of Saskatchewan College of Engineering

Since the 1950s, engineering students in Saskatoon have been showcasing the engineering profession through the Spectrum Engineering Show. This very entertaining and enlightning show has become the largest of its kind in North America.

Depuis les années 50, les étudiants en ingénierie de Saskatoon attirent l'attention de la population sur leur profession grâce au "Spectrum Engineering Show". À la fois amusant et révélateur, ce spectacle est devenu, en son genre, le plus important en Amérique du Nord.

The engineering profession has traditionally been a source of mystery to the average lay person. Indeed, every engineer can attest to some of the commonly held myths and misunderstandings that he or she has encountered about the profession. The public, for the most part, has a very limited understanding of what engineers do. With this in mind, engineering students in Saskatoon have sought to improve public understanding through the Spectrum Engineering Show.

Held every three years in Saskatoon, the Spectrum Show has been entertaining and enlightening the public since the 1950's. The original intent of the show was to promote Engineering at the University of Saskatchewan. In recent years, however, the intent has moved more towards educating the public about engineering. The show has since been recognized throughout North America for the quality of its displays and activities, and is currently the largest show of its kind in North America. Although the Spectrum Engineering Show is presented jointly by the University of Saskatchewan College of Engineering and the Saskatoon Engineering Students' Society, it is organized and run almost entirely by student volunteers.

The show consists of displays and exhibits put on by students and industry, presenting topics ranging from basic principles of physics and chemistry, to engineering methods, and the latest in technological innovations. The show takes a family-oriented approach, providing displays for all ages and interests. The idea is to provide a show that is both entertaining and educational. As well, the show tries to encourage young people to consider engineering as a career.

Highlights of Spectrum '92:

This year's Spectrum Engineering Show was held from January 17 to 19. In those three days nearly 16 000 visitors passed through the doors. Of this total, 2 300 were school children who came as part of organized school tours. Spectrum '92 had thirty industrial and feature exhibits, and numerous engineering student displays. In all, there were 23 companies and engineering groups, each with their own trade show type displays, and 7 feature exhibits. The company displays represented local, provincial, and nationally-based firms which regularly employ engineers. Some of the companies represented included SED Systems of Saskatoon, Sask Power, Northern Telecom, and Dow Chemical. The student displays were divided into thirty display themes listed in Table 1.

The feature exhibits proved, by far, to be the most popular. Among these were a Leonardo da Vinci display, an architects working model of Skydome, a Dancing Waters Piano, and a Gyroplane.

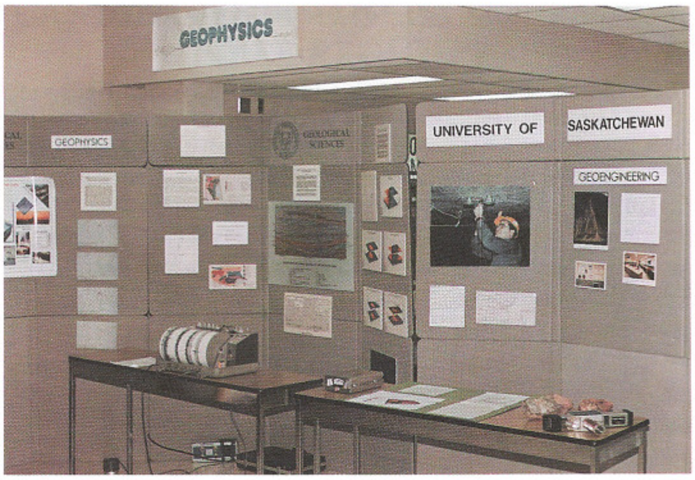
The Leonardo da Vinci display, which is currently touring North America, consisted of working models of some of da Vinci's proposed inventions. The models were created by IBM, from da Vinci's drawings and notes. The display included among other things a model of a paddle wheel ship, a hygrometer, an anemometer, an odometer, a helicopter, and a tank. Although these machines may sound commonplace today, da Vinci had proposed them in the 15th century, hundreds of years before any of the machines were actually exploited. The display served as a tribute to da Vinci who many consider to be the greatest engineer and scientist of the Renaissance period.

Another feature was the working model of Skydome. This particular model was the actual scale model built and used by the Skydome architects. The model, constructed from brass, stood eight feet tall. The model employed the same mechanism for opening and closing the roof as is used in the actual Skydome. Demonstrators used the model to show how the roof on the actual Skydome opens and closes. They also showed how the model had been used to detect potential problems with the design. This exhibit drew a lot of visitors who may otherwise never see the actual Skydome. As well, it helped demonstrate to visitors one of the methods engineers use in testing their designs.

The Dancing Waters Piano created by the Saskatchewan Water Corporation also drew a lot of attention. This exhibit consisted of a water fountain and lighting system controlled by an electric piano. Each time a note was played on the piano, a specific fountain nozzle was activated. The diameter of each fountain nozzle varied with the frequency of the notes required to activate it; the higher the frequency, the smaller the diameter of the nozzle. Since all of the nozzles were supplied by a single pump, the height of each fountain varied inversely with the nozzle diameter. Thus the higher the note played,

TABLE 1 SPECTRUM ENGINEERING '92 STUDENT DISPLAYS

Structural Engineering	Controls Engineering
Civil Engineering	High-tech Audio/Visual
Mechanical Engineering	Image Processing
Computer Automated Design	Soils
Environment	Electrical Engineering
Hydraulics	Atmospheric Studies
Aids for the Disabled	Engineering Physics
Intelligent Vehicle Highway Systems	Geographic Information Systems
Nuclear Energy	Speaker Systems
Municipal Engineering	Biomedical Engineering
Neural Networks	Marine Engineering
Student Designs	Chemical Engineering
Wind Tunnel	MicroElectronics
Petroleum Engineering	Engineering Materials
Geotechnical Engineering	Computers in Civil Engineering



University of Saskatchewan Geophysics booth and geoengineering displays.

the higher the fountain spray. When the highest notes were played, the corresponding fountains sprayed as high as 10 metres. Needless to say, the ceiling of the display theatre got quite wet. Since each fountain head was activated by a different note, the fountain waters would appear to "dance" to whatever tune was being played on the piano by the demonstrator. The display was used to teach people about basic principles of water conservation (the fountain recycled the water it used) and fluid dynamics.

One exhibit that was of interest to flying enthusiasts was the gyroplane exhibit. A gyroplane is an experimental amateur-built flying machine. The machine is a hybrid between an airplane and a helicopter. In appearance, the gyroplane looks like a miniature helicopter in that it has an overhead rotor instead of wings. Unlike a helicopter though, the overhead rotor is not powered. Instead, when the gyroplane moves forward, air flows through the slightly tilted blades of the overhead rotor causing it to spin. The spinning rotor causes lift. Thus all the gyroplane needs to fly is forward thrust which is provided by a rear propeller. Because of its simplicity and its small size and weight, one does not have to be a licensed pilot to purchase or operate a gyroplane; a short training course is all that is required. Rotary Air Force Inc. of Ponoka, Alberta, which produces and sells gyroplane kits, displayed a fully constructed model at the Spectrum Show.

Among the companies that had exhibits at the Spectrum Engineering Show were some big names such as Northern Telecom, Dow Chemical, and Atomic Energy of Canada (AECL). Northern Telecom's display concentrated on fibre optics. It showed how several fibre optic strands, combined into a cable less than 2 cm in diameter, could be used to replace bulky copper cables in communication systems. Dow Chemical had a display showing the work it

Wheelchair loading device is an example of how engineering can improve the quality of life for some people.

is currently doing in the area of recycling plastics. Dow's display showed how discarded plastics could be melted down and reused for such things as furniture and construction materials. AECL's display explained the basics of how electricity is generated from uranium in a CANDU reactor. As well, AECL showed some of the areas that are being researched, such as nuclear waste management. The company exhibits together showed a variety of areas where engineers have an impact.

Most of the student displays concentrated on specific areas of engineering and the physical sciences. The displays ranged from protecting the environment to neural networks. One agricultural engineering exhibit showed visitors how computers are being used to identify and sort various types of grains and seeds through image processing. Another display demonstrated how a wind tunnel can be used to measure the drag coefficient of new vehicle designs or to predict how snow will drift around buildings. A series of engineering physics displays demonstrated some of the more interesting areas of physics such as lasers and holography, superconductivity, and electricity and magnetism. These student displays helped show visitors some of the many exciting areas that engineers and scientists can work in.

Although many of the displays were purely visual, some allowed visitors to get involved. Among the most popular was a student display consisting of a children's racing track that was powered by exercise bicycles. The track had two racing cars, each powered by electricity generated from one of the exercise bicycles. The faster a person pedalled, the faster his or her car would go. This display proved to be especially popular with children as they could "race" against each other by pedalling the exercise bicycles.

Another display that proved to be extremely popular, was one that was presented by the local student section of the IEEE. At this display, visitors could have their picture taken with a special video camera which transferred a fixed image to a personal computer. Once the picture was transferred to the computer, visitors could then choose to have other images (such as a picture of the "Terminator", Arnold Schwarzenegger) added to their pictures along with a message or title. The resulting pictures were then printed and given to the visitors as a souvenir of the Spectrum Engineering Show.

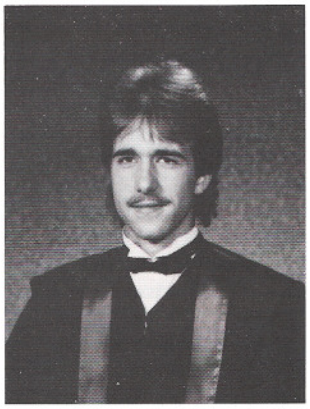
The above descriptions provide only a small sampling of the displays that appeared at Spectrum, but they all served to educate people about the engineering profession. More importantly though, they also served to encourage young people to take an interest in science and to consider engineering as a career. With experts predicting a shortage of engineers in the future, this kind of exposure will soon become important.

Conclusion:

The Spectrum Engineering Show '92 was the largest and most varied Spectrum Show held to date. It took two years of planning for Spectrum '92 organizers to put the show together. The hard work of these students, along with the contributions of numerous volunteers made this year's Spectrum the most successful ever. Congratulations to Spectrum '92 Coordinator, **Greg Newman**, the Spectrum executive and directorate, and the 800-plus student volunteers for putting on another first rate show.

About the author

Ian Marshall was graduated from the University of Saskatchewan College of Engineering (Electrical 1990) and has participated as a volunteer in both the 1986 and 1989 Spectrum Engineering Shows. A former Industry Internship student with IBM Canada, Mr. Marshall has just completed a second degree in Computer Science at the University of Saskatchewan. During the summer months, Mr. Marshall is self-employed as a Computer Consultant.



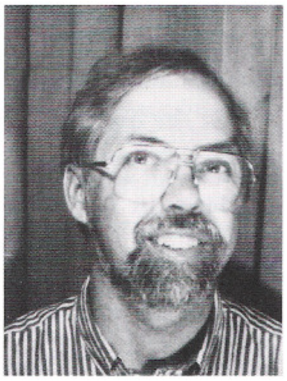
1992 COUNCIL MERIT AWARDS

We are glad to announce the following 1992 Council Merit Awards:

Eastern Canada Council Merit Award - **Yves M. de Villers**, Quebec City
Central Canada Council Merit Award - **Wallas H. Khella**, Toronto,
Western Canada Council Merit Award - **Mohindar S. Sachdev**, Saskatoon.

Mohindar S. Sachdev received his B. Sc. degree in Electrical and Mechanical Engineering at the Benares Hindu University, India, and his M. Sc. in Power System Engineering at Panjab University. In 1965, Mr. Sahdev came to the University of Saskatchewan where he received his Ph. D. in 1969. He has taken a keen interest in IEEE activities, having served as Chairman of the Saskatchewan Section, Chairman of the Western Canada Council and Chairman of the Region 7 Awards Committee. In addition to his current duties as Professor and Head of Electrical Engineering at the University of Saskatchewan, he is Vice Chairman of the Power System Planning and Operation Section of the CEA.

Wallas H. Khella, P. Eng., SM-IEEE, obtained his B.Sc. degree in Electrical Power Engineering from Cairo University, Egypt in 1955 and his Ph. D. from Dresden University, Germany in 1962. He is currently Manager of Distribution Design at Etobicoke Hydro and has served on several CSA, MEA, and EIC Committees, developing material standards and R&D. From 1976 to 1989 he acted succesively as Coordinator of Educational Activities, as Treasurer, as Secretary, as Chairmen and as Past Chairman of the IEEE Toronto Section. Through his teaching activities over the past 27 years, Dr. Khella has also made an important contribution to the continuing education of those working in the Electric Power Distribution field.



Yves M. de Villers received the B. Sc. and the M Sc. degrees in Electrical Engineering from Laval University, Quebec City, in 1980 and 1984, respectively.

He has been with the Defence Research Establishment at Valcartier, (Qué.), since 1982, where he has been involved in a variety of topics related to millimeter radar imaging and signal processing. More recently, he has been involved in ISAR imaging study of moving targets. In the IEEE, Mr. de Villers has been a member of the Quebec Section's Executive Committee since 1980, Treasurer (1980 - 1983), Chairman (1983 - 1988), Vice Chairman 1989, again Chairman (1990), and Membership Development Committee Chairman (1990 - 1992) and is currently acting as Treasurer.

1992 STUDENT PAPER COMPETITION WINNERS

ECC Life Member Award – **Marc Kimpe** and **Raymond Knopp** of McGill University with their paper entitled *Practical Implementation of a Soft Decision Block Decoder*

CCC Life Member Award – **Samuel Black** of Ryerson Polytechnical Institute, paper entitled *Real-Time Video Digitizer*

WCC Life Member Award – **William Wong**, University of British Columbia, paper entitled *An Imaging System for Digital Mammography*

CCC Hackbusch Award – **Peter Ott** of Ryerson, paper entitled *Digital Guitar/Audio Processor*

WCC Hackbusch Award – **Mark Patton**, University of Calgary paper entitled *Adaptive Decision-Feedback Equalization for Cellular Radio Using the QR-Decomposition Least-Squares Algorithm and Systolic Arrays*

CCC Palin Award – **Jeffrey Krul** of Radio College of Canada paper entitled *The Digital Sampler/ Recoder*

WCC Palin Award – **Kelly Baziuk** and **Carl Kornago** of Red River Community College, paper entitled *The Designing, Building and Testing of a Z-80 Controlled Load Levelling and Ride Control Suspension System*

1992 GEORGE G. ARMITAGE OUTSTANDING STUDENT BRANCH AWARD

École de technologie supérieure, IEEE Student Branch – *"pour les efforts de recrutement et pour l'organisation de la diffusion satellite qui a marqué la journée IEEE Canada 1992."*

1992 McNAUGHTON SCHOLARS NAMED

Truong Q. Le	University of British Columbia
Richard Lefebvre	University of Regina
David Cargill	University of Saskatchewan
Albert D. Heller	University of Manitoba
Jeffrey P. Larivière	Carleton University
Alain Marchand	Laval University

McNAUGHTON CENTRE OPENED IN TROIS RIVIÈRES

The latest McNaughton Centre was officially opened in Trois-Rivières during the Eastern Canada Council Section Training Meeting in April. The opening ceremony was performed by **Dr. Vijay K. Bhargava**, Director, Region 7 with **André Thibeault**, Vice-rector of the University. **Andrzej Barwicz**, St-Maurice Section Chair and **Marc Palmarini**, IEEE Student Branch Chair were also present.

Andrzej Barwicz, **Marc Palmarini** and colleagues (background) in their newly-established McNaughton Centre in Trois Rivières.

CANDIDATES FOR DIRECTOR-ELECT, IEEE REGION 7

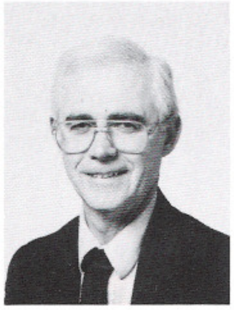
Gregory C. Stone

Canada is in the midst of difficult times, which may be compounded due to future political uncertainty. At present, there is no strong, independent voice representing electrical engineers, technologists and computer professionals before government and electrical / electronic/computer industry associations.

As the representative of Canada's largest independent group of high tech employees, IEEE Canada should be pro-active in helping to maintain jobs and promoting our industries. I believe that with over 15 000 members in IEEE Canada, we can have an influence on policy issues which affect our careers.

I was a vocal member of the IEEE Technical Activities Board to ensure that its decisions reflected the interests of the IEEE members, rather than obsolete policies. I will bring this activism, as well as my experience in large, mid-size and small companies to the IEEE Board of Directors to ensure that the technical interests of its Canadian members are heard.

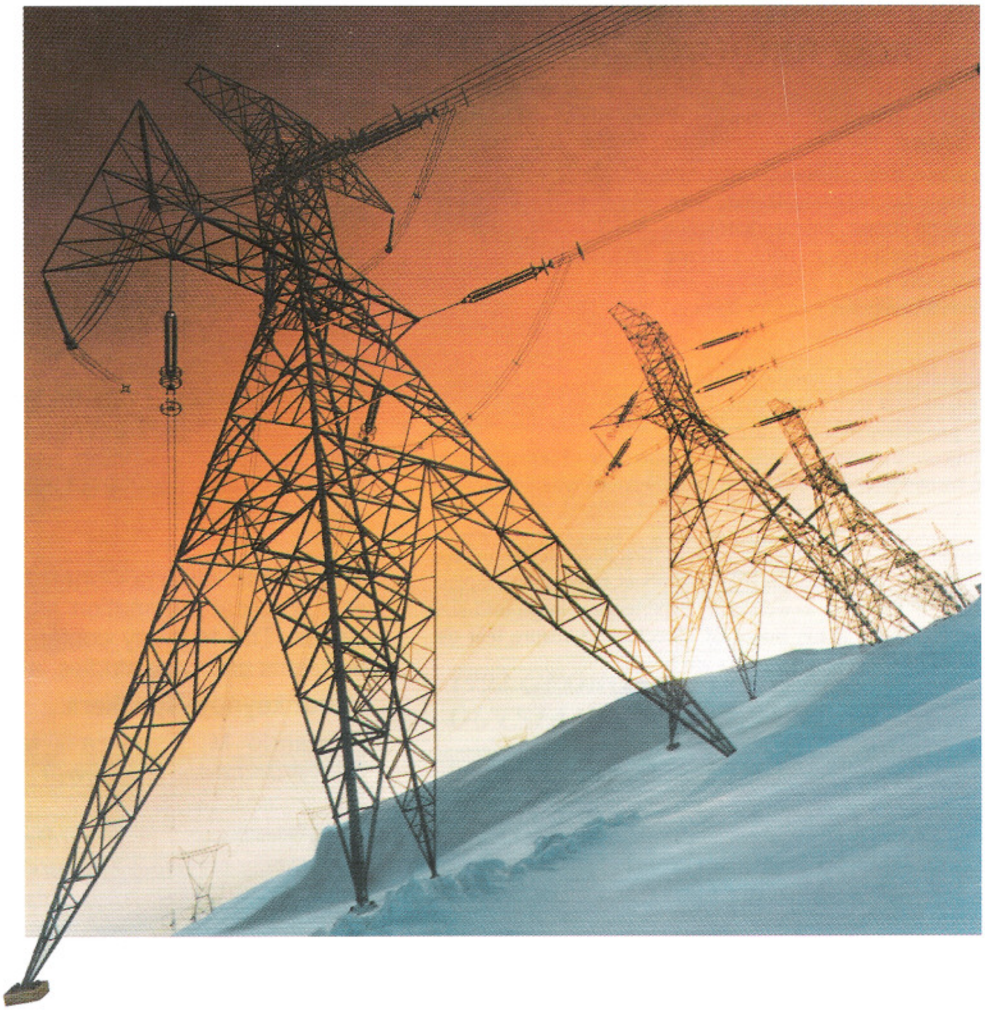
Raymond D. Findlay



What's happening to IEEE ? Dues have shot up and service has plummeted! The Board has failed to provide for basic services to all members. Let's change things! Let's tell them Spectrum needs to be restored to its former glory. Let's tell them the membership needs to be informed, that provision needs to be made for quality service.

We need to emphasize the needs of our unique , Canadian, one-country Region, providing educational opportunities throughout Canada, bringing conference opportunities to all Canadian members, and developing programs so that our graduating students will want to be Members. That means providing support for our Members at the technical, Section and Chapter, and Student levels.

As a member of the Regional Activities Board for the past few years, a working member of 4 IEEE technical societies, and experience working at the technical, conference, Section, Chapter and Student levels, I have the know-how to do the job well. Please tell me what you need, by email at r.findlay@ieee. org, or phone or FAX or mail, then vote for me.



Shaping an Energy Future

ABB Canada plays a major role in the Canadian electrotechnical industry. We design and manufacture innovative products in Canada for export worldwide.

We are committed to satisfying our customers' needs. Because of this commitment, we build and sustain strong relations with our customers, and we continue in our efforts to develop and share advanced technological research.

The pursuit of excellence is our passion. The partnerships with our customers and the drive for continuous improvement ensures a strong future for all.

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