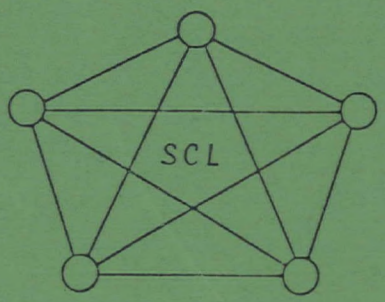
THE DIFFUSION OF TECHNOLOGY TO CANADIAN INDUSTRY

A Research Study



August, 1984

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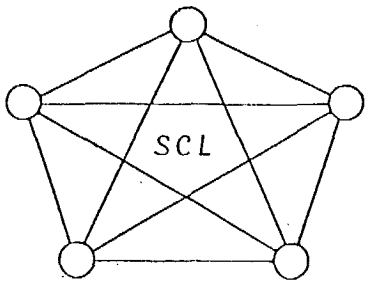

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1. INTRODUCTION

The process of technological innovation consists of producing new products and services from know-how or technology arising from research and development (R&D) activities. No company or nation produces all the R&D it requires solely through its own efforts; all must draw upon work performed elsewhere and integrate it with their own research in order to innovate successfully. Consequently, technology diffusion and technology transfer are of critical importance to the innovation process for all companies in all countries.

The diffusion and transfer of technology is an important aspect of innovation everywhere, but it is singularly important in Canada because of the unusual nature of the technological infrastructure in this country.

In 1979, for example, according to the Organization for Economic Cooperation and Development (OECD), of the $2.5 billion invested in R&D in Canada, 44 percent, or $1.1 billion was attributed to industrial companies; $0.73 billion or 30 percent to government; and $0.65 billion or 26 percent to universities. While both the absolute amount and the percentage of R&D performed by industry has risen since 1979, it remains true that a high portion of the R&D in this country is conducted by non-industrial organizations, and consequently, the diffusion of technology developed by outside agencies to industry is a critical element in the innovation process if the public investment in R&D at universities and government laboratories is to be fully exploited.

The mechanisms for the transfer of technology, defined as knowledge, know-how and embodied technology, are numerous and varied. They include the perusal of printed matter, such as scientific journals or trade magazines; attendance at trade

fairs, seminars, conferences and exhibitions; interactions with equipment suppliers; exchanges of personnel; the use of manual and computerized information systems; the interactions which stem from formal government programs; and informal interactions with government and university laboratories. Most informed observers agree, however, that the most effective transfer occurs when a continuous interaction takes place between knowledgeable individuals in a particular field.

This study was sponsored by the Ministry of State for Science and Technology in order to obtain the following factual information and opinions from private firms:

- the mechanisms through which they obtain access to technology from foreign and domestic sources
- the usefulness of these mechanisms
- perceived barriers which affect the efficiency and effectiveness of the diffusion process
- suggestions for federal policy and program measures which would improve the process.

The sample was to include small, medium and large firms which had been involved with government-industry technology transfer; firms which had received transferred technology from sources other than government; and firms which had not had experience with transferred technology. In addition, companies from all the regions of Canada, and both Canadian and foreign owned companies were to be surveyed.

Fifty organizations, listed in Appendix 1, were interviewed for this study. These comprised forty-six industrial companies, one industrial association, one innovation centre, one industrial research institute, and one research institute associated with a university. The companies represented eight industrial sectors which fell into two main categories: Innovative Industries, in sectors such as biotechnology and CAD/CAM; and Mature Industries, in sectors such as forest products and textiles. It was hypothesized that firms in the Innovative Industries group would be engaged in technology transfer activities primarily aimed at

developing new products and services, while the activities of companies in the Mature Industries group would be oriented more towards acquiring technology to improve productivity.

It should be noted that the small size of the sample precludes drawing any statistically valid conclusions from the data. In fact, when all of the above variables are taken into consideration, some of the cells in the resulting matrix only comprise one or two companies. The results of the study therefore should be regarded only as a brief description of the characteristics of the technology transfer and diffusion activities of a small number of Canadian companies. In particular, small companies which have little or no contact with the commonly used technology transfer mechanisms, and have no technical people on staff, are under-represented in the study.

In terms of policy development, several common threads of thought are discernible from the responses, some of which should be subjected to further, more intensive study, while others could be considered for immediate action.

2. METHODOLOGY

Fifty organizations were interviewed in the course of the study. The industry sectors to be included were selected by the Ministry. An interview guide was developed and reviewed with officials of the Ministry, modified and agreed on (Appendix 2).

An appointment was made with a representative of each firm by telephone, and a letter, accompanied by a summary of the interview guide, was mailed to each person before the interview so that some thought could be given to the subject by the interviewee. The letter guaranteed the company that the information provided would be held confidential and would only be reported in aggregate form.

Included in the fifty organizations are interviews with four institutes or centres which are involved with technology diffusion.

3. RESULTS

The results of the study will be given under the following main headings:

- Characteristics of the Companies
- Diffusion Mechanisms Used
- Sectoral Summaries of Key Findings
- Barriers to Technological Diffusion
- Suggested Measures to Improve Technological Diffusion

3.1 CHARACTERISTICS OF THE COMPANIES

The industry sectors surveyed during the study, and the number and size of the companies in each sector, are shown in Table 1.

Table 1. Sectoral and Size Characteristics

	Size of Firm*			
Innovative Industry Sectors	Small	Medium	Large	Total
CAD/CAM	3	3		6
Remote Sensing	2	4		6
Communications	1	2	3	6
Biotechnology	2	2		4
TOTAL	8	11	3	22
Mature Industry Sectors				
Mining	1		5	6
Textiles		2	5	7
Forestry	2	1	6	9
Food Processing		2		2
TOTAL	3	5	16	24
GRAND TOTAL	11	16	19	46

*Small = 1-49; Medium = 50-199; Large = 200+ Employees.

In the Innovative Industry sectors, 19 of the 22 companies were small or medium sized, while, as might be expected, the pattern of small versus large was reversed in the Mature Industry sector, where 16 of the 24 companies fell into the large category.

Table 2 shows the provincial distribution of the companies. At least one company in each province was contacted. The companies interviewed corresponded as closely as possible, considering the small size of the sample, to the major industrial activites in each province. Thus, in the more diversified economies of Ontario, Quebec and British Columbia, a variety of sectors were contacted, while in Manitoba, for example, two textile firms were interviewed, because of the importance of the textile sector to that province.

Table 2. Provincial Distribution and Sectoral Characteristics

	Sector								
Province	CC	RS	C	B	M	T	F	F&B	Total
B.C.	1	1	2	1			4		9
Alberta					2				2
Saskatchewan		1			1				2
Manitoba						2			2
Ontario	4	2	3	2	1	2	2	2	18
Quebec	1		1	1	1	3	2		9
New Brunswick							1		1
Nova Scotia					1				1
P.E.I.		1							1
Newfoundland		1							1
Total	6	6	6	4	6	7	9	2	46

*CC = CAD/CAM; RS = Remote Sensing; C = Communications; B = Biotechnology; M = Mining; T = Textiles; F = Forestry; F&B = Food and Beverage.

3.2 DIFFUSION MECHANISMS USED

A wide variety of diffusion mechanisms were reported by the companies. These included technology transfers through direct interactions with institutions such as universities, industrial associations, government laboratories and technical institutes; and obtaining information through passive sources such as scientific journals, trade magazines and journals, and from information services such as CISTI. Government programs which led to interaction with scientists at government laboratories or at universities were another source of technological information.

This section summarizes the information gathered on technology diffusion mechanisms used by the companies. Table 3 summarizes the sources of information and assistance, Table 4 lists the government programs used and is followed by a summary of the comments offered by the companies on the benefits and problems experienced with these programs, and Tables 5 to 12 give an assessment of the relative value of the institutions dealt with by each firm.

Table 3 below indicates that some companies in all sectors use most of the sources. Companies in the Mature Industry category use trade magazines and journals, industrial associations, and competitors more frequently than firms in the Innovative Industry category, while the Innovative Industry sector companies are more frequent users of government laboratories. The most commonly used sources of technological information in both categories are trade magazines and journals, closely followed by conferences, seminars and trade shows. Equipment suppliers are another important source of information for all sectors. Companies in the textile sector rely heavily on trade magazines, industrial associations and trade shows for technical information and few dealt with government laboratories or universities. Textile firms also utilize fewer mechanisms per firm than any other sector. The percentage of mechanisms used per firm was slightly higher for the Innovative Industry group (7.9), than for the Mature Industry group (7.7), in spite of the fact that most companies in the Innovative Industry group were much

Table 3. Sources of Technology

	Innovative Industry Sector					Mature Industry Sector				
Source	CC	RS	C	B	Firms Using Source	M	T	F	FB	Firms Using Source
Scientific Js.	4	5	5	4	82%	5	3	8	2	75%
Trade Mags./Js.	4	5	6	3	82%	6	6	8	2	92%
Industrial Assocs.	2	3	6	3	64%	4	6	8	2	83%
Equipment Suppl.	5	6	4	3	82%	4	7	6	1	75%
Customers	5	3	3	2	59%	4	2	5		46%
Govt. Labs.	4	2	5	3	64%	5	1	4	2	50%
Universities	4	1	5	4	64%	5	2	6	2	63%
Competitors		1		3	18%	3	2	5		42%
Info Services	5	1	4	2	55%	3	1	4	1	42%
Science Counsellors		1			4%					0%
Company Library or Info Group	4	3	3	2	55%	4	4	5	1	58%
Conferences, Trade Shows	4	6	5	3	82%	5	6	8	2	88%
Patent Search	2		2	1	22%	3		4	1	36%
IRAP	2		2	2	27%	1		1	1	13%
Other	1	2	3	1	32%	2		1		13%
Total	46	39	53	36		54	40	73	17	
No. of Firms	6	6	6	4		6	7	9	2	
Mechanisms used per firm	7.7	6.5	8.8	9.0		9.0	5.7	8.1	8.5	
Mechanisms used per sector group					7.9					7.7

smaller firms than those in the Mature Industry category (see Table 1). Patent searches were used by only 13 firms and only one company reported contacting an External Affairs Science Counsellor for technical information.

The Federal Government has developed, over the years, several programs which have as their goal the development of technology in Canada. Many of these programs impact directly on technology transfer and diffusion. They are: (Sponsoring Dept.)

IRAP - Industrial Research Assistance Program (NRC)
PILP - Program for Industry/Laboratory Projects (NRC)
PRAI - Project Research Applicable in Industry (NRC)
STEP - Science and Technology Enhancement Program (DRIE)
IRDP - Industrial and Regional Development Program (DRIE)
CIRB - Canadian Industrial Renewal Board; PEMD - Program for Export Market Development (DRIE)
IRI - Industrial Research Institutes (DRIE)
CAT - Centre of Advanced Technology (DRIE)
IIC - Industrial Innovation Centres (DRIE)
CSF - Catalytic Seed Fund (External Affairs)

Information of these and other government programs can be obtained from a publication entitled "The Government of Canada's Support for Technology Development - 1984" published by the Minister of Supply and Services Canada (Cat. No. ST 31-13/1984).

Table 4 shows the extent of interaction of the companies with federally sponsored programs and institutions.

PILP is the most commonly used program, and according to the companies, most PILP contracts involve significant elements of technology transfer, although the funding provided is also important. Comments on EMR programs were similar to those on PILP. While Programs such as STEP and IRDP do not directly involve technology transfer, they are a source of funds for companies to either acquire new technology, or to develop transferable technology. CIRB provides funds to replace obsolete equipment in the textile sector, and is directly responsible for

Table 4. Interactions with Federally Sponsored Programs and Institutions

Program	Innovative Industry Sector				Firms Using Mech.	Mature Industry Sector				Firms Using Mech.
	CC	RS	C	B		M	T	F	FB	
IRAP	1		2	1	18%				2	8%
PILP	4	3	2	4	59%	2		5	1	29%
PRAI	3			2	23%	1		2	2	21%
EMR Programs	1	3			18%	1		3		17%
Ag.Can. Programs					0%				2	8%
STEP	3	2	1		32%			3		13%
IRDP	3	1		2	27%	1		4		21%
CIRB					0%		3			13%
PEMD	2				10%	2				8%
Total	12	9	5	10		7	3	17	8	
Misc. Progrs and Govt. Sponsored Centres										
Microelectronics Centres	3		1		18%	1	2			13%
IRI-CAT	2			1	14%	2		1	1	17%
Innovation Ctrs.	1			1	9%			1		4%
CCA Patent Search	1				5%	3		1		17%
Total	7	0	1	2		6	2	3	1	

much new technology being put into place and for helping to raise productivity levels. PEMD provides funds for travelling to overseas exhibitions and trade shows and thus serves a distinct technology transfer function. IRAP funds the employment of professional staff who bring new technical knowledge to

participating companies.

3.3 SECTOR SPECIFIC FINDINGS

Innovative Industry Segment

3.3.1 CAD/CAM

Six companies in three provinces were interviewed in the CAD/CAM sector. All were Canadian owned, two were small and four were medium sized firms. Tables 3 and 4 show that companies in this sector were the largest users of government programs on a per company basis, and that the average firm utilized 7.7 sources of technological information. All firms in the sector had introduced at least one new product in the preceding three years, and the sector as a whole had introduced 22 new products over this period.

Total sales in 1983 for the firms interviewed in the sector were approximately $40. million, including over $24. million in exports. Expenditures on R&D were $4.3 million, or more than 10% of sales.

All firms used foreign sources of information, principally conferences, seminars and journals. One company had enhanced its technological arsenal through involvement with international committees and through joint ventures with foreign companies. Every company interviewed believes that keeping up to date on relevant technological developments is vital to their continuing success.

Table 5 is an analysis of the value to the firms of the linkages they have established with major institutions which they use as sources of technological information and advice. The only contact mentioned by interviewees with a government laboratory was with the National Research Council (NRC). The lack of contact with other government departments is not unexpected because NRC is the only government laboratory to be working on CAD/CAM applications.

Table 5. CAD/CAM Sector Linkages with Institutions

Firm No.	Prov.	Size			Institution*			New Prods in 3 yrs
		S	M	L	Univ	Ind. Assoc.	Govt. Lab.** NRC	
1	BC		X			U	U	4
2	Ont	X				U	VU	1
3	Ont		X		U	LU	LU	1
4	Ont	X					LU	4
5	Que		X		U	U	VU	8
6	Ont		X		U	LU	VU	4

(*LU = Interactions were of limited use; U = Useful and helpful; VU = Very useful to extremely valuable.)

Government Policies and Programs

Scientific Research Tax Credit - Two companies classified the measure as good, and one called it "a major encouragement for technology transfer". One commented that they had sold their credits for $700,000 which provided much needed cash. Two companies suggested that a better method would be to refund a percentage of last year's R&D expenditures (one suggested 50 percent, the other 100 percent), and one company stated the incentives were of dubious value. One firm called the tax incentives a "rip-off" of the Canadian taxpayer because large companies were selling their credits for millions of dollars.

Make or Buy Policy - Three firms had been involved with the contracting out policy. One rated it a good program, another complained that the tender system was used too frequently, particularly for small contracts, and that the bureaucracy was incredibly slow. The third company also thought the payment and processing was too slow and claimed, "It is

easier for a Canadian company to sell to the U.S. government than to the Canadian government." The complaints were not about the policy, which they generally agreed with, but rather with the administration of the program. One company suggested that a "Buy Canadian" policy be adopted, and that a program ombudsman for each department was needed.

Immigration Restrictions - One company reported difficulty in obtaining permission for technical personnel to enter the country.

PILP and IRAP - Four companies had used PILP, and one IRAP. They all commented that the interactions with the scientists were very useful, but that the processing of applications and payments was too slow. Two firms added that they felt that too much reporting was required with PILP.

IRDP and STEP - One company described IRDP as an employment program for depressed areas, which was not designed to help hi-tech firms. Two others stated that, in their view, the administration at DRIE was too slow and bureaucratic for the rapidly evolving activities in hi-tech fields.

PEMD - Two firms had used PEMD funding to attend foreign technical exhibitions, and both praised the program.

New Product Development - Four companies reported that technical assistance provided by NRC had been instrumental in the development of new products.

Linkages With Government and University Laboratories - Three firms commented that they were not interacting enough with university and government laboratories because they were not able to familiarize themselves with all the relevant activities in these organizations. Two suggested that more funds should be invested in basic research in these institutions, and that the results should continue to be transferred to companies for product development.

Barriers to Technology Diffusion

1. Government bureaucracy is a major problem, especially in connection with the Department of Supply and Services. One company commented that by the time a contract is approved, a U.S. company has already developed the product (in a hi-tech field).

2. Approvals from the Canadian Standards Association (CSA) are too slow. According to one medium sized firm, one project was abandoned because it took too long to obtain CSA approval.

3. Two companies felt that a lack of awareness of R&D activities in government laboratories and in universities was a serious problem, and that better communication is needed between government, universities and industry.

4. One company president of a CAD/CAM company that dealt with small manufacturers stated that the greatest barrier to technology diffusion in Canada is the lack of technically trained people in small and medium sized manufacturing companies.

Suggested Government Measures

1. In the opinion of two companies, the R&D incentive program should be changed to a system which refunds 50 percent of R&D expenditures.

2. One company suggested, half seriously, that contracts should be awarded on the basis of a lottery amongst qualified firms to reduce bureaucratic delays.

3. Another suggested that we get rid of our inferiority complex, and change the Make or Buy Policy to a Buy Canadian Program.

4. It was suggested that a program ombudsman for every department should be appointed to speed up contract processing.

5. Another suggestion was that the skills growth program should be used to train technical people for jobs in the manufacturing sector, with emphasis on the community college level of training.

6. One firm suggested that experts in the technology of a particular industrial sector could be employed as technological intelligence officers by industrial associations to explore relevant developments in university and government laboratories.

3.3.2 REMOTE SENSING

Six companies were interviewed in the remote sensing sector. All were Canadian owned, two were small and four were medium sized. Tables 3 and 4 show that these firms used an average of 6.5 technology transfer mechanisms, and utilized 9 government programs. All six firms had introduced at least one new product in the preceding three years, and the sector as a whole had introduced 15 new products over this period.

Total sales for five of the six companies (the sixth declined to divulge this figure), amounted to approximately $59 million, including about $36 million in exports. Expenditures on R&D were $8.4 million for the five firms which reported sales, which is about 14 percent of sales.

Four firms reported using foreign sources of technological information, principally conferences, seminars and journals. One company had visited Japan and another had established linkages with the science counsellor in Paris.

Table 6 is an analysis of the value to the firms of the linkages they have established with the major institutions which they used as sources of technological information. Responsdents mentioned having contact with government labs in the National Research Council (NRC), the Department of Communications (DOC), and in Energy, Mines and Resources (EMR).

Table 6. Remote Sensing Sector - Linkages With Institutions

Firm No.	Prov.	Size S	M	L	Institution Univ	Ind. Assoc.	Govt. Labs. NRC	DOC	EMR
7	Sask		X		VU	VU	VU	VU	U
8	Ont		X				VU		VU
9	Ont		X				VU		VU
10	BC		X		LU	LU	LU		VU
11	PEI	X			VU	U	VU		VU
12	NFLD	X			VU	LU	U		U

Government Policies and Programs

Scientific Research Tax Credit - Three companies had used the tax credit program, two rated the measure excellent, and one rated it good. One firm believed it encouraged a shift in accounting practices in order to report more R&D expenditures rather than a real increase in R&D.

Make-or Buy Policy - Two firms rated the program as good, but one of these complained of slowness, although they had good rapport with DSS. One company reported that it had started its business with funding from an unsolicited proposal (UP), and that most of its current projects were funded by this program. Another company complained of problems with their local office of DSS, and that "DSS projects were given to persons in the know". This company has stopped submitting bids on government contracts. Another company felt that the controls on the UP program were sometimes too tight.

PILP and IRAP - Three firms had used PILP and all categorized it as a good or excellent program. A fourth company reported that it had tried for eighteen months to obtain a contract and finally given up.

PEMD - One firm had used PEMD to fund a trip to a trade exhibition.

New Product Development - Two companies credited EMR (CCRS) with assisting in the development of new products, and a third firm had developed a new product in conjunction with DOC.

Linkages With Government and University Laboratories - One company had received very useful assistance from EMR(CCRS) but felt that the resources available to CCRS were too limited, and that universities needed more resources for research. Another firm reported that interactions with DOC had led to the development of new products, and that NRC had made indirect contributions to new product development. This company believed that universities should be a training ground for skills, and a source of basic technological concepts. A third company also reported that CCRS had assisted in new product development by providing specific expertise. One company employed a post graduate fellow, funded by NRC, who, because he was an expert in remote sensing technology, was able to make an important contribution to his employer by serving as a technological intelligence officer. Another had used students, funded by NRC, who developed a model which led to a new product being produced. This company also used university professors for contract work in specific fields. Still another company reported using EMR (CCRS) equipment to test their products.

Exchanges of Scientific and Technical Personnel - Two companies had used exchanges of personnel with universities, and one of these firms eventually hired some of these people. The second also had a number of people working with CCRS for a period of four years on a project which resulted in the development of a major new product.

Barriers to Technology Diffusion

1. One company reported that the Department of National Defence retarded technology transfer by its insistence on obtaining

international bids on contracts when the necessary expertise was available in Canada.

2. Another firm claimed that in the United States, government departments (particularly the Defence Agencies) assure companies of long term funding of R&D until a product is developed, whereas in Canada there is no assurance of long term (or even short term) funding, as our program structure does not allow for the provision of continued support for the R&D required to develop products.

3. Lack of a central information source on R&D activities in government and university laboratories inhibits companies from seeking information.

4. Remoteness from sources of information was mentioned by three companies. One company had moved its R&D group to Ottawa from the east coast to foster interaction with government laboratories.

Suggested Government Measures

1. The government should fund demonstration projects in new fields of technology and establish centres where cooperative facilities, to be shared by Canadian firms, could be established. It should also initiate a program to ensure that R&D is funded, perhaps to the level of 50 percent, in specific high-technology areas.

2. Government policies in the areas of technology transfer and technological innovation should be made more cohesive and should "support winners", and the Canadian market should be protected for Canadian companies in the chosen areas using the tariff and non-tariff measures employed by other developed countries. The general perception of the firms is that other countries use non-tariff barriers more extensively than does Canada.

3. A program should be introduced to provide firms with funds to assess new technology. It should allow companies to

obtain up to $20,000 three or four times per year to investigate the value and usefulness of new technologies which are judged by the firm to be potentially useful.

4. Tax breaks should be provided for offshore equipment in drilling operations.

3.3.3 COMMUNICATIONS

Six companies were interviewed in the communications sector. One was foreign owned and five were Canadian owned. One was small, two were medium sized, two were large and one was very large. Tables 3 and 4 indicate they used an average of 8.8 technology transfer mechanisms, and utilized five government programs. All six firms had introduced new products or services in the preceding three years, but the very large company could not provide detailed information about the number of these. The other five firms had introduced eleven new products over this period.

Total sales for the two small firms were approximately $1.8 million, with exports of over $1.2 million. One large firm had sales of $2 billion and had no exports because of the nature of its business. Another large firm had worldwide sales of $4. billion, with exports from Canada of $400 million. The other large firm had sales of $200 million with exports of $40. million. The six companies spent over $376 million on R&D, with $373 million of this accounted for by the two largest firms.

Five of the companies reported that they used foreign sources of information, principally conferences, seminars and journals. One medium sized company drew upon sources in Hong Kong, and the large companies participated in international telecommunications committee work and belonged to foreign associations.

Table 7 is an analysis of the value to the firms of the linkages they have established with the major institutions which they use as sources. Only the laboratories of the National

Research Council and the Department of Communications were mentioned as sources of information and assistance.

Table 7. Communications Sector - Linkages With Institutions

Firm No.	Prov.	Ownership		Size			Univ.	Institution		
		F	C	S	M	L		Ind. Assoc.	Govt. NRC	Labs. DOC
13	Ont		X		X		U	LU		U
14	Ont		X		X				U	
15	Que		X			X	U	VU	U	VU
16	BC		X	X			LU		VU	LU
17	BC	X				X	VU		LU	VU
18	Ont		X			X	VU		VU	U

Government Policies and Programs

Scientific Research Tax Credit - Three firms rated this measure as good or excellent, but one of these felt that a better approach would be to refund 50 percent of the funds spent by the company on R&D in the previous year.

Make Or Buy Policy - One company described the program as "helpful but slow", and one commented that the unsolicited proposal program was very good.

Customs Procedures - One firm had experienced problems with slow and cumbersome customs procedures and was planning to manufacture its products in the United States as well as in Canada to avoid the "customs hassle", and thus become more competitive with American suppliers.

PILP and IRAP - One firm reported the PILP and IRAP were quite useful, while another felt that programs such as these with rigid research objectives and schedules were too inflexible for the rapidly changing requirements of leading edge technologies in the communications field.

EDP - One company had received a major business development grant under EDP, but felt that a better way of providing funds would be to give tax credits.

New-Product Development - One company reported that DOC had provided important technical assistance in the development of a new product.

Linkages with Government and University Laboratories - The larger firms all interacted with universities, and one had recently assigned two people on a full time basis to engage in liaison with universities in Canada and the U.S. This company was also making a deliberate effort to establish more substantial linkages with government laboratories through major joint projects. The larger companies in this sector looked upon universities as a source of fundamental research, while the small firms had few technological interactions with universities.

Barriers to Technology Diffusion

1. Large ponderous government, over regulation, and the failure of regulatory bodies to keep up with technological advances were barriers related to the utilization of new technology identified by companies in this sector.

2. One small firm stated that more information was needed on technological developments as it was very difficult for one company to be aware of all the relevant activities in its sphere of interest.

3. One company felt that work in government laboratories should be linked more closely to industrial needs.

Suggested Government Measures

1. Committees, comprising government and industrial personnel, should examine, assess and approve programs for federal government laboratories.

2. The government should bring in foreign experts to interact with Canadian firms.

3. There should be selective tariff reductions on equipment used in the industry that is not manufactured in Canada.

4. Government purchasing should be based on a "Buy Canadian" policy.

5. The government should emulate the Japanese practice of identifying key areas of technology and encouraging companies to develop technology in these areas.

6. Individuals should be allowed to write off the cost of acquiring equipment related to information acquisition.

3.3.4 BIOTECHNOLOGY

Four companies were interviewed in the biotechnology sector; one foreign owned and three Canadian owned. Two of the companies were small and two medium sized. Tables 3 and 4 show that they used an average of nine technology transfer mechanisms and utilized ten government programs. Two companies had introduced six new products in the past three years, and the other two, which had only recently been established, were in the process of developing a number of new products. The two firms with a track record had combined annual sales of about $4 million, including $500,000 in exports. R&D expenditures for these two companies were $3.2 million, or 80 percent of sales.

All four firms used foreign sources of information, principally conferences, seminars and journals. One company had visited Japan, and another had established the practice of holding a monthly seminar for its technical staff which featured four outside experts brought in under contract from laboratories in Canada and the U.S., in order to keep abreast of new developments. All companies in the sector stated that keeping up to date on technological advances was critical.

Table 8 is an analysis of the value to the firms of the

linkages they have established with the major institutions they use as sources. Industry-government contacts were only noted between the biotechnology firms and laboratories in the National Research Council (NRC), Environment Canada (ENV), and Energy, Mines and Resources (EMR). No contacts with industry associations were found.

Table 8. Biotechnology Sector - Linkages With Institutions

Firm No.	Prov.	Owner-ship		Size			Institutions			
							Univ.	Govt. Labs.		
		F	C	S	M	L		NRC	ENV	EMR
19	BC		X	X			VU	VU		U
20	Que		X		X		VU	U		
21	Ont		X		X		VU	U		
22	Ont	X		X			VU	U	U	

Government Policies and Programs

Scientific Research Tax Credit - Two firms rated the measures as good, and another thought it was excellent because the company had sold its credits for $500,000 which they were using as seed capital. The fourth company felt the idea was good, but that the feature which allowed the sale of tax credits was an abuse of tax funds.

Make or Buy Policy - One firm commented that the make or buy policy was sound, but that in practice it needed wider dissemination. Two companies had not used the contracting out program. A third company stated they were reluctant to become involved in programs which vested the rights to the technology in the Crown. Another company stated that the minimum worthwhile project had to be $200,000 because of the amount of paperwork.

Immigration Policies - One company thought that we needed a freer system of immigration to attract key personnel.

PILP and IRAP - All four companies had used the PILP program, and one had used IRAP. They spoke favourably of the benefits of the interactions with the scientists involved, but two felt that the processing procedures and payments were too slow.

Linkages with Government and University Laboratories - According to one firm, the information received from government laboratories was useful, but the cooperation received from the scientists there could be better. It was felt that the scientists had no incentives to assist industry, and sometimes did so reluctantly. One small firm owed its existence to a spin-off from university research, and it maintained close working relationships with the university. This company thought that, in order to commercialize university research, individuals with an industrial background must join with scientists from universities to form companies. Two firms stated that fundamental R&D should be conducted at universities, and industry should draw upon this work as a base for developing commercial products.

Exchanges of Scientific and Technical Personnel - One company had employed university personnel on an exchange basis, another had arranged a joint venture with a university, and a third had negotiated a research partnership with a university.

Barriers to Technology Diffusion

1. Two companies stated they suffered from a lack of knowledge of R&D activities which were relevant to their needs.

2. The practices of the Foreign Investment and Review Agency (FIRA) hinder joint ventures and the transfer of technology, according to one firm.

3. Canada lacks the protection for plant breeders' rights which exists in most developed countries.

4. The terms of reference of government programs are too restrictive and require too much reporting.

Suggested Government Measures

1. According to one company, France, Germany and Italy all protect their markets in biotechnology, and Canada should establish permanent tariffs to do the same.

2. More discussion should take place between government laboratories and industry to determine industry's needs. The emphasis should be on supporting R&D, not on doing it. There is also a need to know what work the laboratories are doing.

3. The government should establish linkages among programs such as PILP, IRAP, IRDP and PEMD. Presently, a firm must make separate applications for support under each program with each involving delays caused by the evaluation and approval process. For example, a firm with a single innovative project could apply for financial assistance from NRC's IRAP to cover some of the costs of research, later apply to DRIE's IRDP for funds to help pay for the cost of the development phase of the project, and still later apply to PEMD for financial assistance in showing the product at a foreign trade show. If appropriate linkages were established, one approval, contingent upon the successful completion of the preceding phase, would provide funding for all the innovative stages of the project and thus stimulate usage of the full spectrum of Federal Government technology development programs, and significantyl reduce the evaluation and approval delays experienced at present.

4. The terms of reference of government programs should be loosened, with more emphasis being put on the quality of the ideas and their technological potential, and less on rigid timetable and onerous reporting requirements.

3.3.5 MINING

Six companies in the mining sector were interviewed, two of which were foreign owned and four Canadian owned. One company was small, five were large, and the sample included one federal and one provincial Crown Corporation. One company was a medium sized supplier to the mining industry, and the others were ore or oil producers.

Tables 3 and 4 indicate that the firms in this sector used an average of nine mechanisms and utilized seven government programs. Three of the companies had introduced ten new products in the past three years, and four companies had introduced major new equipment or systems to improve productivity. In addition, numerous small, incremental technological improvements had been made which were productivity oriented.

Four companies provided sales, export and R&D information. These firms had sales of approximately $3.4 billion, exports of about $2.3 billion, or 68 percent of sales, and R&D expenditures of $15 million, or 0.4 percent of sales.

Five firms reported that they used foreign sources of information and technology comprising seminars, conferences and trade shows, foreign research associations, and licensed technology from other countries. Two companies reported having had exchanges of personnel with a university and another was considering this approach.

Two companies stated that their technology was at the leading edge or state-of-the-art, while others felt that they were generally ahead of other firms in the business, but not quite at the state-of-the-art level.

Table 9. Mining Sector - Linkages With Institutions

Firm No.	Prov.	Ownership		Size			Institution				
								Ind.	Govt. Labs.		
		F	C	S	M	L	Univ.	Assoc.	NRC	ENV	EMR
23	Que		X			X	U	VU*	VU	U	VU
24	Alta	X				X	LU	VU	U		U
25	Alta		X	X			U		VU	U	VU
26	Sask		X			X	U	VU*	U		U
27	Ont	X				X			U		U
28	NS		X			X	VU	U	VU	VU	VU

* Belong to a foreign Industry Association

Linkages with Industrial Associations

Most companies belonged to several industrial and professional associations, and three were members of foreign industrial associations in the U.S. and Britain. These associations, particularly the foreign institutes, which performed R&D, were considered an excellent source of technical information, which was acquired through regular publications, papers on research projects, seminars, and informal interaction between members.

Linkages with University and Government Laboratories

All companies in the sector dealt with NRC and with the CANMET laboratories of EMR and rated these interactions as useful or very useful. Three firms dealt with Environment Canada laboratories, two of which found the assistance useful and one very useful. Three companies reported that CANMET had assisted in the development of new products, and two that NRC had provided important assistance by helping them develop models of their production systems. Four firms dealt with universities and reported their assistance ranged from being of limited use to very useful.

Government Policies and Programs

One company had utilized several government programs, including PILP, PRAI, and EMR programs, and expressed satisfaction with both the program administration and the interactions with the scientists. This firm had also dealt extensively with provincial research organizations. A second company had attempted to use IRDP and PEMD and expressed strong concern about the amount of time required and the paper burden involved in these programs. This firm commented, "programs should be staffed by technical and managerial people who know how to evaluate the information in a proposal".

Scientific Research Tax Credit

One firm rated the incentives as good, the two Crown Corporations did not benefit from it, and a fourth company was dubious about the benefits.

Barriers to Technology Diffusion

1. Crown Corporations have difficulty in obtaining contracts and are not eligible for government programs, according to one firm. This firm felt it was easier to deal with the U.S. government than with the Canadian one.

2. The paperwork burden and the time involved in dealing with DSS is excessive.

Suggestions for Government Measures

1. The proposed Patent Law changes which would reduce the level of protection provided to owners of technology patented in Canada, would retard the flow of technology into Canada and should be scrapped.

2. Funding under IRDP should not be based on the level of unemployment in a location, but on the future potential of the technology under review.

3. A serious effort should be made to reduce the red tape

associated with the administration of the IRDP.

4. Taxation measures to encourage R&D performers to diffuse technology should be inaugurated. R&D performers, which could include universities and industrial laboratories, could be given a tax break for successfully transfering technology to a Canadian company.

5. Educational institutions should be encouraged to educate students to be R&D oriented.

6. A system of grants to build prototypes and stimulate investment in new equipment is needed.

3.3.6 TEXTILE SECTOR

Seven companies in the textile sector were interviewed, three of which were foreign owned, and four Canadian. Two were medium sized and five large. Table 3 shows that they used an average of 5.7 technology transfer mechanisms, although it should be noted that two companies used three and one only two. Table 4 shows that the only government program used by any firm was the Canadian Industrial Renewal Board (CIRB) program, and that three firms had utilized this, while another was considering it. Only two new products had been introduced in the past three years by the companies, although dozens of style changes had taken place. Many productivity improvements had been achieved by introducing new production equipment, particularly by the larger firms, in the past three years, although two of the smaller companies had made only minor changes in their production systems.

Two smaller companies declined to provide sales and export data. Total sales for the other five were $951 million, with one very large firm reporting about two-thirds of that amount. Exports were $7.5 million, or 0.78 percent of sales. R&D expenditures were $1.6 million, or 0.17 percent of sales, although only two companies reported that they had formal R&D programs.

Five companies reported that they used foreign sources of information. These were mostly equipment suppliers which are predominantly foreign, although three companies found it useful to visit Europe regularly to review equipment, and one had acquired valuable information from exchanges of technical personnel with European companies. Two of the firms rated their production systems as "the most modern in the world", and, "the best in North America", while another stated, "it is not the most modern, but using people (rather than machinery) gives you flexibility". Another firm was using obsolete equipment but had hired a consultant to develop an equipment renewal proposal.

Table 10. Textile Sector - Linkages With Institutions

Firm No.	Prov.	Owner-ship		Size			Institution			
		F	C	S	M	L	Univ.	Ind. Assoc.	Govt. Lab. NRC	
29	Ont	X			X			LU		
30	Ont	X			X			LU		
31	Que		X			X	U	VU**		U
32	Que	X				X		U		
33	Man		X			X	VU*	LU		
34	Man		X			X	U	VU**		
35	Que		X			X		LU		

* One firm had linkages to European Colleges
** Belong to foreign Industrial Association

Government Policies and Programs

Three companies were using the CIRB program and all rated it as good or excellent, although the very large firm felt that the $30 million limit was too low. Several firms stated that the continuance of the quota system was critical to their continued existence and to their efforts to remain competitive by improving productivity through technological improvements. One company

president commented that he was not aware of any government programs but that "whatever it is doing now it should do less".

Scientific Research Tax Credit

Two companies who used the measure rated it as good.

Linkages with Government and University Laboratories

One company reported useful contacts with NRC, and two with Canadian universities. One company had established very useful linkages with European colleges which have courses designed to educate and train personnel for the textile industry.

Barriers to Technology Diffusion

1. The cost of equipment, most of which is not manufactured in Canada, was called a major impediment.

2. Rapid changes in government policy. According to one firm, the removal of the 50 percent write-off for capital equipment was very costly, and should have been done gradually over a period of years.

Suggestions for Government Measures

1. Reduction of the cost of equipment by subsidies and/or tariff reductions.

2. Retention of the quota system - the existence of the industry as well as all programs to improve productivity, depend on import quotas.

3. Provide encouragement for community colleges and universities to establish courses in the textile field.

4. Encourage industry associations to perform R&D and become more active in technology transfer, perhaps with a technological intelligence officer subsidized by the government.

3.3.7 FOREST PRODUCTS SECTOR

Nine companies in the forest products sector were interviewed. Two were very small firms with four and six employees which had developed specialized equipment for the forest industry, and the remainder were large. Both small firms, and six of the seven large companies were Canadian owned. Tables 3 and 4 illustrate that the firms in this sector used an average of 8.1 diffusion mechanisms, and utilized seventeen government programs. Four new products had been introduced, and numerous product refinements had been made in the past three years. Seventeen major systems changes, and many more minor equipment changes aimed at improving productivity were reported during this period.

Six companies provided information on sales, export and R&D levels. Revenue from sales was $3825 million, exports were $2263 million, and R&D expenditures were $14 million, or 0.4% of sales. It should be noted that there was a wide divergence of expenditures on R&D. One large firm had an R&D group comprising 110 professional and technical staff, while another large company had only allocated two professionals to formal R&D activities.

Eight companies used foreign sources of information. These included visits to Scandinavian firms by two companies, interactions with Scandinavian and U.S. suppliers by four, and with the Forest Products Laboratory in the U.S. by one. In addition, most companies perused foreign journals, and attended seminars and conferences in the U.S. and occasionally in Europe.

Exchanges of Scientific and Technical Personnel

Two companies reported exchanges with other firms in the U.S. and Scandinavia, and three had received technical assistance from university professors on leave.

Eight companies reported that keeping up to date on technological advances was either important or essential. Most of the producing firms felt that their technology was up to date in some mills and plants but behind in others. One company reported

that capital costs in Scandinavia were 25 percent of overall costs, and only 5 percent in Canada, which could indicate a high level of obsolescence in the equipment used here.

Table 11. Forestry Sector - Linkages With Institutions

Firm No.	Prov.	Owner-ship		Size			Institution				
								Ind.	Govt. Labs.		
		F	C	S	M	L	Univ.	Assoc.	NRC	AG	FOR
36	Ont		X			X	U	LU	U		
37	Ont		X			X		VU	VU	U	
38	Que		X			X		LU			
39	BC	X				X	VU	VU*			
40	BC		X			X	VU	U			
41	BC		X	X				U			VU
42	Ont		X			X		VU			
43	Que		X	X					U		
44	NB		X			X		VU			

Linkages with Universities and Government Laboratories

Table 11 indicates that companies in this sector did not interact extensively with universities or government laboratories. One firm reported that they had received good cooperation from NRC, another that the scientists at NRC, EMR and Agriculture Canada "tended to call the shots on projects". One company suggested there is a gap between universities and the industry in terms of understanding each other's needs, and another commented that few universities were working on pulp and paper problems, and that they could play a broader role. Another company reported that useful technical assistance had resulted from their interactions with universities.

Linkages with Industrial Associations

Most firms belonged to several industrial and professional associations, and all of the producing companies rated the technical information and assistance received as useful or very

useful. The associations transmitted information through regular publications, special reports on research projects, seminars, and plant visits. It should be noted that the Pulp and Paper Research Institute of Canada, which is the largest such institute in the country, serves this industry. Four companies reported that they dealt with provincial research organizations.

Government Policies and Programs

IRDP - Four companies had used the program as a source of funds to modernize their production systems. One commented that, "the program was, on balance, good but decisions were made slowly". Another suggested that more money should be spent on modernization and R&D and less on grants to depressed areas where in the opinion of the interviewee, "the benefits to the nation were illusionary". Two others felt that it took too long to get funds (one reported a two year period between application and funding), and that using the program involved too much red tape. IRDP does not fund projects with less than a three year payback. One firm suggested that a loan program for this time frame was needed.

Scientific Research Tax Credit - Five firms rated this policy as good, although one objected to the feature of selling tax credits. One stated that they had been advised by their accountant that the policy was not useful for very small firms, and another respondent felt that it had no effect on R&D expenditures. One company reported that 70 percent of their R&D costs were disallowed in 1981, and that the regulations for this measure should be held constant and applied consistently.

PILP - A number of firms had used PILP and none had adverse comments.

Make or Buy Policy - Two companies indicated that this was a useful policy, and two rated the Unsolicited Proposal program as good.

FIRE - Two companies reported that, in their experience, this EMR program was the easiest to work with.

Barriers to Technology Diffusion

1. One small company complained the government funding structure was so complex that a consultant was needed to use it.
2. According to one company, there is a lack of awareness of the details of government R&D activities which is exacerbated by being located outside of central Canada.
3. Availability of capital for modernization was cited as a problem by three firms.
4. The existing programs are not effective because of slowness, and processing at DSS and DRIE should be speeded up, according to one company.

Suggestions for Government Measures

1. Tax laws which encourage investment in technology, similar to those in Scandinavia, are needed.
2. IRDP should provide loans for modernization projects which have short payback periods.
3. More R&D is needed in the housing field. The Division of Building Research, according to one firm, is being "eased out" of this field to assist Forintek, but Forintek is not filling the gap.
4. Three companies believed that much more emphasis should be placed by government on the problems of the forest industry, which is, according to one firm, the largest contributor in Canada to the GNP. They recommended the establishment of a separate Forestry Department or Ministry in Ottawa to provide needed integrated long term planning to overcome the problems besetting the industry.

5. Companies now must purchase equipment from other countries, particularly Scandinavia. The government should encourage Canadian companies to become suppliers, using the "Scandinavian approach" to encourage cooperation among companies through tax incentives and other measures.

3.3.8 FOOD AND BEVERAGES

Two companies were interviewed in the food and beverage sector, both of which were Canadian owned. One was medium sized and the other large. Tables 3 and 4 show they used an average of 8.5 technology transfer mechanisms and utilized eight government programs. They had introduced fourteen new products in the past three years. They had combined annual sales of $960 million, and exports of $25 million. R&D expenditures were $2.2 million, or

of new technological advances was very important to their survival. One company had introduced four major and many minor technological changes which improved productivity. Both companies reported that their interactions with government laboratories had assisted in the development of new products, and one stated that NRC assistance had resulted in improved productivity.

Both firms used foreign sources of information extensively. One had established strong direct linkages with a number of foreign countries, and participated in United Nations activities. The other regularly visited companies and universities in Europe, and belonged to European industrial associations. Both published extensively and used scientific and trade journals as sources of information. They also attended both national and international seminars and conferences.

Table 12 is an analysis of the value to the firms of the linkages they have established with the major institutions they use as sources. Only the National Research Council and Agriculture were noted as having contact with firms in this sector.

Government Policies and Programs

Scientific Research Tax Credit - Both companies reported they had benefitted from these measures and rated them as good incentives to perform R&D.

Table 12. Food and Beverage Sector - Linkages With Institutions

Firm No.	Prov.	Size S	M	L	Institution Univ	Ind. Assoc.	Govt. Labs. NRC	AGR
45	Ont		X		VU	U*	VU	VU
46	Ont			X	VU	U*	VU	VU

* Belongs to foreign Industry Association

Make or Buy Policy - One firm had obtained contracts under this program and reported it had worked well.

Immigration Policies - One company felt that the current immigration policy made it difficult to bring highly skilled professionals into the country.

PILP and IRAP - Both companies had used IRAP and praised the program, although one company stated that establishing a longer term time frame of up to ten years would improve it. One firm had used PILP and commented that while the interactions with NRC scientists was extremely valuable, the administrative aspects of the program were too slow.

Government and University R&D - Both firms dealt extensively with universities and believe that their role should be to do fundamental research which companies can draw upon. Both companies had established strong linkages with NRC and Agriculture Canada, and reported that they had received excellent cooperation from government scientists.

Exchanges of Scientific and Technical Personnel - One company judged personnel exchanges to be very beneficial and employed them with both government and university

laboratories extensively, and, in addition, had sent staff overseas to European institutions on sabbatical.

Barriers to Technology Diffusion

No specific barriers were identified, although one firm believed that more interaction between industry and universities was needed in the country as a whole.

Suggested Government Measures

1. Encourage more interaction between industry and universities.

2. Patent rights in Canada should be strengthened, and in particular the Plant Protection Act should be passed.

3.4 USEFULNESS OF A TECHNOLOGICAL INTELLIGENCE OFFICER

One of the issues which the study team was asked to explore with interviewees was the question of the usefulness of a technological intelligence officer (TIO) to companies. The TIO, whose salary might be subsidized fully or partially by government, would search for information on technological or scientific developments relevant to a company and bring such information to the attention of the key people in the firm. In effect, the TIO would act as a "technological gatekeeper"; a role well documented in the literature on the management of technological innovation.

The idea of a generalist who could work with all sectors was rejected unanimously by the respondents. Some companies felt, however, that a Technical Intelligence Officer, who was an expert in the technologies used by the firm, might be helpful.

Three interviewees suggested that a TIO might be very useful to small firms if the TIO was employed by a trade association serving a specific industrial sector. The information collected by the TIO could then be disseminated to the association's members in a variety of ways.

3.5 USE OF LICENCING

The use of licencing as a vehicle for the transfer and diffusion of technology was also specifically addressed in this study.

Five companies in the Innovative Industry Group and seven in the Mature Industry Group reported they had acquired technology under licence. In most cases, the source of the technology was a company outside of Canada.

3.6 TECHNOLOGY DIFFUSION ACTIVITIES OF ASSOCIATIONS AND INSTITUTES

Some aspects of the the technological infrastructure in Canada are relatively underdeveloped compared to other countries such as Germany, Japan and the U.S., but Canada does have a number of technical institutes, centres and industrial associations. Some of these organizations are already involved in technical diffusion and transfer activities to their clientele, and others have the potential for undertaking such activities.

The following are the results of interviews with four organizations representing four different types; a Centre of Excellence, an Industrial Innovation Centre, an Industrial Research Institute, and an Industrial Research Association.

3.6.1 CENTRE FOR COLD OCEAN RESOURCE ENGINEERING

This centre which is located at Memorial University in St. John's, Newfoundland, conducts research and development in the areas of remote sensing, seabed scouring and ice mechanics. It is funded by grants and contributions from government and the oil industry, and from income earned from contract R&D.

A number of commercial products have resulted from their work and and two new companies have been created as a result of R&D conducted at the Centre.

The Centre uses both foreign and domestic sources of information. The Canadian sources include the laboratories of the National Research Council; Energy, Mines and Resources; and Environment Canada.

The Centre is not eligible for financial assistance under Federal Government programs, but does bid on contracts under the Make or Buy Policy. The interviewee felt that DSS administrative procedures involve too much red tape.

3.6.2 CENTRE FOR INDUSTRIAL INNOVATION - MONTREAL

This Centre is one of two in Canada, funded by the Departmet of Regional Industrial Expansion, which is engaged in a number of activities which support technology transfer and diffusion. Centre personnel evaluate technical ideas submitted to the Centre by academics from its host university (Ecole Polytechnique) and from other universities, and from outside inventors. Technical ideas which are judged to have commercial potential are then provided with developmental assistance which could involve some technical development, the preparation of a business plan, conducting market studies, arranging for venture capital, or any combination of these forms of assistance.

The Centre also provides an "incubator" service for innovators or entrepreneurs who are in the process of establishing a company based on a technical idea. The Centre has worked extensively on 25 projects since opening in 1981, and is now concentrating on five or six projects which are judged to have high market potential. The Centre is attempting to link projects with an industrial partner early in the development stage in order to ensure successful transfer and commercialization of the technology.

3.6.3 TECHNOLOGY DEVELOPMENT CENTRE - ECOLE POLYTECHNIQUE DE MONTREAL

This Industrial Research Institute, originally funded by the Department of Industry, Trade and Commerce (DRIE), has been in operation since 1971. Its purpose is to stimulate interaction between the university and small and medium sized companies by providing the business community with a contact point at the university that can arrange for contract R&D to be conducted by university faculty and staff. The Ecole IRI is one of several IRI's established at universities across Canada. Other universities which have IRI's include McGill, Waterloo, McMaster, Ottawa, and Manitoba.

The Technology Centre at Ecole has been successful in generating over $10. million in contract research since 1971, and university personnel are currently conducting about $2.3 million in contract R&D annually for business clients.

The Institute arranges for projects to be carried out in the areas of tests and analyses, feasibility studies, and research and development studies in the fields of communications, design, energy, environment, materials and transport. These activities benefit the university by involving academics in real-life projects, and companies by transferring technology and know-how from the university to industry.

3.6.4 PULP AND PAPER RESEARCH INSTITUTE OF CANADA

This industrial research association serves the pulp and paper industry, and is not only the largest, but one of the very few industrial research associations in Canada. Its professional staff comprises 120 people, and its main laboratory at Pointe Claire, Québec is supplemented by field offices at other locations, including mill sites. Its revenue comes from members' fees, grants from NRC, professional and technical services fees, and royalties.

The principal activities of the Institute include:

- Educational activities such as courses and seminars for technical personnel, mill managers and executives;
- Research and development with emphasis on the long term needs of the industry. Projects are approved by committees of members. Progress reports are issued every six months and when projects are completed;
- Personnel exchanges with member firms;
- Commercialization of R&D results - suppliers are located and licensing agreements arranged;
- Informal interactions - includes visits to mills, providing library resources, solving technical problems;
- Communications with members - regular monthly reports on technical developments, reports on R&D results, reports on conferences, video cassettes depicting new developments, and staff presentations.

The association interacts with a multitude of national and international sources, and has extensive linkages with NRC, EMR and Environment Canada - all of which are rated as very useful. Interactions with the two Canadian universities which work in relevant areas are also extensive.

PPRIC Comments

1. The Institute is concerned that Canadian companies are falling behind international competitors in adopting new technologies, particularly those companies in Scandinavia where much of the equipment for the industry is produced.
2. The Association rated the R&D tax incentives as a very good mechanism, and the unsolicited proposal fund as a good measure.

3.7 FINDINGS FROM RECENT STUDIES OF TECHNOLOGY TRANSFER IN CANADA

This section is a summary of the results from two recently completed studies of technological innovation in Canada conducted by the authors of this report for other government departments. The first summary is from a study conducted for the National Research Council of Canada, and the second from a study of transportation microelectronics technologies for Transport Canada.

3.7.1 Summary of a Study of Firms Which Are Not Users of Laboratory Linked Programs

Permission was given by the Program Evaluation Office of NRC to summarize some of the results of a study entitled "A Study of the Industrial Impacts of the Interactions Between NRC Laboratories and Canadian Companies," prepared for the National Research Council by Frank J. Doyle in March 1984. One segment of this study involved surveying firms which were not using either PILP or IRAP, and were not interacting informally with NRC laboratories. One hundred responses were received to a questionnaire sent to companies which were randomly selected from a DSS list of contractors.

A response rate of 50 percent was achieved, with respondents from all regions of the country. The sample included manufacturers, consultants, firms whose main activity was research, and miscellaneous other segments of industry.

Findings

Level of Awareness of NRC Programs	Percentage of Responses
Unaware of any programs	37.2%
Aware of PILP	22.4%
Aware of IRAP	37.2%
Other	3.2%
Total	100.0%

Reasons Company Had Not Used NRC Programs	Percentage of Responses
Programs not suitable	25.0%
Lack of knowledge	42.5%
Funds not worth the trouble of dealing with govt.	7.5%
Do not believe in govt. programs	5.0%
Other	20.0%
Total	100.0%

Most of the firms surveyed (56.2%), had never contacted NRC laboratories, and a large majority of companies stated they would like to receive information on NRC programs. It should be pointed out that NRC does not have within its existing budget, adequate human, technical or financial resources to accommodate a major increasein its interactions with Canadian firms.

3.7.2 Study of Microelectronics Transportation Firms in Canada

This recently completed study was concerned with determining the level of capability of Canadian firms to supply microelectronic and communications technologies to the transportation sector in Canada. The study included companies which provide microprocessor-based equipment and systems to the aviation, railways, marine transportation, automobile/road vehicles and traffic control, urban mass transit and pipeline companies in Canada and abroad.

Approximately 30 companies were interviewed and their technological information gathering activities examined along with their views on the market for microelectronics technology in Canada.

There was general agreement that American companies, either

directly through their subsidiaries or through distributors or Canadian systemhouses, have been and will continue to be the main suppliers of microprocessor-based transportation hardware for Canadian transportation systems operators.

The major source of technology for most of the companies interviewed was their in-house technical staff. Even the smallest firm interviewed relied mainly on its own expertise, not on external sources.

Even some of the large foreign subsidiaries interviewed claim that most of their sales are based on technology developed in-house and that technology transfer from their parents is minor.

Universities and government laboratories were seldom mentioned as a source of technology. Only three companies mentioned any contacts with universities. Transfers of technology from government laboratories via NRC's Program for Industry/Laboratory Projects was also rare with only four firms acquiring technology this way.

Other potential sources of microelectronics technology, which are relatively new, are the Federal Government supported provincial microelectronics centres and the Ontario Centre for Microelectronics Technology (OCMT) funded by the Ontario Government. Three companies had made use of these centres.

One important point which came out of this part of the study is that no one complained that a lack of technology was holding them back at the present time, although several respondents felt that a lack of capability in the Very High Speed Integrated Circuit (VHSIC) area would have a negative impact on their product lines in the future. It was also noted that Canada's lack of effort in the area of artifical intelligence, and in particular "expert systems", would eventually freeze Canadian companies out of an area that is quickly becoming as vital as integrated circuits themselves.

Only companies in the aviation area had noticed some problems with U.S. restrictions on the transfer of VHSIC technology to Canada. One pipeline company suspected that the transfer of Canadian developed microelectronics technology was being hindered by U.S. officials in Washington who administer the technology flow to COMCON designated countries. The hinderance was in the form of delays so that American firms could jump in to a project and try to outbid the Canadian company.

Most interviewees relied on trade magazines, equipment suppliers and trade shows to keep up to date on the latest changes in technology in their area of interest. Other lesser mentioned channels were seminars, talking to clients, and NRC's CISTI. Only three companies, all located in Ottawa, said that they had used CISTI.

Trade associations were not mentioned as a source of information about technological advancements, and licencing was not an important source of technology. Only two firms were manufacturing a product under licence and in both cases it was technology that they had developed under contract to a government department.

The lack of use of government and industry laboratories as a source of technological information and technology simply reflects the fact that these organizations do very little research in the area of application of microelectronics to the transportation sector.

The one major exception to this is the R&D activities of Canadian National Railways. They develop microprocessor-based train traffic control systems for their own use. When asked why they do not transfer some of the technology they develop to the private sector, the interviewee replied that they had neither the time or resources to transfer the technology to Canadian firms, and in addition, CNR did not think it was their responsiblity to transfer technology to the private sector.

3.8 SUMMARY OF MEASURES SUGGESTED BY FIRMS TO IMPROVE TECHNOLOGY DIFFUSION

Government Policies and Programs

1. IRDP should be broadened to provide loans for projects which have less than a three year payback period.

2. The government should establish a "Buy Canadian" purchasing policy.

3. A program ombudsman should be appointed in each department to expedite the processing of program applications, to act as a contact point for firms having difficulty with programs, and to report on the performance of program administrators.

4. A program to fund the assessment of new technologies should be established.

5. Linkages between programs such as PILP, IRAP, IRDP, and PEMD should be organized to reduce or eliminate the need for a number of applications for assistance to several departments for different phases of the same project.

6. The terms of reference in most programs should be modified to give more emphasis to the quality of ideas and their technological and market potential, and less to the overall financial strength or former track record of the program applicant.

7. Consideration should be given to modifying the existing R&D tax incentives to provide a refund based on the previous year's expenditures on R&D.

8. A program to fund medium and long term R&D, perhaps to the level of 50 percent of costs in specific high technology areas, should be established.

9. Joint industry/government planning committees should set programs for government laboratories.

Assistance in the Acquisition of Equipment

1. The tax laws should be modified to encourage investment in equipment, perhaps following the Scandinavian model. (Several companies in two sectors made this suggestion even though they could not provide precise information about the Scandanavian approach.)

2. The cost of production equipment not manufactured in Canada, should be reduced by subsidies or tariff reductions.

3. The quota system in the textile sector should be retained to provide a large enough market to justify capital investment.

4. Funds should be provided to build prototypes and stimulate investment in new equipment.

Manpower and Training Measures

1. Students in universities and community colleges, especially those in arts, business, science and engineering, should be introduced to fundamental concepts of technological development and technical entrepreneurship, emphasizing the roles of R&D, technology diffusion, and technology transfer in the innovation process.

2. Measures should be developed to stimulate interaction and technology diffusion between universities, community colleges and industry.

3. Community colleges should be encouraged to develop technical courses in the textile field.

4. The Skills Growth Program should be used to fund the training of technical personnel for the Canadian manufacturing industry, particularly at the community college level.

Miscellaneous Suggestions

1. The proposed legislation which would weaken the Canadian Patent Laws would reduce technology transfer into Canada,

and should not be passed.

2. The Plant Variety Protection Act should be passed to encourage the transfer of technology in this field from foreign sources.

3. A forestry department or ministry should be created to give more focus to the long term forestry and forest industry problems, and in recognition of its role as the major industrial contributor to the GNP.

4. The Canadian market in high technology fields should be protected by tariff and non-tariff barriers to the same extent as in other countries.

5. Tax breaks should be given for off-shore drilling equipment.

6. The government should subsidize the costs of providing technological intelligence officers to selected industrial associations.

7. Individuals should be allowed to write off the costs of equipment for information acquisition in order to encourage the use of computers and information technologies, to increase the flow of information, and to stimulate the market for these services in Canada.

8. The government should fund demonstration projects in new fields of technology, and establish centres where cooperative facilities could be shared by Canadian firms.

9. Cohesive government policies should "support winners".

10. Taxation measures to encourage R&D performers to diffuse technology should be initiated.

4. ANAYLYSIS AND DISCUSSION

4.1 DIFFERENCES BETWEEN THE MATURE AND INNOVATIVE INDUSTRY GROUPS

The technological characteristics of the Innovative Industries were distinctly different from those of the Mature Industries. Innovative industries developed many more new products - an average of 2.8 per company responding to this question - compared to an average of 0.6 per company in the Mature Industry sector. They invested about fifteen percent of their total revenues in R&D, compared to less than one percent by the mature industries. While both groups interacted with a multiplicity of sources for technical assistance, information from industrial associations was usually a very important source for mature industries, but either not used or not very important for most innovative industries. Innovative industries reported that government laboratories and universities were their most valuable sources of information. On the whole, companies in the Innovative Industry Group felt that they need more information about technological developments in their field than was currently available. The Mature Industry Group expressed less concern about knowledge of new technologies, and in the case of the forest products and textile industries, felt that the limiting factor for technology diffusion was obtaining the funds to modernize their production facilities. They were well aware of what new production technologies were available, they simply could not afford them.

Another significant difference between the two groups was that mature industries tended to view technology principally as a means of improving productivity, whereas innovative industries regard technology as a means of developing new products and were seldom concerned about productivity. These divergent characteristics indicate that distinctly different policy measures to encourage technological diffusion will be needed for each category of companies.

A number of companies in the Mature Industry Group used a

variety of forms of personnel exchange to acquire technological knowledge whereas this approach, which is considered to be the most effective mechanism for efficient and effective technology transfer, was rarely mentioned by interviewees in the Innovative Industry Group.

A few companies commented on immigration policies and their effect on recruiting skilled personnel. While some felt the policies retarded their R&D efforts, others believed that the present approach had long run benefits as they had been forced to use existing personnel and develop their own personnel. The lack of comment by most interviewees would imply that there is no serious problem with present immigration laws.

4.2 BARRIERS TO TECHNOLOGY DIFFUSION

There were some common threads which emerged from the discussion, complaints and suggestions for policy measures by the company representatives interviewed. There were:

- a multitude of complaints about the slowness of evaluation, processing and payment procedures of government programs.
- a widespread belief, particularly among managers in small companies in the Innovative Industry Group that they were not aware of all the potentially useful R&D activities being carried out in government laboratories and universities.
- a concern that the flow of industry specific technological information was inadequate. A number of companies had, in their quest for technical information, joined foreign industrial associations and while they found these affiliations useful, the information was not always appropriate for conditions in Canada.

These problems and suggestions are reviewed in this section

and recommendations from the study team for government action are included.

4.2.1 Government Policies and Programs

Companies in every sector which had utilized government programs identified slow bureaucratic procedures, slow processing, and excessive reporting requirements as a barrier to the utilization of government programs which encourage technology diffusion.

Those programs which involve direct interaction between scientists and industry personnel, such as PILP, IRAP, and the EMR programs, were generally well received, although some firms felt that even these reacted too slowly to applications, needed more flexibility for hi-tech applications, required excessive reporting, and were too slow in arranging payments. Prompt payments are particularly important to small companies which usually must borrow at high interest rates if payments do not arrive when anticipated. While there were some concerns expressed about slow processing, and rigidity in terms and conditions in the laboratory linked programs, the harshest criticisms were aimed at the Department of Supply and Services' administrative and payment procedures, with the most vehement complaints coming from small firms.

It should be realized, however, that the Make or Buy Policy is, on the whole, highly effective. In the aforementioned study of the Industrial Impact of Interactions Between NRC Laboratories and Canadian Companies, 154 companies which were doing contract work for NRC in December 1983, responded to a questionnaire requesting, among other things, their views on the technological and commercial benefits of the contracts. Nearly all companies (98.6%) attributed additional scientific or technological benefits to the contract, 36.3% reported that technology was being transferred from NRC, and most companies (85.9%) expected to apply the technology developed during the contract. They also estimated that they expected to create 1350 new jobs, and realize revenues from new products and new services stemming from the

contract work amounting to $800. million over the next five years. This group of companies, however, did echo the complaints about the slow processing, red tape, and slow payments reported in this study.

In summary, the contracting out program should be regarded as a successful program which requires significant improvements in its administrative procedures.

The programs administered by DRIE, which were recently modified and integrated under the umbrella program IRDP, were also described by the firms as being too bureaucratic, too slow, and with terms and conditions that were too rigid. In addition, a number of companies, particularly those in the Innovative Industry group, objected to the "depressed area" emphasis of IRDP. These firms believed that it would make more sense to invest in high growth, high technology fields which have real potential for the future, rather than in depressed areas.

Recommendations

Governments are, by nature, large and bureaucratic and, typically, are reluctant to delegate authority - particularly the authority to spend money. These attributes manifest themselves in program administration in the form of multiple approvals for all transactions, the over-use of committees for decision making, and the practice of obtaining numerous bids on contracts well below the amounts specified in the Treasury Board Guidelines.

This problem is an extremely difficult one to deal with because it stems from the basic nature of the organization of government. Nevertheless the study team is convinced that if the government is serious about removing barriers to technological diffusion, an extensive review of existing program administrative procedures should be undertaken, with the prime objective of streamlining and speeding up the entire process of dealing with applications, processing them once they are approved, and making payments. In addition, as was suggested by one company, the

establishment of a program ombudsman in those departments which administer industrial programs should be considered.

4.2.2 AWARESS OF R&D ACTIVITIES IN CANADA

A second major barrier to technological diffusion reported was a lack of knowledge of the R&D activities in government laboratories and in universities. This problem was related to company size and geographical location, and was mentioned most frequently by firms in the Innovative Industries group. Typically, a small or medium sized company, even one which actively sought out sources of technology, was likely to restrict its search to neighbouring universities, and establish only a few linkages with government laboratories. These firms were usually convinced that relevant R&D, of which they were not aware, was being carried out in other universities and government laboratories, but they did not have the resources to conduct nation-wide, let alone world-wide, fishing expeditions.

Recommendation

There are a number of possible measures which could be undertaken to overcome this problem, but most would require the regular collection from universities which have science, engineering, medical or related faculties, and from all government laboratories, of summaries of their R&D activities. This information would then have to be categorized and disseminated to all interested companies.

It is recommended that a study be initiated to investigate the feasibility of a project to accumulate and disseminate this information and, if it is judged to be feasible, to delineate optimal approaches, estimate their costs, and make detailed recommendations for implementation.

Another approach which would compliment the above measure would be to encourage government departments and universities to publish articles about their work in trade magazines, and not simply rely on the scientist or engineer publishing in learned

journals to convey information to the private sector. Not all companies have technical staff who read academic journals.

4.2.3 PAUCITY OF INDUSTRIAL RESEARCH ASSOCIATIONS IN CANADA

The technological infrastructure in Canada is missing an important element which exists in most European countries and in many industrial fields in the U.S., namely industry specialized, industrial research associations of the type described earlier which serves the pulp and paper industry. Britain has nearly fifty such associations, West Germany seventy or eighty, France around fifty, and Japan has hundreds of sectoral or horizontal technical centres. These associations usually serve Mature Industry sectors. They carry out R&D projects to serve the specialized needs of their industrial sector, usually concentrating their efforts on the "D" end of the R&D spectrum. They also search the world for relevant technologies and keep their member companies aware of developments through a wide variety of information dissemination activities.

Recommendation

A study should be made of the industrial sectors which are important in Canada, with the emphasis on the Mature Industry sectors, to determine which are candidates for industrial research associations.

Factors which should be considered are the vulnerability of the sector to competition, the existence of industrial associations (many sectors have associations which do no research or technology transfer and, in fact, have little or no technical capability), and the potential for improved productivity through technological modernization. If this approach proves feasible, the subsidization of the cost of a technological intelligence officer should be considered for some sectors, while in others, the establishment of an organization which carries out some R&D and provides technical information and assistance to member companies may be preferable.

5. CONCLUSIONS

This report has compiled a plethora of suggestions from participating companies for measures to improve the process of technological diffusion and technology transfer in Canada. The Ministry of State for Science and Technology will, of course, consider these suggestions in the context of overall technological and industrial policy development, but, in the opinion of the study team, many of the suggestions have considerable merit. Suggestions from the companies in two different sectors, textiles and forestry, indicated that these firms believed that tax and other measures in place in Scandinavian countries have been highly effective in encouraging the development and diffusion of production technology, and their potential for application in Canada could well produce useful policy ideas which could be implemented in Canada.

The study also found that some companies, especially those in the Innovative Industry Group, consider that the existing technology diffusion system was not adequately meeting their needs and that measures to facilitate the process were needed.

The suggestions that the government should do more to stimulate interaction between universities and industry also are worthy of serious consideration. A program exists in DRIE to establish Industrial Research Institutes and Centres of Advanced Technology, which are centres at universities to foster industrial contacts, but it is underfunded and has a long list of waiting applicants. If further stimulation of technology transfer from universities to industry is required, the best approach would be to make more funds available to this program.

In addition to the suggestions for new measures, this report has documented the actual sources of information used by a number of companies in eight industrial sectors. As noted in the introduction, the survey sample was quite small and one important segment of the industrial population, comprising small and medium sized Canadian manufacturers who employ few or no technical staff, was under-represented. Consideration should be given to a

thorough investigation of the need for measures to assist this quite large and probably highly vulnerable group to acquire state of the art technology in order to keep up with competitors from other countries.

APPENDIX 1

ORGANIZATIONS INTERVIEWED

Abitibi Price Inc.
P.O. Box 21
Toronto, Ontario
M5K 1B3

Accugraph Corporation
Courtyard-112 Merton Street
Toronto, Ontario,
M4S 2Z8

Allelix Inc.
6850 Goreway
Toronto, Ontario
L4V 1P1

Bell Northern Research
3500 Carling Avenue
Nepean, Ontario

Bio Endo
10900 Rue Hamon
Montreal, Quebec
H3M 3A2

Bio Logicals
20 Victoria Street, Suite 304
Toronto, Ontario,
M5C 2N8

Canstar Oil Sands
14th Floor, 140 Fourth Avenue S.W.
Calgary, Alberta
T2P 3N3

Cape Breton Development Company
Box 2500
Sydney, Nova Scotia
D1T 6K9

C-CORE
Memorial University of Newfoundland
St.John's, Newfoundland
1B 3X7

Centre de Developpement Technologique
Ecole Polytechnique
Montreal, Quebec

Centre d'Innovation Industrielle - Montreal
Campus de l'Universite de Montreal
C.P. 6079, Succ. A
Montreal, Quebec
H3C 3A7

CIP Research Ltd.
179 Main Street
Hawkesbury, Ontario
K6A 2H4

Consolidated Bathurst Company
1035 Hodge Street,
Montreal, Quebec
H4N 2B4

Cymbol Cybernetics Corporation,
169 Colonnade Road,
Nepean, Ontario,
K2E 7J4

Dees Communications
6475C - 64th Street
Delta, B.C.
V4K 4E2

DIPIX Systems
120 Colonnade Road,
Nepean, Ontario,
K2E 7J5

Dominion Textiles,
1980 Sherbrooke West, 8th Floor
Montreal, Quebec
H3H 1E2

Doris Hosiery,
7471 Leonardo da Vinci
Montreal, Quebec
H2A 1P1

Epic Data Systems
7280 River Road
Richmond, B.C.
V6X 1X5

FENCO Newfoundland Ltd.
P.O. Box 8246
St. John's, Newfoundland
A1B 3N4

Forest Technology Systems
2665 Sook Road
Victoria, B.C.
V9B 1Y5

Forintek Canada Corporation
800 Montreal Road
Ottawa, Ontario
K1G 3Z5

Gulf Canada Resources
Box. 130
Calgary, Alberta
T2P 2H7

ICAM Technologies
1900 Sources Road
Pointe Claire
Quebec

Imapro Inc.
West Royalty Industrial Park
Charlottetown
P.E.I.

Intera Environmental Consultants
785 Carling Avenue,
Ottawa, Ontario

Irving Pulp and Paper Ltd.
P.O. Box 3007, Station B
Saint John, New Brunswick
E2M 3H1

Jarvis Clarke Co. Ltd.
P.O. Box 5049
Burlington, Ontario
L7R 3Y8

Kingrain Co.
Box. C.P.1088
Chatham, Ontario
N7M 5L6

Labatts Brewery Ltd.
150 Simcoe Street
London, Ontario
N6A 4M3

Lac-Mac Ltd.
425 Rectory Street
London, Ontario
M5W 2W5

Logging Development Co.
5858 Cote des Nieges
Montreal, Quebec
H3S 1Z2

MacDonald, Dettwiler and Associates
3751 Shell Road
Richmond, B.C.

McMillan Bloedel Research,
1075 West Georgia Street
Vancouver, B.C.
V6E 3R9

Microtel Pacific Research
8999 Nelson Way
Burnaby, B.C.

Nabu Manufacturing Corporation,
1051 Baxter Road,
Ottawa, Ontario

Noranda Research Centre
240 Hymus Blvd.
Pointe Claire
Quebec
H9R 1G5

Orcatech Inc.,
2680 Queensview Drive,
Ottawa, Ontario

PCS Mining
Potash Corporation
SEDCO Centre
Saskatoon, Saskatchewan
S7K 3X5

Pulp and Paper Research Institute of canada
St. John's Road
Pointe Claire
Quebec

Quadra Logics
3590 West 41st Street
Vancouver, B.C.

Salent Canada Ltd.
2301 Keele Street
Toronto, Ontario
M6M 3Z9

SED Systems
P.O. Box 1464
Saskatoon, Saskatchewan
S7K 3P7

Standard Modern Technology
69 Montcalm
New Toronto, Ontario
M6E 4N9

Tanjay Company
1771 Inkster
Winnipeg, Manitoba
R2X 1R3

Teleglobe,
880 Sherbrooke Street West,
Montreal, Quebec
H3A 2S4

Trillium Telephone Systems Inc.
603 March Road
Kanata, Ontario

Weldwood of Canada Ltd.
1055 Hastings Street
Vancouver, B.C.
V6J 3V8

Westcott Fashions
1150 Fife Street
Winnipeg, Manitoba
R2X 2Z4

APPENDIX 2

THE DIFFUSION OF TECHNOLOGY TO CANADIAN INDUSTRY

Interview Guide

Date:

BACKGROUND INFORMATION (base data on last fiscal year)

Company Name:

Address:

Telephone:

Chief Executive Officer:
Title:

Contact:
Title:

Industry Sector:

Employees: Total:

In R&D: Professional and Technical:

Ownership: Canadian ___ % Foreign ___%

Associated Plants or Offices:

Major product/service lines:

Gross Sales 1983: Exports:

What are your major R&D projects:

Expenditure Level on R&D:

1. In the past three years has your company introduced any new or improved products or services based on new technological developments? If yes, describe products or services and how you learned about these new technologies that you could use?

2. Has your company improved productivity or reduced operating costs by utilizing new technologies, equipment or know-how in the past three years? In particular, does your organization make use of either Computer Aided Design or Computer Aided Manufacturing; if so in what applications?

3. How does the technology you presently use in your products/services or manufacturing process compare to what is considered to be the state-of-the-art?

4. To what extent do you have to rely on new technology to stay in business? (How quickly is the technology changing)

5. Does your company make a deliberate effort to seek out information on new technological developments?

6. Does your company use foreign as well as domestic sources of information? (Give examples). (If multinational, do you have a formal mechanism for intelligence gathering from subsidiaries?)

   How widespread is intercompany intelligence gathering?

7. What domestic and foreign sources do you use to obtain information on new developments in your area, such as information about new, more efficient manufacturing technologies, or information which could assist in the development of new products or services?

   Scientific Journals

   Trade magazines

   Industrial association(s)

   Personal contacts with equipment suppliers, customers, technical personnel in government or university, consultants, competitors, etc.

   Information services such as CISTI, TIS

   Science Counsellors

   Company technical information department

   Conferences and meetings

   Patent literature or patent search services

   IRAP inquiry

   Other

How effective are your present methods of learning about new scientific or technological developments (do these mechanisms meet the needs of your company?)

8. Has your company obtained technical information or assistance from any federal government laboratories, either by direct contact or through one of the many programs available?

NRC

DOC

EMR - CCRS

Ag. Can

Env. Can.

How useful was the information or assistance? What elements of these programs did you find most helpful?

Did it lead to the development of a new product or service, or improvements in manufacturing processes?

9. Are you aware of the various technology transfer/diffusion programs of the Federal Government?

PILP

PRAI (Univ)

START

STEP

Industrial Research Institutes/CATS

Industrial Innovation Centres

Microelectronic Centres

IRDP Modernization/expansion element

Canadian Industrial Renewal Board

Technical Information Search Service (Patent Office)

Have you used any of these services? If yes, what was your experience with them? How useful were they? What are their best features?

10. If you are familiar with some of these programs, can you suggest how their technology transfer/diffusion activities could be improved.

11. Are you familiar with the Canadian and Foreign Patent Systems and the procedures involved with initiating a patent search? Are you aware of the Technical Information Search Service of the Canadian Patent Office?

12. Do you feel there would be any benefit to your company of having a "Technological Intelligence Officer" to work with your technical staff to seek out new technologies for your company? (short term basis)

13. Which governments programs, policies and internal administrative procedures encourage the diffusion of technology in Canada, and which hinder the process?

14. Does your company belong to an Industry Association?

    If yes, what, if any, role does the association play in providing information on technological developments?

15. What role do you feel industry associations should play in technology transfer or diffusion?

16. Are you familiar with institutions such as technology brokers or provincial research organizations? If yes, do you make use of these organizations as sources of technological information?

17. Have you had any interactions with the Universities when developing or adopting new technologies or methods? (What form did this interaction take and how satisfied were you with it?)

18. What role do you feel the universities should play in technology transfer?

19. Have you had exchanges of scientific or technical personnel with university or government laboratories? If yes, what was the nature of the exchange ?

    Sabbatical

    Executive interchange

    Incubator program of NRC

    Other

    Did your company benefit from the exchanges? If so, how?

20. What mechanisms do you believe are useful in stimulating the utilization of new technology developed in Canada and in other countries?

Personal Contacts

Seminars/Conferences

Industrial Associations

Journals, Trade Magazines

Interchange with Government Labs

University Interchange

Suppliers of Industrial Equipment

Licensing

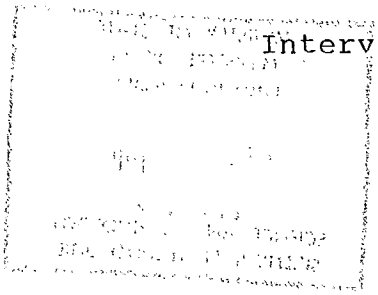
Other

21. What factors in Canada do you feel impede the diffusion of new technologies developed domestically or in foreign countries?

22. How can government impediments to technology transfer and diffusion of already existing technologies be modified to reduce or eliminate their impact? e.g. relaxed immigration policies for technically trained people.

23. What impact do you believe the various policies of the Federal Government, such as the Make or Buy policy, immigration policies, Unsolicited Proposal Fund, R&D tax incentive policies have had on technology transfer and diffusion in Canada?

GENERAL COMMENTS



Interview Length _____