Ministry of State
Science and Technology

Ministère d'Etat
Sciences et Technologie

FEDERAL SCIENCE PROGRAMS 1977/78

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Science and Technology Sciences et Technologie

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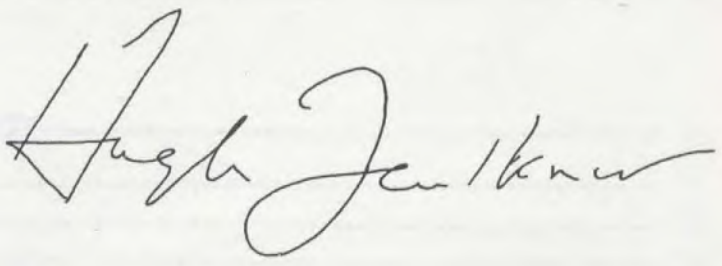
Foreword

This publication reports on the scientific and technological activities that will be undertaken in the 1977/78 fiscal year with federal government funds. It is the first time such a comprehensive account of future science programs has been published by the federal government, which plays a major role in the use of science and technology to achieve national goals.

The report adds to the information given in the 1977/78 Main Estimates. It covers all federal support for research and development and related scientific activities in the natural and human sciences. It shows how activities performed by the government are to be distributed and how the government supports science in the universities and industry. The report pays particular attention to the federal departments and agencies that provide 80% of all federal funds for scientific activities and emphasizes projects that will require particularly large resources or show a significant change of emphasis from previous years.

I believe this report will be of interest to tax payers and to members of the House of Commons and the Senate. It should also provide a base of information for analysing the federal government's spending on science and technology and for making decisions on scientific activities.

The Ministry of State for Science and Technology has a mandate to develop science and technology policy in Canada and to advise the government on resource allocation in these fields. This affords us a comprehensive overview of federal science programs. In preparing this report we have had the cooperation of all federal government departments and agencies that fund scientific activities, and I thank them for their assistance. We must particularly mention the Treasury Board Secretariat and Statistics Canada, without whose help the report would have been less up-to-date and complete.



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Chapter 1

Overview

The federal government through its policies and decisions has a significant impact on Canada's scientific progress. It is the principal source of funds for research and experimental development. Over the years, half of the national expenditures on R&D have originated in the federal government.

Federal expenditures on scientific activities are estimated to be $1,664 million in 1977/78. This represents an increase of 5.5% over forecast 1976/77 expenditures - the same increase as total federal spending*(budgetary plus non-budgetary). In the new fiscal year expenditures on science will account for 3.7% of federal government estimates, unchanged from last year. This is the first year since 1970/71 that science expenditures have not declined relative to the estimates as a whole.

Science activities are made up of research and experimental development (R&D) and related scientific activities (RSA). Expenditures on R&D will increase 8% to $1,078 million while expenditures on RSA will increase 1% to $586 million, including the cost of administering extramural programs (see Figure 1).

Some of the science and technology projects funded by the federal government are performed intramurally, that is, in federal laboratories, while others are conducted extramurally by other levels of government, universities, non-profit institutions, business enterprises, other private sector organizations and the foreign sector. Of the amount shown in Figure 2, $1,052 million or 63% are for intramural scientific activities while $612 million are to be performed extramurally.

Intramural current expenditures are $969 million. Increases in these expenditures will occur in the programs of almost all departments, with the exception of Statistics Canada, whose expenditures are to drop by $25 million as a result of the reduction of the work load associated with the 1976 quinquennial census. The major factor contributing to increases is the salary and wage component, despite the fact that the estimated man-years devoted to scientific activities will drop by 2.5% to 33,552 for 1977/78.

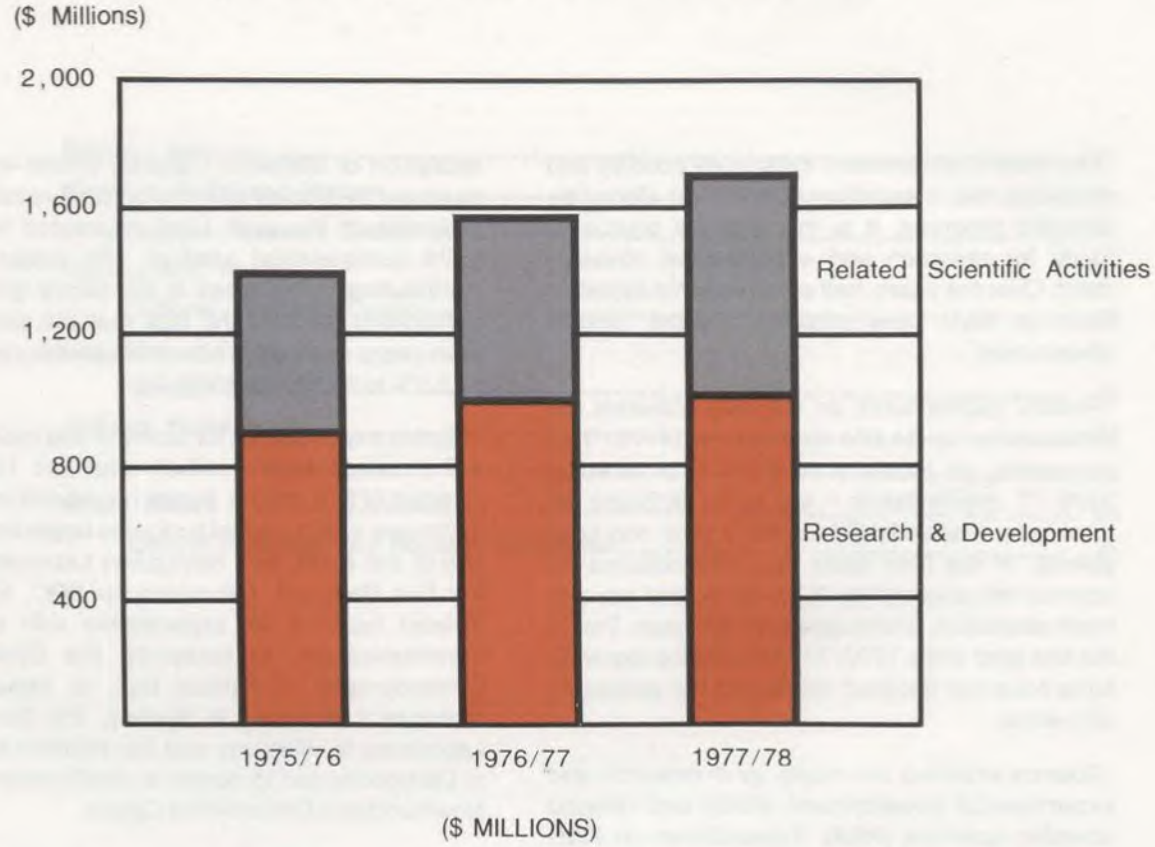
Capital expenditures for science and technology will increase by $5 million over the 1976/77 forecast of $78 million. Funds have been included in the new year's capital budget to begin construction of the Arctic Sea Navigation Laboratory and the Fire Research Laboratory at NRC, to lease Telesat facilities for experiments with satellite communication, to complete the Centre for Oceanography at Patricia Bay, to expand the Fisheries Laboratory in Sydney, the Bio-Assay Laboratory in Winnipeg and the Bedford Institute in Dartmouth and to continue construction of the Newfoundland Environment Centre.

Expenditures in the industrial sector will be $264 million, a reduction of $4 million from 1976/77. Two opposing trends are at work: R&D contracts under the contracting-out policy are to increase by 19% to $121 million, and grants are to decrease by 22% to $98 million. Cancellation of the Industrial Research and Development Incentive Act (IRDIA) administered by Industry, Trade and Commerce removed $30 million of grants of the IRDIA program in a single step. Exclusive of the IRDIA program, expenditures in industry will increase by 12%.

Payments to the university sector for science and technology activities are estimated at $229 million, which represents an increase of $26 million (13%) over 1976/77. The sum of grants and scholarships from the National Research Council, Medical Research Council and Canada

Federal Expenditures On Scientific Activities

By Activity, 1975/76 To 1977/78



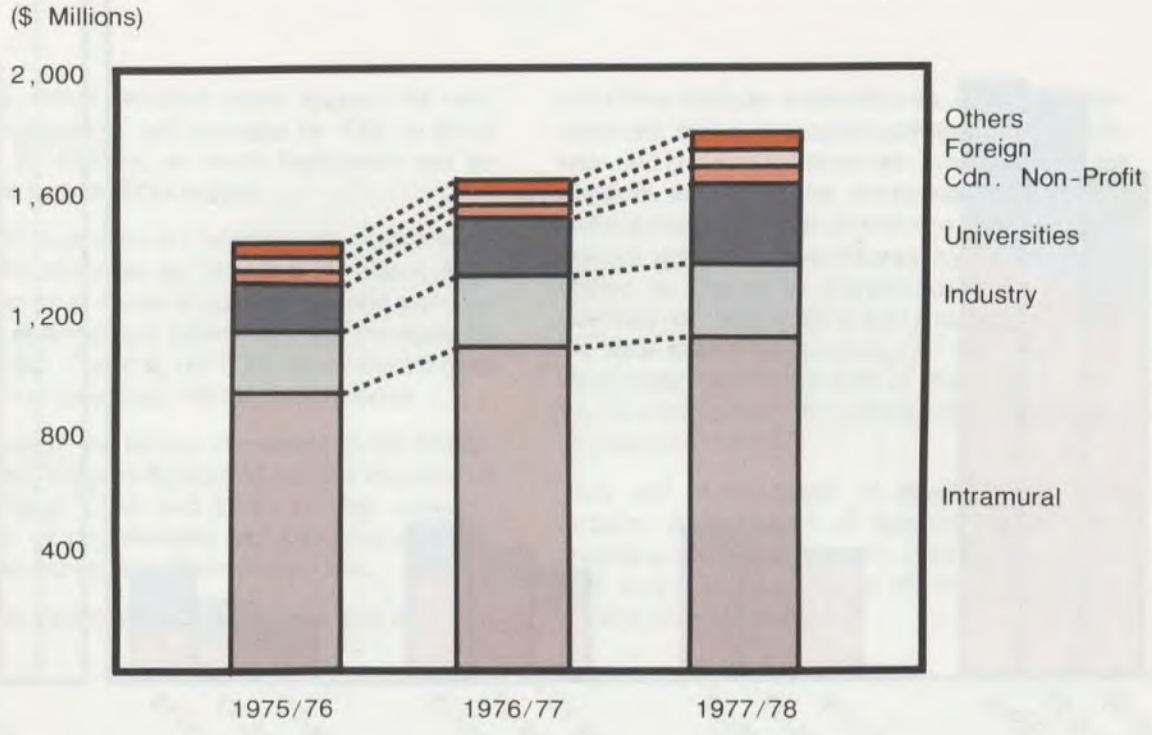
Activity*	1975/76		1976/77		1977/78	
	$	%	$	%	$	%
Research & Development	890	(65)	999	(63)	1,078	(65)
Related Scientific Activities	478	(35)	578	(37)	586	(35)
Total	**1,368**	**(100)**	**1,577**	**(100)**	**1,664**	**(100)**

* Includes administration of extramural programs.

FIGURE 1

Federal Expenditures On Scientific Activities

By Performer - 1975/76 To 1977/78

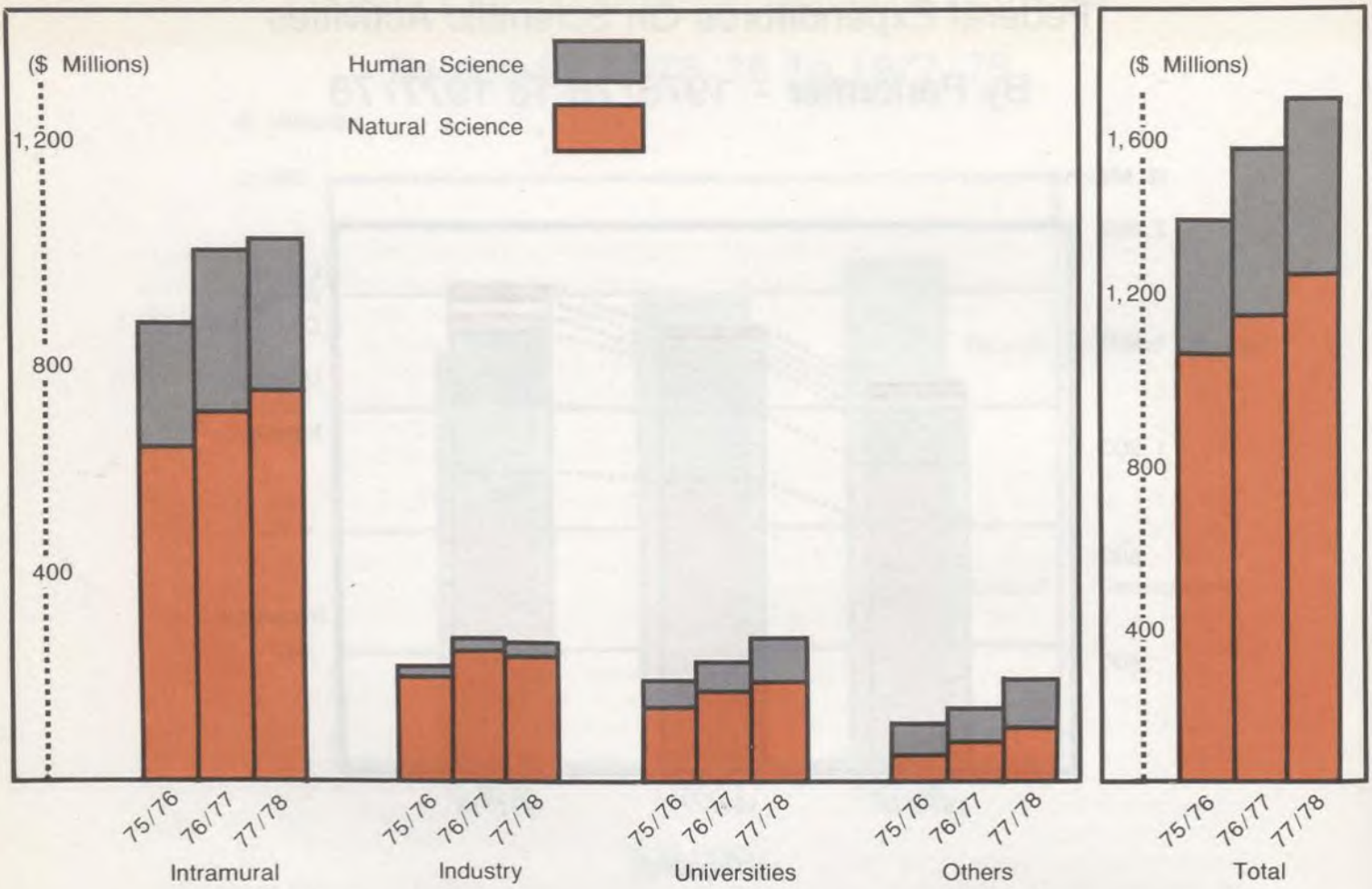


Performer	1975/1976		1976/1977		1977/1978	
	$	%	$	%	$	%
Intramural	876	(64)	1,006	(64)	1,052	(63)
Industry	215	(16)	268	(17)	264	(16)
University	188	(14)	203	(13)	229	(14)
Cdn. Non-Profit	13	(1)	19	(1)	15	(1)
Foreign	49	(3)	50	(3)	54	(3)
Others	27	(2)	32	(2)	50	(3)
Total	**1,368**	**(100)**	**1,577**	**(100)**	**1,664**	**(100)**

- Details do not necessarily add to totals due to rounding.

FIGURE 2

Natural And Human Science Expenditures By Performer



($ MILLIONS)

	Intramural	Industry	Universities	Others	TOTAL
Natural Science					
1975/76	648	203	152	46	1048
1976/77	704	249	164	51	1168
1977/78	761	243	183	59	1247
Human Science					
1975/76	227	12	36	43	320
1976/77	302	19	38	51	410
1977/78	290	20	46	60	417

FIGURE 3

Council, which includes some support for non-profit institutions, will increase by 12% to $185 million in 1977/78, of which Parliament will be asked to provide $181 million.

Federal payments to Canadian non-profit institutions will decrease by 18% to $15 million. Payments to other levels of government and individuals for science and technology will increase by 56% to $51 million in 1977/78. This includes over $12 million for energy R&D to the provinces.

The bulk of the federal payments to the foreign sector will support developing nations through the programs of CIDA and IDRC. Foreign expenditures by all departments and agencies are estimated to increase by 6% to $54 million.

Federal expenditures on scientific and technical activities include expenditures on the human sciences, that is, the social sciences and humanities, and the natural sciences, which include the physical, environmental, mathematical and engineering sciences. The distribution of natural and human science expenditures by performer is shown in Figure 3. Expenditures on human sciences are estimated at $417 million or 25% of the total estimated science and technology expenditures, down from 26% of the total in 1976/77, (due primarily to the reduction in expenditures by Statistics Canada).

The rest of this report is devoted to a more detailed examination of special policies and programs of the government, of extramural activities, and of the activities of the major funders of science and technology.

*Throughout this publication comparisons are made on the basis of 1976/77 forecast expenditures, not of 1976/77 estimates. Federal spending in 1977/78 will increase by 7% over 1976/77 estimates.

Special Policies and Programs

Energy

Energy is essential for our well-being, yet there is a growing gap between the demand and supply of Canada's energy. To fill the gap, Canada can import large quantities of oil; but this solution, if taken alone, threatens Canada's trade balance for years to come. Domestic efforts to increase supply, if taken alone, would require massive capital and real resources. The realistic course is a combination of both solutions while at the same time limiting demand by a substantial conservation effort.

Energy research and development is one critical factor in pursuit of this course.

The federal response has been to award increasing resources to energy research. An interdepartmental panel led by the Department of Energy, Mines & Resources was formed to coordinate this larger energy R&D program and will monitor and guide the expenditure of $138 million in 1977/78. This compares with the 1976/77 level of $128 million. Most of this increase will go for work on the renewable resources and on conservation.

These figures cover only direct energy R&D expenditures and therefore exclude participation in major commercial projects such as Syncrude. Also excluded are research expenditures for resource assessment, such as much of the work done by the Geological Survey of Canada, and research expenditures for environmental protection, such as studies on reducing sulphur emissions from thermal power stations.

The energy R&D field has been divided into five tasks. These tasks, and the percentage of total R&D funds they will receive in 1977/78, are conservation (9%), fossil fuel resources (11%), nuclear energy (68%), renewable energy resources (7%) and energy transportation and transmission systems (5%). The program proposed for 1977/78 devotes a smaller proportion of R&D funds to nuclear studies and larger shares for renewable resources and conservation studies than did the program for 1976/77.

The interdepartmental panel referred to previously recommends greater emphasis on R&D dedicated to solving long-term energy problems. However, the urgent need to carry out short-term research on renewable energy resources and the current spending restraint has resulted in little recent improvement in the short-term/long-term imbalance although efforts will be made to solve this in the future.

The energy conservation research program will include various elements designed to decrease demand as well as to promote new supplies and appropriate substitutes for scarce energy forms. Since the cost of saving a unit of energy is likely to be much less than the cost of producing an extra unit, research on ways to increase energy efficiency in industrial processes and reduce the large quantity of energy used in Canada to heat and cool buildings will be intensified. Research will also be done to improve automobile fuel economy and the energy efficiency of urban and inter-city transportation.

Fluid fuels require special consideration since they are essential to the transportation sector (which accounts for about a quarter of Canadian energy consumption). A number of new liquid fuel technologies will be emphasized, including enhanced recovery from conventional pools, the exploitation and processing of oil sands and heavy oils, and the liquefaction and gasification of coal. Improved mining techniques will be needed if coal is to be successfully taken from the unique, disturbed, underground deposits found in Western Canada, whether for conversion or as an unconverted energy source.

Nuclear fuels must be available for expanding

nuclear power generation. The most promising development is the recycling of spent fuel, first with uranium then with thorium, to extend existing resources many times. A complementary approach is to increase uranium reserves by improving exploration techniques and finding economically viable methods of extracting uranium from abundant low-grade ores. Programs aimed at harnessing nuclear fusion and at the spallation process have immense potential but are accorded lower priority because any commercial application is likely to occur well into the future.

Research on renewable energy includes: hydro, tidal and waves; solar radiation; agricultural and forestry biomass; wind; and geothermal heat. This research includes finding alternative methods of heating buildings after the available supplies of oil and natural gas run out. One example of renewable energy research supported by the federal government is the 200 kilowatt Darrieus-type vertical axis windmill on the Magdalen Islands. This prototype, which feeds into the islands' electric power system normally supplied by diesel generators, is one stage in the scale-up to units that may eventually deliver 1 megawatt. Several experiments, by government researchers and by the private sector under contract, are being done on solar heating in the Canadian environment. A new Renewable Energy Resource Branch in the Department of Energy, Mines & Resources has been established.

New distribution systems for oil, gas, coal and electricity require many years to complete; thus R&D on these systems must proceed simultaneously with the search for energy supplies. The federal government is undertaking R&D so as to be in a position to respond to proposals from the private sector that include new technology in land and marine delivery of frontier oil and gas.

Oceans

Canadians have always been interested in the oceans because of geography and our very long coastline. This interest has become more intense since we proclaimed jurisdiction over an economic zone extending 200 miles from the coast and since we saw the possibilities for development of oil, gas and other undersea mineral resources in areas such as the Beaufort Sea, the Labrador Sea and the Arctic islands. Total S&T expenditures on oceans and ice-covered or ice-infested waters will be over $45 million in 1977/78, an increase of 7% over 1976/77. Many departments and agencies will take part in these activities, with major roles for Environment, National Research Council, National Defence, Energy, Mines and Resources, and Transport.

Environment, through its Fisheries and Marine Service, is carrying out a variety of research and monitoring programs. One objective of this work is to ensure that when waste is dumped at sea, the impact on the marine environment is held to a minimum. Ocean pollution is also being studied at NRC, where research will be undertaken to establish analytical standards for ocean water so that the nature and source of non-standard impurities can be determined. Another major objective is to find ways to deal with oil spills in

cold, particularly ice-covered, waters. Studies of oil/ice interactions and oil spill containment should help to improve clean-up technology.

Environment's West Coast work on oceanography and hydrography will be consolidated this year in the new Institute of Ocean Sciences at Patricia Bay, B.C., built at a cost of $21 million. The transfer from temporary quarters in the Victoria area into the new main laboratory building is expected to be completed by the spring of 1978.

The National Research Council, together with Environment, is sponsoring further development of the Canadian Ocean Data System (CODS) by Hermes Electronics of Dartmouth, Nova Scotia. Phase I of this program, which started as an unsolicited proposal under the contracting-out policy, has been successfully completed at a cost of $2.5 million. Phase II will continue the development work and will evaluate the use of buoys for specific applications. It will require $1.4 million in 1977/78. Development of a drifting buoy has been added to the CODS program; it is in the final testing stages and is a part of Canada's commitment to the World Meteorological Organization/ Intergovernmental Oceanographic Commission's first global atmospheric research experimental program. A significant transfer of technology from government to industry has already taken place under this program during Phase I, and NRC participation in Phase II will enhance this process.

Ocean-related projects being carried out by National Defence are on underwater acoustics, on marine propulsion and on human effectiveness in high-pressure environments. This last program, while aimed primarily at increasing knowledge of the physiological and pathological effects of hydrodynamic pressures on divers, includes a large study of underwater clothing and equipment.

Energy, Mines and Resources has a major role in work related to the future development of offshore mineral resources. Transport continues its work on icebreaking, which will be important for the exploitation of these resources when they are located under arctic waters.

Food

The objective of food S&T is to provide Canadians with a nutritious, palatable diet at reasonable cost. The food sector is also a major exporter, and it helps to solve the technical problems of less developed countries. Federal science and technology activities play a major role - principally through the programs of Agriculture, Health and Welfare, Environment, the National Research Council and Industry, Trade and Commerce - in the development of better food products. Consumer and Corporate Affairs, through its regulatory responsibilities, also takes part in food S&T activities.

The Agriculture department has a major role in food production, food processing and human nutrition. It will spend well over $100 million on science activities in 1977/78. Specific projects include the development of new crop varieties to increase yields, the creation and development of

disease-resistant strains and of varieties with greater nutritional value, the improvement of traditional breeds of animals and the development of better techniques for preserving and storing fruit. In addition, the department is active in research intended to improve the protection and the management of environmental elements (land, water, air) that are essential to food production.

Within Environment, the Fisheries and Marine Service undertakes research to increase the production of fish for the table. In addition to research designed to strengthen stocks of indigenous species, such as lobster and Pacific salmon, the service is working to improve the nutritional value of fish. Future research will be directed toward aquaculture, including the husbandry of aquatic plants and animals. Since the quality of food and water can be harmed by pollutants, the department's environmental responsibilities are also important here. Environment's S&T activities related to food will be over $30 million in 1977/78.

One of Health and Welfare's responsibilities is to ensure that food is nutritious and safe for human consumption. The department does research on the safety of biological and chemical aids in food production, the use of additives in food preservation and processing, the availability of minerals and vitamins and the nutritional value of food proteins. They also ensure that drinking water is safe.

The National Research Council will devote $5 million to food-related S&T in 1977/78. This includes the further development of the use of legumes to meet the increasing demand for protein concentrates and to diversify agricultural production. In a related project, technology for processing high-protein field peas has been transferred from NRC to industry, and a $2 million plant has been built in Saskatoon. Another project, involving extensive laboratory and field studies of the life cycle of the marine alga Irish Moss, has established the technology for harvesting it commercially; the process is ready to be licensed to industry. Similar research is now under way at the Atlantic Regional Laboratory on dulse, another edible marine alga.

An interdepartmental study of food research has begun, chaired by the Ministry of State for Science and Technology. The main purposes of the study are to identify the long-term research needs, to establish priorities for food research that meet the objectives of the government's food policy, and to decide what government action is required to encourage such research. Federal departments and agencies actively taking part in the study include Agriculture, National Research Council, Health and Welfare, Environment, Consumer and Corporate Affairs, Industry, Trade and Commerce, Finance, the Treasury Board Secretariat, the Privy Council Office and the Science Council.

Transportation

Transportation plays a vital role in a country as vast and thinly populated as Canada. The S&T activities include social and economic research into our future transportation needs as well as technological development.

Because of the diversity of problems a number of departments will combine to spend over $64 million in 1977/78, about the same as the previous year. A third of this will be spent outside the government. The major funders include Transport, National Research Council, Environment, Urban Affairs and Energy, Mines and Resources.

In addition, Industry, Trade and Commerce, whose objective is industrial development, has also supported transportation R&D such as the Short Take-Off and Landing aircraft (STOL), the Light Rapid Comfortable Train and the Voyageur Air Cushion Vehicle. These developments should make a significant contribution to the transportation system.

Transport's role includes not only S&T activities directed at operational improvements but also research into urban and inter-urban systems. Transport's expenditures on S&T will be over $25 million in 1977/78.

Transport is putting significantly greater effort into transportation which uses energy more efficiently, emphasising factors unique to Canada such as transportation in cold and ecologically delicate conditions. The department is making technical and economic studies of pipelines, tankers for oil and natural gas, and the transport of coal by rail.

The Montreal/Ottawa STOL demonstration known commercially as Airtransit was terminated on April 30, 1976, but data on its operational feasibility, passenger acceptance, community reaction, and some aspects of economic viability are still being evaluated.

The Canadian Organization for the Simplification of Trade Procedures, known as COSTPRO, aims to improve domestic and international trade and transport procedures through the innovative use of systems and computers. It is partially funded by Transport.

The National Research Council has traditionally provided major R&D facilities for use by government agencies and the private sector, such as wind tunnel and rail test facilities. The research program of NRC includes improved switch technology for winter operation, aerodynamics of low-speed transit vehicles on elevated guideways, improved automatic gear oils, extensive testing of ship hulls for Arctic applications, design of docks and canals, studies of vertical and short take-off and landing aircraft, and testing of air cushion vehicles for transportation over muskeg. Expenditures are forecast to increase to $12 million.

Environment's estimated expenditures on S&T activities in support of transportation are over $17 million. The major departmental activity is the provision of hydrographic services. In anticipation of increased tanker traffic along the northern British Columbian coast and into the Strait of Juan de Fuca, the department is continuing its Pacific coast surveys. Western Arctic surveys are also being continued. Laser bathymetry, through-the-ice sounding techniques and aerial hydrography are three major technical developments in progress. The department also collects, analyses and distributes data for weather and ice predictions to aid marine, air, and ground transportation.

Urban Affairs defines standards for urban transportation services and sets priorities for the allocation of funds to urban transport. Urban Affairs also studies integrated utility and transport corridors and makes cost/benefit analyses of transit systems.

Space

Canada's space program emphasizes the practical, seeking to use space technology to provide better or cheaper national services, particularly in communications, meteorology and remote sensing. There are operational programs to maintain services already in place and experimental programs to develop new ones. Total expenditures on federal S&T activities related to space will be about $64 million in 1977/78. Several departments and agencies are involved in space programs, the main ones being Communications, Energy, Mines and Resources, Environment, National Defence; the National Research Council and Transport. Canadian industry takes a significant part in the program by providing high technology products and services.

Communications will use the 12/14 gHz transponder in the new Telesat ANIK-B satellite (to be launched by NASA in 1978) to develop this frequency for satellite communications, particularly for northern communities. Successful development of high-power communications will reduce overcrowding in existing systems, allow more freedom in siting small earth stations and help to exploit Canadian industrial capability. The transponder will be leased for three years at a cost of $34 million, a quarter of which will be committed in 1977/78. This will be used for communications systems experiments such as tele-education and tele-medicine now using Hermes, Canada's communications technology satellite launched in January 1976.

Another major program, in cooperation with NASA and the European Space Agency, is the aeronautical satellite system (AEROSAT). The system will eventually use two satellites for aircraft communications over the North Atlantic. Meanwhile an extensive experimental program is being conducted with the U.S. satellite ATS-6 and Transport Jetstar aircraft. Studies of ultra-high-frequency antenna designs have been carried to the point at which Canadian firms can develop the hardware. Canada is represented in the AEROSAT Council by members from Transport, External Affairs and Communications.

Canada is also participating in an experimental satellite system called Symphonie, developed by France and the Federal Republic of West Germany. In cooperation with Teleglobe Canada, Communications manages Canadian experiments on the Symphonie system, thus enabling groups in Canada to exchange information with similar groups in France and Germany.

Environment's ground stations routinely collect information for weather forecasting, using three U.S. space systems (NOAA, NIMBUS-6 and TIROS-N). An example of the use of satellite imagery for resource assessment is the Large Area Crop Inventory Experiment. Agriculture and Energy, Mines and Resources' Canada Centre for Remote Sensing (CCRS) use the new American LANDSAT-2 satellite for rapidly assessing the ever changing acreage and health of crops worldwide. Clearly the method could be used for planning in cases of crisis and for marketing. LANDSAT imagery is also used by Environment, through CCRS, to help ships navigate through ice, to help fight forest fires, to make hydrological maps and to assess environmental pollution.

Canada makes a unique contribution to the NASA Space Shuttle with the design and manufacture of the remote manipulator system that will be used to transfer satellites from the bay of the Shuttle to space.

Contracting-Out

It is the government's objective to have Canadian industry take as large a part as possible in meeting the departments' science and technology requirements. This is intended to broaden scientific support for government programs, to stimulate the economy by encouraging innovation and to strengthen the science and technology base in Canadian industry. The government's policy of contracting-out is part of its strategy for achieving these goals.

This policy was introduced in 1973. It provided that wherever possible, new departmental requirements for research and development in the natural sciences were to be contracted out to Canadian industry. In 1976 the policy was expanded: it now covers ongoing R&D and related science activities in the natural sciences and in the human science fields of urban, regional and transportation studies.

The Ministry of State for Science and Technology is responsible for formulating and evaluating the policy on contracting-out; each operating department is responsible for using the policy to meet its science and technology requirements as effectively as possible; and Supply and Services is responsible for contracting.

One important feature of the policy, introduced in 1974, is a mechanism for handling unsolicited science and technology proposals from the private sector, which has received widespread support from industry. It permits the government to act promptly on sound, unique proposals which will contribute to departmental missions. A fund managed by Supply & Services finances the work until the sponsoring departments can obtain funds through the normal budget process. Total expenditures since the inception of the Unsolicited Proposals Program exceed $18 million. Up to $12 million will be available for this purpose in 1977/78.

Expenditures through R&D contracts with industry were $75 million in 1975/76, and are forecast to exceed $100 million in 1976/77. The estimate for 1977/78 is $121 million.

Many small, innovative and expanding Canadian companies have taken part in the contracting-out program. Among the larger research contracts handled recently are SPAR Aerospace Products of Toronto, on behalf of the National Research Council, for the development of a remote manipulator system for NASA's space shuttle program; MacDonald Dettwiler and Associates of Vancouver, on behalf of Energy, Mines and Resources, for the development of a new satellite receiving station; and Hermes Electronics of Dartmouth, N.S., on behalf of Environment, for the development of an Ocean Data Buoy System.

Chapter 3

Extramural Support

The federal government plays a major role in the support of scientific and related activities in Canadian industry, universities and provinces, as well as internationally.

Industrial

The principal support to industrial research and development is through a variety of special programs administered by Industry, Trade and Commerce, the National Research Council and others.

Several of the development incentive programs of Industry, Trade and Commerce are being consolidated into one program, the Enterprise Development Program (EDP). The Innovation Assistance component of the program replaces the Program for the Advancement of Industrial Technology (PAIT), the Program to Enhance Productivity (PEP) and the Industrial Design Assistance Program (IDAP). It will provide financial support for product development, pre-production design and engineering, productivity studies and studies to determine market feasibility and strategies. The EDP will normally finance up to 50% of the eligible costs of specific innovation projects. The program will assist firms when the project appears commercially viable and represents a significant burden on the firm's resources. There is a provision for up to $26.7 million for the Enterprise Development Program in 1977/78.

Industry, Trade and Commerce also has an Industrial Energy Conservation Research and Development Program which will provide assistance for R&D aimed at new energy-conserving technologies. $1.5 million has been included for it in the 1977/78 Estimates.

A good example of the kind of assistance that ITC's support programs provide is the case of a leading Canadian supplier of business machines who, until 1971, was basically a manufacturer of electro-mechanical cash registers for the Canadian market. As a consequence of PAIT support for two projects, the company's R&D operations have been greatly expanded and the Canadian company is now its parent's sole source of 'read-capture-proof' cheque-handling equipment for all world markets. Sales of this equipment are expected to amount to many times the federal contribution of $8.3 million. Over 85% of the sales to date are to the U.S. and another 8% has gone to other markets abroad. Employment in Canada attributable to these projects exceeds 900 jobs, including over 150 in R&D.

The Defence Industry Productivity Program (DIP) provides assistance to firms for the purpose of developing and sustaining the technological capability of the Canadian defence industry as a means of generating economically viable defence exports and related civil exports. It helps to finance selected R&D projects, the acquisition of modern machine tools required for plant modernization, and the establishment of production capacity and qualified sources for the production and export of component parts and materials. The costs of these projects are shared by Industry, Trade and Commerce, the Canadian firm concerned and, at times, the governments of other NATO countries. Federal spending on this program is estimated to be $44.2 million for 1977/78.

The Industrial Research and Development Incentives Act has now been terminated but there will be an expenditure of about $15 million in 1977/78 to meet outstanding commitments, down $30 million from 1976/77.

The Industrial Research Assistance Program, funded by grants from the National Research Council, is intended primarily for applied research and development up to, but not including, preproduction engineering. Support is concentrated on long-term applied research through the establishment of new industrial research teams or the expansion of existing groups. This program alone supports about 10% of the scientists engaged in R&D in the manufacturing industries. The estimated level of funding for 1977/78 will be $16.6 million, up 9% from 1976/77.

NRC also administers the Pilot Industry-Laboratory Program (PILP) to accelerate the transfer of technology to industry by contracting out parts of NRC research programs. Canadian industry will do research costing $5.4 million under this program in 1977/78 ($2.7 million in 1976/77), on such projects as thin film technology, purification of effluent from tar sands treatment plants by spherical agglomeration and development of photogrammetric plotting instruments.

The transfer of nuclear technology to Canadian industry and the development of the industrial base for nuclear power are vital parts of the program of Atomic Energy of Canada Limited. During the 1977/78 fiscal year, R&D contracts totalling over $6 million are expected to be placed with Canadian companies. As part of the consulting services provided by AECL for the construction of nuclear power stations, contracts worth more than $7 million are expected to be awarded to firms for engineering, design and technical services. An important feature is that AECL technical staff will directly supervise these industrial contracts, and about 60 professionals from Canadian industry and power utilities will be attached to AECL. As a result of these programs, industry has been able to take on an increasing share of the more sophisticated engineering and applied development work.

Canadian industrial effort in the nuclear energy field has grown from $67 million in 1965 to $536 million in 1975. A significant result of this growth is that the Canadian content of components in the steam supply systems of our nuclear power plants is 75% and still rising.

To meet national standards for effluent control, the Canadian pulp and paper industry will have to spend up to $1 billion over the next ten years to install pollution control equipment. To develop cheaper and more effective methods of dealing with water and air pollution in the industry, a cooperative government-industry program of research, funded at $1.5 million a year, is administered by the Canadian Forestry Service of Environment and guided by a joint government-industry committee. Over 130 research projects have been supported by this Cooperative Pollution Abatement Research (CPAR) program. Typical are projects aimed at reducing the effluents from pulp bleacheries, identifying sources of fish toxicity, taste and odour, developing new techniques for reducing toxicity and dealing with the problem of suspended solids in pulp mill effluents.

Environment's Development and Demonstration of Pollution Abatement Technology (DPAT) program shares the cost of needed technology developed and demonstrated by industry. The present departmental allotment for DPAT funding is $2 million.

Other government agencies have limited programs in support of science and technology in industry. An example is the Communications space industry support program of $1 million in 1977/78.

University

The federal government provides the principal support to Canadian universities for scientific activities through a variety of special programs administered by the three research councils and other departments and agencies.

The granting programs of the three councils (National Research Council, Medical Research Council and Canada Council), whose expenditures in 1977/78 (exclusive of support of the Tri-University Meson Facility at the University of British Columbia) will be about $185 million, ($20 million more than in 1976/77), are to be restructured through legislation introduced in Parliament in December 1976. The granting function of the National Research Council is to be transferred to a new council, to be called the Natural Sciences and Engineering Research Council. This will enable the NRC to focus on the management of its laboratories. The granting program of the Canada Council in the area of the social sciences and humanities is to be transferred to a new council, to be called the Social Sciences and Humanities Research Council. This will enable the Canada Council to devote its full attention to the support of the arts. The creation of the two new granting councils will require little increase in administrative costs since the same personnel and office space will be used as at present.

An Inter-Council Coordinating Committee, under the chairmanship of the Secretary of MOSST and reporting to the Minister of State for Science and Technology, will coordinate the councils' granting policies.

The new Natural Sciences and Engineering Research Council's program of scholarships and grants will amount to $98 million in 1977/78, to support research and provide highly qualified manpower in the natural sciences and engineering, mainly, but not exclusively, at universities. It is estimated that $75 million of this will go to universities as peer adjudicated grants, which are awarded to selected individuals and groups for research expenses and equipment costs. Developmental grants of $9 million will go to individuals, groups and institutions for major research installations, research programs and special projects and for regional development of research capability to meet needs related to scientific, economic and resource development. The Highly Qualified Manpower Training and Development Program ($12 million in 1977/78) awards scholarships and fellowships in national competition to scientists and engineers for advanced study or research and professional development, tenable at universities, industrial firms and other institutions in Canada.

The Medical Research Council supports R&D in the faculties of medicine, dentistry and pharmacy in Canadian universities and affiliated institutions. The major part (75%) of its estimated $57 million expenditures for 1977/78 is for grants in aid of research. Direct personnel support including studentships, fellowships, scholarships and associateships will take another 20% and special purpose operating grants will receive the balance. These latter grants include the financing of Medical Research Council groups for research in especially productive areas, development grants to assist universities in recruiting highly qualified full-time investigators in areas needing development, visiting professorships and support for scientific symposia.

The new Social Sciences and Humanities Research Council will support the development of research skills in the humanities and social sciences through competitive doctoral fellowships, assistance to research through fellowships and grants for research projects and publications, exchanges and meetings, research collections,

etc. These expenditures for 1977/78 are estimated to be $30 million, making this new council the major source of funding for human sciences in Canadian universities.

In addition to these major university support programs, federal agencies and departments will support their own mission-oriented work in Canadian universities. Agriculture, for example, will provide $3.4 million in university support in 1977/78. Environment will spend $5.4 million, National Health and Welfare will spend $13 million for health care and $2.4 million for health protection in the university sector in 1977/78. Total payments by all federal departments and agencies to Canadian universities for S&T activities will be $229 million.

The federal government also provides an estimated $15 million support for a number of Canadian non-profit institutions. One of these is the Institute for Research on Public Policy, with whom the Privy Council Office has contracted for a program of futures research to identify and interpret trends in Canadian society. The institute will receive a sum of $1.4 million over a four-year period, including a payment of $0.5 million in 1977/78. The institute will receive a further $1 million in 1977/78 to match contributions from the private sector.

Federal-Provincial

In recent years, governments have become increasingly aware of the contributions science and technology could make to social and economic development. This has induced a number of intergovernmental agreements for the funding of research and related activities. In the fiscal year 1977/78, the federal government is expected to increase its contributions to such programs.

In the energy sector, the federal government is jointly funding with Alberta the Canada-Alberta Agreement on the Alberta Oil Sands Environmental Research Program, the Canadian Energy Research Institute at the University of Calgary and the new Canada-Alberta energy R&D program. EMR also has agreed to contribute to the Canada-Saskatchewan program for developing heavy oil recovery technology and to the Canada-New Brunswick-Nova Scotia studies on the feasibility of Bay of Fundy tidal power. Support of these and other studies totals more than $12 million. The federal government is also providing funds for a renewable energy demonstration program on Prince Edward Island.

Federal departments and agencies will provide support to provinces and municipalities for non-renewable resources evaluation programs, aeromagnetic surveys, terrain studies, environmental assessment studies, forest resources research, basin management studies, guaranteed income experimental projects and R&D projects in urban transportation and urban renewal. One demonstration project is the Ark on Prince Edward Island, a closed conservation system where the entire food-production chain from fish pond to greenhouse, as well as recycling facilities and residential quarters, are all under one roof. Solar collectors and windmills supply the power.

The provinces will also receive federal contributions toward the capital costs of training and

research facilities in health and veterinary sciences; for innovative projects in areas such as family courts, the delivery of social services and manpower training and for the development and adaptation of new agricultural crops and varieties for commercial production.

International

The Canadian government will spend $54 million on scientific activities outside the country in 1977/78. The purpose of these expenditures is both to take advantage of advances elsewhere and to contribute to the development of less privileged countries. In the latter category, the Canadian International Development Agency will spend $20 million to support international scientific activities both directly and through the United Nations and other agencies. The International Development Research Centre will also provide $20 million for science activities on the problems of the developing regions of the world.

To avoid duplication and to assist in directing its own efforts into the areas of highest return, the federal government collaborates with other countries and with various international agencies. Bilateral cooperative arrangements in science and technology have been established with France, Belgium, the Federal Republic of Germany, the U.S.S.R, the People's Republic of China and Japan. Of even more importance is our traditionally informal but very extensive cooperation with the U.S. and the U.K., frequently at an agency-to-agency or even scientist-to-scientist level.

To assist in these information-gathering and cooperative activities, Canada maintains a small network of science counsellors attached to our embassies in France, Belgium, West Germany, Japan, Britain and the United States.

Canada takes part in science-oriented programs with a number of international organizations, among them the North Atlantic Treaty Organization, the Organization for Economic Cooperation and Development, the various specialist agencies of the United Nations, the Commonwealth Scientific Council and the International Institute of Applied Systems Analysis.

Most of this international effort is delegated at the working level to the science and technology based departments and agencies. The National Research Council will spend $2 million abroad to support their engineering and natural sciences research program and $1.6 million abroad in the scholarships and grants program. The Medical Research Council will spend $2.5 million abroad in the fiscal year 1977/78. National Defence is estimating expenditures of $2 million on international scientific activities related to defence.

A good example of these international programs is to be found in Agriculture, which is helping some countries to increase their own ability to produce food. The department expects to have seven scientists on overseas assignments in 1977/78. The department has contributed to research in dryland India, plant breeding in Kenya, cereal crop management in Tanzania and pest control and potato breeding in South America.

Chapter 4

Major Funders of Science & Technology

Agriculture

The agriculture industry, the vital source of most of our food, accounts for some 3.4% of Canada's Gross Domestic Product. Moreover, agriculture is a major exporting industry - wheat accounted for over 6% of Canada's merchandise exports in 1975, and in 1976 food, feeds, beverages and tobacco contributed a surplus of $1.3 billion to our international balance of payments.

Rising labour and energy costs have made agriculture increasingly dependent on technology. This, combined with Canada's size, wide range of climatic and soil conditions and correspondingly wide range of agricultural crops and animals, makes it essential to coordinate research effectively.

In 1977/78, Agriculture will spend $119 million - 18% of the departmental budget - on S&T activities. This represents an increase of 8.5% over the estimated 1976/77 expenditures. As in previous years, the Research Branch will perform most of the department's research studies. Its entire budget will be spent in support of scientific activities. The Administration (Economics), Production and Marketing, and Health of Animals Branches and the Canadian Grains Commission will fund more modest S&T programs.

The 1977/78 expenditures of the Research Branch will be $107 million, an increase of 8.4% over the forecast expenditure for the current year. Personnel costs will increase by $8.7 million. Expenditures for the construction of facilities and the acquisition of major items of equipment will decrease by $3 million, largely because the $25 million office-laboratory building at the Lethbridge Research Station was completed in 1976/77. The building is being shared by the federal and provincial governments. Major capital expenditures in the new year will be for the $17 million office-laboratory complex at Kentville, N.S., and the plant growth building at Saskatoon.

The Research Branch will support a number of expanded research programs. One is aimed at the economical conversion of cellulose and carbohydrate waste materials to feed-stock for ruminants and other animal species; others are concerned with the extraction and processing of proteins derived from plants, models for predicting crop production on the basis of soil and weather information and remotely sensed light reflectance from crop canopies, and a combined cultural and chemical control system for wild oats. Approximately $800,000 of contract funds have been allocated for the expansion of these programs.

The branch will continue its central core of food-related research programs intended to improve the genetic characteristics of crops and livestock. One by-product of such studies is that branch scientists have developed techniques for sexing and for the successful transfer of cattle embryos. These techniques will increase the international exchange of superior gene pools. Continued research into the causes of early pregnancy failure, the mechanisms of transmission of diseases which reduce reproductive efficiency, and the artificial control of the female estrous cycle may lead to further improvements in the productivity of the Canadian breeding stock.

There will be a modest increase in the resources devoted to research programs that tackle energy and environmental problems. The emphasis of energy research will be on the energy efficiency of agricultural production systems and the conversion of animal wastes to useable energy forms. The environmental program will continue to emphasise research into the use of biotic agents for controlling agricultural pests and studies of the

nature and effect of toxicants arising from infestations, additives, chemical control agents or inadvertant contamination.

The federal government, in cooperation with the various provincial governments, supports an active soil survey program, to which the Research Branch contributes $3.5 million per year. Surveys have shown that the land available for agriculture and food production is limited. Only about 5% of our total land area, or about 120 million acres is improved farmland and it is estimated that no more than 40 million acres of land, most of it marginal, remains to be brought into use. This has given added impetus to land use research. In the new year the branch will give priority to improved evaluation methods and criteria concerning land productivity, and to the collection, collation, and manipulation of field data relating to crop yield, soil properties, economic inputs, climatic parameters and other aspects of land productivity.

The Economic Branch will expand its S&T program in the areas of production economics, new technologies and management systems for farm use, appraisal of agricultural research resources, and energy modelling and monitoring of the agricultural system. The Production and Marketing Branch will continue its contribution of $1 million to producer and industry groups, universities and provincial agencies for the development and adaptation of new agricultural crops and varieties for commercial production. The Health of Animals Branch will intensify its research efforts on diagnostic procedures for animal diseases, the development of wildlife rabies vaccine and studies of the prevention of diseases in high density cow-calf operations.

Agricultural research in Canada is conducted through a network of federal, provincial, university and industrial organizations. About 50% of the work is performed in federal laboratories. Agriculture, as the focus of this federal involvement, has played an active role in developing the research infrastructure and in establishing cooperative research programs. The department is represented on the several committees that are engaged in the planning, financing and co-ordinating of the national research effort. Through its research agreement program, the department awards about $1.3 million a year to scientists at Canadian universities. It will contribute $2 million in 1977/78 to the provinces for the expansion of veterinary science teaching facilities at the Universities of Guelph, Montreal and Saskatchewan. The department has contracted out some of its research in engineering, reproductive physiology, intensive swine production, whey utilization and meat research. The funding of the program has increased sixfold over the last three fiscal years, and contracts awarded in 1977/78 are expected to exceed $3 million.

Communications

The science and technology activities of Communications are carried out in both the Research Sector and the Space Sector and will involve the expenditure of about $31 million in 1977/78, 36% of the department's total budget and an increase of 16% over 1976/77.

The research sector is engaged in a variety of scientific and technological programs of mission-oriented basic and applied research to advance the state of communications and computer communications.

The remote communications program aims to strengthen communication links among communities in the north and between people in the north and the south. Current research includes an overall study of intra and inter-community communications needs, development of a reliable telecommunications system integrating HF radio telephone into community satellite terminals or automatic exchanges, and an investigation of the use of high power beams of radio energy to create regions of dense ionization in the ionosphere for more reliable HF/VHF reception. Another project is the development of small, easily operated systems that people in remote areas can use to keep in touch with their base communities. A prototype is currently being field-tested at Koartak in Northern Quebec.

Canadian rural communications networks are not of the same high standard as the urban systems. A high priority program is aimed at rectifying this situation. Activities include studies of current needs and technical options, with particular emphasis on radio and fibre optic systems, and the identification of opportunities for the government to stimulate industrial electronics development.

Another R&D activity is concentrated on urban systems studies, broadband and data communications, mobile radio data systems and image communications.

A major responsibility of the research program is to advise the department on the use of the radio frequency spectrum and to assist other departments and agencies in making communications systems decisions. The major objectives are to develop computer systems for predicting communication systems performance in the VHF and UHF bands, to study radio interference and noise in the HF, VHF and UHF bands, and to help develop an automatic system for monitoring use of the bands.

The major focus of the research on man-machine interaction is the Communications Technology Satellite. Ten of the CTS experiments involve the use of a satellite for specialized services such as education, medicine and cultural exchanges, in preparation for the day when an operational satellite will provide full-time services.

The department will spend $15 million on space applications next year, a fifth outside the government. The space sector's activities are outlined in Chapter 2.

The science program also includes activities on behalf of other federal departments and agencies. National Defence is the largest customer and accounts for about a third of the total current effort of the research sector and about a twelfth of the effort of the space sector. The work includes communications, radar and satellite system studies.

Energy, Mines and Resources

Energy, Mines and Resources' expenditures on science and technology will rise from $90 million in 1976/77 to $110 million in 1977/78, or about 70% of the department's budget if the payment of oil import compensation ($800 million) is not considered. About 30% of the 1977/78 expenditures will be outside the federal government.

The department encourages the effective use of Canadian mineral and energy resources (mainly fossil and nuclear fuel) and administers these resources on federal lands in the provinces and in the newly declared offshore areas. New knowledge in geology, resource technology and earth physics is gathered and catalogued by the department; this information base for resource exploitation is then made available to the private sector.

The department's role in energy-related research and development and in funding research by the provinces is described in Chapters 2 and 3 respectively.

The research activities in geoscience, minerals and energy technology provide the base needed for minerals and energy policy development. Thus, research programs of the Geological Survey are directed in part to developing new exploration techniques and resource analysis techniques for land and offshore areas. Other research improves methods of understanding mineral and hydrocarbon occurrences; thus exploration and accurate resource assessment are encouraged.

The consequences of resource exploitation are carefully considered. For example, the 1977/78 program includes an appraisal of continental shelf oil and gas resources and the environmental consequences stemming from their development.

At the Earth Physics Branch a research program is directed toward a better understanding of Canadian earthquakes, seismicity, and seismic risk and hazard. Investigations of the gravity and magnetic fields and the geothermal regime of the earth are carried out in aid of navigation, transportation, communications, surveying and geophysical prospecting.

The higher level of R&D funding in the Canada Centre for Mineral and Energy Technology for 1977/78 reflects current concern over the availability of minerals. Investigation of new technologies in metallurgy and mining is designed to lead to improvements in productivity, the health and safety of miners, and the environmental impact. In addition, increased research into the extraction, processing and use of minerals for engineering materials and for chemicals is intended to meet changing Canadian needs.

Some of the R&D activities bear directly on issues of environmental protection. For example, the studies of permafrost not only provide information that will help in planning northern development but also provide the necessary data for assessing the environmental impact.

The geodetic framework, which is the responsibility of the Surveys and Mapping Branch, consists of tens of thousands of precisely located points and is essential to all other surveys and studies of the earth, as well as for most large engineering projects. Multi-purpose topographic mapping is the foundation of a host of federal and national activities such as resource development, transportation, communications, urban and rural administration, education, defence and recreation.

The growing technology of remote sensing from satellites and aircraft is used by the Canadian Centre for Remote Sensing to provide data for such activities as ice reconnaissance, crop forecasting, and forest fire prevention.

Atomic Energy of Canada Limited

The Crown corporation's prime responsibility is to develop nuclear energy technology to meet Canadian requirements. Its objective in this area is to make available, by the year 2000, about 80,000 MW of nuclear-electric capacity (1 1/2 times Canada's present total electric capacity). It also produces radioisotopes and develops associated products such as radiation processing equipment and radiotherapy instruments for use in medicine and industry. The corporation's science and technology activities will account for expenditures of $96 million in 1977/78, an increase of 2% over 1976/77.

Applied research and development activities, mainly performed at Chalk River, Ontario, and Whiteshell, Manitoba, are carried out on power reactor systems, nuclear fuel, environmental protection and radioactive waste management, heavy water production, radiation equipment and radioactive isotopes. The applied work is supported by basic research in physics, chemistry and materials science. In addition, the corporation contracts out over $6 million of research and development annually to industry. There is close collaboration with utilities and industry, since this program provides the technological base for the largest industrial program ever initiated, developed and put into industrial practice by Canadians. Currently, about 30,000 people are employed in the Canadian nuclear industry.

The research and development ranges from work at the laboratory bench to experiments using multi-million dollar research reactors and associated facilities. Much of the nuclear power activity involves the CANDU pressurized heavy water system; as well, there is work in support of heavy water plants. Particular attention is paid to developing reliability through sound design and good maintenance procedures, so that high capacity factors already achieved (87% for the Pickering generating station in 1976) will continue in the future. A slowly increasing percentage of the work (about 10% in 1976/77 and 20% in 1977/78) is devoted to the development of new fuel cycles to ensure nuclear fuel supplies adequate for centuries.

The entire research program is mission-oriented and there is close interaction between basic and applied researchers. This gives access to expert consultants in relevant disciplines and to international research results through personal contacts. Thus AECL keeps abreast of developments in all methods of nuclear power generation.

The corporation is mindful of its responsibilities to protect people and the natural environment from the undesirable effects of radiation. About 10% of its research effort is devoted to radioactive waste management, health physics, environmental research and biology research.

Environment

The department is the largest funder of science and technology in the federal government. It will spend $292 million in 1977/78 on science activities. This is 51% of its total budget, up 6% from 1976/77. Of this, $21 million will be spent outside the government.

The Fisheries and Marine Service (FMS), which administers the Fisheries and Marine Program, has jurisdiction over Canada's living aquatic

resources, a mandate for the provision of oceanographic and hydrographic services, and responsibility for the protection of the aquatic environment. In addition to S&T activities described elsewhere (see Chapter 2, Oceans and Food), the service carries out environmental contaminants and hydrography programs. Its 1977/78 science spending will be $88 million, 32% of the total for the program and up 5% from 1976/77.

The environmental contaminants program is concerned with the potentially deleterious effect of chemical contaminants on the health and survival of fish stocks and on the wholesomeness of fish sold as food. The widespread presence of these contaminants and our heightened perception of their negative impacts on biological systems, especially in the Great Lakes, makes this issue an important one. Most of the contaminants effort is committed to toxicological studies of the environmental dynamics and the biological effects of specific problem chemicals. Under the new Environmental Contaminants Act, administered by the Environmental Protection Service, FMS is responsible for providing the scientific back-up for the regulation of contaminants in the marine environment.

The service's hydrography effort extends to all of Canada's oceans. Surveys of western Arctic waters provide basic information for the exploration and use of northern petroleum resources. Work on the Pacific coast will continue in 1977/78, in anticipation of increased tanker traffic. An aerial hydrography research project will be conducted in partnership with Energy, Mines and Resources' Canada Centre for Remote Sensing on the feasibility of using photogrammetric techniques to generate hydrographic charts. If successful, it will lead to considerable savings by reducing the need for a large number of time-consuming surface operations.

Science expenditures for the Environmental Services Program will be $202 million, or 75% of the total program budget, a growth of 6% from last year.

Within the Environmental Services Program the Environmental Management Service is concerned with the conservation and wise use of lands, forests, water, wildlife and environmental systems. Its 1977/78 S&T budget will increase by 5% over 1976/77, to $99 million.

Major efforts continue in support of a joint Canada-United States multi-billion dollar effort to clean up the Great Lakes. Emphasis in the research efforts is shifting to studies of the pathways and effects of toxic contaminants and at understanding the atmospheric transport of pollutants into the Great Lakes system. The service is also conducting a study of the effects on the environment and groundwater of underground disposal of certain highly toxic and persistent industrial and nuclear wastes, for which conventional waste disposal techniques are inadequate. A third series of investigations deals with hydrologic factors affecting construction problems, for example where roads and pipelines cross rivers in the sub-Arctic.

Wildlife science activities include the study of fish-eating birds which concentrate contaminants found in fish. It will increase knowledge of the biological pathways of pollutants. Other activities include the work of the Canadian Wildlife Service in its role as scientific authority for the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and attempts to re-establish rare or endangered species such as the peregrine falcon and the whooping crane in the wild.

Forestry research activities are mainly directed toward protection, and the development of alternatives to costly, environmentally hazardous, large-scale aerial insecticide spraying to control tree-damaging pests. The possible alternatives include naturally occurring insect viruses, bacteria and parasites, physiological materials such as sex attractants and juvenile hormones, and cultural and forest management practices. The Forestry Service also undertakes research on the effects of logging activities on forests and is currently engaged in federal-provincial research projects to conserve the country's natural forest gene pools, to produce fast growing, disease-resistant strains of trees, and to assist industry in setting and meeting national standards for effluent control.

The major scientific activities in the Atmospheric Environment Service (AES) are weather prediction systems (the service's major activity), ice prediction systems, air quality research, investigation of the causes of stratospheric pollution and studies of ice-covered waters. Scientific activities in the AES are estimated at $93 million, an increase of 7% over 1976/77. The major activity is the operation of a national atmospheric data collection analysis and dissemination system for weather prediction. Systems are also in operation for ice prediction for use in the navigation of ice infested waters. AES also provides consulting services in the field of applied meteorology and supplies information on air quality, with particular attention to man's activities in the atmosphere.

There are small research programs on stratospheric pollution, effects of supersonic flight, continued use of freon sprays, effects of climatic change, and weather modification. The service is also taking part with the Fisheries and Marine Service in the development of unmanned, automatic data gathering meteorological buoys.

The Environmental Protection Service, whose responsibilities range from industrial pollution to oil spills in Arctic waters, will engage in a S&T program whose 1977/78 estimated budget is $10 million, an increase of 16% over 1976/77. This S&T program is organized into work on solid waste management, environmental contaminants, environmental emergencies and water and air pollution control.

The solid waste management S&T program has two principal objectives: to cut down the environmental degradation caused by solid waste disposal, and to encourage energy and resource recovery systems. Activities include studies on the reuse of secondary waste material, energy recovery from solid wastes, and a Canada-wide data base of methodology and field investigations.

The Environmental Contaminants Control work involves the development of methods to destroy halogenated hydrocarbons thermally and to extract chlorinated hydrocarbons from manufactured equipment, better ways to dispose of hazardous chemicals, and the adaptation of disposal sites so that they can take certain kinds of hazardous wastes.

The Environmental Emergency Branch has a $2.6 million S&T program in 1977/78 ($0.6 million in 1976/77) on oil spill countermeasures (including $2.3 million contracted out to industry), of which $1.7 million is dedicated to R&D in the Arctic. This work is expected to continue in future years in anticipation of the growth of off-shore oil exploration and development activities in the Arctic. Environmental studies related to oil spills, such as sensitivity mapping and dispersant toxic-

ity work, will continue as will work on countermeasures equipment, materials and techniques such as skimmers, booms, sorbents, and dispersants. The related scientific activities of the branch include the operation of one of the most comprehensive government/industry environmental emergency information computer systems in the world.

Water Pollution Control is responsible for formulating industrial effluent regulations. However the success of this program depends on the availability of efficient, economical technology for the treatment of waste waters. Current projects include the development of demonstration systems for removing heavy metals, radioactive products, nitrogen and toxicity from various industrial processes. Projects on the treatment of municipal waste waters include the development of systems for treating specific pollutants and dewatering and disposing of sludge. The main program areas for northern studies are utilities delivery, waste treatment, and residue management and disposal.

The regulations of the Clean Air Act establish the maximum concentrations of air contaminants that may be emitted into the air by stationary sources. Their enactment, however, requires the development of methods of sampling and analysing the contaminants, which in turn requires a high level of scientific and technical expertise.

Canadian International Development Agency

In 1977/78, the Canadian International Development Agency (CIDA) reports it will spend $44 million on science-related activities compared to $38 million in 1976/77. A principal activity is the participation in the Consultative Group on International Agricultural Research, which coordinates support for agencies such as the International Maize and Wheat Improvement Centre (Mexico) and the International Rice Research Institute (the Philippines). CIDA contributes over $7 million - about 9% of the international total - in grants to such institutions. These agencies study a wide range of crops with the object of doubling current yields through genetic improvement, for example by selectively breeding a crop for pest and disease resistance as well as for high production. Success with wheat has doubled India's production in six years and increased annual world production by over 600 million bushels. At least one of the improved varieties is grown in Canada. Similarly, rice production has been increased by more than 30 million tons per annum. These increases are enough to provide a subsistence ration of a pound of grain a day each for 300 million people.

In addition to the crop-oriented institutes, CIDA supports the International Laboratory for Research on Animal Diseases in Kenya, which is searching for immunological solutions to the problems of trypanosomiasis (spread by tse-tse flies) and East Coast fever (spread by ticks). The control of these diseases in Africa will increase the pastureland available for cattle ranching and other animal agriculture.

In 1976 the agency began to support a new research effort on malaria, sleeping sickness, schistosomiasis and other parasitic diseases which are extremely widespread in tropical countries. This will be administered through an organization similar to the Consultative Group, with the World Health Organization as the executive agency. In addition, the agency will contribute $1.3 million to the World Health Organization program of research and training in human reproduction.

International Development Research Centre

The International Development Research Centre helps the developing regions to build up the research capabilities, innovative skills and institutions required to solve their problems. The main approach to this goal is through support of specific projects in developing countries. The centre's budget for 1977/78 (all S&T) is $38 million, consisting of a parliamentary grant of $34 million and the remainder from interest income. In 1976/77 the grant provided $30 million of the total forecast expenditure of $32 million.

Research to improve food production and nutrition has been a foremost concern. Other projects have studied modernization and change and its consequences, especially in rural communities in developing countries. Environmental health, disease prevention and care in these communities, and the many variables that influence the size of families have also been focal points of research. The centre also collects and disseminates information about development.

The Agricultural, Food and Nutrition Sciences Division supports research into plant, animal, marine and forest resources, such as research on crops, farming systems and reforestation in arid and semi-arid lands, multiple and inter-cropping, the use of agricultural wastes and by-products in animal feed, fish farming and shellfish culture, fish preservation and processing, post-harvest technology and the needs of the rural family.

An important example of the division's work is research on cassava, a tropical root crop and staple food in many developing countries. It has serious nutritional drawbacks such as low protein content and high toxicity; it is highly perishable after harvesting. The centre has provided, often in conjunction with the Canadian International Development Agency, over $4 million in support of a network of cassava research projects over the past four years. The aim of these projects is to improve production by the use of new varieties and thus increase the use of cassava in Asia and Latin America, as well as to make sure that farmers in each region can get the results of applied research

Social Sciences and Human Resources Division's research focuses on the effect of modernization and change, especially on rural peoples, on strategies for harmonious development of urban and rural areas, on the formation of appropriate science and technology policies, on delivery systems for mass primary education, and on the determinants of population change and the formulation of population policies. The division also administers a scholarship program to increase the number of scholars trained in the problems of development. For example, Science and Technology Policies, a network of projects that have received over $4 million in grants, supports research into technologies appropriate to developing countries. The Science and Technology Policy Instruments project is one of the largest - it has received $1.4 million from the centre since 1973. This project will help to make better use of indigenous abilities, will adapt imported technology where necessary, and above all will give the participants the opportunity to link science and technology directly to their national development goals.

The main research interests of the Population and Health Sciences Division are environmental health and disease prevention, fertility regulation, and rural health care delivery in developing countries. An example is the support for research into biological control of vector-borne diseases. The centre has just approved a one-year grant of $500,000 to a special program, coordinated through the World Health Organization, to develop new tools for prevention, diagnosis and treatment

of tropical parasitic diseases. This will help countries where the diseases are endemic by providing training in biomedical sciences and various forms of institutional support. The focus initially will be on the major human parasitic infections encountered in tropical zones - malaria, schistosomiasis, filariasis, trypanosomiasis, leprosy and leishmaniasis.

The Information Sciences Division provides information on development through cooperation with United Nations agencies to establish worldwide information services with developing countries, improvement of industrial extension services, the creation of centres supplying specialized information on subjects of interest to developing nations (e.g., tropical crops), building of information services on family health and family planning, library services, and map-making from satellite images. To date the centre has made grants of over $3 million for information centres and systems. In its support for agricultural information services, for example, the centre supports the U.N. Food and Agriculture Organization's International Information System for the Agricultural Sciences and Technology (AGRIS), which has been in operation since early 1975. The system collects information from national and regional centres and periodically compiles them into a bibliography of world agricultural literature.

Statistics Canada

Statistics Canada provides the statistical information required for understanding the Canadian economy and society. This information is needed to develop and monitor the economic and social policies and programs of virtually all levels of government, as well as to support research work and decision-making throughout the nation. For example, the Labour Force Survey's unemployment statistics and the Consumer Price Index are key indicators of the economic health of the nation. The agency's program consists almost totally of related scientific activities (RSA) in the human sciences and represents nearly half of total federal spending on human science RSA.

The 1977/78 main estimates of Statistics Canada are $136 million. This is 16% lower than in 1976/77 and provides for 941 fewer man-years, the enumeration phase of the 1976 Quinquennial Census having been completed. During 1977/78 the department will undertake a substantial analysis of the census data.

Recognizing that 1977/78 is a year of fiscal restraint, the department plans no new major programs. It will continue to improve the timeliness and quality of its statistical series and to coordinate the production of statistics within the federal government. To that end, the Task Force on the Integration of Economic Statistics, with other government departments, will check the ability of large firms to supply complete, consistent information for government departments and the National Statistical System.

In response to demand from the public and private sectors, the department will propose ways of producing more social statistics. During 1977/78, 'Perspectives Canada' Volume II, a social statistics compendium of Statistics Canada infor-

mation, will be published. It will update the material in Volume I (1974) and add a section on social indicators. Development work for the Family Expenditure Survey, to be undertaken in 1978/79, will begin in this fiscal year. This survey will provide the data needed to re-weight the Consumer Price Index, evaluate the anti-inflation program, determine the wage adequacy level (the poverty line), and provide data for policy evaluation exercises such as the Social Security Review.

By 1978, all the provinces in the Integrated Prisons Program will be included in the Correctional Informational System for Canada and as a result, more comprehensive judicial statistics will become available.

National Defence

National Defence will spend $82 million on science and technology in 1977/78, 2% of the total budget and an increase of 25% over 1976/77 (a third of this increase is for new construction). The main responsibility for science and technology in the department rests with the Chief of Research and Development Branch. Its objectives are to carry out R&D as required to meet departmental needs and to provide scientific and technical advice and assistance to all elements of the department. The branch is establishing a broad technology base which will be maintained in the six Defence Research Establishments across Canada, in industry and in other departments and agencies. In line with the contracting-out policy, external resources are used wherever practical, but in many areas vital to defence, the technology base is maintained in-house. Outside contractors are used, where possible, to provide advice on military training or operations and on human performance in the military environment. They are also used for equipment-related activities, ranging from demonstrations of feasibility, through development, to performance evaluation and engineering tests.

One program conducted by the Defence Research Establishments is the Technical Program on the Acoustic Detection of Submarines. This program is carried out jointly by the DRE Atlantic and the DRE Pacific in all three oceans bordering Canada, using research ships and scientific equipment developed mainly by the Establishments. The program aims to improve the military ability for reconnaissance, location and surveillance of submarines in waters of Canadian interest. It is concerned with all aspects of underwater acoustic propagation: natural and man-made interfering noise, signal processing and analysis, and transducer technology. International cooperation and information exchange are important parts of the program.

One important role of the technology base is to provide the background for development. The Penetrating Rocket System is an example. This improved air-to-ground rocket uses a high-performance composite propellant in which DRE Valcartier had developed expertise. Canadian industry had the necessary technical background and the production facilities, having produced earlier rockets for the Valcartier program. When the Canadian Forces saw the need for an improved rocket in 1972, Canada had the capability to design, develop and manufacture it. DRE

Valcartier designed the rocket motor and produced initial models. Industry then produced a prototype lot of 60, which was successfully test fired, indicating that the technology had been satisfactorily transferred from government laboratory to industry. Then followed pre-production models, performance testing at the Aerospace Engineering Test Establishment, and the development of operating procedures. The rocket has now been cleared for use on the CF-104 aircraft and clearance trials for other aircraft are in progress. In January 1976 the department let a production contract for rocket motors to meet the CF-104 requirement, and recently some NATO countries have expressed an interest in the weapon.

National Health and Welfare

The health activities of National Health and Welfare are concerned with programs of health care, medical services, health protection and fitness and amateur sport. Compared with 1976/77, departmental science spending in 1977/78 has risen by 12%, from $50 million to $56 million.

The department's major new thrusts will be in health protection, including major research projects on the non-medical use of drugs. Among them are research projects on problems associated with alcohol, tobacco and non-medical drug use; synthesis of the international scientific literature on the same topics; preparation and distribution of related scientific publications; and development of scientific and professional expertise in Canada in the biomedical, evaluation and epidemiological fields. Extramural research projects at university and research institutions across Canada are to be given high-priority support: for example, the department has a major contract (totalling $1.3 million) for biomedical research into the pharmacology, toxicity and metabolism of various drugs and another important contract ($0.5 million) for the assessment of alcohol and drug dependency treatment.

The Environmental Health Directorate is preparing a program on occupational health, with four main aims risk identification, preventive action, regulatory strategy and co-ordination. The first two will include a study of Canadian occupational health problems and a project to develop uniform health standards for Canada.

The objective of the Bureau of Medical Devices is to ensure that devices sold in Canada are safe and effective. Extramural research programs will identify hazards and problems, develop criteria and recommend performance standards, while intramural programs will translate these recommendations into regulations.

Scientific activities associated with fitness, physical recreation and sport are supported under the program of the new Ministry of Fitness and Amateur Sports. The program will include studies of the biochemistry and epidemiology of exercise, exercise physiology, sports medicine, biomechanics, psychomotor learning and the psychology, sociology and social psychology of sport. Funds allocated to the program for the fiscal year 1977/78 total $0.8 million.

The National Health Research and Development program is the department's principal extramural research and development funding program, with a budget in 1977/78 set at $11 million. The objective of the program is to improve the quality of health and health services in Canada. The program provides support for a spectrum of scientific activities, including data acquisition and analysis, demonstration projects, scientific research, preliminary development and application of new technologies and information dissemination. The activities funded will deal with the biology of human populations, health hazards from the physical and social environment, the health implications of lifestyles, and the health care delivery system. The program also provides for the training and career support of health research personnel.

Medical Research Council

The objective of the Medical Research Council is to help attain the quality and extent of research in the health sciences essential to the maintenance and improvement of health services. The council uses almost all of its funds to support research and research training in universities and teaching hospitals, maintaining no laboratories of its own. Because the research and research training are carried out within, or close to, the health care delivery system, not only is the new knowledge utilized more quickly but it is also directed toward the solution of actual problems. The council has the continuing advice of 25 standing committees with a total of 150 members, many of whom are also on review panels or editorial boards of Canadian and foreign scientific journals; thus the standards applied to the assessment of research proposals submitted to the Medical Research Council are not only national but international.

Expenditures in 1977/78 will total $58 million, an increase of $6 million over 1976/77. The work supported by the council extends over the whole spectrum of medical research, from clinical trials designed to determine the efficacy of certain drugs and new methods for the treatment of specific diseases, to very basic studies in the fields of biochemistry and molecular biology designed to throw light on the cause or mechanisms of disease states.

One example of research funded by the council is a seven-year trial of human growth hormone, shown to be effective in increasing growth in certain types of dwarfism in children. The council plans to continue to fund the production and distribution of the hormone for those who can benefit from it, until alternate sources are available.

Another example is the council's plan to continue its collaboration with the National Cancer Institute of Canada and the Ontario Cancer Treatment and Research Foundation in sponsoring the clinical trial of the BCG vaccine for the treatment of lung cancer.

Another is basic studies of protein synthesis designed to determine the way the body produces insulin. An understanding of this mechanism is a part of the information needed before researchers can develop new sources of insulin or a cure for diabetes.

The council has developed three major programs of research support. The first of these - the direct support of operating costs of research - uses about 75% of the total available funds. Awards are made in the form of grants-in-aid of research to individuals, program grants to research teams, and support for ten Medical Research Council Groups comprising three to six researchers each.

Salary support for research training and for a limited number of highly qualified researchers utilizes a further 20% of the funds. This support is essential to maintain a base of researchers working at the frontiers of knowledge with access to new information emerging abroad as well as in Canada and the ability to adapt it to Canadian needs.

Thirdly, development grants to alleviate regional disparity, a matter of concern to the council, are provided each year. They assist new endeavours in departments where the research effort is not yet adequate to support professional education or the delivery of high quality health care in the region.

The council also convenes special ad hoc working groups to review current research practices and policies and to make recommendations. A group of scientists and laymen is currently considering the ethics of human experimentation. Another group is developing guidelines for MRC-supported research involving the handling of recombinant DNA molecules and certain animal viruses and cells.

National Research Council

Apart from the Program of Grants and Scholarships, which will become the responsibility of the new Natural Science and Engineering Research Council and is described in Chapter 3, the National Research Council manages two other major science programs: the Engineering and Natural Sciences Research Program, whose estimated expenditures for 1977/78 will be $160 million, including new funds of $3.7 million for energy research and $1 million for the development of ocean data collection; and the Scientific and Technical Information Program, which will spend $13 million in 1977/78. Virtually all of the expenditures of NRC are on science, $173 million in 1977/78 compared to $149 million in 1976/77 for these two programs. In the case of the Engineering and Natural Sciences Research program, projects undertaken extramurally will account for $59 million or 34% of the total.

The Engineering and Natural Sciences Research program includes ongoing and new activities in basic and exploratory research; research related to long-term problems of national concern; research in direct support of industrial innovation and development; research to provide technological support of social objectives; and research and services related to standards. The program also provides and manages national R&D facilities as a service to industry, government and the universities.

A quarter of the in-house program expenditures will be devoted to basic and exploratory research in such diverse fields as the study of sub-atomic forces, spectroscopy of atomic and molecular species, cell biology and plant breeding, the theory of air dynamics and astronomy. Studies done at NRC on sub-atomic forces, for example,

have provided the first critical tests of fundamental physical theories. Spectroscopy research has recently played an important role in the international examination of inter-galactic matter. Scientists at the Herzberg Institute - named after Canada's first and only Nobel Prize winner in the sciences - were the first to detect the presence of water in the recent Kohoutek comet and have recently identified the largest molecule to be discovered in interstellar space. NRC astronomers have been instrumental in developing long base-time interferometry for measurements on very distant stellar objects. In biology, the Prairie Regional Laboratory is an international leader in the techniques of somatic hybridization for the transfer of specific factors from one type of plant to another.

Research on long-term problems of national concern will see increased resources for energy and a continuation of activities in transportation, food, and construction technologies. In the energy area, activities will range from improving the efficiency of energy consumption in buildings and research into the uses of solar energy, to research on fundamental aspects of laser technology. In the food area, work related to the greater use of legume seeds as a source of protein will be expanded. There will be a joint NRC-industry study of microwave heating in food processing.

Increased funding has been provided for research in direct support of industrial innovations. A major project, contracted to Canadian industry, is the development and construction of an advanced remote manipulator system as part of the Canadian contribution to the U.S. Space Shuttle program. The total cost of the system is estimated at $76 million. The highly successful Industrial Research Assistance Program (IRAP) and the Pilot Industry-Laboratory Program (PILP) will be expanded (see Chapter 3).

Research to provide technological support of social objectives will continue at the same level as previously, in four broad areas - public safety, environment, health, and education and training. Much of the work of the Division of Building Research, and in particular the Fire Research Laboratory, is concerned with improving safety in commercial and residential buildings. By conducting basic studies and providing expert advice and assistance in investigations of specific incidents, NRC scientists help other federal and provincial groups to discharge their responsibilities for vehicle and aviation standards. Environmental projects range from studies of the accumulation and toxicity of chemicals, through the development of improved detection methods, to studies of noise effects and abatement techniques. In the health area, NRC will continue to perform basic and applied research in biochemistry, and developmental work on prosthetic and other medical and clinical devices.

NRC operates scientific research facilities, such as the wind tunnels and high voltage accelerators for nuclear physics research, and observational facilities, such as the Dominion Astrophysical Observatory and the Algonquin Radio Observatory. NRC is also participating in the Canada-France-Hawaii Telescope project. A modest increase in the new year's funding will upgrade the Algonquin telescope and improve the sound abatement facilities at the Wind Tunnel. Responsibility for completion and continued operation of the TRIUMF high energy meson accelerator has been transferred from the Atomic Energy Control Board to NRC. Commencing in 1977/78, the accelerator will be operated as a national facility within the Engineering and Natural Sciences Research Program. The budget for 1977/78 will be $7.1 million.

Research and services related to national standards will continue at last year's level of activity, but additional emphasis willl be placed on the automation and modernization of testing services. NRC is responsible for maintaining national primary standards, such as time standards, and carrying out primary calibration checks, as well as for the R&D effort involved in setting new measurement standards in such fields as laser technology, acoustics and neutron radiation. New component and performance standards aimed at improving the efficiency of energy use in buildings are being prepared for the National Building Code.

The Scientific and Technical Information Program will continue at about the same man-year level as last year. Increased expenditures caused by the increased use of information services and by salary increases will be recovered by increasing revenue from some specialized information services. The STI program has three main interests. The National Information Services (including CISTI, the Canada Institute for Scientific and Technical Information) provide a wide range of services to industry - to firms with advanced scientific facilities and to small and medium-sized firms with virtually no technical and engineering support. Network Planning and Research is concerned with providing a Canadian network of STI services. Research and Development investigates ways to improve the handling of STI, it also develops standards and procedures for exchanges between national and international systems. CISTI, the National Library and a group of Quebec and Ontario universities will continue to evaluate a new computer system for automated library management. The system could considerably reduce the additional resources needed to handle the continual increase in published information, and to strengthen the connections between major libraries.

Canada Council

The Canada Council's expenditures for support of the human sciences in 1977/78 are estimated to be $32 million, consisting of $26 million in parliamentary appropriations and $6 million in income from endowments, special funds, bequests, etc. The total includes the expenditures of the Social Sciences and Humanities Program ($30 million) and parts of other Council programs. The Parliamentary appropriation is 13% higher than for the previous year.

The proportion of funds devoted to direct support of research has increased steadily over the years, and almost 50% of the expenditures are now devoted to research grants, leave fellowships to permit full-time research, general research grants and negotiated grants. Support for the latter will continue at the 1976/77 level and allows research teams to make large-scale (frequently interdisciplinary) studies of such problems as the marginal work world of the Maritimes, juvenile delinquency in Montreal, changing public perceptions of social values, and Canadian resource economics and policies.

An important aspect of social sciences and

humanities research is support for the communication of research results both through publications and presentations at conferences and seminars. This support has been increased yearly and now represents about 10% of the expenditures. As a further means of increasing research effectiveness the Council had been increasing its support of learned societies and the Humanities Research and Social Science Research Councils, but to meet budgetary constraints it reduced this support during 1976/77.

To maintain the priorities of direct research support and research communications, the support for graduate studies over the past five years has been held to about the same level in dollars, some $1.0 - 1.5 million below the peak support of 1970/71 and 1971/72. For the same reason, there has been little support for the improvement of research facilities, such as libraries, archives and data banks.

Solicitor General

Within the Ministry of the Solicitor General, the Research Division reflects the Ministry's recognition of the importance of research to both policy and program decision-making in the criminal justice system. The role of the division is to initiate, provide and coordinate human science research for the department and its agencies, while influencing the development of strategies to reduce the economic and social costs of crime in Canada.

The budget of the research division will be $3.3 million in 1977/78, the same as in 1976/77, representing 0.3% of the ministry total.

Five high priority areas of research have been identified for 1977/78.

Victimization studies provide information permitting more confident statements on the nature, level and costs of crime, and risks of victimization. For example, surveys examine the characteristics of victims and explore such factors as the situation surrounding the offense, injury or loss suffered, whether or not the event was reported to the police, and the reasons for not reporting. These studies provide information for strategic planning, ongoing evaluation of crime prevention and victim compensation programs.

Police prescriptive packages for crime prevention consist of manuals of research-derived information, models and operational guidelines. These manuals include methods to measure and analyse program results. They include but are not limited to, team policing, family crisis-intervention, police-community relations, police management information systems.

The annual survey of attitudes to criminal justice policies, developed in 1976/77 will continue until 1982, and will enable assessment of attitudes to criminal justice policies and policy options. In response to concerns expressed by police administrators about citizen non-cooperation with police, another study will analyse the attitudes of the police, and of the public towards the role of the police, to assist in identifying areas of tension between the police and the public. A further study is underway to assess the impact on the public of locating community residential correctional cen-

tres in specific communities. It is hoped that results from this study can assist in establishing correctional centres, and in dealing constructively with community attitudes.

In the area of correctional services, research to identify the dangerous offender and alternative correctional intervention strategies is underway. The research will look at the behaviour of long-term inmates, attitudes of staff, and the influence of long-term inmates on the functioning of institutions. Research in the area of temporary absence, remission, parole procedures and supervision of those released on parole is an area of importance in the coming year.

The concept of 'diversion' usually refers to alternative measures for people in immediate jeopardy of a court appearance. This involves, among other approaches, the establishment of community oriented preventive services. The ministry is actively involved in developing a policy on diversion, is carrying out extensive consultation throughout the country, and supporting a number of experimental projects.

Research on the use by the police and the judiciary of the recently enacted first and second degree murder provisions, and of the proposed legislation on dangerous offenders, include studies of the factors affecting the decision-making of the police, prosecutor, judge and jury, in relation to the handling of violent offenders. Studies will assess the effectiveness of the new gun control measures.

The Ministry of the Solicitor General publishes annually the 'Guide: Research Programs', indicating areas of high priority for the ministry research program. In order to implement the program the ministry's Research Division contracts out about half of the annual budget. It also provides support for the development of research centres and fellowships to encourage expertise in the field of criminology and related disciplines.

The ministry will publish many of the research reports in a form that can be readily understood by laymen and specialists alike. Other initiatives to ensure that findings are communicated to the public, parliament and the criminal justice system will be undertaken.

Transport

The department's responsibilities include the development of air, sea and surface transportation and the provision of facilities and service when necessary.

Transport's expenditures on S&T activities will increase from $23 million in 1976/77 to $26 million in 1977/78. The Transportation Development Centre (TDC) in Montreal will spend $9 million or 36% of the total science expenditures. Most of TDC's expenditures are contracts for research by the private sector.

TDC supports a wide range of railway research activities, many of them on a shared-cost basis with the two major railways. Areas include the dynamic interaction of railway vehicles and track, improvements to freight car tracks, track structure

research, specialized instrumentation techniques and improved rail metallurgy. In connection with Transport Canada initiatives in the development of improved rail passenger services, a number of new research and development activities are being initiated in the areas of level crossing safety, a new railway passenger seat and instrumentation for high speed passenger train testing. Under a contract with the Canadian Institute for Guided Ground Transportation, research is proceeding into magnetically levitated passenger trains of the future which would be capable of speeds up to 300 m.p.h.

A $1.5 million, two-year project to define an intermediate capacity urban transit system is nearing completion. The system, using existing rail rights-of-way, is suitable for Canadian conditions and can be implemented economically in cities of 100,000 people or more. New technology is needed to develop small vehicles that can operate economically and frequently throughout the day, even during off-peak hours. They would be fully automated, electrically powered, small steel-wheel-on-rail vehicles, capable of operating singly or in trains.

Trials of an air cushion icebreaking bow platform in 1976 were highly successful, and TDC is continuing the tests this year. Last winter's trials used a bow platform attached to a light Canadian Coast Guard icebreaker, and the ship was able to operate continuously in ice 2 1/2 times as thick as her normal limit. This year, the trials involve industry participation, and the platform will be attached to either a small tug or the bow of a large tanker during simulated commercial operations at Thunder Bay. The success of these trials would substantially improve winter navigation on the Great Lakes.

TDC supports a university program to maintain the number of qualified graduates in the transportation disciplines. The program is also intended to encourage academic research, usually interdisciplinary, into contemporary Canadian transportation problems. One program offers about 35 fellowships a year for students at the Masters or Ph.D. level. TDC also supports centres for transportation studies at U.B.C., the University of Manitoba, Université de Montréal, the University of Toronto-York University Joint Program in Transportation.

The Urban Transportation Research Branch of the Surface Administration conducts a program of research, experimental and demonstration projects designed to improve urban mobility. It includes studies of conventional fixed route transit systems, systems for the disadvantaged, future needs and new systems.

S&T studies of motor vehicle safety include bicycle and pedestrian safety measures, design studies in highway pavements, studies in traffic accidents and in noise pollution. A motor vehicle test centre at Mirabel offers regulatory testing and R&D for government and industry.

Air Administration's scientific activities include noise pollution measurement and prediction and the measurement of aircraft emissions. The AEROSAT project to investigate the use of satellites for North Atlantic air traffic control also falls within the administration's responsibility.

Marine Administration's scientific activities include improvements to existing industrial and technological development programs, such as the design of in-shore and polar icebreakers, buoy systems and telecommunications for marine navigation.

Urban Affairs

Understanding urbanization in Canada is the basic research objective of Urban Affairs. The ministry will spend $8 million on scientific and technological activities in 1977/78, one half million less than in 1976/77.

Studies in human environment are developing standards for the range and accessibility of community amenities and social services. A major research project, for example, attempts to identify public priorities among urban services.

Energy studies examine the urban impact of developments in the energy sector and the effects of urbanization on energy requirements.

Natural environment and resources studies examine the effect of urban development on the physical environment, and seek to combine better management of the natural environment with federal urban policies.

Studies are also undertaken on the processes that determine the patterns of human settlement in Canada. The social costs and benefits of alternative settlement patterns are being considered.

Metropolitan community development studies determine the major factors influencing the growth of large cities, such as congestion, deterioration and commercial development; as well, patterns of change in urban neighbourhoods and their socio-economic and environmental effects are being assessed. Other studies are focussing on the potential for making small communities livelier and more attractive.

Urban economy studies examine ways of improving employment opportunities in declining and slow-growing communities and of encouraging the orderly development of employment opportunities in large and rapidly-growing urban centres.

Studies also examine patterns of land use in and around urban centres and the factors affecting the price and efficient development of urban land.

The urban transportation service studies are mainly concerned with standards and priorities.

An example of a major S&T project performed by the ministry is the organization of the 'Seminar on Energy Considerations in the Planning and Development of Human Settlements'. It will take place in Ottawa in October 1977, under the auspices of the Committee on Housing, Building and Planning of the UN Economic Commission for Europe. Up to 150 participants are expected from member-states of the ECE and representatives of other nations and international organizations will attend as observers.

Central Mortgage and Housing Corporation

CMHC's science objectives are to advance knowledge and technology of Canadian housing through housing research and development, to provide information and data for systematic analyses of housing problems by CMHC and other agencies, to provide leadership in the search for alternatives in housing and community building and to test and demonstrate innovative ideas. This science program will cost $18 million in 1977/78, an increase of 43% over the 1976/77 expenditure.

The range of research into housing needs includes housing and market analysis, housing unit surveys and consumer preference surveys.

Similar work on housing affordability and accessibility includes the analysis of capital markets, economic analysis and forecasting, and reviews of mortgage insurance fees and premiums.

CMHC also reviews present housing programs. For example, community housing research deals with co-operative, income mix, minority group housing and other special studies, while public housing research includes a data base on public housing and topics such as tenant characteristics, capital and operating costs, social needs and management.

Another group of research projects includes proposals on housing for the elderly and handicapped. Joint research with Urban Affairs on housing policy for the 1980's is also being carried out. Some projects are the revision of the National Housing Act, the shelter and income policy, housing distribution and conservation, and the housing and settlements policy.

Three major thrusts of research in housing research are wastewater/sewage treatment and disposal studies, building technology research, and energy and resource conservation, with emphasis on alternate energy sources.

A major research project in progress is the Canadian Water Energy Loop (CANWEL). It is an innovative system of managing waste which conserves water and energy and does not cause environmental pollution. CANWEL consists of three subsystems - sewage treatment, water polishing and solid waste treatment - which can be applied separately or together. A simple, reliable and efficient system, it promises to be economical to install and cheaper to operate than conventional processes.

Another major project, in human science, is the analysis of the Survey of Housing Needs, started in 1974. The survey was designed to monitor the occupancy of dwellings at two or three year intervals, and to ask the occupants about their previous household and dwelling unit characteristics. Such topics as shelter costs, rents, house prices, income, equity, indebtedness, dwelling unit quality, type and size can be studied and related to household composition as well as compared between metropolitan areas and with previous data.