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Canada's advanced-technology industry

The challenge, the opportunity in Canada's offshore

An international licensing agreement for Canadian technology

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Photo: NASA

The Canadarm, Canada's contribution to the NASA space shuttle program, was built by SPAR Aerospace Ltd. of Toronto, under a cooperative agreement between NASA and the National Research Council of Canada. The Canadarm will be used in space to deploy and retrieve satellites.

FOREIGN INVESTMENT REVIEW

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News briefs

Government economic departments reorganized

In January 1982, Prime Minister Pierre Elliott Trudeau announced plans to reorganize the departments of the Canadian government responsible for economic matters. "This reorganization is a necessary response to changing regional and industrial circumstances and a more competitive and complex trading world," Mr. Trudeau said.

The reorganization project consists of the creation of a Ministry of State for Economic and Regional Development, which will develop a major project management capability; the creation of a Department of Regional Industrial Expansion to oversee the national and regional coordination of government industrial development policies and programs; and the restructuring of the Department of External Affairs to give a new priority to the expansion of international trade and economic issues.

The Ministry of State for Economic Development will take on added policy, analysis and coordination responsibilities when it becomes the Ministry of State for Economic and Regional Development (MSERD). The new department will assist Cabinet with analysis and information on regional economic development issues. With a system of regional offices, MSERD will be able to help ensure that government policies are sensitive to regional issues and to help regional officials of other Canadian government departments to understand the objectives and decisions of Cabinet. The new department will also expand its capacity to analyse global trade strategy, in particular the trade dimensions of regional and sectorial economic development policies.

Parts of the former departments of Industry, Trade and Commerce and Regional Economic Expansion will fuse as the Department of Regional Industrial Expansion (DRIE). In addition to the various industrial incentives programs of the two predecessor departments, the DRIE minister will have responsibility for the Foreign Investment Review Agency, the Federal Business Development Bank, Canadian Patent Development Limited, National Design Council, Enterprise Development Board, Canadian Industrial Renewal Board, Textile and Clothing Board, Cape Breton Development Corporation, Atlantic Development Council, the Office of Industrial and Regional Benefits and the Industrial Opportunities Program Board. The minister will also head the new Office of Industrial Adjustment, which was announced as part of the reorganization project. A Minister of State, Small Business and Tourism will assist the Minister of Regional Industrial Expansion.

At the Department of External Affairs, the present Secretary of State for External Affairs will be joined by a Minister for External Relations and a Minister for International Trade. This restructuring will allow the department "to aggressively pursue international export markets and give greater priority to economic matters in the development of foreign policy," Prime Minister Trudeau said in announcing the changes.

The new Minister for International Trade will be responsible for the trade part of the former Department of Industry, Trade and Commerce, including the Trade Commissioner Service, the Export Development Corporation and the Canadian Commercial Corporation.

The Minister of State for External Relations will support the Secretary of State for External Affairs in the areas of international social, cultural and humanitarian affairs, relations with francophone Africa, the Agence de coopération culturelle et technique and other assignments.

In making the announcement, Prime Minister Trudeau said that the reorganization will facilitate economic development in all regions of Canada and will assist in "marketing the product of these developments in a tough and competitive world trade environment."

Industrial and regional benefits initiatives

In August 1981, the Government of Canada announced measures to increase its ability to identify and stimulate industrial benefits associated with, in particular, the development of Canada's natural resources. These measures included the creation of an Office of Industrial and Regional Benefits, enunciation of the government's industrial benefits objectives and guidelines for owner/sponsors of major projects, and formation of a Committee on Industrial and Regional Benefits.

The Office of Industrial and Regional Benefits seeks to ensure that major projects (usually those involving $100 million or more in capital investment) make maximum use of Canadian planning skills, project development ability, machinery and materiel supply capability, and capacity for further processing of resources. The mandate of the office was strengthened in the reorganization of economic departments in January 1982. Part of the Department of Regional Industrial Expansion (formerly Industry, Trade and Commerce), the office uses the results of government-industry information exchanges to ensure that Canada realizes the greatest possible industrial and regional benefits.

In making the announcement on behalf of the government, The Honourable Herb Gray, Minister of Regional Industrial Expansion said, "The development of major projects can play a critical role in fostering regional economic diversification, enhanced economic growth, and industrial restructuring in Canada during this decade and beyond. But for this to happen Canadian companies must have timely access to full information on project requirements and early participation in the bidding process."

The government's industrial objectives are designed to meet three needs: to immediately improve the access for Canadian companies to opportunities generated by projects within the Canadian market; to ensure that the Canadian industrial structure is developed to extract maximum benefits from projects and help establish expertise in areas that will permit Canadian firms to compete anywhere in the world; and to strengthen the capability of the Canadian engineering and construction industry.

The Industrial and Regional Benefits Guidelines for owner/sponsors of major projects set out the information they should provide and the steps they should take to meet the government's expectations. The guidelines are aimed at ensuring that major projects will provide equal opportunity for Canadian participation, which will in turn result in optimum benefit to Canada in terms of national and regional industrial development.

Mr. Gray said, "In drawing up and applying these measures, the federal government fully recognizes our international trading obligations. These initiatives will apply equally to all firms operating in Canada."

The interdepartmental Committee on Industrial and Regional Benefits, with the secretariat support of the Office of Industrial and Regional Benefits, will play an important role in the administration of the industrial benefits provisions of Bill C-48 "The Canada Oil and Gas Act". The Committee continues the work of the Advisory Committee on Industrial Benefits, which it replaced, but with a strengthened capability.

More new foreign banks

Since the new Bank Act took effect in December 1980, a total of 47 foreign bank subsidiaries have been authorized in Canada, an increase of 36 since the last issue of the *REVIEW* was published. According to the Department of Finance, a further group of foreign banks is expected to be established in the first half of 1982, bringing the total to 60. About half of these are expected to be conversions of non-bank financial corporations already operating in Canada, and the other half new incorporations.

Changes relating to the National Energy Program

Following a series of consultations by senior officials with a representative group of business people and professionals, a number of modifications have been made to the means of measuring Canadian ownership rates and control status for purposes of the National Energy Program.

These changes are aimed primarily at reducing the administrative tasks associated with the program, thereby facilitating compliance with it. Some rules will apply in the first year only, while others will apply on a continuing basis.

For example, the definition of "small applicant", a continuing rule, has been amended to permit relatively small businesses in the oil and gas sector to apply for a Canadian ownership rate certificate with a minimum of paperwork. This easing would be effected through raising the size thresholds for firms that would be entitled to qualify as small applicants. Second, the rules respecting the treatment of securities that may be converted into corporate shares, such as convertible shares and debentures, as well as warrants, rights and options, would be adjusted so that fewer applicants would be required to trace the ownership of such securities in measuring their Canadian ownership rate than had been previously planned.

For further information, contact the Petroleum Monitoring Agency, P.O. Box 4514, Postal Station "E", Ottawa, Ontario K1S 5B5.

Real capital spending up in 1982

Real capital spending in Canada may increase by about 9 percent in 1982 over the 1981 level, according to the October 1981 Department of Industry, Trade and Commerce (now Department of Regional Industrial Expansion) Survey of Business Capital Investment Intentions of Large Firms. The approximately 300 large firms responding to the survey indicated planned new plant and equipment expenditures of about $35 billion in constant 1981 dollars, an increase of about $3 billion over 1981.

The survey also showed that:

- Capital spending by manufacturing firms is expected to drop slightly in 1982.
- Non-manufacturing sector capital spending is expected to increase by about 13 percent over 1981.
- The Atlantic region, the Prairies and British Columbia are areas of strength, with expected percentage increases above the national average.
- In 1982, sales are expected to increase by about 14 percent in current dollar terms, or about 2 percent in real terms.

After adjustment, the survey results suggest that for 1982 actual or realized business spending on new plant and equipment (excluding housing) for all businesses in Canada may be up 2 to 3 percent in real terms over 1981. (Adjustment is required because the survey does not cover smaller firms, investments in housing or agriculture, direct government outlays, etc.) This compares with estimated increases for previous years of 5 to 7 percent for 1981, 8.6 percent for 1980, and 12.1 percent for 1979.

Capital expenditures of selected large companies* for 1981 and plans for 1982 — Canada (Constant 1981 $ Millions)

	1981 Reported in Oct. 1981	1982 Reported in Oct. 1981
Industry		
Food & Beverages	401.1	384.3
Forest Products	2,055.5	1,950.2
Primary Metals	1,668.7	1,637.6
Chemicals	1,155.0	1,525.0
Transportation Equipment	1,362.2	802.5
Other Manufacturing	1,357.7	1,593.5
Total Manufacturing	8,000.2	7,893.1
Mining Companies	2,143.2	2,443.9
Oil & Gas Companies	7,270.7	9,078.7
Oil & Gas Pipelines	1,915.6	2,131.8
Transportation & Storage	1,976.1	1,992.2
Communications	2,823.8	2,939.0
Electric Utilities	6,879.2	7,216.7
Trade, Finance and Other Commercial	1,180.8	1,475.0
Total Non-Manufacturing	24,189.4	27,277.3
TOTAL	32,189.6	35,170.4

*Only the 279 firms that reported for the April and October 1981 surveys are included.
Source: Department of Industry, Trade and Commerce

Canada's advanced-technology industry

by Marie Plante

When analysing the advanced-technology industry, one immediately tends to look at the most obvious technologies within the industry, such as computer applications, microelectronics, fibre optics, lasers, biotechnology and so on. With such an approach, however, one can get lost in a maze of specialized activities and lose sight of the heart of the matter: research and development (R&D).

Although no one precise definition of the advanced-technology industry has been agreed upon, organizations such as Statistics Canada have developed a number of data bases that could lead to a definition. In its studies the Ministry of State for Science and Technology (MOSST), which relies on Statistics Canada data, has used certain indicators, such as the ratio of R&D spending to sales, to establish which industrial groups belong to the advanced-technology category. MOSST has found that regardless of the indicator used, the industrial profiles obtained are consistent.

The National Research Council (NRC), the Canadian government research organization, uses a definition based on the ratio of engineers and scientists to all employees, a good indicator of a company's potential to create, adapt or modify new advanced technology. The NRC's specific threshold is three to four engineers or scientists per 100 employees. This definition excludes companies that may be included in an advanced-technology industrial category but do not depend for success on their in-house technological capability. Thus, using the NRC's definition, Canada's advanced-technology industry comprises approximately 1,000 companies that are responsible for 80 to 90 percent of all industrial research and development in Canada. Within this group are 200 companies with at least 10 scientists or engineers for every 100 employees, that concentrate their activities in the aerospace, computer-electronics, pharmaceutical and petrochemical products fields. The advanced-technology industry as a whole, however, includes significant parts of industries such as pulp and paper, chemical products, primary metals, transportation, scientific instruments, food processing and industrial services. So defined, Canada's advanced-technology industry accounts for 10 percent of the gross national product.

In terms of the balance of trade, Statistics Canada data indicate that in 1979 Canada registered a $7-billion trade deficit in advanced-technology products (inorganic chemical products, machinery, aircraft and parts, electrical products, scientific instruments and office machines). However, Canada's exports of these products have increased steadily, from $1.6 billion in 1970 to $6.7 billion in 1979, a reflection of the growing dynamism of the industry.

In fact, Canada has become a world leader in several advanced-technology fields. In particular, it has a reputation for excellence in telecommunications and satellite systems, as shown by Canadian accomplishments in fibre optics and telephones, development and application of high-frequency satellite systems, and the manipulator arm carried by NASA's space shuttle Columbia. Numerous companies specialize in the office equipment field, producing a variety of data and text processing systems. In addition, Telidon, an interactive television system developed in Canada, uses the world's most advanced videotext technology. In aerospace, Canada has carved an important place in international markets for her short takeoff and landing (STOL) aircraft, private business jets, small turbine engines and a wide variety of electronic systems. Canadian technological strength in mining, geophysics, commercial explosives and underground excavation equipment may be less well-known, but is also considerable.

Structure of the industry

In contrast to most industries, the advanced-technology industry is active in all economic sectors. As mentioned earlier, the element common to advanced-technology companies, be they in resources, manufacturing or services, is research and development.

The largest private industrial research and development company in Canada is Bell-Northern Research (BNR). Owned by Northern Telecom and Bell Canada, BNR earmarked $165 million in 1981 for the development of new telecommunications

Marie Plante is editor of L'investisseur étranger.

and computer products. It has more than 2800 employees, of whom about 1700 are scientists, engineers, industrial designers, technicians and other professionals, and it supports the manufacturing and service functions of Northern Telecom and Bell Canada through its design and technology research.

With combined total revenues of $6 billion in 1980, the Bell Canada group is one of Canada's largest enterprises, and a prime example of a fully integrated advanced-technology enterprise. Bell-Northern Research carries out research in the areas of activity of its owners. Northern Telecom manufactures and markets a wide range of telecommunications equipment, digital transmission and switching systems and information processing systems and equipment destined for the "office of the future". Bell Canada is, in turn, Northern Telecom's principal customer. In addition to maintaining telecommunications services and installations in six provinces and in the Northwest Territories, Bell Canada offers consulting services to numerous foreign telecommunications organizations. But the Bell Canada group is different from most Canadian advanced-technology companies due to its size.

In fact, most advanced-technology companies are small- or medium-sized. The Canadian Advanced Technology Association (CATA), whose membership includes more than 110 Canadian-controlled advanced-technology companies, has drawn a profile of the typical member. In the first year, the company realizes sales of $200,000; it grows at a rate of 100 percent a year for the first four years, and 50 percent a year thereafter. By the tenth year, annual sales surpass $18 million. Thus, after 10 years, sales bring in a cumulative total of more than $52 million, operating capital required amounts to $7.3 million, and R&D expenditures rise to $2.6 million.

Some of Canada's advanced-technology companies are found in or near Ottawa, the nation's capital, partly because historically the Canadian government has been a major client for technological businesses. In addition, a significant research and development infrastructure has existed for a long time in the national capital, including the National Research Council and Bell-Northern Research, respectively the leading public and private research organizations in Canada. Both have been important spawning grounds for enterprising scientists and engineers who have founded several advanced-technology firms in the Ottawa area.

One of the best known examples of rapid growth in Canada, Mitel Corporation of Kanata (near Ottawa), was founded in 1973 and now has 4200 employees in 12 factories and 38 sales offices in Canada and abroad. In 1975 Mitel's sales were $300,000, but for the fiscal year ending in February 1981, they had risen to $111 million. Estimates for the last fiscal year are $200 million. The company, whose products include integrated circuits, is among the world's largest manufacturers of PABX (private automatic branch exchange) telephone systems.

Numerous other companies have experienced similar growth and have been successful in international markets. One such company, Systemhouse Ltd. of Ottawa, a specialist in the design of computer systems and software, has opened nine subsidiaries in the United States and expects to have 30 by 1983. Lumonics Inc. of Kanata, the largest Canadian laser manufacturer, specializes in pulsed gas lasers. One of its contracts, with the European Economic Community, is for food labelling codes. Comterm Inc. of Montreal manufactures microprocessor-based display terminals for the data transmission industry. One of its principal product lines is the object of a contract with Saudi Arabia that runs until 1983. AES Data Ltd. of Montreal produces two distinct types of text processing system, employs more than 2000 people in Canada and abroad, and sells its products in more than 50 countries.

Other examples include Develcon Electronics Ltd. of Saskatoon, Saskatchewan, whose products include limited distance data transmission devices (modems) and microprocessor-controlled data transfer equipment; Gandalf Technologies of Manotick, Ontario, a group of three data communications companies; Epitek International of Canada of Kanata, which manufactures thick-film resistor networks and chip hybrid microcircuits; Leigh Instruments of Ottawa, a specialist in avionics which also produces air traffic control systems, frequency control devices and optical character recognition systems. These are but a few examples.

A trend seems to be emerging in small- and medium-sized advanced-technology companies. In an effort to take advantage of economies of scale and to become more competitive, they are forming consortiums for the realization of specific projects. For example, Canadian Education Microprocessor Corp. was established to design and manufacture a microcomputer for the educational market. OCRA (Office Communications Research Associates), a group including, among others, Gandalf, Mitel, Nabu Manufacturing Corp., CN-CP Telecommunications, and cable companies, operates in the "office of the future" equipment market.

Another large group of companies, ones that do not fit the CATA profile, rounds out the picture of the advanced-technology industry. Some of them even approach Bell Canada in terms of size. Their activities include pharmaceutical and chemical products, food, pulp and paper, electrical machinery and aerospace. A number of these specialize in biotechnology, a field that may one day rival electronics in industrial potential.

Major R&D performers in Canada

	$ millions[a]	% of sales	Principal field of activity
Bell Canada[b]	183.7	3.5	communications
Pratt and Whitney	47.0	10.2	aerospace
Canada Development Corporation	35.8	1.7	various (holding company)
Alcan Aluminum Ltd.	32.8	0.6	aluminum
Imperial Oil Ltd.	32.5	0.5	petroleum
Gulf Canada Ltd.	30.0	1.0	petroleum
Control Data Canada	18.5	14.7	data processing
CIL Inc.	17.0	1.9	chemical products
Canadian General Electric	16.2	1.2	electrical and electronic products
Inco Ltd.	16.0	0.6	mines
IBM Canada	15.0	1.2	data processing
CAE Electronics	12.5	37.9	electronic products
Canadian National	10-15[c]	0.3-0.5	transportation and communications

[a] 1979 figures
[b] Including Northern Telecom
[c] Estimate
Source: Ministry of State for Science and Technology

Computer industry

Any review of the advanced-technology industry must include the computer industry. Computer applications support the most diverse industries, from forest products to transportation, from mining to the "office of the future".

According to the results of a survey by Evans Research Corp. of Mississauga, Ontario, annual revenues of the Canadian computer industry exceeded $4 billion in 1980. In 1975, these revenues had been just $1 billion, or 0.6 percent of GNP. The industry experienced annual growth rates between 17 and 25 percent over the last five years, and in 1980 accounted for more than 1.4 percent of GNP. In the text processing and small business computer sector, revenues rose 36 percent over 1979 to $428 million in 1980, perhaps due to the growing popularity of "office of the future" equipment.

Among computer applications is CAD/CAM technology, in which design and manufacturing are computer-assisted. CAD/CAM techniques are particularly important in light of the present state of Canadian manufacturing industries. In fact, over the next decade, manufacturing industries must increase their productivity enough to maintain traditional markets and acquire new ones, despite reduced tariff protection and growing foreign competition. CAD/CAM technology is proving to be an important, if not essential, tool in the effort to achieve a level of productivity that will permit the Canadian manufacturing industry to be internationally competitive. (A more detailed description of one CAD system can be found in the article "An international licensing agreement for Canadian technology" in this issue.)

Common challenges

Advanced-technology companies face a number of special challenges. For example, to be viable, an advanced-technology company must offer a world-class product or service that is not just competitive, but the best of its kind. Because the Canadian market is too small for products and services of this complexity and specialization, it is essential for advanced-technology companies to turn to export markets, to build recognition for and to market their products in the highly competitive international marketplace. CATA member companies export an average of 70 percent of their production. This export orientation is even more evident in the aerospace industry, where 88 percent of sales in 1981 were outside Canada.

One of the most pressing problems for the industry is a shortage of skilled manpower which threatens the industry's growth. This has led to consultations between government, industry and educational institutions aimed at establishing training strategies. Not only do advanced-technology companies need scientists and highly-skilled technicians, they also need marketing people who have an intimate knowledge of the technology they are hired to sell.

Advanced-technology companies also face a special financing challenge, which corresponds directly to the nature of their activities, specifically the high risk associated with their ventures and the often considerable time lag between the research and marketing stages. Like other small businesses, start-up funds often come from personal savings, but with research and development costs added to capital and market development expenditures, this source of funds soon proves insufficient. Unlike other businesses, advanced technology firms can seldom obtain full financing from the chartered banks. For the risk capital they need, these companies must approach other financial institutions and venture capital investors.

In addition, because of their relatively small size and the large element of risk associated with them, advanced-technology companies do not have easy access to financial markets, although the huge success of a few such companies has helped to bring the financial community and the industry closer together. Studies have been undertaken to find ways of facilitating capital formation for smaller companies. While there are few advanced-technology companies whose shares are traded publicly, it is likely that more of them will appear on the financial markets over the next few years. Indeed, since 1979 more than six advanced-technology companies have had their shares listed on Canadian stock exchanges.

R&D and the government

Last year the Ministry of State for Science and Technology announced the Government of Canada's national research and development expenditure

The largest revenue producers in the Canadian computer industry

	Company name	Ownership	$ millions Total revenues 1980	$ millions EDP revenues[a] 1980
1.	IBM Canada Ltd.	U.S.	1,506.0	1,120.0
2.	Northern Telecom Ltd.	Can.	2,055.0	568.2
3.	Digital Equipment of Canada Ltd.	U.S.	163.7	163.7
4.	Control Data Canada Ltd.	U.S.	162.6	162.6
5.	NCR Canada Ltd.	U.S.	176.6	150.1
6.	AES Data Ltd.	Can.	155.0	147.3
7.	Sperry Rand Canada Ltd.	U.S.	124.0	124.0
8.	Philips Data Systems Ltd.	Netherlands	100.3	100.3
9.	Honeywell Ltd.	U.S.	260.5[b]	85.0
10.	Burroughs Business Machines Ltd.	U.S.	105.0[b]	83.0
11.	Canada Systems Group (EST) Ltd.[c]	Can.	77.9	77.9
12.	Datacrown Inc.	Can.	68.6	68.6
13.	Hewlett-Packard (Canada) Ltd.	U.S.	99.4[b]	49.7
14.	Xerox of Canada Ltd.	U.S.	484.2	48.4
15.	Mitel Corp.	Can.	43.4	43.4
16.	Amdahl Ltd.	U.S.	43.0	43.0
17.	B.C. Systems Corp.	Can.	40.2	40.2
18.	Computel Systems Ltd.[c]	Can.	38.1	38.1
19.	I.P. Sharp Associates Ltd.	Can.	35.5	35.5
20.	MAI Canada Ltd.	U.S.	35.0	35.0
21.	Memorex Canada Ltd.	U.S.	32.3	30.8
22.	Storage Technology of Canada	U.S.	28.8	28.8
23.	Gandalf Data Communications Ltd.	Can.	26.4	26.4
24.	Canadian General Electric	U.S.	N/A	26.0
25.	Olivetti Canada Ltd.	Italy	N/A	24.0

[a] Includes domestic, export and offshore EDP-related
[b] Estimated by Evans Research Corporation
[c] These companies merged in 1982
N/A Not available
Source: Evans Research Corporation

Canadian industry excels in the design and construction of telecommunications satellites.

objective of 1.5 percent of GNP by 1985. The industry share of this target was pegged at more than 50 percent, and the government share at 33 percent. Statistics Canada estimates that, in 1981, research and development expenditures in Canada totalled $3.5 billion, an increase of 16 percent over 1980. These expenditures represent 1.1 percent of GNP, the highest percentage since 1972.

Among recent government initiatives to encourage research and development are: the provision for funding a microelectronics centre in each province; a microelectronics information program designed to give all industrial sectors access to new techniques; and an additional $27.5 million for further development and marketing of Telidon videotext technology. In addition, the government has announced that it will add $132.1 million to the budget for activities in space, bringing its space-program commitment to $475.8 million between 1981and 1985. These funds will reinforce and promote the Canadian contribution to telecommunications, remote sensing and technological growth, as well as enhance Canadian participation in large European space projects. Federal expenditures on R&D, not counting fiscal expenditures, will approach $1.5 billion in 1982-83. In addition, numerous programs of assistance for research and development have been put in place by the governments of Canada and the provinces.

Foreign control and technological development

Too often Canadian subsidiaries of foreign companies lack autonomy in decision-making related to research and development, which creates a dependence on parent companies for technology and limits opportunities for innovation in Canada. This has resulted in the relatively low level of R&D carried out by foreign-controlled businesses in Canada. For this reason the government included a criterion in the Foreign Investment Review Act that deals with the effect of foreign investments on technological development, innovation and product variety in Canada. It also included a criterion that deals with the compatibility of foreign investments with national and provincial industrial and economic policies, which among other things give a high priority to R&D.

Among the undertakings that have been offered by investors are the support and expansion of Canadian R&D facilities and the establishment of new ones. Others ensure that the results of research and development carried out by Canadian subsidiaries can be effectively used in Canada. Often, this is done by means of world product mandates which give Canadian subsidiaries exclusive responsibility for the research, development, manufacturing and world-scale marketing of products or product lines.

According to FIRA statistics, to the end of December 1981, foreign investors had undertaken to invest more than $169 million for R&D in Canada. This does not include R&D commitments that are a function of sales levels or gross receipts, or the costs associated with using the research facilities that the investors have undertaken to establish.

To remain internationally competitive, Canada must continue to develop its capacity for technological innovation. Laser technology, fibre optics, microelectronics and so on are increasingly being applied in every industrial sector because they are clearly the building blocks for Canada's industrial future.

The challenge, the opportunity in Canada's offshore

by Bridget Madill

A new, advanced-technology industrial sector is emerging to take up the challenge of exploiting Canada's offshore resources. Ocean industries, those that provide goods and services for offshore commercial and scientific activities, can include any firm that makes equipment or provides a service that could be used in the oceans. They span the range of manufacturing, service contracting and consulting companies, but exclude marine surface transportation and traditional fishing activities.

Ocean industry firms are mainly small, privately-owned, advanced-technology, capital-intensive Canadian companies that sell a low volume of a wide variety of products and offer a broad range of services. They are often undercapitalized and heavily dependent on export markets. Most ocean firms are young — few existed before 1970 — and have an emphasis on the supply of goods and services for offshore oil and gas exploitation.

The problems of all advanced-technology industries, high development costs, large risks, long lead times from concept to sale, shortage of skilled workers, and difficulty in attracting equity or debt financing, characterize ocean firms. With oil and gas multinationals and governments as the major customers so far, developing product credibility with a wider range of buyers and selling to a global market are challenges that must be met by the fledgling ocean industry company.

There are three categories of ocean industry companies. Core companies, which usually produce one specialized product or range of products or services, are almost entirely dependent on the ocean market. Secondary companies are partially dependent on the oceans, and often have developed their marine products or services from their land-based lines. Tertiary companies are those that only incidentally sell products and services, like rope and winches and helicopters, into the ocean markets. Unlike most core companies, secondary and tertiary companies do not necessarily provide advanced-technology products or services.

The Canadian ocean industry sector is a hybrid that does not fall neatly into the pigeonholes of any traditional industrial classification system. That means that statistics are at worst unobtainable, at best unverifiable, and usually not comparable. The lack of statistics collected under standard criteria makes traditional analysis of the industry impossible. However, despite the fact that they almost defy classification and measurement, ocean industries are real, and they are on the brink of an enormous expansion.

According to the 1978 report by the Sector Task Force on the Canadian Ocean Industry, sales by all Canadian ocean industry firms were probably less than $5 million in 1969, but by 1976 sales by core companies alone had grown to $176 million. The domestic ocean industries market, which has historically been too small to support development of Canadian ocean industries, is expected to grow substantially. From $750 million in 1980, according to the Canadian Ocean Industries Association, the domestic market is forecast to reach $5 billion by 1990. The world market, estimated at $8 billion in 1977, is expected to reach $20 billion by 1985. In 1976, according to the Sector Task Force, 86 percent of the manufacturing output of Canada's ocean industries was exported, while almost all services were related to the domestic market. Another indicator of imminent growth is the forecast by the Canadian Shipbuilding and Ship Repairing Association that $33 billion in vessels and floating equipment, which includes more than ocean-industry products, will be required by the oil and gas industry in Canada's offshore between 1982 and 1990.

Growth is also apparent in terms of the number of companies engaged in the Canadian ocean sector. In 1976 there were 180 core and secondary companies; by 1981 there were 240 according to the Canadian Ocean Industries Association. Over the same period, the number of core companies rose from 40 to 50. The number of tertiary companies is difficult to determine.

About 70 percent of the ocean industry jobs require skilled or professional employees. The Sector Task Force on the Canadian Ocean Industry estimated that development of Canada's ocean industries could create between 20,000 and 30,000 direct and 150,000 indirect jobs by 1990, numbers almost incomprehensible in relation to a sector that employed just 3,200 in 1976. Based on a formula of 20,000 jobs per billion dollars of investment, this 10-fold growth now seems assured: capital expenditures for offshore petroleum exploration in Canada reached $326 million in 1980, according to the Petroleum Monitoring Agency, a 58 percent increase over 1979.

It is obvious from these statistics that a new industry has sprung up in just over a decade. The Canadian ocean industry is

Bridget Madill is editor of the Foreign Investment REVIEW.

expected to continue to grow at an ever-increasing pace for the foreseeable future.

The history

With nearly 60,000 miles (96,000 km) of island and mainland coastline and with lands reaching north into a sea four times the size of the Mediterranean, Canada's last frontier is perhaps her largest. In fact, Canada's is the longest and least populated coastline of any nation in the world. But the offshore is not only her biggest frontier, it is also her most formidable and least understood.

Before the entry of oil and gas companies to the offshore, Canada's involvement with the ocean was one of fundamental research such as ocean-bottom mapping, largely undertaken by government agencies. As something was discovered, it had to be measured. This measurement required appropriate instruments and a suitable platform from which to work. Thus, advances in science were usually intermeshed with advances in technology. The advanced technology in turn often revealed other anomalies that had to be measured, and new instruments were required to do the measuring. Before the oil and gas explorations offshore, government was virtually the only technology-using body operating offshore and therefore almost the only market for ocean technology; it remains a major market today.

By the beginning of the 1970s, it was widely recognized that Canada and the rest of the world would soon need the energy resources locked in the still largely unknown subsea lands. Canada realized that to benefit from activity in her offshore regions and to gain energy self-sufficiency, she had to develop and control the means of exploiting those resources. In 1973 an oceans policy was announced. It was designed to stimulate offshore development, to promote Canadian participation in industrial and technological aspects of the exploitation of the oceans, to encourage a wide range of marine science and technology, to help Canada achieve excellence in operating in ice-covered waters, and to maintain a current information base about Canada's offshore resources.

Coupled with the increased interest in exploiting her offshore resources, in 1977 Canada declared a 200-mile ocean management limit, mainly to control overfishing off the east coast. This meant that more Canadian fishermen and others would find it profitable to work farther out, and some ships and equipment being used offshore would become obsolete due to their limited capacity and limited range. This in turn meant that there were new opportunities for developing ocean industries. It also meant that enhanced navigation and location techniques would be required to meet the challenges of some of the world's roughest seas infested with ice. At the same time, the increased interest in searching out and exploiting offshore oil and gas presented related challenges. For example, in the Arctic much of the bottom has not been mapped. It was only in November 1981 that the Canadian research ship *Hudson* completed the first detailed survey of part of a deep-draught tanker route through the Beaufort Sea, where much of the Arctic oil exploration is taking place.

For a long time, government was not only the main customer for ocean technology, but also the engineer, builder and supplier. Agencies like the Bedford Institute of Oceanography and the Nova Scotia Research Foundation in Nova Scotia, the Institute of Ocean Sciences in British Columbia, and the Canada Centre for Inland Waters in Ontario for many years spearheaded ocean exploration and ocean technology. With the potential undersea wealth of oil, gas and other minerals and the increasing feasibility of farming the ocean, that orientation had to change, to provide the kinds of information needed for resource exploitation at a pace accelerated by the growing urgency of resource needs. Government, in conducting basic research, had little need to do the engineering on the properties of materials in the ocean environment. Industry, on the other hand, undertook engineering research to overcome new obstacles as they were found. Now, however, the engineering needs and challenges are so urgent that industry alone cannot supply all the necessary products and techniques fast enough to meet them.

Canada decided to attempt to ensure continuing cooperation for the advancement of technology.* It is now policy that development of technology for government in all sectors will be contracted out to private-sector firms. And there is a program that works in reverse — government will help to develop technology proposed by industry. Industry needs government information and research. Government needs industry ideas and experience, and the universities need the support and cooperation of both.

In the early research stage and in the current oil exploration and development phases, equipment could be set up on drifting ice and vessels could run from icebergs and storms. But now an oil production phase has begun. The Petroleum Monitoring Agency reported $19 million in capital expenditures for offshore oil production in Canada in 1980. Now the platforms will have to be anchored securely. Now the vessels and the people will have to stay and face the ice and storms, because to be economically viable, the oil-producing industry must be able to operate year-round. New technologies that were not essential before the reserves were proven will now have to be developed — and quickly.

The technology

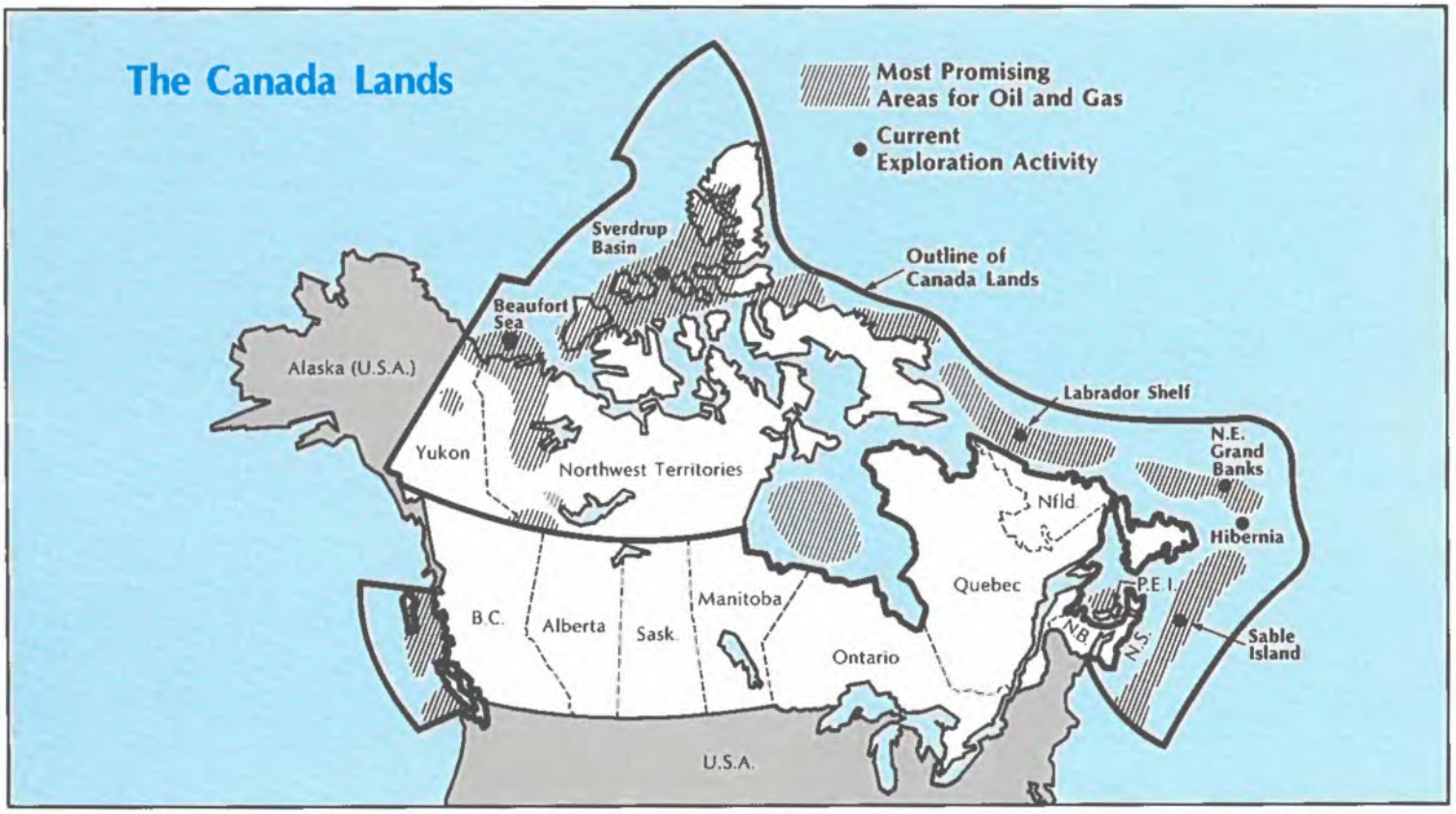
Ocean industries and offshore resource development are very advanced and highly competitive internationally, and much that is available can be adapted to Canadian requirements. Britain's experience in the North Sea has proven valuable to Canada's ocean pioneers, as Houston platform technology aided North Sea production efforts. But while North Sea technology is largely applicable to working at the Sable Island gas field off Nova Scotia or to the Hibernia oil discovery off Newfoundland, it is not transferrable to the northern ice-infested waters off the Labrador coast or in the Beaufort Sea.

No one else, anywhere else, has worked with comparable ice and weather conditions. Off the east coast are the icebergs; in the north the pack ice; and in the Beaufort Sea exceptionally cold water that freezes on the ships and weighs them down as they navigate through fields of undersea icicles called pingos. There is no precedent for Canadian industry to follow, and therein lies Canada's greatest opportunity.

Canada has already developed major capabilities in the offshore: hydrographic seismic surveys, oceanographic surveys, subsea vehicles, cold water and ice technology and subsea well-completion techniques. In fact Canada has one of the world's largest concentrations of oceanographic research facilities in the Halifax-Dartmouth area of Nova Scotia. Canada has excelled in receiving and processing remote sensing information transmitted by the American Landsat satellite, information that can be used to monitor large-scale ice moment, keep track of offshore oil rigs, and watch fishing and pollution in the 200-mile management zone. Despite the fact that semi-submersible and jack-up rigs, built in shipyards in Nova Scotia and Quebec for example, have been successfully exported, Canadian companies may not be able to compete on a world scale in producing large items like platforms, but they already have a foothold in the supply of specialized, and usually advanced-technology, equipment.

There are Canadian ocean industry companies like Meyer Systems Incorporated of Vancouver, with 1981 projected sales of $100,000, which produces an ocean bottom tracker and plankton counter. Leigh Instruments started in 1961, went public in 1965, and now with about 1300 employees worldwide and annual sales in the area of $50 million, is known for its sea traffic management system. CTF Systems Inc. has 30 employees who make dive support instrumentation. Canadian Applied Technology, a division of Arrowflight Holdings Limited, makes

**A wider range of government-industry co-operation programs are described in "Canada's advanced-technology industry" and "Assistance to industry for research and development" in this issue.*



hydrographic data logging and recording systems.

It would be impossible to list all the ocean industry companies operating in Canada, but among the familiar names are Hermes Electronics, Internav Limited, Sea Nav Ltd., Seimac Ltd., Atlantic Marine and Diving Co. Ltd., Artec Canada Limited, Canadian Oceanic Services Inc., Fathom Oceanology Limited, Pallister Resource Management Ltd., and The DALCOR Group.

Much of the high-technology equipment has been developed as a result of some level of government-industry cooperation. An instrument called the BATFISH is one of the best known examples of Canadian offshore technology. Developed at the Bedford Institute of Oceanography, and now manufactured under licence by Guildline Instruments of Smiths Falls, Ontario, the BATFISH is a towed device that can be used to measure water temperatures, plankton levels and salt content of sea water. "Flying" in a sawtooth pattern from the surface to a depth of 300 metres, the instrument makes possible continuous measurement from a moving ship. Guildline, one of Canada's "older" ocean companies, was established in 1951 as a subsidiary of a British company and became independent in 1957. With more than 70 employees and more than $3 million in annual sales, the company also markets other products overseas, like a laboratory salinometer and its profiling system.

At the request of the Bedford Institute of Oceanography, the Nova Scotia Research Foundation (NSRF) developed an electrical slip ring to be used with a fish counter. The slip ring was later adapted for use in a deep-diving system, making it possible to bring the power, communications and gas umbilical cord down to the divers, and possible to reel the cord up on a winch. Then NSRF developed a gas slip-ring that would pass helium and oxygen. After creating product credibility through trade shows, NSRF transferred the gas slip-ring technology under licence to a new Nova Scotia company, Undersea Equipment Limited, which today sells advanced-technology diving system components around the world.

The result of a partnership of government and industry, a program called SEABED uses a deep-tow high resolution seismic system developed in 1974 by Huntec (70) Limited of Toronto to develop methodology for the geological mapping of the seabed and 200 metres into the earth below. Huntec is a typical Canadian ocean company — about 65 percent of its estimated $3 million in annual sales is exported. The program is just one of many projects that contribute information to data handling systems like the one being developed at the Bedford Institute which will make information available to all users.

The Newfoundland Oceans Research and Development Corporation (NORDCO), a provincial Crown corporation, was the first company in the world to lasso a million-ton iceberg, proving that it is practical for a small tugboat to steer icebergs away from drilling rigs to ensure the safety of people and equipment. An essentially independent company that began with provincial and federal government financing, NORDCO is a front-runner in all aspects of ice investigation, with researchers spending weeks on vessels locked in ice to learn how to predict the patterns of movement of ice floes and icebergs. NORDCO also provides an ongoing weather and ice-location service to workers off Canada's east coast.

Research and development facilities, bringing university, government and industry together, are essential to the fledgling ocean industry in Canada. In recognition of this, in Newfoundland, a $48-million world-class Arctic Vessel and Marine Research Institute is expected to be operational in 1983-84. To be built by the National Research Council at the Memorial University campus in St. John's, the institute will include model test basins for simulation of offshore and ice conditions. It will permit expansion of government and industrial research and design of vessels and other marine structures.

Already in place at Memorial University is the Centre for Cold Ocean Resources Engineering (C-CORE) which has conducted studies into the effect of oil spills on ice, for example. C-Core has discovered that the value of using airborne radar to examine icebergs is limited because the radar signals scatter in the ice, but airborne radar can be used to predict where icebergs can be expected to scour the ocean floor. The risk of iceberg scour is great in much of Canada's offshore, presenting a threat to undersea cables, pipelines, well heads and other structures.

Other products of international caliber developed through Canadian industry-government cooperation include fish

inventory sonars, electronic navigation equipment, side-scan sonar, sonar-sensing data-collecting buoys, an electrically-powered hardrock drill capable of obtaining core samples from seabed 3,000 metres below the water surface, ice-breaking ships, wave recorders, submersibles, and aerial bathymetry technology to name just a few. Currently being developed are technologies to improve navigation through ice, to predict iceberg scour, to measure the effects of offshore drilling on the earthquake zones and the animal life of the Arctic, to use lasers to monitor ice, to lay pipe though ice to transport oil and gas to land (and possibly to bury it beneath the seabed), to determine potential environmental impact of offshore exploitation, and to determine how to regulate the use of materials in the oceans to ensure the safety of people and equipment working offshore.

The advanced-technology ocean equipment industry will be an integral part of offshore development, producing the multitude of specialized equipment and instrumentation essential to any offshore venture. In addition, a range of support industries, the drafting, printing, rope-making, steel-fabricating, metal-stamping, plastics-moulding, food-catering and myriad others will all have an opportunity to support offshore activity, and to grow in proportion to the ocean ventures they will serve. It is the development of advanced technology to work with Canada's unique conditions, however, that will be critical to the establishment of a strong ocean industry sector.

Toward the future

Canada's offshore oil and gas potential has been the undeniable driving force behind the growth of her ocean industries. In the Hibernia discovery, the National Energy Board has accepted 50 million m^3 of crude oil reserves as "established" or proven and has projected that additional reserves of up to 100 million m^3 will be proven in the future. Estimates of recoverable conventional oil reserves in the Arctic range as high as 8 billion m^3, almost five times Britain's proven oil reserves in the North Sea, although as of June 1981, Canada's National Energy Board did not consider any oil reserves "established" in the Arctic. However, marketable natural gas reserves in the Arctic (which includes the Mackenzie Delta, Beaufort Sea and Arctic Islands) have been established at more than 460 billion m^3 by the National Energy Board and at more than 580 billion m^3 by the Canadian Petroleum Association. The extent of other mineral reserves under Canada's oceans and the potential of cultivating instead of simply harvesting the ocean's fish and plant resources off the east coast are just now being measured. When proven exploitable, they too will offer opportunities for ocean industry companies.

Although Canada has strengths in the fledgling ocean sector, there are problems as well. For example, to date there has been little significant Canadian technical participation in the offshore due to the high level of foreign ownership in Canada's energy sector and to the tendency for multinationals to source equipment and services from their traditional suppliers regardless of the availability of competitive items in the host country, or to depend on foreign-based parent firms for research and development. In fact, in December 1981 the Honourable Herb Gray, Minister of Regional Industrial Expansion (formerly ITC), said that an estimated 50 percent of all equipment and materials being used in offshore and frontier petroleum exploration projects is imported, and that refining and processing projects import 100 percent of their engineering services. A 1981 study, *Industrial Development and the Atlantic Fishery*, found that over 90 percent of Atlantic Canada's electronic fish-finding apparatus (a $4-million to $5-million market each year) is imported. The study also forecast a 100 percent increase in the market by 1990. In only four of the 30 fisheries-related product categories listed in the study was Canada a net exporter. The four were communications, navigation instruments and parts, ships and boats, and hoisting machinery and parts. Overall, Canada's fishing industry spends more than $200 million on equipment each year, much of which is imported. Organizations like the Canadian Ocean Industries Association have expressed hope that government initiatives such as the National Energy Program and the provisions of Bill C-48 "The Canada Oil and Gas Act", which recently was passed by the House of Commons, will help to change this import propensity to the benefit of Canada's ocean industries.

Dependence on imports may be due to the fact that the problems and costs of technology development for the offshore, whether destined for fundamental oceanography, industrial exploitation or environmental protection, are generally too high for any one company to bear, and unacceptably inefficient to duplicate. Cooperation must increasingly be the watchword of a Canadian ocean industry sector.

That the Government of Canada recognizes the importance of moving quickly in developing offshore capability is demonstrated by the designation of oceans as an area of national importance in which university scientists can obtain funding under a program of the Natural Sciences and Engineering Research Council. In addition, according to the Ministry of State for Science and Technology, in 1981-82 the Canadian government is expected to spend $63 million for oceans science alone, an increase of almost $7 million over the 1980-81 level. This amount does not take into account expenditures for ocean-related aspects of transportation, environmental protection, food and energy.

Government-industry-university cooperation will continue through the many incentive and support programs that are already in place. But other joint action will likely be taken. For example, in both British Columbia and Nova Scotia, industrial parks to be occupied exclusively by ocean industry firms are being set up beside government ocean research facilities connected with universities. The former Department of Regional Economic Expansion (now part of the Department of Regional Industrial Expansion) estimated that in the Atlantic region alone more than 2,000 scientists, technicians and support personnel are engaged in government, university and commercial projects costing about $35 million a year.

It has been said that the exploitation of offshore hydrocarbons will be risky. Northern Baffin Bay, for example, is an earthquake zone. Will subsea drilling prompt tremors? Ocean bottom seismometers, when in place, will tell. Ice scour will be a never-ending concern for subsea production facilities, vessels and pipelines. But man-made facilities will not be alone in facing hazards. If the patterns of ice movement are disturbed by "steering" icebergs or by the presence of artificial oil production islands, what will the environmental impact be? How will the oceans respond to the vibration and pollution of greatly increased surface and subsurface traffic?

Because we know relatively little about the offshore and Arctic environments, it is essential that potential impact of resource extraction on the environment be carefully evaluated. One of the groups that will be looking at such impact is the Beaufort Sea Assessment Panel, set up in the early part of 1981. The task is immeasurable, its importance incomparable, the difficulties almost insurmountable. The instruments to measure the effects of offshore intervention have not yet even been conceived, let alone tested. The creation of technologies to probe and correct adverse effects on the environment is another of the challenges, and one of the opportunities, emerging from Canada's offshore.

In frontier oil and gas exploration $48 billion is expected to be invested by 1990 according to a study published by the Canadian Institute for Economic Policy in 1980. This is an unprecedented opportunity. The oil and gas industry invested only $646 million between 1967 and 1980 off the east coast, according to the study, and just $2.8 billion between 1951 and 1980 in the Arctic Islands and the Northwest Territories. Despite her embryonic capabilities, Canada must seize this opportunity to prove herself a world leader in ocean technology and ocean industries. The next decade will be critical for Canada's ocean industries.

An international licensing agreement for Canadian technology

by Jack McFadden

One of the most debated issues related to technological development in Canada is the transfer of technology from foreign-controlled multinationals to Canadian companies. Little attention has been paid, however, to technological transfers in the opposite direction, that is from Canadian-controlled companies to foreign firms. In this article, the author describes one such transfer involving Canada's largest private research and development organization, Bell-Northern Research Limited and one of the world's largest advanced-technology firms, International Business Machines.

Is it good business for a major research and development company to spend $10 million developing a technology to make it more competitive, and then sell the know-how to its competition? Bell-Northern Research Limited (BNR) thinks that under the right circumstances it can be. The company has recently completed a deal that will ensure that BNR technology is offered to potential competitors throughout the world. The deal is with International Business Machines (IBM) and the technology is a computer-assisted design system used for designing printed circuit boards.

Bell-Northern Research is a highly successful Canadian research and development organization. Its five major installations in Canada employ more than 2300 people. Two other major installations in the USA have 560 employees.

BNR is 70-percent-owned by Northern Telecom Limited, the parent company, and 30-percent-owned by Bell Canada. Northern Telecom, 55-percent-owned by Bell Canada, is a Canadian manufacturing company with 32,000 employees, that produces large telecommunications switches and other electronic communications products.

BNR was established in 1971 to support Northern Telecom and Bell Canada in design, development research, long-range planning and systems engineering in all fields of communications. It is not required to show a profit and indeed any profits that might be generated by its efforts on behalf of Northern Telecom are lost in the sales figures of the parent company's own products. However, BNR does have its own relatively small marketing division. Its activities before the recent technology sales were limited to selling BNR's research and development capability to customers other than Northern Telecom and Bell Canada, about $7 million worth of business each year.

BNR's prime interest in research and development contracts is in the knowledge it gains. The indirect value of what it learns from doing research for others is considered of potentially greater benefit than the revenue. The attitude toward the sale of its technology is just the opposite; licensing was added with the purpose of gaining both revenue and knowledge, but with the emphasis on revenue.

In part, it was the ready-made marketing structure of IBM that made the US company so attractive to BNR. IBM's Data Processing Division, with headquarters in White Plains, New York, has a large highly organized marketing capability extending around the world. A pioneer in computer and office equipment technology, IBM is still very much a leader in the field. Along with the computer hardware, it sells applications programs which, as the name implies, are ready-made programs that apply the computer's special qualities to specific requirements such as in design or manufacturing. It is a BNR computer-assisted design (CAD) system that IBM will market as a software applications package.

The technology that BNR is selling is a set of computer programs (software packages) used in the design and development of printed circuit boards (PCB). The PCB is the base and provides all the interconnections for scores of integrated circuits and other electronic components used in

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virtually all modern electronic equipment.

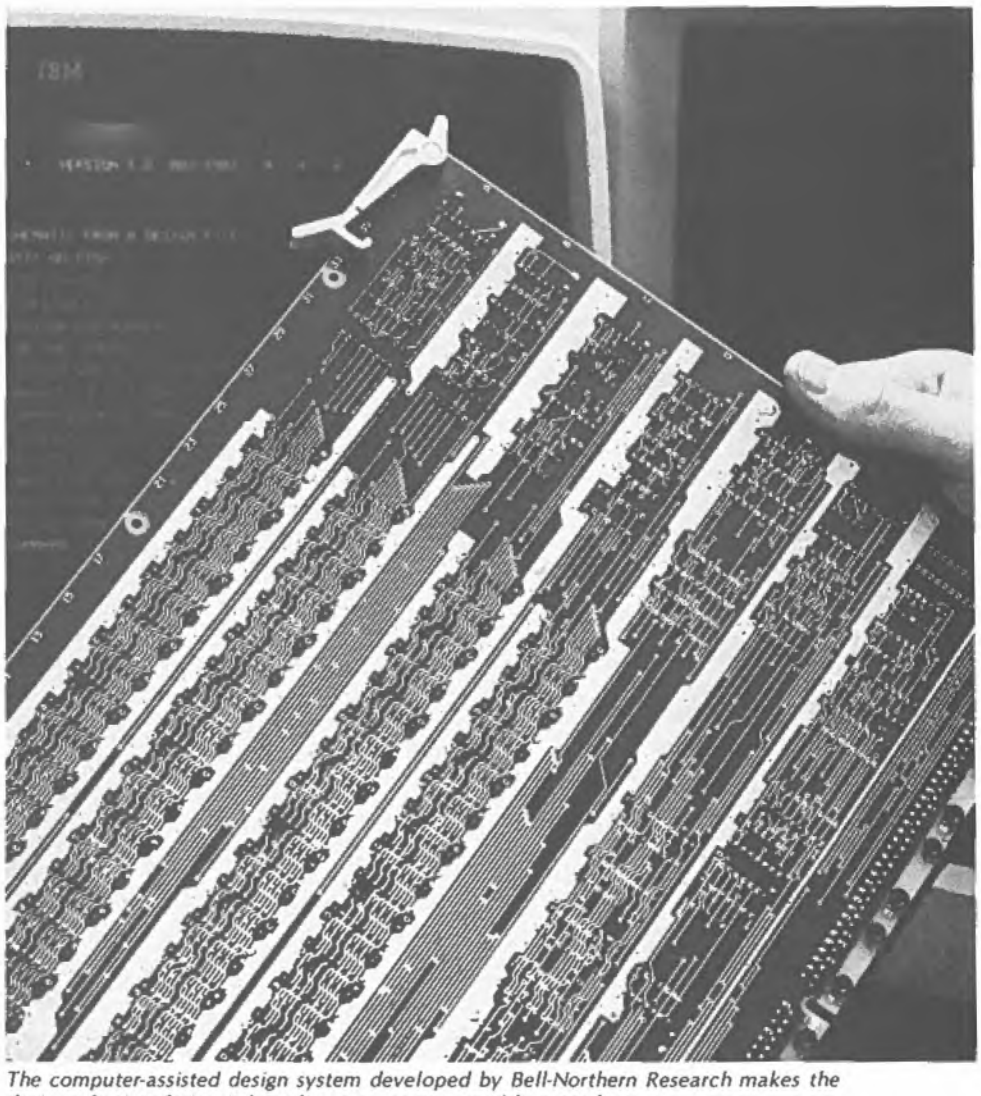
The interconnections on each board can number in the thousands. They consist of metallized pathways of precise lengths carefully separated from each other. The length of each path is critical because it affects the time it takes each electrical pulse to leave one device and arrive at another. Pulses must arrive at just the right time through each of these paths to preserve the timing relationships. Working to these rules results in a complexity of pathways that would make the most difficult maze seem child's play by comparison.

But there is yet another set of rules the designer must heed when designing the printed circuit board: the practical limitations of manufacturing. Making boards like these is not easy. In some manufacturing environments, rejection rates can be as high as 30 out of 100, and the cost of correcting a fault at this stage can be 100 times greater than correcting it during the design stage. The greatest challenge, therefore, is to design the boards so that they can be realiably manufactured. This is where the real value of the BNR technology lies; their CAD system assists in designing PCBs so that this expensively high rejection and correction rate is greatly reduced.

The idea of computer-assisted design was applied in BNR as early as 1973, when the Ottawa installation began developing bits and pieces of such a system. Development of CAD on a large scale, however, is expensive. It was not until 1977 that a project came along of the size needed to support the development of a comprehensive circuit board CAD system.

The project involved the design of a new series of large telecommunications switching units called the DMS-100. To be manufactured by Northern Telecom, the DMS-100 would require the design and development of scores of new circuit boards. To retain a competitive edge in this field, BNR had to find ways to reduce the design and manufacturing time to get the DMS-100 on the market in the shortest time possible. So, in parallel with the development of DMS-100, BNR also developed COPES, Customer Optimized Product Engineering System, which was designed to work with a Digital Equipment Company computer. The acronym was appropriate: the aim of the system was to help the designer of a circuit board cope with all the hundreds of possible interconnections on each board while working within the limitations of design and "manufacturability".

According to Don Innes, BNR manager for Circuit Board Design Development, "The cheapest point to find and correct any error is during the design stage." He might have added that if the design can be done without building a physical model or touching a component, so much the better!



The computer-assisted design system developed by Bell-Northern Research makes the design of printed circuit boards more accurate and less costly.

COPES allowed the designer to design the board in the computer, capturing the design information as it developed, and automatically being reminded of the rules that applied to increasing the manufacturability of the board. Testing could also be done by a computer simulation of the board's design and the design revised as necessary. Finally the information would be captured more permanently in a data storage system. By 1979, the use of COPES as a design tool had extended to Northern Telecom where it controlled the design changes being made to the DMS-100 product line.

Although justified by the circuit board design application for the DMS-100 alone, BNR naturally looked for other possible uses for the complete COPES and its modular parts, most of which can be used in stand-alone applications. The digital logic simulation module, FLOGIC, found a valuable application in the BNR division that designs customized integrated circuits. These tiny devices contain the circuitry for hundreds of thousands of transistors and present problems as complex as those of any circuit board. Don Innes said he believes that with further development, the complete system in Ottawa will eventually provide direct input to numerically controlled machines in Northern Telecom's plant near Toronto on a computer-to-computer link.

The possibility of licensing other companies to use the technology was an early consideration. Northern Telecom had already made highly successful inroads into the tough European market by licensing its manufacturing technology.

BNR decided to license the right to use its COPES, not only for the direct revenue it would produce, but also for the feedback of information that would result from the external user's experience with the system. As fully committed as it was, however, the research company decided that it could offer COPES in whole or in part only on an "as is" basis. That is, it could not offer to modify the system or provide any other support to the customer.

Despite this restriction, during 1979 and 1980 nine right-to-use licensing agreements for the Circuit Pack Subsystem (CPS) of COPES were made with companies in Europe, the USA and Canada as well as two agreements permitting the

user to sub-license the CPS. In 1979 the rights to use the FLOGIC module were licensed to one company in the USA and to two companies in Japan.

Among those who approached BNR in 1978 was IBM. However, IBM wanted the system modified to be compatible with its own computers and wanted additional support that BNR was not prepared to supply at that time. By 1980 the Canadian company came to accept that if it wanted to widen its potential market, it would have to offer modification and support of the system. BNR officials readily admit that their decision was influenced by the potential for valuable feedback of technological information from a company such as IBM, although they insist this was secondary to making a healthy profit from an exciting business opportunity.

The deal with IBM was struck in 1980. It marked the first time that an agreement was reached to license the complete COPES system. Under its terms, IBM is licensed to use the system within its own organization and to sub-license the right to use the technology to other buyers. By 1981, COPES was made compatible with IBM computers and was renamed the Circuit Board Design System (CBDS). It was introduced to the world at large and demonstrated in New York City in June 1981 at an international conference of circuit board manufacturers, where IBM offered the CBDS software applications package and its computer hardware as a one-stop shopping arrangement.

The deal calls for IBM to do the marketing, administration, and all the "front-end" work. BNR supplies the documentation, some of the training and error correction (a second-line maintenance task). The cost of the BNR support is offset by BNR's share of the IBM royalty.

An interesting point is that the right to market the design system technology is not exclusive to IBM since other companies in Europe still have the right to sub-license parts of the system. However, IBM offers the only fully supported complete system.

The evaluation and the education phases in the IBM-compatible system were completed in the fall of 1981. Satisfied that its own people have the necessary knowledge, IBM is now preparing the system for its internal use and for shipping to other users. BNR is already discussing with IBM several enhancements to the system in what could be a two-year development program.

IBM offers the CBDS as three interlocking subsystems: the Circuit Pack System, the Design Verification System and the Data Storage System. The first is being presented as the key application while the other two are listed as options. Monthly charges for the complete CBDS are in the area of $4,000 US. Of course, this does not include the charges for the IBM System/370 computer which is the type of machine designated to be used with CBDS.

BNR has not disclosed what its share of the $4,000 per month per customer is. But it is obvious that if IBM is successful, there is a financial benefit to BNR in addition to the technology gains.

However, Don Innes and Ray Fortune (BNR Corporate Director of Marketing and Program Services) said that the gains made through technology feedback have already been of significant value to BNR. As Mr. Innes put it, "In our dialogue with IBM on further development of the system, they have to divulge to some extent what their own thinking and the thinking of their clients is in terms of technology."

Mr. Innes also said that the resulting exposure to IBM's suppliers is another beneficial spin-off. Through the IBM connection, BNR can exert more influence on these companies to think along the lines of future BNR requirements, the development of special test equipment for a proposed BNR project, for example.

There is no doubt that technology feedback is a two-way street. But so far BNR is confident that it can sell its latest technology yet still keep the competitive edge because of the time factor. BNR, of course, is already applying its own technology. It may take up to two years for a licensee to completely install and put the system into full use.

Ray Fortune emphasized that BNR does not have the last word on whether its software technology will be sold. Since the application of its software technology is directly related to the success of Northern Telecom products, and since Northern Telecom provides the funding for most of the development, Northern Telecom has a direct say in the release of software technology. Both companies are constantly reassessing the advisability of selling their technology, particularly the BNR technology which helps to keep Northern Telecom products so competitive.

Northern Telecom will evaluate each proposed future transaction on its individual merits. Some agreements may prove advantageous, but it must first be shown that there would be no detrimental effects. Despite its caution, Northern Telecom has set up an in-house venture-capital group that will probably continue to give technological support to the companies in which it decides to invest, even if those companies threaten to become competitors.

Ironically, it may be a shortage of manpower rather than competition that restricts BNR's activities. As is the case throughout advanced-technology industries, shortages of skilled personnel impose a severe growth limitation. BNR's resources can barely keep up to the current Bell System's demands. It has become increasingly difficult, therefore, under the support concept of marketing, to divert BNR personnel resources from their primary role of research and development to support the technology once it is sold.

The IBM deal is not necessarily one of a kind. However, unless BNR can find the resources to support the CAD/CAM technology it is willing to sell, it may be that, despite all their advantages, deals of this size will always be the exception to the rule.

Some applications and benefits of CAD/CAM technology

In addition to circuit board design such as that described in this article, computer-assisted design and manufacturing (CAD/CAM) technology can be applied to a wide range of operations in any industry. According to a report by the CAD/CAM Technology Advancement Council, set up by the Government of Canada in 1978, CAD/CAM applications can include customer order handling; scheduling, inventory control and material requirements planning; control of manufacturing processes such as pattern and fabric cutting, flow soldering, spray painting, and automated assembly; automated material handling, automated inspection of machined parts, testing of electronic components and pattern recognition; coordination of material and information in packaging, weighing, and labelling; and automated label reading, and package sorting and routing.

The report also suggested that the use of CAD/CAM technology, particularly in manufacturing, may result in economic benefits from increased and more efficient use of capital equipment; shorter delivery time; reduced work-in-progress inventory; more disciplined design and manufacture, greater design creativity through computer graphics; reduced costs through design optimization; improved use of materials; reduced waste by minimizing error; improved quality control through enhanced machining accuracy, repeatability, and automated testing; improved coordination of the manufacturing process from design to accounting; increased workforce productivity; and automation of short production runs.

Government assistance for small business

by Robert D. Irvine

Increasing attention is being paid to the major role played by small businesses in fostering innovation, employment and regional development in Canada. The Government of Canada has a number of business assistance programs of interest to both small entrepreneurs in Canada and foreign investors.

The importance of the small business community in the Canadian economy is obvious. Canada's one million small businesses account for 97 percent of all firms in the country. They provide 42 percent of private sector employment, and their products and services constitute 30 percent of the contribution of business to Canada's GNP.

The Canadian government carries out a range of activities to help the small business community in Canada. Many are long-standing efforts such as the operations of the Federal Business Development Bank (established in 1944 as the Industrial Development Bank) while others, such as the Business Opportunities Sourcing System, are relatively new. Together they ensure a positive climate for both the small entrepreneur already established in Canada and the foreign investor considering a joint venture or other arrangement. Canada was a pioneer among western nations with the appointment in 1976 of a Minister of State for Small Business. This was followed soon by the establishment of a Small Business Secretariat in the Department of Regional Industrial Expansion (formerly Industry, Trade and Commerce); the publication in 1977 of a federal strategy for small business; and the creation of the Office for the Reduction of Paperburden (since amalgamated with the Small Business Secretariat) in 1978.

The government's "arsenal" of financial assistance measures for small- and medium-sized firms has also increased in recent years. Many measures involved the tax system. Perhaps most notable is the lower corporate income tax rate for small business. The rate, which is less than half that for large firms, represents an annual cost of $1.5 billion in foregone revenues to the Government of Canada. The rate compares very favourably with those of other western countries which, in some cases, provide no special tax treatment for smaller firms.

Another tax incentive established in the 1970s was the special investment tax credit on research and development (R&D) expenditures by small business. Through this incentive, a Canadian-controlled private corporation that qualifies for the small business tax rate receives an investment tax credit of 25 percent on all its R&D expenditures. As in other countries, small businesses are playing a critical role in the advanced-technology sector in Canada. This tax credit is designed to assist them.

Other tax features which were established during the same period included:

- the deferral of up to $200,000 of capital gains on transfers of small businesses from parents to children and grandchildren;
- the exemption from federal sales tax of small business manufacturers with annual sales of less than $50,000;
- arrangements whereby owners of unincorporated businesses may pay tax-deductible salaries to their spouses; and
- permission to venture capital companies investing in the shares of small- and medium-sized businesses to elect to have their earnings taxed as capital gains instead of as ordinary income.

These other existing incentives represent a further $1 billion in federal tax expenditures (revenue which the government has chosen to forego) for small business each year. They are in addition to the many general tax incentives and other financial assistance available to firms, both large and small, such as accelerated write-offs, investment tax credits, and direct grants.

The 1981 budget of the Canadian government built on these existing measures. The lower corporate tax rate is one example. The budget raised the annual taxable income limit for the small business tax rate from $150,000 to $200,000. The cumulative limit was increased from $750,000 to $1 million. In terms of specific benefits to an individual entrepreneur, these adjustments mean another $52,500 of potential tax saving to a small business.

The Small Business Bond was also adjusted in the 1981 budget. Formerly called the Small Business Development Bond (or SBDB for short), the measure was retitled to reflect its new focus on those in greatest need. Since the Small Business Development Bond was first established in 1979, over $2 billion in financing has been made available by private financial institutions to over 10,000 small businesses across Canada.

A bond is negotiated directly between a borrower and a private lender, without government involvement or special paperwork. Interest paid on a bond is treated as a dividend, so banks and other lenders do not incur a tax liability on the interest received from a loan under the program. For this reason, a small business can obtain substantial savings on its interest costs.

The bond program was scheduled to expire at the end of 1981, but was ex-

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tended in the recent budget to December 31, 1982 under a slightly different format. The measure now concentrates on firms temporarily in financial difficulty and now also covers unincorporated small businesses including farmers and fishermen.

With its new focus, the Small Business Bond is still a help to small entrepreneurs. Indeed, the Department of Finance has forecast that extension of the bond program will entail approximately $100 million in tax expenditures through fiscal year 1985-86.

To help meet the Canadian government's revenue objective, the November 1981 budget extended the current corporate surtax until the end of 1983. However, small businesses were exempted from the surtax on that portion of their income eligible for the lower corporate tax rate. This exemption will result in an estimated total tax saving of $100 million for small businesses in Canada through 1983.

Another boost to small business from the budget was the small manufacturers rule. Under the tax rules existing before the budget, the federal corporate tax rate of 15 percent for a small business was reduced to 10 percent on income from manufacturing and processing. As a result of the budget, small businesses primarily in manufacturing no longer have to separate their manufacturing income from their other income to use the lower manufacturers' tax rate.

The 1981 budget benefited business, both small and large, in a wider sense through its effort to reduce the government's deficit and substantially curtail its borrowing requirements. Under the fiscal plan outlined by the Minister of Finance, the majority of government expenditures will continue to be held to a rate of growth less than that of the GNP.

Incentives available through the tax system are only part of the effort to provide financial assistance to the small business community. For example, the Federal Business Development Bank, through its 103 offices across Canada, offers financing to small- and medium-sized firms by means of loans, loan guarantees, equity financing or a combination of these. The bank currently has over $2 billion in outstanding loans with 40,000 customers. It also has over $40 million in equity investments with about 150 investment customers.

Financial assistance is also provided through the Small Business Loans Program of the Department of Regional Industrial Expansion. Through it, small businesses can obtain loans guaranteed by the Government of Canada from private lenders at interest rates set at 1 percent over the prime lending rates of the chartered banks. As of the beginning of 1982, about 98,500 loans totalling $1.9 billion had been made to small businesses under the program.

The Enterprise Development Program (also administered by Regional Industrial Expansion) focuses on high potential small- and medium-sized firms that are prepared to undertake relatively high-risk but viable projects which promise attractive rates of return. EDP offers contributions and loan insurance for product and process development and business restructuring.

The Government of Canada has a host of programs which provide aid to small businesses in ways other than through financial assistance. Many of them are specifically designed to help small entrepreneurs respond to the rapid pace of technical change and an increasingly interrelated world economy.

One example of such a program is the Technical Information Service (TIS) of the National Research Council. TIS provides manufacturers with the most direct access possible to current technology for the solution of industrial problems. Its services are of particular use to firms that have few technical resources.

The service helps companies adapt existing scientific and technological knowledge to their own specific operations. This includes helping them solve technical problems, improve production operations, increase productivity, develop new products and markets, reduce costs and increase profits.

A distinctive feature of TIS is its field service. TIS engineers and scientists visit their clients at their plants. The field service assists clients to identify and solve their technical problems, helps them to enhance their technological capabilities and performance and makes them aware of the availability and value of technical information. The field services are supported by a group of specialists at the TIS national office in Ottawa.

Another non-financial assistance program is BOSS, the Business Opportunities Sourcing System of the Department of Regional Industrial Expansion. A computerized bank of data on Canadian companies, their products and the markets they serve, BOSS takes information from individual manufacturers and international trading companies across Canada and incorporates it into a system that quickly and efficiently identifies Canadian-based suppliers for international and domestic markets. Some 10,000 firms have already provided information to BOSS. Additional participants are being sought to make BOSS an even more powerful tool for the private sector.

These are just a few examples of the many measures designed by the Government of Canada to help small entrepreneurs. The various provincial governments also offer a range of programs for small firms. Together, they truly represent big help for small business.

For more information . . .

Subject	Contact
All Canadian government business information programs	Business Information Centre, 34/2 Department of Regional Industrial Expansion Ottawa, Canada K1A 0H5
Small Businesses Loans Program	Small Businesses Loans Administration, 41/A Department of Regional Industrial Expansion Ottawa, Canada K1A 0H5
Enterprise Development Program	Programs Branch, 41/A Department of Regional Industrial Expansion Ottawa, Canada K1A 0H5
Business Opportunities Sourcing System	Corporate Systems Branch, 97/1 Department of Regional Industrial Expansion Ottawa, Canada K1A 0H5
Government policies and programs for small business	Small Business Secretariat, 63 Department of Regional Industrial Expansion Ottawa, Canada K1A 0H5
Technical Information Service and other science-related assistance programs	Industry Development Office National Research Council Montreal Road, M-55 Ottawa, Canada K1A 0S3
Small Business Bond Program	Legislation Branch Revenue Canada—Taxation Ottawa, Canada K1A 0L8

Information is also available from the Government of Canada offices located in every major centre in Canada, and from Canadian posts abroad.

Saskatchewan's economy, on the upswing

by Edward Greenspon

After a long run as one of Canada's poorer provinces, Saskatchewan has emerged in recent years as one of the stronger economies in the country. The province led all 10 in real economic growth last year, helping to dispel the persistent myth that Saskatchewan is a backward place totally reliant on the vagaries of a vulnerable grain crop.

The province enjoyed a 4.9 percent compound annual rate of growth in the 1970s compared with 3.9 percent for Canada as a whole according to Government of Saskatchewan figures. Mining, construction, finance, insurance and real estate all enjoyed compound annual growth rates in excess of 17 percent during the decade. Investment, which has been relatively immune to interest rates because of the number of large projects with long life expectancies, continued to escalate in 1981, growing by 25 percent to $5.4 billion. Farm cash receipts also increased by 25 percent to $4 billion in 1981, following a poor harvest in 1980.

The mining sector outstripped all others in growth during the past decade. Saskatchewan has 40 percent of world potash reserves, a 3,000-year world supply at current consumption rates. It is Canada's second largest petroleum producer, though a distant second, and an increasingly important uranium producer. In terms of quality, Saskatchewan is endowed with the best possible uranium and potash, and poor oil and coal. Saskatchewan is the world's largest producer of sodium sulphate and produces small quantities of salt, copper, zinc, gold, silver, cadmium, selenium and tellurium. The province took in $727.2 million in mineral revenues in 1980, all but $25 million from petroleum and potash. This figure in 1981 is expected to reach $1 billion.

Between 1952 and 1970, Saskatchewan experienced wide swings in its growth figures. In eight of those years there was a decrease. Five times growth fluctuated by more than 18 percent from one year to the next as economic performance slavishly followed the yield of the grain crop. Today, the province has experienced nine uninterrupted years of positive growth. But the huge influence retained by agriculture was amply illustrated by the modest 0.9 percent growth in 1980, a partial drought year. In contrast, in 1981, with the second largest crop in the province's history, Saskatchewan's economy grew by 8 percent according to the province's figures, by 5.3 percent, according to the Conference Board of Canada. Either way, it was the best in the country.

The Saskatchewan economy began its advance in the 1970s. The gross domestic product rose to $12.8 billion in 1980 from $3 billion in 1970. Personal income increased fourfold to $8.7 billion in 1980. The value of exports rose sharply to $6.9 billion from $1.2 billion. With a population holding steady at just under one million people, the Saskatchewan economy is dependent on international markets to consume its production. But instead of just riding the grain market cycles as in the past, Saskatchewan has spread the risk of reliance on world commodity markets onto several export cycles.

The decade of growth has been orchestrated by a provincial government that intervenes heavily in the economy. The province has a tradition of agrarian populism that today is expressed largely in the strong presence of cooperatives. The biggest company in the province is the Saskatchewan Wheat Pool, with sales approaching $2 billion a year. Owned by 70,000 farmer-members, the pool handles grain, sells insurance, manufactures fertilizer, mines phosphate and processes margarine, among other things. Federated Cooperatives Ltd. is a retail cooperative that

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also has more than $1 billion in annual sales. In fact, of the seven Saskatchewan-based companies listed in the Financial Post's leading 400 by sales, two are cooperatives, three are wholly-owned by the provincial government and the other two are publicly traded companies with substantial provincial government ownership.

Through the Crown Investments Corporation (CIC), the government owns 17 commercial companies and has investments in other businesses operating in Saskatchewan. CIC has $4.3 billion in assets. The Crown corporations are an integral part of the government's economic development plans. The Saskatchewan Mining Development Corp., for instance, has the right to buy half of any uranium exploration venture in the province. Saskatchewan Telecommunications has been granted legislative monopolies on certain aspects of new communications technologies. The Potash Corporation of Saskatchewan, the protagonist in a controversial government move into the industry in the mid-1970s, today accounts for more than 40 percent of Saskatchewan potash production. The Crown corporations are engaged in numerous joint ventures with private industry, particularly in mining.

Saskatchewan's diversification has been limited to the primary sector, which accounts for about one-third of the gross domestic product. Manufacturing is still a relatively small sector of the provincial economy, comprising just 6 percent of gross domestic product. The growth of the primary sector has helped stimulate the service sector. Finance, insurance, real estate and services accounted for 29.3 percent of 1980 gross domestic product. (See table.) The nature of the economy has helped Saskatchewan avoid the high unemployment rates experienced by most of the country.

Saskatchewan is putting away its newfound wealth in a special account, known as the heritage fund, which has assets of more than $1 billion. About $1 billion, from provincial resource revenues, is to be channeled through the heritage fund in 1981-82. A majority of the funds will end up in the provincial government's regular accounts. The money left in the heritage fund will then be allocated either as incentives to the oil industry, for capital projects that will not earn any return, or to the Crown corporations in the form of loans or equity. The fund planned loans of $239 million to the Crown corporations in 1981-82, covering 30 percent of their external financing needs. The heritage fund also lends money to the province's regular account to reduce the need for short-term borrowings.

The provincial government and the Crown Investments Corporation, together with the federal government and the private sector, have long-term plans to develop more resource processing in the province in the 1980s. The processing of by-products from potash and sodium sulphate production is one area being explored. Among others are uranium refining, heavy oil upgrading, further oil refining, petrochemical manufacturing and fertilizer manufacturing.

Agriculture

Agriculture is still the backbone of the Saskatchewan economy, directly employing 20 percent of the work force and accounting for 17.9 percent of gross domestic product in 1980, a poor crop year. Agriculture's share of the economy has fluctuated between 16.8 percent and 30 percent in the last decade. There are 69,000 farms in Saskatchewan, averaging 970 acres (about 392.5 ha) in size. Saskatchewan's dryland farms produce about half the country's grain. Non-residents of Saskatchewan are not allowed to buy more than 10 acres (about 4 ha) of farm land. The 1981 grain crop was Saskatchewan's second best ever, one million tonnes below 1976's record 20 million tonne production, but commodity prices were lower than expected. The province produces six grains and oilseeds — wheat, barley, oats, rye, canola and flax.

Crops accounted for 78 percent of farm cash receipts in 1980, with wheat responsible for 62.9 percent of the crop total. The other 22 percent was generated by livestock production, led by cattle. Wheat, oats and rye are marketed exclusively through the Canadian Wheat Board. Farmers have the option of marketing feed grains through either the board or private grain companies. The

Saskatchewan Gross Domestic Product at Factor Cost of Industry ($ million)

	1975		1976		1977		1978		1979		1980	
Agriculture	$1,756	26.4%	$1,701	23.1%	$1,347	17.6%	$1,630	18.5%	$1,680	16.8%	$2,079	17.9%
Forestry	18	0.3	16	0.2	17	0.2	18	0.2	22	0.2	23	0.2
Mining	437	6.6	475	6.5	621	8.1	757	8.6	964	9.7	1,180	10.2
Construction	401	6.0	493	6.7	541	7.1	498	5.6	618	6.2	657	5.7
Manufacturing	416	6.3	442	6.0	454	5.9	525	5.9	624	6.3	721	6.2
Transportation, communications and storage	484	7.3	568	7.7	628	8.2	734	8.3	859	8.6	958	8.3
Utilities	139	2.1	160	2.2	173	2.3	190	2.2	243	2.4	256	2.2
Trade	699	10.5	808	11.0	799	10.4	893	10.1	1,037	10.4	1,166	10.1
Finance, insurance and real estate	745	11.2	892	12.1	1,015	13.3	1,312	14.9	1,315	13.2	1,509	13.0
Services	1,018	15.3	1,172	15.9	1,309	17.1	1,456	16.5	1,662	16.7	1,891	16.3
Public administration	534	8.0	625	8.5	747	9.8	819	9.3	954	9.6	1,149	9.9
GROSS DOMESTIC PRODUCT AT FACTOR COST	$6,646	100.0%	$7,353	100.0%	$7,651	100.0%	$8,832	100.0%	$9,978	100.0%	11,589	100.0%

Percentages have been rounded
Source: Saskatchewan Provincial Economic Accounts, May 1981

board has set an export target of 26 million tonnes for the crop year ending July 31, 1982, 13 percent better than the 1979-80 record year.

Net farm income, including inventories, in 1981 is expected to reach $1.5 billion on farm cash receipts of $4 billion, although the farm community considers this forecast optimistic. Payments from various price and income stabilization programs are expected to account for about $1 billion, or 25 percent, of this amount. Both the Canadian and Saskatchewan governments have introduced income-stabilization programs, such as crop insurance. The newest is a provincial beef stabilization program, designed to assist the troubled cattle sector.

Agriculture in Saskatchewan is benefiting from record international grain trading. In order just to keep pace with Canada's traditional market share, the Wheat Board is projecting exports of Canadian grain to reach 30 million tonnes by 1985 and 36 million tonnes by 1990, far better than has ever before been achieved. Few farmers and academics believe the goals will be reached, at least not the 1985 target. But farmers, stung by the 1980 partial grain embargo of the Soviet Union, were buoyed in 1981 by the signing of a record, five-year, 25-million-tonne contract with the Soviet Union. Purchases in the first year exceeded the minimum set out in the agreement.

The two major constraints to achieving the export targets are the ability of farmers to grow that much grain and the ability of the transportation and handling system to get it to port from the landlocked province. Agricultural experts generally say that physically the export goals are feasible, but the necessary adjustments will take some time. There are political hurdles to overcome as well, the most significant of which is rail transportation policy.

Despite the impressive addition of rolling stock in the past several years, the rail system is still fragile at the best of times. A work slowdown at one rail point in British Columbia during the winter of 1980-81 significantly curtailed the movement of prairie grain. The damaging of a bridge in Vancouver by a Japanese freighter in 1979 isolated some port facilities from the mainland, and exports fell below target levels.

Aside from the host of things that can go wrong, however, the movement of grain is endangered by limited capacity on main rail lines, which will not be able to satisfy demand by mid-decade. Some upgrading projects have been initiated, but the railways — one privately owned and the other a commercial venture of the Canadian government — say they are not earning enough money from grain transportation to justify the $7.7 billion cost of doing all the work required. The railways say they lost $250 million in 1981 hauling grain. The railways claim that the cost of moving grain is actually five times what farmers pay under a statutory rate structure, known as the Crow's Nest Pass freight rate, established in 1897 and unchanged since 1925. This so-called Crow rate of half-a-cent per ton mile means farmers can ship a bushel of grain to port for less than the cost of a postage stamp. The Crow rate has also been blamed for retarding the development of agricultural secondary processing on the Prairies because raw goods can be transported for less than processed goods. The rail capacity problem has implications for other Saskatchewan bulk commodities, which must move to tidewater before going overseas.

Oil

Saskatchewan produced 57.9 million barrels of crude oil in 1980. Production peaked in 1966 and the province is turning to its less conventional oil reserves. The province sees its future in heavy oil, which is difficult to recover, hard to transport, and expensive to refine. There are an estimated 20 to 30 billion barrels (about 3 to 5 billion m^3) trapped in sandy formations in the 31,000 km^2 area shown on the map around Lloydminster, but recovery rates for heavy oil average less than 10 percent, even using waterflood. But with enhanced recovery techniques such as steam injection or an underground fire to thin the oil and pressure it upward, oil companies and the province are hoping to increase the recovery rate to as much as 30 percent. Twelve experimental enhanced recovery projects, costing $25 million to $30 million each, currently are operating or planned.

Heavy oil is used for asphalt or exported to certain American refineries capable of handling the troublesome crude. But a consortium of three private and two Crown oil companies is studying the feasibility of building a 40,000 to 100,000 barrel-a-day (about 6500 m^3 to 16,000 m^3 per day) heavy-oil-upgrading plant in Saskatchewan to bring the heavy oil up to refinable quality. The cost of the project is expected to be between $1 billion and $1.75 billion, the largest single undertaking in the province's history. The consortium says the plant will be built preferably near Moose Jaw or else near North Battleford. While the plant will employ up to 3,000 people at peak construction and about 300 people full-time, far more work will be generated in the oil fields designated to supply the plant.

The economics of heavy oil production have not been firmly established because the province is adjusting its royalty and tax structure regarding low-producing oil wells and wells using enhanced recovery techniques. The provincial government has supported the idea of an upgrader and is expected to help ease its way. The consortium is anxious to have the project started by 1983 and completed by 1986 because two scheduled multi-billion-dollar oil projects in Alberta may cause manpower shortages in Saskatchewan. However, an environmental impact assessment must be conducted before the consortium can obtain provincial government permission to proceed with the upgrader.

Saskatchewan recently entered into a five-year oil pricing agreement with the Canadian government which will bring the province $5.8 billion in revenue. The Government of Canada will get $3.5 billion and the industry will be left with $6.1 billion. Oil production in the first seven months of 1981, before the agreement, dropped 21 percent, drilling was down 40 percent, and revenue from rights sales fell to $37.3 million from $77.6 million in 1980.

The industry in general has reacted favourably to the Canada-Saskatchewan agreement, however, and is awaiting the details of the province's revised royalty structure. The sale of Saskatchewan crude oil outside the province was $1.37 billion in 1980.

Saskatchewan also has modest reserves of natural gas — 38.4 billion cubic metres or about 2 percent of established Canadian reserves. The province imports 64 percent of its natural gas from Alberta, but the government is working on policies to promote more natural gas exploration, with the intention of using the gas for resource and industrial projects. Saskatchewan has also announced plans to build a pilot ethanol plant that would initially use barley as a feedstock but would later switch to wood when the technology is proven.

Uranium

Northern Saskatchewan has some of the world's richest uranium deposits. There are currently three mines operating. The largely French-owned Amok Ltd. mine at Cluff Lake started production in 1980. It represents the new generation of Saskatchewan uranium mines with rich deposits and low production costs from open-pit mining. Cluff Lake yielded a phenomenal grade of 7 percent uranium on its first ore body. (Average world grade is 0.15 percent uranium content.) Veins mined subsequently will not be as rich, but they will be far above the traditional uranium grade levels. The second of these northern Saskatchewan super-deposits is at the Key Lake mining project. One-third owned by the German company Uranerz Canada, it will be the most expensive economic development in northern Saskatchewan history, costing about $500 million by the time the mine and mill start producing in 1984. The mine is expected to produce 12 million

Western Forest Products Ltd.			
Improvement and expansion of pulp production	1984	205	near Squamish
Improvement and pollution control	1984	60	Port Alice
Improvement of sawmills	1984	60	Vancouver

Alberta

Alberta Energy Company Ltd. and Du Pont Canada			
Low-density polyethylene plant (planned)	1984	200	near Edmonton
Alberta Gas Chemicals Ltd.			
Methanol plant expansion	1982	140	Medicine Hat
Alberta Gas Ethylene Company Ltd.			
Second ethylene plant	1984	500	near Joffre
Third ethylene plant	1985	590	near Joffre
Alberta National Supply Co. Ltd.			
Drilling equipment plant	n.a.	19	Red Deer
Alberta Pork Producers Marketing Board			
Meat packing plant	n.a.	30	n.a.
Biewag Energy Resources			
Methanol plant (planned)	n.a.	700	northeast of Edmonton
British Columbia Forest Products Ltd.			
Sawmill	1982	23	Fox Creek
Newsprint complex	1985	165	Hurdy
Canadian Liquid Air Ltd.			
Air-separation plant	1982	16	Edmonton
Celanese Canada Inc.			
Methanol plant	1982	255	near Edmonton
Vinyl acetate monomer plant (planned)	n.a.	500	near Edmonton
C-I-L Inc.			
Polyethylene plant expansion	1984	128	Edmonton
Dow Chemical of Canada Ltd.			
Polyethylene plant (planned)	1984	75	Fort Saskatchewan
Expansion of ethylene dichloride production	1984	135	Fort Saskatchewan
Esso Chemical Canada			
Fertilizer plant expansion	1982	45	Redwater
Ammonia and urea plant	1983	457	Redwater
Gainers Ltd.			
Meat processing plant	n.a.	20	Edmonton
Gulf Canada Products Co.			
Benzene plant	1985	250	Edmonton
Imperial Oil Ltd.			
Ammonia and urea fertilizer plant	1983	250	Edmonton
Phosphate fertilizer plant	1982	45	near Edmonton
Interprovincial Steel & Pipe Corp. Ltd.			
Pipe plant	1983	60	Calgary
Makin Project Initiators Ltd.			
Pulp and paper mill	n.a.	160	south of Edmonton
Mohawk Oil Co. Ltd.			
Recycling plant	1982	12	Edmonton
Molson Companies Ltd.			
Brewery expansion	1983	24	Edmonton
National Supply Co. Ltd.			
Drilling equipment	1982	22	Red Deer
Nova, an Alberta Corporation and Shell Canada Ltd.			
Styrene plant	1984	240	near Edmonton
Low-density polyethylene plant	1984	250	Joffre
Prudential Steel Ltd.			
Pipe plant expansion	1982	12	Calgary
Ram Steel Corp. Ltd.			
Pipe plant	n.a.	11	Red Deer
Sherritt Gordon Mines Ltd.			
Nitrogen fertilizer plant	1983	320	Fort Saskatchewan
Union Carbide Canada Ltd.			
Ethylene plant	1984	300	Central Alberta
Air-separation plant expansion	1982	12	Fort Saskatchewan
Wescan Pipe Protection Ltd.			
Pipe coating plant (2nd phase)	1983	14	Edmonton

Manitoba - Saskatchewan

Air Canada			
Expansion of repair and data processing activities	n.a.	60	Winnipeg, Manitoba
Aluminum Co. of Canada Ltd.			
Aluminum plant (planned)	1984	500	Rockwood, Manitoba
CSP Foods Ltd.			
Oilseed processing plant	1982	30	Harrowby, Manitoba
Expansion and improvement	n.a.	16	Nepawin and Saskatoon, Saskatchewan and Altona, Manitoba
Griffin Canada Ltd.			
Plant expansion	1982	10	Winnipeg, Manitoba
Northern Telecom Canada Ltd.			
Plant	n.a.	12	Winnipeg, Manitoba
Prince Albert Pulp Co. Ltd.			
Sodium chlorate plant	1984	17	Prince Albert, Saskatchewan
Simplot Chemical Ltd.			
Nitrogen fertilizer plant expansion	n.a.	35	Brandon, Manitoba

Ontario

Abitibi-Price Inc.			
Newsprint mill improvement	1982	111	Iroquois Falls
	n.a.	66	Thunder Bay
	n.a.	15	Smooth Rock Falls
Algoma Steel Corp. Ltd.			
New seamless tube mill	1984	300	Sault Ste. Marie
Upgrade hot strip mill	1982	50	Sault Ste. Marie
American Can of Canada Ltd.			
Kraft pulp mill modernization	1984	80	Marathon
BCM Technologies Ltd.			
Sodium chlorate plant	1982	15	Amherstburg
Boise Cascade			
Newsprint mill improvement	n.a.	80	Kenora
Canada Packers Inc.			
Beef packing plant	1982	16	Toronto
Canada Starch Co. Ltd.			
Corn wet-milling plant	1982	17	Cardinal
Liquid corn sweetener plant	1982	50	Port Colborne
Canada Wire and Cable Ltd.			
Plant construction and improvements	1984	50	Toronto
Caterpillar of Canada Ltd.			
New assembly plant	n.a.	n.a.	Brampton
Celanese Canada Ltd.			
Expansion of polyester production	n.a.	11	near Kingston
Chrysler Canada Ltd.			
Truck plant conversion and expansion	1983-84	203	Windsor
Car plant conversion and modernization		184	Windsor
Casting plant conversion		11	Etobicoke
Improvement of various plants		108	n.a.
New research and development facilities	n.a.	20	Windsor
C-I-L Inc.			
Ammonia plant	1984	217	Courtright
Cyanamid Canada Inc.			
Calcium carbide plant	1983	20	Niagara Falls
Fertilizer plant expansion and improvement	1983-84	20	Niagara Falls
De Havilland Aircraft of Canada Ltd.			
Expansion	1983	75	Toronto
Dennison Manufacturing Company			
Expansion	n.a.	10	Mississauga
Diemaster Tool Inc.			
Modernization and new plant	n.a.	12	Mississauga
Dofasco Inc.			
Expansion of steel production	1984	90	Hamilton

Dominion Foundries and Steel Ltd.			
Second hot strip mill	1983	450	Hamilton
Fourth galvanizing line	1984	90	Hamilton
Domtar Inc.			
Linerboard and newsprint plant modernization	1982	43	Red Rock
Plant modernization	n.a.	120	Cornwall
Du Pont Canada Inc.			
Polyethylene plant expansion (2nd phase)	1983	n.a.	Sarnia
Textile plant expansion	n.a.	16	Kingston
E.B. Eddy Forest Products Ltd.			
Pulp and bleach facilities, specialty paper machines and other projects	1983	250	Espanola
Modernization	n.a.	35	Ottawa region
Esso Chemical Canada (Imperial Oil)			
Polyethylene plant	1983	150	Sarnia
Polyvinyl plant expansion	1983	37	Sarnia
Ford Motor Co. of Canada Ltd.			
Assembly plant conversion	1983	115	Oakville
General Motors of Canada Ltd.			
Expansion and modification	1982	71	Oshawa
Auto assembly plant	1982	100	Oshawa
Paint finishing plant	1982	30	Oshawa
Grant & Wilson Ltd. and Partners			
Lumber mill	1982	24	Englehart
Great Lakes Forest Products Ltd.			
Modernization, paper mill	1983-84	250	Dryden
Expansion and modernization, fine paper	1983	90	Dryden
Newsprint mill modernization	n.a.	90	Thunder Bay
Imperial Tobacco Ltd.			
Expansion and new equipment	1981-86	21	Guelph
Jarvis Clark Co. Ltd.			
Mining equipment plant	n.a.	13	Burlington
Kellogg Salada Canada Inc.			
Cereal plant	n.a.	10	London
Kimberly-Clark of Canada Ltd.			
Kraft pulp mill improvement	1982	12	Terrace Bay
MacMillan Bloedel Ltd.			
Modernization	n.a.	12	Sturgeon Falls
Miracle Mart Ltd.			
Meat processing plant	n.a.	20	Toronto
Mitel Corp.			
Expansion of production lines	n.a.	72	Kanata
New plant	1983	29	Renfrew
Nelson Steel Co. Ltd.			
Steel processing plant	1983	n.a.	Nanticoke
The Ontario Paper Co. Ltd.			
Newsprint mill modernization and expansion	1984	260	Thorold
Petrosar Ltd.			
Modifications (phase 1)	1982	50	Sarnia
(phase 2)	1984	400-500	Sarnia
Pilkington Glass Ltd.			
Special glass production	n.a.	20	Scarborough
Polysar Ltd.			
Butyl rubber and isobutylene plant	1982	250	Sarnia
Expansion of waste treatment installations	1982	26	Sarnia
RDB Building Products Ltd.			
Manufacture of bricks and tiles	1982	12	Milton
Rio Algom Ltd.			
Expansion and modernization	1991	100	Welland
Spruce Falls Power & Paper Co. Ltd.			
Modernization, new thermo-mechanical pulp mill, environmental protection	1982	100	Kapuskasing
St. Lawrence Cement Co. Ltd.			
Expansion	n.a.	21	Mississauga
The Steel Company of Canada Ltd.			
Expansion program	1986	655	Nanticoke, Hamilton

3M Canada			
Tape manufacturing	1982	14	Perth
Union Carbide Canada Ltd.			
Expansion and modification	1984	40	Sarnia, Walkerton
Urban Transportation Development Corp. Ltd.			
Manufacture of transportation equipment	1982	30	Kingston
Uniroyal Inc.			
Increase capacity of tire plant	1982	23	Kitchener
Waferboard Corp. Ltd.			
Plant expansion	1982	13	Timmins
Xerox Canada			
Research Centre	1983	18	Toronto

Québec

Abitibi-Price Inc.			
Expansion and pollution control	n.a.	250	Saguenay - Lac St-Jean
Plant conversion	1983	80	Beaupré
Alcan Aluminum Ltd.			
New smelter - 3rd phase	1982	150	Grande Baie
Alumina plant upgrading	1982	42	Jonquière
Alumina plant upgrading	1982	42	Vaudreuil
Pollution abatement	1982	13	Beauharnois
New aluminum fluoride plant	1984	95	Jonquière
Alcan Products Canada Ltd.			
Wire and cable plant renovation	n.a.	20	Shawinigan
Bombardier-MLW Ltd.			
Plant modernization	n.a.	16	Montréal
Plant expansion	n.a.	14	Valcourt
Plant expansion	n.a.	12	La Pocatière
Canada Wire and Cable Ltd.			
Copper rod mill	1982	25	Montréal
Canadian Reynolds Metals Co. Ltd.			
Aluminum plant expansion	1984	500	Baie Comeau
Celanese Canada Inc.			
Expansion of polypropylene fibre production	n.a.	15	Saint-Jean
Canadian General Electric Company			
Engine parts plant	1983	97	Bromont
Canadian International Paper Company			
Modernization and expansion	1984	60	Trois-Rivières
Pollution control	1982	24	La Tuque
Plant modernization	1985	n.a.	Matane
Consolidated-Bathurst Ltd.			
New pulp mill and improvements	1982	35	Grand'mère
Newsprint mill improvement	1982	32	Shawinigan
Plant improvement	1982	61	Trois-Rivières
Plant modernization	1984	85	Port Alfred
Dominion Bridge-Sulzer Inc.			
Plant expansion	1984-85	28	Lachine
Domtar Inc.			
Newsprint mill improvement	n.a.	29	Dolbeau
Conversion and pollution control	1983	36	Donnaconna
Donohue Inc.			
Newsprint mill modernization	1986	50	Clermont
Donohue-Normick Inc.			
Newsprint mill	1982	190	Amos
Erco Industries Ltd.			
Sodium chlorate plant expansion	1983	20	Buckingham
Forex Leroy Inc.			
Corrugated cardboard plant	1983	25	Val-d'Or
GLC Canada Inc.			
Graphite electrode plant	n.a.	62	Lachute
Gaspesia Co.			
Expansion of production	1986	90	Chandler
IBM Canada Ltd.			
Plant conversion	n.a.	60	Bromont
Imperial Tobacco Ltd.			
Expansion of cigarette manufacturing	1986	100	Montréal, Québec

Assistance to industry for research and development

To round out this issue of the *Foreign Investment REVIEW*, with its focus on the advanced-technology industry, what follows is a description of industrial assistance programs designed specifically to encourage research and development.

In recognition that the growth and competitiveness of industry depends to some extent on innovation in products and processes to keep up with the demands of a changing world, both the federal and provincial governments have set up a range of programs designed to encourage business to undertake or increase research and development activities. These programs range from outright grants to salary subsidies to in-plant problem-solving to technical information.

Research and development assistance programs complement and often may be used in combination with the other, more general incentive programs usually described in the *REVIEW* (for federal government programs see Vol. 4, No. 2; for provincial programs see Vol. 5, No. 1). Programs described in this issue are not the only ones available, however. For instance, some municipalities and private organizations also offer R&D assistance to industry, and programs included here are open to everyone.

Some departments or agencies of government, like Newfoundland's Department of Fisheries, may fund projects on an individual basis although no formal research and development program exists. Centres of advanced technology at universities and research councils across the country can provide a wealth of information and practical assistance. Industrial parks such as Innovation Place in Saskatoon, Saskatchewan are designed to help research and development and advanced-technology businesses become established in an environment suited to their particular needs. Alberta is one of the provinces that publish material about how to start and finance a business, and other provinces like Ontario have full-scale policies of industrial stimulation that specifically support research and development. The Government of Canada, in fact, has set an annual spending target of 1.5 percent of the gross national product for research and development by 1985.

Government of Canada programs

National Research Council

Technical Information Service

In-plant technological assistance and an information service provide the most direct assess possible to current technology for the solution of industrial problems. **Contact:** National Research Council, Ottawa K1A 0S2

Canadian Institute for Scientific and Technical Information

The Institute collects information and makes it available at very little cost in the form of tailored research reports for individual firms, academic institutions, government and individuals. **Contact:** National Research Council, Ottawa K1A 0S2

Program for Industry/Laboratory Projects (PILP)

Financial and technical assistance, up to the full underwriting of the company's project or product development costs, is available to Canadian-based companies, either alone or with others. The program is designed to promote the transfer to industry of government and other non-industrial research results and to develop their commercial potential. **Contact:** PILP Program Office, National Research Council, Ottawa K1A 0R6

Industrial Research Assistance Program

To increase the calibre and scope of industrial research and development in Canada in the business environment, the program will pay the salaries of individuals working on approved projects, covering about 50 percent of the overall costs of selected research projects. The program can also assist firms too small to carry out their own research by paying for sub-contracted research. All provincially or federally incorporated companies engaged in physical and life sciences and engineering technology are eligible. **Contact:** National Research Council, Ottawa K1A 0R6

Natural Sciences Engineering Research Council

Strategic Grants in Aid of Research

Grants are available to indidivuals or groups of researchers at Canadian universities for research in areas of national concern, e.g. energy, environment, oceans. **Contact:** Natural Sciences Engineering Research Council, Ottawa K1A 0R6

Project Research Applicable in Industry

To capitalize on advances in university research showing potential for eventual commercial exploitation in Canada, grants are available to support projects with a

Department of the Environment

Energy from the Forests (ENFOR)

Contracts are awarded to Canadian organizations to undertake research and development projects to substitute forest biomass for petroleum. **Contact:** ENFOR Secretariat, Department of the Environment, Ottawa K1A 1G5

Development and Demonstration of Research and Energy Conservation Technology Program (DRECT)

Designed to help the private sector to develop and demonstrate equipment, systems or products to recover or otherwise save energy through resource recovery, the program supports business proposals to develop and construct energy-recovery or energy-saving prototypes and demonstration installations. **Contact:** DRECT Secretariat, Department of the Environment, Ottawa K1A 1C8

Water Pollution Technology

The Wastewater Technology Centre has facilities to solve waste treatment and disposal problems. Equipment is available for rent. Through the Research and Development Program, contracts are awarded for oilspills technology research and development. **Contact:** Department of the Environment, Ottawa K1A 1C8

Forestry Services, Research and Development

Advice and information is available to help provinces and industry effectively manage and use our forest resources. It researches ways to improve forest productivity, including studies of soils, fertilizers, genetics, insects and disease control and true biology. **Contact:** Department of the Environment, Ottawa K1A 1G5

Canada Employment and Immigration Commission

New Technology Employment Program

The program is designed to create employment for qualified post-secondary graduates in technologically innovative work in manufacturing, product development, small-scale energy conservation and alternative energy technology by contributing up to 75 percent of wages to a maximum of $290 per week per job for a maximum of 12 months, to a limit of $150,000 per employer. Small private-sector firms, individuals, associations, community colleges, universities, research institutes and community organizations are eligible to become employers. **Contact:** Canada Employment and Immigration Commission, Ottawa K1A 0J9

Canola Council of Canada

Canola Utilization Assistance Program

Funding for research and development for improving manufacture and increasing commercialization of rapeseed products is provided to universities and private research institutions. **Contact:** Canola Council of Canada, Room 301, 433 Main Street, Winnipeg, Manitoba R3B 1B3

Public Works Canada

Construction Technical Systems Support

Computer design programs are available to consulting firms and other members of the public for energy analysis, design and construction, etc. **Contact:** Technical Systems Secretariat, Public Works Canada, K1A 0M2

Department of Communications

Technical Support for Space-Related Industry

David Florida Laboratory provides testing facilities on a cost-recovery basis for assembling and testing space hardware. The High Reliability Laboratory accepts only specialized, complex space technology problems on a cost-recovery basis. **Contact:** Communications Research Centre, Department of Communications, Box 11490, Station H, Ottawa K2H 8S2

Canada Mortgage and Housing Corporation

Housing Technology Incentives Program

Up to $10,000 may be contributed for the development and implementation of new ideas that increase the utility or performance of housing through improvements in design, construction or products. Energy conservation and housing rehabilitation are priorities. Any Canadian firm or individual may submit a proposal. Proposals must produce a practical demonstration and have potential to meet the National Building Code and Residential Standards. **Contact:** Canada Mortgage and Housing Corporation, Ottawa K1A 0P7

Department of Supply and Services

Contracting-Out

The Department of Supply and Services manages a contracting system and maintains lists of potential contractors to encourage private-sector research for government requirements. **Contact:** Department of Supply and Services, Ottawa K1A 0S5

Unsolicited Proposals for Research and Development

Interested Canadian firms submit unsolicited proposals for research and development projects they feel relevant to some government program. Departments examine the proposals within their specific mandate. If a department supports a proposal and is able to fund its implementation, it is usually approved. The Department of Supply and Services unsolicited proposals fund provides bridge financing to initiate projects pending their incorporation in departmental budgets. **Contact:** Science Centre, Supply and Services Canada, Ottawa K1A 0S6

Canertech

Firms with interests in energy conservation and renewable technology are eligible for this program which offers participation in joint ventures, equity investments, commercialization and marketing. **Contact:** Canertech, c/o Petro-Canada, 350 Sparks Street, Suite 306, Ottawa K1R 7S8

Federal Business Development Bank

Businesses with a reasonable chance of success but unable to attract needed financing on reasonable conditions may obtain financial aid including loans, loan guarantees, interim financing and equity financing, and management services. **Contact:** Public Affairs Department, Federal Business Development Bank, Box 6021, Montreal, Quebec H3C 3C3

research, product models and prototypes, prototype testing, development of product specifications, and industrial graphics and packaging design. **Contact:** Department of Commerce and Development, Industrial Development Branch, P.O. Box 6000, Fredericton, New Brunswick E3B 5H1

Research and Productivity Council

The council provides significant scientific and technological capacity in certain fields, promotes the qualitative as well as quantitative benefits of research and industrial technology, provides independent technical and scientific advice to industry, concentrates on applied research, and attempts to shorten the time lag between the discovery of new processes, techniques and methods and materials and their useful application in business, industry and government in New Brunswick and elsewhere. Scientific, engineering, technical and management services are available to governments and companies in primary, manufacturing and service industries, usually on a contract basis. **Contact:** Research and Productivity Council, P.O. Box 1236, College Hill Road, Fredericton, New Brunswick E3B 5C8

Quebec

Technological Information Service

To disseminate technological, industrial and commercial information to Quebec business, the service provides telephone industrial information to industry; consultation on metric conversion (in-plant seminars, conversion plans); an information and awareness program on new energy sources for Quebec business; an industrial information bank; technological development assistance programs for businesses. No financial assistance is available. **Contact:** Quebec Industrial Research Centre, Department of Industry, Commerce and Tourism, at P.O. Box 570, 245 Hymus Boulevard, Pointe Claire, Quebec H9R 4S6, or at P.O. Box 9038, 333 Franquet Street, Sainte-Foy, Quebec G1V 4C7

Research and Development Service

Research and development is undertaken by a multidisciplinary team in cooperation with businesses. Design assistance and a support program are offered in cooperation with Design Canada. No financial assistance is available. **Contact:** Department of Industry, Commerce and Tourism, 710 Place d'Youville, Quebec, Quebec G1R 4Y4

Industrial Renewal Fund

Business may withdraw the lower of 25 percent of an eligible expenditure or the balance of the sum deposited in its name by the Quebec Minister of Revenue of Quebec. (Half of the provincial taxes the company has paid may be deposited in the fund.) The company must spend $20,000 within 12 months of being granted a certificate for, among other things, increased research and development, design, improvement or implementation of production procedures or products. The program is designed to permit small and medium enterprises to plan expansions, to encourage reinvestment of profits and to ease the financing of plans to improve their procedures. **Contact:** Industrial Renewal Fund Administration, Department of Industry, Commerce and Tourism, 710 Place d'Youville, Quebec, Quebec G1R 4Y4

Ontario

Program to Encourage Products and Process Innovation

Investors or small business entrepreneurs based in Ontario may obtain up to 100 percent of eligible costs, to a maximum of $10,000 to create prototypes of new inventions and to prove their feasibility. Projects of up to $15,000 that have sound market potential and adequate patent protection are eligible. **Contact:** Ministry of Industry and Tourism, Small Business Development Branch, Queen's Park, Toronto, Ontario M7A 2E1

Industrial Engineering Assistance Program

To assist Ontario-based manufacturers experiencing problems such as high production costs and low productivity, free-of-charge industrial counselling may be provided in areas such as facility design, selection and design of tools and equipment, planning and control systems, job evaluation systems, and office systems and procedures. **Contact:** Ministry of Industry and Tourism, Small Business Development Branch, Queen's Park, Toronto, Ontario M7A 2E1

Manitoba

Industrial Technology Centre

The centre was set up to enhance the viability of existing industries, stimulate creation of manufacturing enterprises based on new technology and make companies aware of the benefits of using contemporary technology. Scientific and technical services available to private companies include material and product evaluation and testing and product and process development. **Contact:** Industrial Technology Centre, Manitoba Research Council, Department of Economic Development and Tourism, 1329 Niakwa Road, Winnipeg, Manitoba R2J 2T4

Canadian Food Products Development

Individuals and companies involved in the food and beverage and feed industries may obtain technical assistance including use of pilot plant facilities for simulating production processes, evaluating equipment, etc.; information on equipment, procedures, data interpretation, government support programs, etc.; microbiological and chemical evaluation and testing of food products; and product development assistance. **Contact:** Canadian Food Products Development Centre, Manitoba Research Council, P.O. Box 1240, 810 Phillips Street, Portage la Prairie, Manitoba R1N 3J9

Industrial Benefits Program

The program is designed to assist new investors and expanding businesses to find Manitoba suppliers, and to assist Manitoba suppliers in meeting the needs of investors. Activities include the compilation of a sourcing directory, assisting investors to identify their needs, matching the needs with the firms listed in the directory, and assisting Manitoba-based firms in developing new technology and marketing. **Contact:** Industrial Benefits Branch, Department of Economic Development and Tourism, Winnipeg, Manitoba R3C 0V8

Manitoba Design Institute

The institute provides design consulting and advisory assistance to manufacturers for design research and product innovation. Cost-shared funding is available for design projects — packaging design, brochure design, corporate identity, and product design improvement. **Contact:** Manitoba Design Institute, 155 Carlton Street, Winnipeg, Manitoba R3C 3H8

Microelectronics Centre

Contract technology support is available to the industrial community. **Contact:** Department of Economic Development and Tourism, Winnipeg, Manitoba R3C 0V8

Industry Sector Development Program

Expertise and non-financial support are available to assist in evaluating new opportunities, particularly in six sectors: aerospace, electronics, food and beverage, health care products, light machinery, transportation equipment. **Contact:** Department of Economic Development and Tourism, Winnipeg, Manitoba R3C 0V8

Saskatchewan

Product Development Program

Manufacturing and processing firms may receive assistance of 50 percent of the costs of approved projects, to a maximum of $10,000 to develop new products, upgrade existing products and develop special processes. **Contact:** Department of Industry and Commerce, 7th Floor, Power Building, Regina, Saskatchewan S4P 3V7

Product Development Management Program

Consulting assistance is available to manufacturing and processing firms introducing new or improved products into the market, including a professional review of the company's product development plans and recommendations for carrying out these plans. The company shares from 10 to 25 percent of the approved costs for assistance in management and technology design, marketing and feasibility studies, including prototyping and production drawings. **Contact:** Department of Industry and Commerce, 7th Floor, Power Building, Regina, Saskatchewan S4P 3Y7 or Saskatchewan Research Council, Industrial Services Division, 30 Campus Drive, Saskatoon S7N 0X1

Special Technological Consulting Services

Assistance in product design, value analysis, metallurgical failure analysis, machine health monitoring and manufacturing technology is available. **Contact:** Industrial Services Division, Saskatchewan Research Council, 30 Campus Drive, Saskatoon, Saskatchewan S7N 0X1

Alberta

Product Development Program

Manufacturers located in Alberta may claim up to 75 percent of eligible costs of projects not exceeding $30,000 to increase their in-house design management understanding and capability. **Contact:** PDP Program Manager, Department of Economic Development, 10909 Jasper Avenue, Edmonton, Alberta T5J 3M8

Product Design and Marketing Program

Industrial technology grants are available to Alberta-based firms. **Contact:** Department of Economic Development, 10909 Jasper Avenue, Edmonton, Alberta T5J 3M8

British Columbia

Technical Assistance Program

The program is designed to assist proposed and existing British Columbia-based manufacturers, processors, and service-related manufacturers and processors with the costs of hiring consultants to do market and feasibility studies, testing and product improvement studies in order to expand facilities, diversify product line, create jobs or establish a new business. Up to 50 percent of consultant fees and 50 percent of the costs of studies may be claimed, to a maximum of $5,000. **Contact:** Ministry of Industry and Small Business Development, Victoria, B.C. V8V 1X4

Research Grants

Grants ranging from $10,000 to $200,000 are available to individuals in both the public and private sectors to further their research. Awards are made for research in eight categories: agriculture and food; aquatic sciences; electronics and communications; energy; forests and forest products; manufacturing; mining, minerals and metals; and transportation. **Contact:** Science Council of British Columbia, c/o Secretariat on Science, Research and Development, 301-7671 Alderbridge Way, Richmond, B.C. V6X 1Z9

Graduate Research in Engineering and Technology

Scholarships are provided for graduate students engaged in scientific and engineering research in B.C. universities, industries and government, to encourage graduate students to work on research projects of interest to local companies. The $6,000 scholarships may run for a maximum of three years. Projects must be undertaken in cooperation with local industries or organizations. **Contact:** Science Council of British Columbia, c/o Secretariat on Science, Research and Development, 301-7671 Alderbridge Way, Richmond, B.C. V6X 1Z9

Health Care Research Foundation Research Grants

Grants to support medical and health care research related to priority British Columbia problems are based on the experience and training of the individual or group applying. Equipment that cannot be obtained from other sources may also be purchased. **Contact:** Science Council of British Columbia, c/o Secretariat on Science, Research and Development, 301-7671 Alderbridge Way, Richmond, B.C. V6X 1Z9

Industrial Development Subsidiary Agreement

One program assists businesses to undertake market and economic feasibility studies so that they will be able to implement their ideas and thus accelerate the creation of new economic opportunities and jobs. Up to 50 percent of the total cost, to a maximum of $50,000, may be available for firm-specific market studies and economic feasibility studies related to manufacturing and processing. Research related to product design and development is not eligible.

A second program supports consultant studies of specific industrial opportunities that have demonstrable positive benefits for the province and its economy. Non-firm-specific research projects may be funded up to 100 percent, firm-specific research up to 50 percent, to maximum of $50,000.

Studies must be related to industries or regions within the eligible area. Neither program is available in the Lower Mainland or Southern Vancouver Island, and all studies will be made available to the public. **Contact:** IDSA Research Program Coordinator, Ministry of Industry and Small Business Development, Victoria, B.C. V8V 1X4

Northwest Territories

NWT Financial Assistance Programs

The Government of the Northwest Territories administers a number of financial assistance programs to promote the development of economic activity and the creation of jobs in the NWT by assisting business operations and related activities. Special emphasis is given to businesses owned or operated by the Territories' original peoples. Assistance may include immediate interim financing to resident business enterprises, and seed capital funds to complement development loans. Special ARDA cash grants are given for projects that provide jobs and improve incomes and opportunities of people of Indian and Inuit ancestry. **Contact:** Government of the Northwest Territories, Box 1320, Yellowknife, NWT X1A 2L9

Statistical tables

REVIEWABLE ACQUISITION CASES*

Table 1 — Outcome or status

	1977	1978	1979	1980	1981
Reviewable new cases	261	360	380	337	341
Carryover from previous period	65	73	106	114	123
Total of above	326	433	486	451	464
Total resolved	253	327	372	328	287
Allowed	231	282	320	249	230
Disallowed	12	28	24	37	29
Withdrawn	10	17	28	42	28
Carried over to next period	73	106	114	123	177
Allowed cases as percentage of resolved (%)	91	86	86	76	80
Value of assets, all cases ($000,000)	1,145	4,489	4,049	3,988	8,320

Table 2 — Country of control

	1977	1978	1979	1980	1981
Total	261	360	380	337	341
United States	171	243	248	197	202
United Kingdom	40	47	52	53	46
Other Western Europe	41	52	68	65	70
Austria	-	-	1	-	-
Belgium	2	1	2	1	4
Denmark	2	1	1	1	2
Finland	-	-	2	3	2
France	6	5	9	12	12
Germany, West	15	17	22	20	21
Greece	-	-	1	-	-
Italy	3	1	2	2	2
Liechtenstein	-	1	1	2	-
Luxembourg	-	1	-	-	-
Netherlands	4	8	6	7	4
Norway	-	1	-	1	2
Spain	-	-	1	-	-
Sweden	2	7	13	6	9
Switzerland	7	9	7	10	12
All other	9	18	12	22	23
Australia	1	-	3	4	2
Bermuda	-	-	1	1	2
Japan	3	7	2	2	3
Others	5	11	6	15	7
Allowed cases as percentage of resolved	%	%	%	%	%
United States	91	87	85	74	75
United Kingdom	95	78	87	79	78
Other Western Europe	90	89	88	78	92
All other	80	80	93	76	90

Table 3 — Industrial sector

	1977	1978	1979	1980	1981
Total	261	360	380	337	341
Primary	20	30	29	17	17
Agriculture, fishing and trapping	4	5	4	1	3
Forestry	1	1	-	2	-
Mines, quarries, oil wells	15	24	25	14	14
Manufacturing	108	162	178	141	132
Food, beverage and tobacco	15	15	14	14	6
Rubber, plastic and leather	6	12	5	6	8
Textiles, knitting and clothing	5	4	14	7	10
Wood, furniture and paper	12	14	10	8	15
Printing, publishing, and allied	2	4	5	4	6
Primary metal and metal fabrication	12	20	34	24	22
Machinery and transport equipment	14	28	43	23	22
Electrical products	12	16	20	17	10
Non-metallic mineral products	5	8	4	6	5
Petroleum and coal products	1	1	1	-	1
Chemical	10	22	17	12	17
Miscellaneous	14	18	11	20	10
Construction and services	133	168	173	179	192
Construction	3	1	6	6	15
Transportation, communication, utilities	10	10	9	9	8
Trade	72	101	93	93	83
Finance, insurance, real estate	15	19	12	27	19
Community, business, personal services	33	37	53	44	67

*Provision for review of acquisitions came into force April 9, 1974.

REVIEWABLE NEW BUSINESS CASES*

Table 4 — Outcome or status

	1977	1978	1979	1980	1981
Reviewable new cases	328	331	379	398	421
Carryover from previous period	58	52	64	70	129
Total of above	386	383	443	468	550
Total resolved	334	319	373	339	347
Allowed	297	273	323	287	247
Disallowed	12	21	22	27	43
Withdrawn	25	25	28	25	57
Carried over to next period	52	64	70	129	203
Allowed cases as percentage of resolved (%)	89	86	87	85	71
Planned investment, all cases ($000,000)	803	323	202	1,005	1,068

Table 5 — Country of control

	1977	1978	1979	1980	1981
Total	328	331	379	398	421
United States	184	192	205	223	237
United Kingdom	31[r]	26	45	37	40
Other Western Europe	85	80	82	111	78
Austria	-	3	-	3	-
Belgium	-	1	5	1	2
Denmark	6	4	2	7	2
Finland	1	1	7	1	4
France	17	16	15	23	19
Germany, West	26	18	19	25	23
Gibraltar	-	-	-	1	-
Greece	1	1	-	1	-
Ireland	-	1	1	-	1
Italy	10	10	6	14	4
Liechtenstein	-	-	-	1	-
Luxembourg	-	1	-	1	1
Monaco	1	-	-	-	-
Netherlands	3	1	4	12	8
Norway	3	3	1	3	1
Portugal	-	1	-	-	-
Spain	-	2	1	2	-
Sweden	9	5	6	9	5
Switzerland	8	12	15	7	8
All other	28[r]	33	47	27	66
Australia	3	3	2	3	1
Hong Kong	3	3	4	6	27
India	1	1	1	-	3
Japan	10	6	17	3	14
Others	11[r]	20	23	15	21
Allowed cases as percentage of resolved	%	%	%	%	%
United States	88	86	86	84	71
United Kingdom	82	81[r]	92	83	76
Other Western Europe	95	87	88	89	75
All other	81	82[r]	83	75	61

Table 6 — Industrial sector

	1977	1978	1979	1980	1981
Total	328	331	379	398	421
Primary	22	27	16	42	23
Agriculture, fishing and trapping	6	2	-	7	4
Forestry	2	2	1	2	-
Mines, quarries, oil wells	14	23	15	33	19
Manufacturing	94	99	100	126	118
Food, beverage and tobacco	7	6	11	11	5
Rubber, plastic and leather	5	5	9	11	10
Textiles, knitting and clothing	9	5	8	6	10
Wood, furniture and paper	5	6	9	14	9
Printing, publishing, and allied	-	4	5	4	3
Primary metal and metal fabrication	19	12	13	24	21
Machinery and transport equipment	19	19	20	18	23
Electrical products	5	7	8	13	7
Non-metallic mineral products	5	6	1	5	6
Petroleum and coal products	-	-	-	1	1
Chemical	3	6	7	9	10
Miscellaneous	17	23	9	10	13
Construction and services	212	205	263	230	280
Construction	4	14	12	12	18
Transportation, communication, utilities	5	11	11	7	11
Trade	133	103	156	129	149
Finance, insurance, real estate	16	11	14	7	11
Community, business, personal services	54	66	70	75	91

*Provisions for review of new businesses came into force October 15, 1975.
[r]Revised.

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