COMMUNICATIONS RESEARCH CENTRE

ANNUAL REPORT 1972-1973

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COMMUNICATIONS RESEARCH CENTRE
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Dr. J.H. Chapman,
Assistant Deputy Minister (Research)

Dear Sir:

I have the honour to submit to you the Annual Report of the activities of the Communications Research Centre for the fiscal year 1972/73.

Yours faithfully,

Director-General.

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FOREWORD

Although a research centre has been in existence for 26 years at the Shirley Bay site, until 1969 it had come under the auspices of the Defence Research Board (DRB) as the Defence Research Telecommunications Establishment. It has been a branch of the Department of Communications (DOC) for the last four years – a short period of time in terms of research. Consequently, the Centre continues to undertake new responsibilities and establish precise objectives.

Objectives

The roles of the Communications Research Centre (CRC), as established by the Assistant Deputy Minister for Research (ADMR), are based upon the current objectives of the Department:

1. To foster the orderly development and operation of communications for Canada in domestic and international spheres.

2. To foster, develop and introduce new communications systems facilities and resources.

3. To foster, develop and extend telecommunications services in order to obtain optimum benefits for Canada both immediately and over the long term.

4. To protect and sustain Canadian interests in international telecommunications systems services and undertakings.

5. To improve and extend the use of the radio frequency spectrum.

6. To encourage the development and growth of radio communications.

CRC supports the general roles of the Department by directing our activities towards specific research objectives:

1. To perform research and development (R&D) in communications science and technology and determine its potential impact upon man.

2. To direct R&D contracts.

3. To meet with and advise the research elements of industry and universities.

4. To support other Departments and Agencies of the government by performing R&D in areas where CRC possesses unique capabilities and facilities.

Personal objectives had been established for the Director General (DG) of CRC and his five Directors. During the 1972/73 fiscal year, the objective-setting process was extended to the level of project managers and 30 June 1973 was projected as the overall implementation date of the 'Management by Objectives' program. A panel of experts, under the chairmanship of Dr. Hartz, was created in order to assist all levels of CRC staff in determining viable objectives for themselves.

Organization

CRC has been set up by directorates. There are four research directorates, Radio Research (RR), Satellite Communications Systems (SCS), Informatique (I) and Communications Systems (CS), and one directorate for Administration. Each Director is responsible for several programs; each program manager for several projects. Although the projects are designed to vary according to need, the programs represent the permanent working level within the establishment. The organization chart shown in Figure 1 is only an outline since reorganization at the program level has not yet been completed.

A considerable share of the present research effort is directed towards the support of other government departments. Since this work is distributed throughout the four research directorates, Mr. F.W. Simpson has been appointed Coordinator of Government Programs. He reports directly to the DG.

Due to the large size and the international nature of the Communications Technology Satellite (CTS) project, a direct line of responsibility has been created between the Director of SCS, Dr. Paghis, and the ADMR. Dr. Franklin, CTS Project Manager, is responsible for the spacecraft, while Dr. Barry, Deputy-Director of SCS is directing the various programs within the directorate. Both men report to Dr.Paghis. The responsibility for the post-launch Communications Experiments on CTS rests with Dr. Blevis, a program manager in the CS directorate.

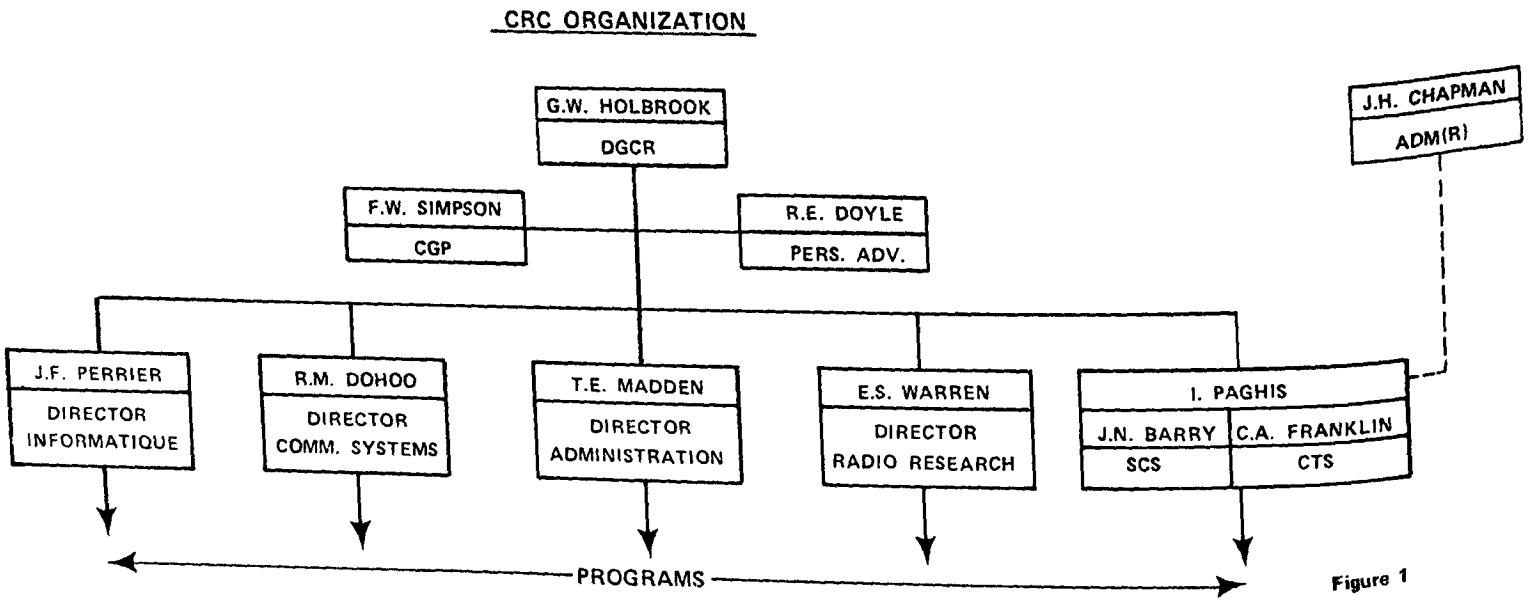

Figure 1

ERRATUM

CRC ANNUAL REPORT 1972-1973.
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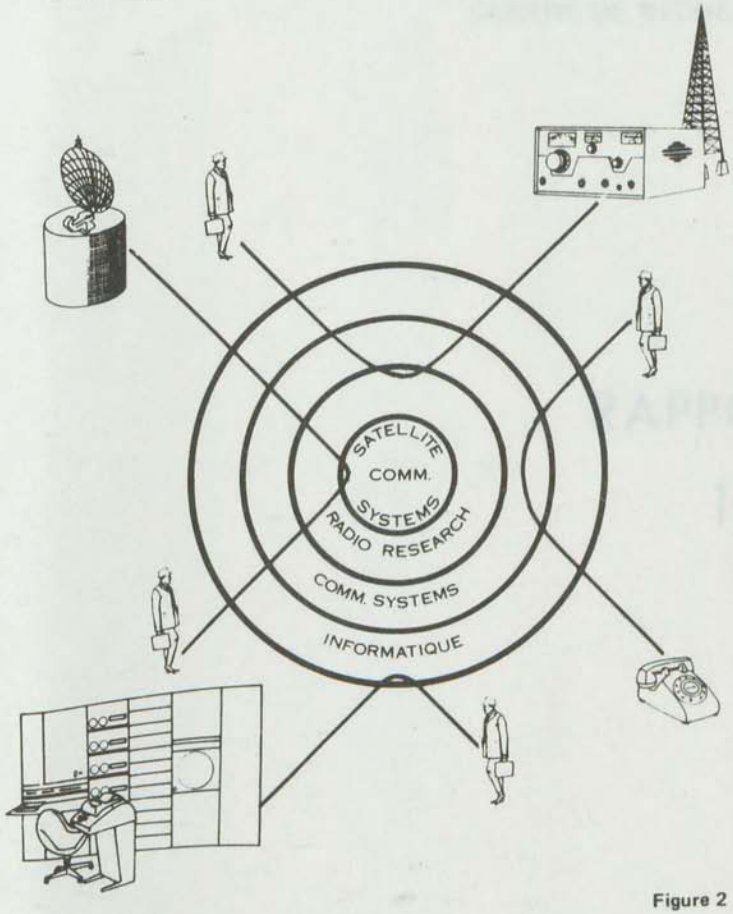


Figure 2

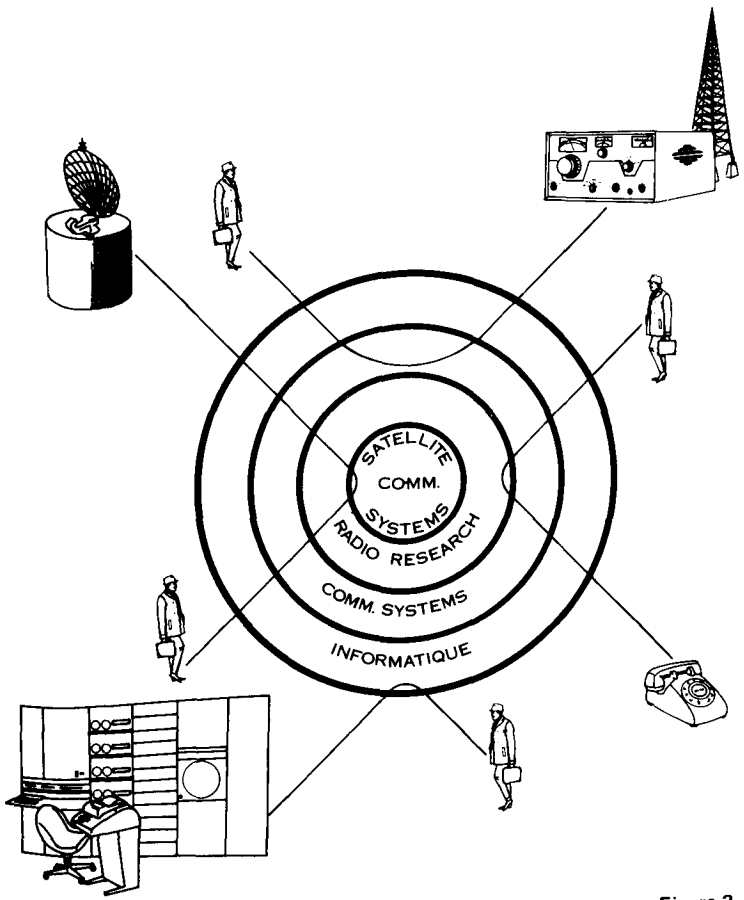
Functional Responsibilities

CRC has attempted to coordinate internal projects, encouraging a productive overlap between responsibility areas of the directorates while eliminating any unnecessary duplication of effort.

Figure 2 represents the functional responsibilities of the four research directorates in terms of the interface between man and a communications system. As the communications link between man and man increases in sophistication, more directorates must be involved in the process of contributing to the solution of the problems that arise in establishing that link. Simplistically speaking, and only considering examples, Informatique Directorate would be concerned with communications by computer systems; Communications Systems Directorate would also participate if the system included communications by telephone or other line networks; Radio Research Directorate with communications by terrestrial radio systems; and Satellite Communications Systems Directorate with communication by satellite.

The Administration Directorate provides all the administrative and technical support for the Centre. Since there is no cost accounting to the research projects for the technical services performed, this directorate assumes a significant portion of the indirect cost of the projects. This is the basis for the resources distribution shown graphically in Appendix A.

The computing service for the Centre is handled in-house by the Informatique Directorate. Again, no cost accounting is made to the projects, although an experiment involving 'paper dollars' was initiated in February 1973. This study will be continued throughout the 1973/74 fiscal year.



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Tasks from Other Departments

It is estimated that about 25 percent of the 1972/73 research effort was performed in support of other government departments. Appendix B lists the wide-ranging topics undertaken by CRC for these departments. DND, under the auspices of DRB, has proven to be our largest external customer - a long-standing agreement exists between DRB and CRC establishing the total level of research and its method of funding. Since much of our work undertaken for DRB is classified it has been separately documented and reported upon in confidential quarterly progress reports.

Since the resources available to CRC are severely limited, all of our priorities must be thoroughly considered before undertaking research work for other departments.

Contracting In

CRC has assumed the responsibility of providing scientific and technical aid to industry in those fields where CRC possesses unique expertise and/or equipment not found in the competitive Canadian market. For example:

a) Consulting Services.
b) Test, design and/or assembly of hardware using CRC staff, laboratories and facilities.
c) Rental of unique CRC equipment and facilities to industry.
d) Secondment of CRC staff to industry.
e) Circulation of a list of all unclassified publications, the *CRC Index of Research Publications.*

Due to economic and personnel considerations, CRC cannot undertake every service that might be requested by industry. We attempt to undertake work which complements and falls within the overall framework of our current resources, programs and objectives. All such work is performed strictly on a cost-recoverable basis. During 1972/73, an interim policy on services provided to industry was formulated at CRC, and approved by the ADMR. It is being implemented pending an extended term-examination of the procedures.

Contracting Out

CRC relies heavily upon outside contracts to industry and Canadian universities for the implementation of many of our research projects. About 80 percent of the 1972/73 Capital budget was expended on these contracts. The university program was carried out mainly in two ways: some projects were sponsored by CRC and financed by the departmental research committee; other projects were sponsored and financed by CRC. Appendix C lists university contracts by topics. The CTS program depends almost entirely on contractual arrangements with industry and represents the largest single input to the CRC industrial contracts.

External Relations

CRC must liaise with the research sectors of manufacturing industries, operating companies and Canadian universities. To improve this interface, certain directors have been appointed to coordinate the developing relations: R.M.Dohoo, D/CS, for the manufacturing industries; J.F. Perrier, D/I, for the operating companies; and E.S. Warren, D/RR, for the universities. The coordinators arrange for scientists and engineers within CRC to act as focal point liaison officers communicating with the liaison officers designated by the specific companies and universities. While cooperation at the working level is encouraged between CRC personnel and these organizations, any formal exchanges of information are made through the appropriate liaison officers.

Highlights of Activities 1972/73

Coincident with the signing of a Memorandum of Understanding between DOC and the European Space Research Organization (ESRO) in May 1972, our Minister, Mr. Robert Stanbury, hosted a reception at CRC for representatives of the ESRO nations and Canadian industry. This reception reflected the cooperation that has been developing between ESRO and the CTS project. We were honoured to welcome these distinguished guests to the Research Centre.

Friday, 29 September 1972, marked the 10th anniversary of the launching of Alouette I, the first satellite designed and built in Canada. The general mission objective has been to conduct comprehensive studies of the upper ionosphere. This achievement was celebrated at CRC by a four-day Open House designated 'Ten Years in Space'. Alouette I made her 49,862 pass at 12:04EST on the 29th September with more than 600 official guests present to witness the passing of command signals from the Minister to the Satellite. The gathering included senior representatives of various countries associated with the Alouette/ISIS program; representatives from industry and NASA; and many of the scientists, engineers, technicians and support staff who were personally involved in the design, construction and launching of Alouette I. The ceremonies included the official opening of the C.David Florida Laboratory at CRC by the Deputy Minister and the unveiling of a plaque commemorating the event by Mrs. Florida. During the four days of the program, about 5200 visitors were conducted through the exhibits on the site. The resounding success of the events resulted from the hard work and team spirit shown by the CRC and DOC staff members involved in the project.

This year the Public Service United Appeal Drive was organized by DOC and CRC provided 16 liaison officers to help make the campaign a success. At CRC, we collected $7,139.59, representing 108 percent of our target figure, due in particular to the organization and dedication of Miss Doris Jelly and her assistant Mrs. Allison Morrison, and the generosity of our employees.

Our new minister, The Honourable Gérard Pelletier visited the centre on 18 December 1972 in order to attend a briefing session of the Departmental Research Committee by senior management; to lunch with the research committee; and to tour the CRC laboratories.

INFORMATIQUE

Until 1972, the Informatique Directorate was vaguely grouped, without any precise organization. It was under the leadership of the first Director, Dr. J.F. Perrier, that the directorate established itself with a formal budget and a specific organizational structure. During the fiscal year 1972-73, the directorate addressed itself to the task of defining its responsibilities, particularly in respect to the behavioural aspect of man-to-man telecommunications. Staffing action was initiated in this area and a psychologist, Dr. J.Craig, joined the directorate. The first project in this field was a study to investigate the interaction of groups joined in meeting by a teleconference system and to determine its feasibility as an administrative instrument for use by federal departments and agencies. A teleconference link was set up between DOC Headquarters in Ottawa and CRC at Shirley Bay, about 13 miles away. Plans were drafted to assess the efficiency of working meetings conducted over the link between officials at both sites .

CRC terminal of the DOC–HQ/CRC experimental teleconference link.

Experimental set-up employing an He-Ne laser for studies in holographic data storage.

In the area of computer science, the directorate has undertaken a cooperative feasibility study of linking together the computing centres of Canadian universities under project CANUNET. A dialogue between the interested groups at universities, and provincial and federal agencies was established. The task remains to collect from these groups the necessary information to determine the practicability of the scheme.

In 1972, research in optical communications was officially granted its place at CRC. Although interesting calculations were verified, little experimental progress was achieved. Nevertheless, it has been possible to demonstrate in the laboratory a new type of miniature laser that may permit the future realization of a communication system with high rates of transmission.

This year, more than 300 scientists and engineers were provided with computer services by our Sigma 6 central processing unit. It is expected that the computer's capacity will be doubled in the next year but the cost of this increase will represent only five percent of this year's cost for the computer.

COMMUNICATIONS SYSTEMS

Steerable antenna and control console provides precise antenna 'look angles' required for microwave propagation studies.

This Fiscal Year saw the completion of the first phase in the establishment of a system analysis capability in the Communications Systems Engineering Program. A team of fifteen professionals, including communications engineers, management scientists, and operational researchers, has concentrated on two specific projects which are directly related to the planning function of DOC. The Integrated Data Communication Systems Project has conducted research into the nature and scope of future data communication requirements and services; into the modelling, analysis and simulation of data systems; and into the feasibility of using R&D within industry to support the implementation of government policy. The Domestic Long Distance Communication Network Study has undertaken research to determine the most viable inter-relationship between satellite communications and the established matrix of terrestrial and satellite facilities for the establishment of long-distance communications services. The study also took into account the economic and network planning factors involved in the provision of such services.

In 1972, we participated in the preparation of a technical specification for a proposed cooperative International Aeronautical Satellite program involving Canada, the United States and the European Space Research Organization (ESRO). As a part of this program, CRC and the Ministry of Transport established a plan definition for the ground facility which Canada will employ to evaluate the use of satellites for air traffic control in the Western North Atlantic. Related activities include a cooperative program with industry to develop a high performance aircraft antenna for satellite communications and also a series of experiments using the American ATS-F satellite.

In October 1972, DOC convened a CTS meeting in Winnipeg to brief potential experimenters on the status of the CTS project and the possibilities of its use for their experiments. Experimenters were informed that DOC would provide satellite ground terminals designed

to meet their individual needs while recognizing certain budgetary constraints. By the end of the fiscal year, we had received 37 proposals for experiments encompassing such areas as communications technology; broadcasting and community development; educational and medical fields; and administrative and data applications.

The Radar Systems Engineering section has been conducting research into aspects of radar technology related to specific Canadian requirements, both civil and military. These include side-looking radar techniques for radar mapping; scatterometry; and the measurement of ice thickness. CRC scientists have developed a technique for measuring the thickness of fresh water ice by radar methods. Ice measurement tests on the Ottawa and St. Lawrence Rivers, conducted in collaboration with the Glaciology section of the Department of the Environment, produced encouraging results.

In October 1972, we began an experiment in cooperation with the Air Force Cambridge Research Laboratories to conduct measurements of tropospheric structure and determine the characteristics of transhorizon propagation, using a forward scatter system at 15.7 GHz over a 500 km path between Boston and Ottawa. The scatter system uses narrow-beam transmitting and receiving antennas which are synchronously controlled to permit the scatter volume to be rapidly scanned over a large region of the upper troposphere.

With the completion of previous research to evaluate indirect methods of determining precipitation attenuation using a weather radar or microwave radiometer, attenuation statistics are now being measured at seven locations representative of the climatic regions in Canada. A 13 GHz radiometer and associated data recording system, designed at CRC, was installed at each location. The radiometers were oriented to the point in space at 114°W longitude that a geostationary satellite would occupy to serve Canada. The experiment is expected to continue for three years.

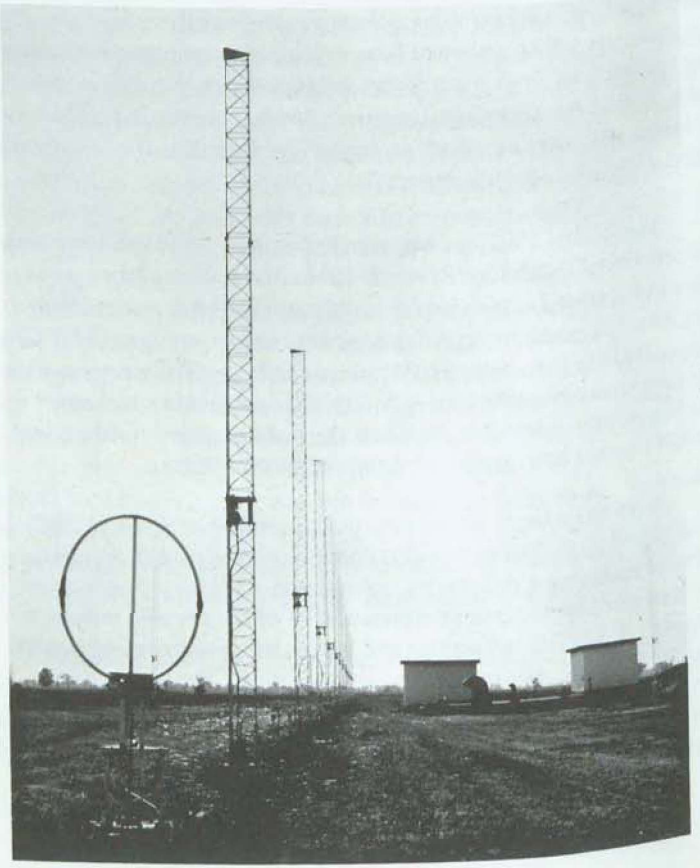
SLAR installation employed for experimental studies in radar technology.

RADIO RESEARCH

During this fiscal year, DOC undertook certain tasks to help the Department of Energy, Mines and Resources (EMR) achieve its goals in a cooperative program with NASA. The Radio Research Directorate provided Canada with the hardware necessary for the reception and preliminary processing of the data from the U.S. Earth Resources Technology Satellite (ERTS). The former Prince Albert Radar Laboratory was chosen as the best site for the ERTS telemetry station and on 1 April 1973, it was officially transferred to EMR as the Prince Albert Satellite Station (PASS). A 'quick-look' facility, devised by CRC and Macdonald Dettwiler Associates Ltd. (Vancouver), in itself constitutes a significant achievement. Data from ERTS can be received at particularly high rates, given a preliminary, almost instantaneous, processing into black-and-white full-resolution pictures and flown immediately to the Canada Centre for Remote Sensing in Ottawa or directly to certain users.

A highly flexible, wide sampled-aperture antenna array was developed to study ionospheric effects which are presently limiting the accuracy of radio direction finders in the high frequency band. The new system, located near Ottawa, is being used to study the directional and temporal properties of oblique or vertical incidence signals. For the first time, this instrumentation has permitted the successful measurement of detailed radio frequency phase characteristics of the diffraction pattern formed on the ground by radio waves obliquely reflected from the ionosphere.

Experimental CRC facility for the study of ionospheric effects related to HFDF.



Jet Ranger in flight over Churchill Falls with the radiometer antenna deployed.

Recent studies of the UHF radiometry technique as a tool for the remote sensing of sea-ice thickness, led to the design of a very sensitive UHF radiometer. It was estimated that the CRC instrument would have a high potential for specific remote sensing purposes when optimized in terms of frequency and spatial resolutions. This radiometer has proven useful in the study of fresh-water ice in fast flowing waters and in the detection of frazil ice deposits. Other potential applications of RF radiometry, from the UHF through the microwave band, were investigated in cooperation with other governmental agencies, including ice reconnaissance, forest fire detection, soil moisture content and water salinity.

A computer program was developed to provide high-frequency radio communicators, spectrum planners and regulations staff with a facility to perform communications system studies by remote terminal. This facility was used to investigate system parameters; to select frequencies; and to investigate the effects of interference. Both the Canadian Broadcasting Corporation and the Canadian Forces Communication Command made use of the facility.

This year a pilot Northern Social Communications project was established to give special attention to the unique problems of northern communications, particularly among Canadian native people. By observing the use the native people made of a modern communications system, the project attempted to determine the effects such a system would have on them. CRC was responsible for all technical aspects of the project in the Keewatin District because of our expertise in HF communications and our continued interest in northern communications. Radio research was responsible for the design, selection, purchase and installation of an HF communication network between the northern communites of Baker Lake, Chesterfield Inlet, Eskimo Point, Whale Cove and Rankin Inlet; and for the installation of an FM broadcast station at Baker Lake.

SATELLITE COMMUNICATIONS SYSTEMS

Fiscal year 1972/73 saw the successful commissioning of the David Florida Laboratory as a national spacecraft assembly and test facility. With its completion, management responsibility was transferred from the CTS project to this directorate. The Laboratory will operate with CTS as the major user/client until 1976 but Canadian developments in space hardware have already been identified which will influence the future of the facility capability. Specifically, the possibility of the Laboratory providing special environmental test and assembly facilities to Canadian contractors working in the NASA 'Space Shuttle' Program was examined, briefings were given, and important contacts made.

On September 29, 1972, Alouette I, Canada's first satellite, passed its 10th year of useful life in space. The success of this satellite,ranked among the most complex of the era, was a key factor in establishing the Canadian credibility in space technology.

In late 1972 Dr. S. Bellier, an SCS scientist, reported on a series of experiments aimed at improving the reliability and shelf-life of a particular class of transistors. A patent claim was made specifically for a metallization process for planar transistors which would prevent the slow dissolution of silicon from the transistor into a metallic surface film of aluminum. The process sandwiched a layer of polysilicon thin enough to maintain all electrical characteristics, between the silicon transistor surface and the top metallization contact layer. Accelerated life-testing demonstrated that the yield of transistors, especially high-frequency units, could be considerably increased. This was one of the most significant recent advances in process reliability technology.

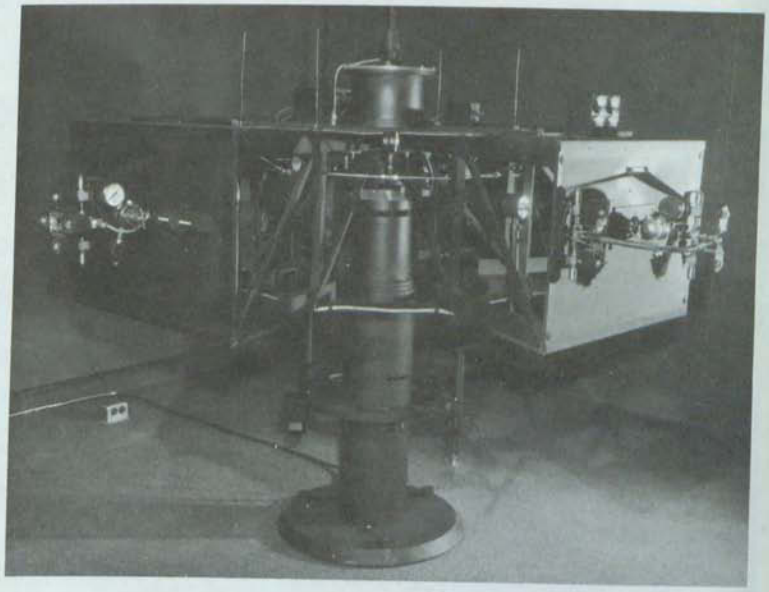
In the previous year, the mini-SEM (Scanning Electron Microscope) was designed and constructed 'in-house' at CRC. The design was seen to be commercially viable and scientists from the directorate have assisted in making the design technology available to Canadian industries through Canadian Patents and Development

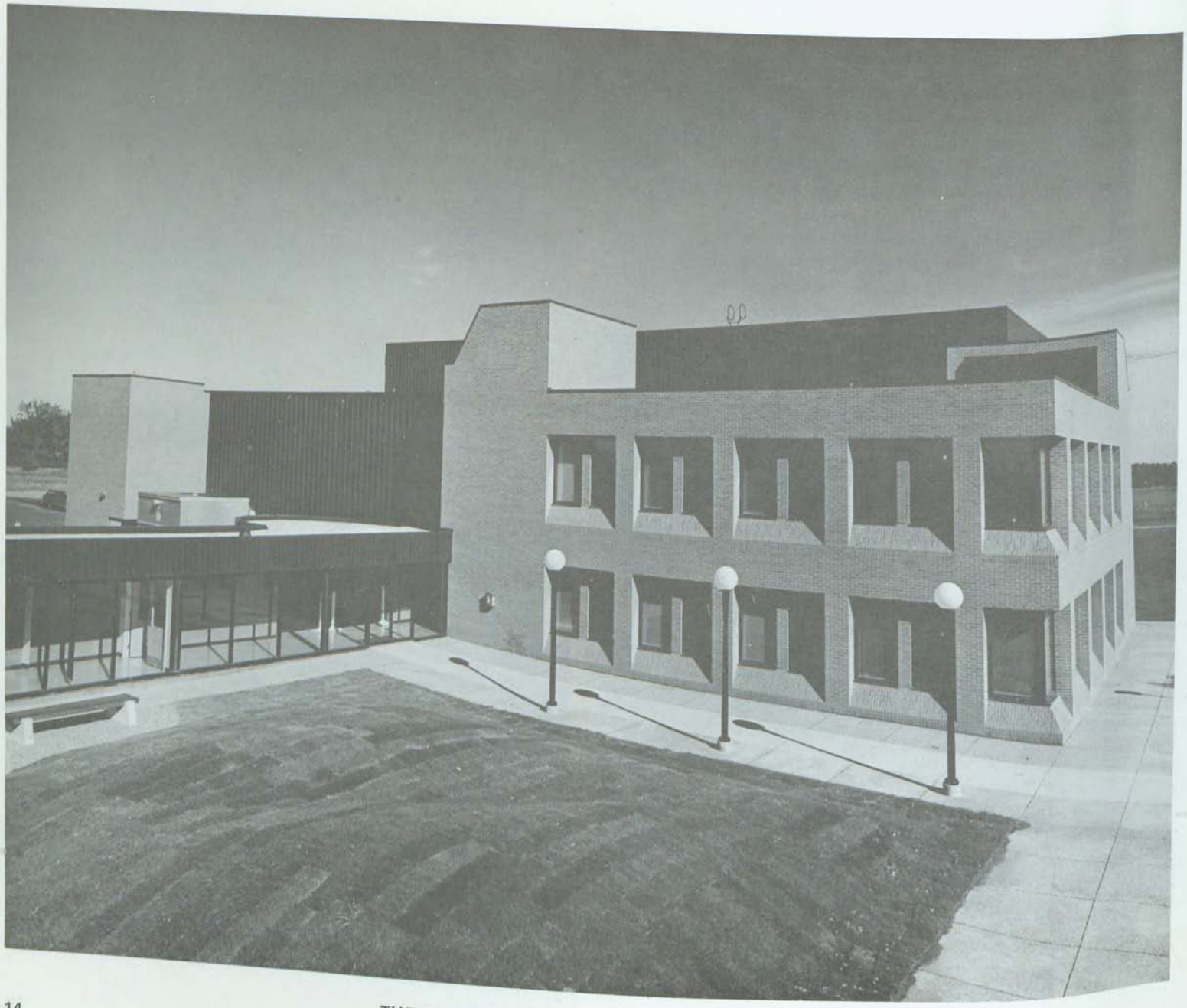
A prototype model of the Mini-SEM designed at CRC.

Limited (CP&DL). CP&DL have in turn licensed the technology to SEMCO Ltd., a Canadian controlled company, established to fabricate the SEM. Since the specialized knowledge cannot be transmitted solely by blueprints and reports, scientists and engineers were seconded to CP&DL to assist in the technology transfer to SEMCO Ltd.

The first phase of the Spacecraft Mechanics air-bearing technology program was completed in 1972 in the form of a hardware simulator that demonstrated the attitude control concept to be used for CTS. The WHECON (Wheel Control) concept employs stored momentum plus gyroscopic coupling of the roll and yaw axes to achieve three-axis attitude stabilization of a geostationary spacecraft using only two-axis attitude sensing. For the demonstration, an experimental platform is mounted on a spherical air bearing and is balanced about its three rotational axes. A telemetry link with a ground computer is employed to allow an information transfer to and from the platform without direct physical contact. The platform carries a momentum wheel as well as components representative of the attitude sensing and propulsion systems. The dynamic performance of the system, supported in a near frictionless manner in the 1-g environment of the laboratory, is similar to that of the orbiting spacecraft. A qualitative demonstration of the validity of the WHECON principle has taken place and the simulator hardware is being upgraded to provide a precise quantitative level of performance for comparison with computer simulations.

An experimental air-bearing platform employed for spacecraft attitude control studies.





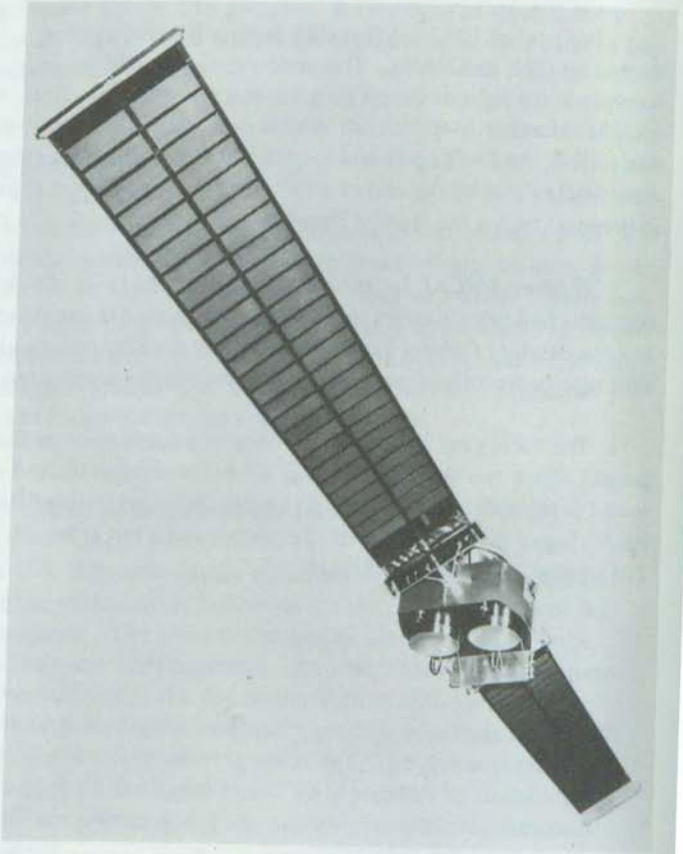
THE DAVID FLORIDA LABORATORY

COMMUNICATIONS TECHNOLOGY SATELLITE

The Department of Communications, in cooperation with the National Aeronautics and Space Administration, will launch a Communications Technology Satellite (CTS) in late 1975. The CTS is an experimental high-power satellite designed to produce advances in satellite communications technology in the 12 to 14 GHz frequency range. The Communications Research Centre of the Department of Communications is the design authority for this spacecraft. The main subsystem contracts are SPAR Aerospace of Toronto and RCAL of Montreal. SPAR will design, fabricate and test the spacecraft structure attitude control and solar array subsystems and RCAL will design, fabricate and test the SHF Transponder, tracking, telemetry, command and power conditioning subsystem. At the beginning of this fiscal year, a Memorandum of Understanding was signed between the European Space Research Organization and DOC, defining ESRO's participation in the program.

Phase C, the design phase, was completed this year. One of the milestones was the design and fabrication by SPAR of the Dynamic/Thermal Model Spacecraft. This model consists of a fully representative structure. Initially fitted with mass modules suitable for conducting the mechanical tests, the model was refurbished with modules to simulate the thermal environment. In September/October 1972 the Dynamics Model was tested at NASA Lewis Research Center in Cleveland and Goddard Space Flight Center in Washington in order to establish the adequacy of the

A model of the Communications Technology Satellite.



structural design. This model was then transformed into a Thermal Model which could simulate the heat dissipations representative of spacecraft conditions during launch, transfer orbit and mission operations in synchronous orbit. The thermal tests were completed in March 1973. They confirmed the thermal mathematical model of the spacecraft and opened the way for extrapolation from initial subsystem designs and spacecraft lay-out to final forms. Analysis of the test data permitted incorporation of thermal design changes before the start of Phase D, the manufacturing phase.

In October 1972 the first CTS Project Review was conducted by CRC and NASA. This review re-defined the project baseline in the light of design progress and mission constraints, with specific reference to the launch vehicle capability. As a result of this review, the Ion Engine and Liquid-Metal Slip-Ring experiments were deleted and by the end of 1972. the new baseline was approved in preparation for the start of Phase D.

SPAR and RCAL began Phase D in January 1973. By this time contracts had been placed for the Ground Control Station Antenna and the Satellite Control Equipment. A first meeting had also been held with prospective Canadian communications experimenters.

The fiscal year 1972-73 was a year of achievement on the CTS project which saw the translation of ideas into designs backed up by sound experimental data. Canadian spacecraft contractors SPAR and RCAL began the final phase of the project and a target launch date of 20 October 1975 was established.

ADMINISTRATION

Administrative Services

A decision was made to disband the on-site fire department. The equipment was sold to the Kanata Fire Department with whom we negotiated a contract for fire protection service and the nine fire-fighters were offered alternate employment in administrative positions on the site. A new garage was constructed and all transport operations were relocated there. Plans were finalized with the Government Telecommunications Agency and Bell Canada to convert our telephone system to an operation more closely integrated with the overall Government telephone system in Ottawa. The change-over date has been tentatively established as April 1975.

Plant Engineering

This year, the David Florida Laboratory was finished in record time through an arrangement with the Department of Public Works, who acted as general contractors. In order to accommodate the influx of contract personnel on the CTS project, 8000 square feet of temporary office accommodation was installed along with gravel parking areas. A Winter Works grant allowed the construction of a combined warehouse and garage. Antennas were erected at several test sites; a new site was developed at Ashton; and assistance was provided at Baker Lake and other points in the N.W.T. for the Community Antenna Program. Support for DREO was continued, particularly directed towards the renovations in Buildings 10 and 22 and the proposed extension to Building 6. During the fiscal year, more than 3725 work requests were processed and approximately 35 contracts were let for maintenance work and repairs.

Materiel Management

A manual Cross-Index File system was introduced to provide information concerning Purchase Contracts, types of service and materials ordered by DSS contracts, DSS Serial Nos., and CRC Requisition Nos. It is planned to add further information and place the system on the CRC computer by 1 April 1974. Special arrangements were made with the Regional Customs Officer to clarify tariff clearances and accelerate customs clearance for all shipments entering Canada for the CTS program. A catalogue of all stationery and office supplies in stock was completed and copies were printed for distribution.

Financial Services

A statement of CRC University Contracts was initiated and issued monthly to the Directors. A statement showing the breakdown by Directorate, of the 1973/74 Recovery program and the Targets for CRC 73/74 Budget were prepared. Next year's Operational Plan was completed and Budget Amounts Report Cards were forwarded to DOC HQ for insertion into the DSS Computer. The 1974/75 Financial Management Program Forecast was also prepared.

Research Publications and Documentation Services

The CRC Research Library continued to increase its holdings, expanding the subject areas to provide for the changing needs of the research programs. The Library acquired an additional 500 books, 250 periodicals and 500 documents. An IBM 2741 Communications terminal was installed in the documents section with access to the main CRC computer for the immediate purpose of setting up the CRC periodical list and testing other applications. The documentation resources supported the 'Open House' in September by designing and providing all the graphic arts works and photographic requirements for the displays.

Instrument Services

This year service traceability was established. All measurements made for CTS and other CRC projects will now be accepted by NASA and other authorities. The capability now exists to perform 'precision' measurements as a direct service to the laboratories.

Technical Services

A detailed half-scale model of CTS was built for Information Canada and has been used at the Paris Air Show, the P.E.I. Centennial in Charlottetown, and the IEEE convention in Toronto. The Scanning Electron Microscope Unit, now being manufactured commercially, was largely designed and built in the Model Shop. Prototype hardware for an antenna unit and a transmission mode sampler unit, consisting of a thin-walled corrugated-horn antenna with a light-weight sampler was also constructed by the shop craftsmen. Requests received by the Plating Laboratory to metallize teflon resulted in the development of methods and procedures to meet these requirements.

Guard House at main entrance to Shirley Bay Site provides for security, visitors' reception and traffic control.

Craftsmen at work in CRC Model Shop.

CONCLUSION

A shortage of laboratory and office accommodation constitutes the greatest single constraint on the activities of CRC. The growth in permanent employees has been relatively modest but contractual staff has increased greatly while there has been virtually no corresponding increase in physical facilities. CRC is now operating under inadequate space conditions and this factor will continue to cramp our response to the increased mandate that we have accepted.

It is evident that the 'buy', rather than 'make' policy in government research will allow only marginal increase in the Centre's manpower. Consequently, CRC must modify its present modus operandi and be prepared to manage more research extra-murally in industry and universities. Plans have been made to conduct an on-site training program for engineers and scientists at CRC on the management of contract research in order to develop the necessary skills and techniques in the professional staff. It is anticipated that this program will be closely integrated with the work of the new Science Procurement Division of the Department of Supply and Services.

During the past year, four inventions filed in previous years were patented and patent action has been commenced in respect of eight new inventions. A summary of these inventions is presented in Appendix D.

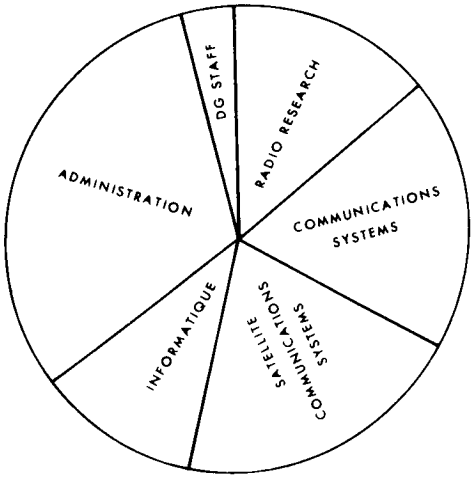
In closing, I would like to extend my thanks to all my colleagues at the Communications Research Centre and DOC Headquarters for their support and advice during the 1972/73 year.

APPENDIX A – CRC Operational Plan – Fiscal Year 1972/73

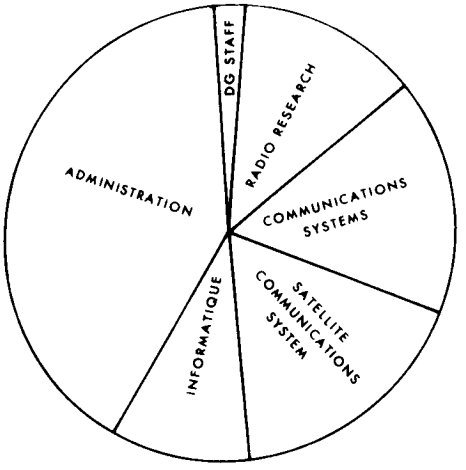
		Man Years	Salary	Goods & * Services	Capital	Total
Director General	Allocated	11	241.7	149.1	42.0	432.8
	Committed			143.0	88.8	473.5
	Expended			94.8	88.8	425.3
Director Radio Research	Allocated	72	919.5	624.8	136.8	1,681.1
	Committed			606.8	127.8	1,654.1
	Expended			556.2	125.7	1,601.4
Director Communications Systems	Allocated	88	1,153.7	598.6	250.0	2,002.3
	Committed			588.9	257.6	2,000.2
	Expended			504.3	234.5	1,892.5
Director Satellite Communications Systems	Allocated	75	775.5	839.7	430.5	2,045.7
	Committed			900.4	492.7	2,168.6
	Expended			805.9	469.7	2,051.1
Communications Technology Satellite	Allocated	25	494.0	365.0	11,969.0	12,828.0
	Committed			341.4	13,768.6	14,604.0
	Expended			321.2	11,862.3	12,677.5
Director Informatique	Allocated	50	690.5	552.0	107.5	1,350.0
	Committed			580.7	106.0	1,377.2
	Expended			542.9	102.5	1,335.9
Director Administration	Allocated	212	1,897.0	1,090.7	415.0	3,402.7
	Committed			2,083.0	621.7	4,601.7
	Expended			1,909.6	605.8	4,412.4
CRC Grand Totals	Allocated	533	6,171.9	4,219.9	13,350.8	23,742.6
	Committed			5,244.2	15,463.2	26,879.3
	Expended			4,734.9	13,489.3	24,396.1

* Includes recoverables from other departments

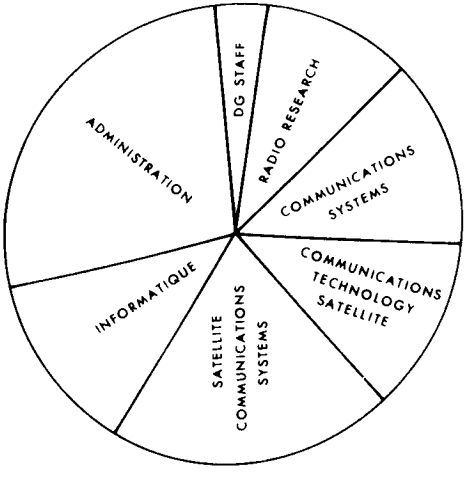
Distribution of Financial and Personnel Resources



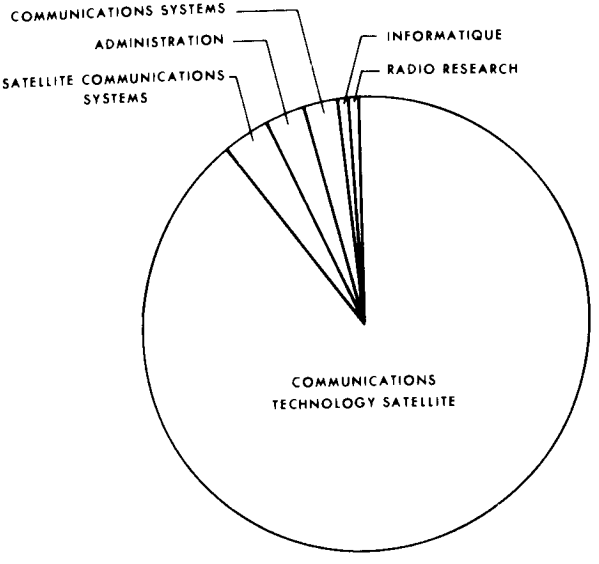
SALARIES



MAN YEARS



G&S



CAPITAL

APPENDIX B – CRC Programs with Other Departments

Program	Activity	Department
Military Program	Recoverable & supplementary funding (On going)	DND/DRB
Aerosat	CRC supervision of MOT contracts (Cooperative program under discussion)	MOT
HF Prediction Service	System for remote access to CRC computer	DND and other departments
Earth Resources Technology Satellite (ERTS)	Design and construction of Data Station for DOE (Completed)	DOE
Development of an Ice Thickness Radar	Cooperative program. DOE funding received	DOE (Water Management Branch)
Radiometric Detection of Forest Fires	CRC to monitor DOE contract with industry	DOE (Forest Fire Res. Inst.)
Radiometric Measurement of Salinity	At a discussion stage (CRC will probably monitor DOE contract)	DOE (Marine Sciences Branch)
Radiometric Measurement of Sea-Ice Thickness	CRC to monitor an MOT contract with industry	MOT (Air Services)
Light Aircraft Echoing Characteristics	DND funding. MOT cooperation in program	DND/MOT
Radio Noise & Signal Spectrum Characteristics	Cooperation (Future funding to be considered)	NRC
HF Propagation & Computer Programs	CRC assistance to users. DND funding	NRC
Radiating Cable Communications	Cooperative Program (CPS funding for G&S)	Canadian Penitentiary Service

Airborne Scatterometer & Processing System	Cooperative program with Canadian Centre for Remote Sensing (CCRS)	EM&R
Teleconferencing Research Program	Joint experimental program with Bureau of Staff Development & Training (BSDT)	Public Service Commission
Satellite Broadcasting Study	Participation in DOC/CBC study	CBC

APPENDIX C – Sponsored External R&D

To augment its own capabilities, CRC has contracts with outside bodies, mainly universities, for research and development in specialized fields. The contracts for fiscal year 1972-73 are listed below, by titles, in two categories:

(a) Contracts, approved by the Research Committee and funded by the Department;

- NETWORK SIMULATION
- PROGRAMMING SYSTEMS FOR THE UNSOPHISTICATED USER
- SPECIAL PURPOSE SIGNAL PROCESSING AND TRANSFORMATION SYSTEMS
- NETWORK PERFORMANCE MEASUREMENTS
- NETWORK STUDIES
- MODULATION PROPERTIES OF SOLID STATE MICROWAVE OSCILLATORS
- THIN DIELECTRIC FILMS
- THIN METALLIC FILMS
- RADIATION EFFECTS ON SILICON INSULATED GATE FIELD EFFECT TRANSISTOR (IGFET)
- DYNAMICS AND CONTROL OF FLEXIBLE COMMUNICATIONS SATELLITES
- APPLICATION OF INTERMEDIATE SPEED TERMINALS TO SCATTERED TEAM RESEARCH
- LARGE DEFLECTION THEORY FOR DIPOLE ANTENNAS ON SATELLITES
- STUDY ON DELTA MODULATION
- SEMICONDUCTOR DEVICES
- ANTENNAS IN THE IONOSPHERE
- CHARACTERISTICS OF TRAVELLING IONOSPHERIC DISTURBANCES
- VLF/LF PROPAGATION STUDIES
- DIGITAL IMAGE PROCESSING
- PROPAGATION IN OPTICAL FIBRES
- PROPAGATION IN BEAM WAVEGUIDES
- REDUNDANCY REMOVAL IN BINARY SOURCES
- DESIGN AND IMPLEMENTATION OF A PROGRAMMING SYSTEM FOR ARTIFICAL INTELLIGENCE APPLICATION
- DATA SYNTHESIS IN MACHINE INTELLIGENCE ASPECTS OF THE COMMUNICATIONS OF IMAGES

(b) Contracts, approved and funded by CRC but not processed by the Research Committee;

- OBSERVATION OF MF AND HF PROPAGATION
- MEASUREMENT AND ANALYSIS OF SURFACE PARAMETERS
- STUDY OF ACQUISITION , ATTITUDE CONTROL FOR COMMUNICATIONS SATELLITES
- DETECTION OF SIGNALS IN NOISE
- IMPLEMENTATION OF A DIGITAL MTI FILTER
- MICROWAVE PROPAGATION
- PROPAGATION STUDIES FOR SPECTRUM MANAGEMENT
- ATTITUDE DYNAMICS AND CONTROL
- HIGH FREQUENCY DIRECTION FINDING
- VLF/IF PROPAGATION STUDIES
- ION ENGINE THRUSTER TEST TANK

APPENDIX D – Patents

SUBJECT	INVENTOR (S)	COUNTRY
Inventions Patented		
1. HF COMMUNICATIONS CHANNEL	Hindson, W.D. Jull, G.W. Page, D.F.. Hatton, W.L. Stevens, E.E.	Canada 896,091 U.K. 1,200,360 U.S.A. 3,543,161
2. ANTI-CLUTTER PROCESSING RADAR RECEIVER	Smith, F.E. Cross, F.R.	Canada 895,019 U.S.A. 3,618,087
3. A HIGH EFFICIENCY DRIVER-STAGE FOR LIGHT EMITTING DIODE	Barry, J.N. Frayn, H.C.	Canada
4. CHANNEL SONDE FOR SHORT RANGE SKY WAVE COMMUNICATIONS	Stevens, E.E. Moss, G.E. Poaps, G.E.	Canada
Applications for patents		
1. A MICROWAVE PRESSURE MEASUREMENT METHOD	James, D.S. Bouchard, F.	
2. PREVENTION OF SILICON PITTING	Bellier, S.	
3. A METHOD OF MAKING SELECTIVE INTER-CONNECTION PATTERNS ON INTEGRATED CIRCUITS	Edwards, W.D.	
4. OPTICAL FIBRE WAVEGUIDE MANUFACTURING PROCESS	Watanabe, A.	
5. AN OPTICALLY TRIGGERED LASER DIODE FOR USE AS A REPEATER IN FIBRE OPTICS COMMUNICATIONS LINKS	Kawasaki, B.S. Watanabe, A.	
6. AN OPTICAL FOURIER TRANSFORMER WITHOUT A SPATIAL MODULATOR	Felstead, E.B.	
7. TELECONFERENCE TALKER IDENTIFIER SYSTEM	Billowes, C.A. Frayn, H.C. Tigges, W.	
8. TONE CALLING WITH SINGLE SIDEBAND RADIO EQUIPMENT	Hindson, W.D.	