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CHARACTERISTICS OF RESEARCH AND DEVELOPMENT PERFORMING FIRMS IN CANADIAN MANUFACTURING

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IN CANADIAN MANUFACTURING

CHARACTERISTICS OF RESEARCH AND DEVELOPMENT PERFORMING FIRMS IN CANADIAN MANUFACTURING

by

U.K. Ranga Chand

Policy Research Group
Industry Branch
Ministry of State for Science & Technology

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The purpose of this paper is to examine some of the salient characteristics of research and development performing firms in Canadian manufacturing. The paper begins by presenting an overview of recent trends in R&D in the Canadian economy and compares Canada's R&D situation with that of six other major industrial nations. The next section analyzes the main characteristics of those firms which undertake research and development activities in Canadian manufacturing industries. This is followed by a section which examines the levels of R&D intensity in terms of small, medium and large R&D performing firms. The paper concludes by summarizing the highlights of R&D performing firms and draws some implications for the structure of Canadian manufacturing based on these findings.

I. RECENT TRENDS IN RESEARCH AND DEVELOPMENT IN THE CANADIAN ECONOMY

An Overview

Research and development is generally defined as investigative work carried out to acquire new scientific and technological knowledge, to devise and develop new products and processes, or to apply newly acquired knowledge in making technically significant improvements to existing products or processes.

The degree of R&D activity in relation to the economy as a whole is measured by the ratio of Gross Domestic Expenditure on Research and Development (GERD) to Gross National Product (GNP). GERD is defined by the OECD as the total intramural expenditures on R&D performed within the national boundaries of a country. In Canada, GERD is the sum of the intramural R&D expenditures of the following sectors: industry, federal and provincial government, universities, provincial research organizations and private non-profit research organizations. The ratio of GERD to GNP provides an indication of the proportion of the country's economic output which is allocated to research and development activities.

In current dollars, GERD more than doubled from $1,065.8 million in 1970 to $2,177.6 million in 1978. However, after adjusting for inflation, GERD in constant (1971) dollars has remained virtually stagnant during the

seventies. This has resulted in a steadily declining ratio of GERD to GNP. At the beginning of the decade, Canada devoted 1.24 percent of the GNP to R&D activities but, by 1978, this figure had dropped to below one percent of the GNP.

Research and development in the manufacturing sector accounts for approximately one-third of GERD. As in the case of GERD, R&D in the manufacturing sector virtually doubled in current dollars during the seventies with expenditures reaching over $770 million by 1978. In constant (1971) dollars, however, there was negligible growth. As a consequence of this, the ratio of R&D in the manufacturing sector to GNP has also experienced a steady decline from 0.43 percent in 1970 to 0.33 percent in 1978.

As with other industrial countries, research and development activities are heavily concentrated in a few industries within the manufacturing sector of Canada.(1) Six industries account for over eighty-five percent of the total R&D expenditures undertaken in Canadian manufacturing. These industries are chemicals, machinery, transportation

(1) Ministry of State for Science and Technology, Performance of Canadian Manufacturing Industries by Levels of Research Intensity, Background Paper No. 4 (Ottawa: July 1978). Page 5.

equipment, electrical products, primary metals, and petroleum. The electrical products industry is the largest R&D performer and accounts for over one-quarter of total R&D expenditures in manufacturing.

Approximately one percent of the total employment in the manufacturing sector is engaged in research and development activities. This figure has remained virtually constant during the seventies. As in the case of R&D expenditures, R&D personnel is also heavily concentrated in certain industries with the same six industries mentioned above accounting for over eighty percent of the total R&D personnel engaged in the Canadian manufacturing sector.

It is interesting and illuminating to compare Canada's research and development activities with those of the other major industrial countries. The latest comparable OECD data available is for the year 1975. Following international convention, Table 1 shows the relative distribution of GERD to Gross Domestic Product (GDP) rather than GNP for the main R&D performing sectors of Canada and six other industrial countries.

One distinguishing characteristic of the Canadian economy is that the manufacturing sector accounts for approximately one-third of GERD with the federal government

TABLE 1

GERD AS A PERCENT OF GROSS DOMESTIC PRODUCT (GDP)

— 1975 —

	MANUFACTURING	GOVERNMENT	UNIVERSITIES	OTHER[1]	TOTAL
Canada	0.34	0.33	0.29	0.07	1.04
France	1.00	0.41	0.26	0.10	1.77
West Germany	1.28	0.33	0.37	0.08	2.11
Japan	1.03	0.23	0.35	0.14	1.76
Sweden	1.10	0.14	0.42	0.12	1.79
United Kingdom	1.19	0.55	0.17	0.17	2.08
United States	1.53	0.38	0.34	0.13	2.38

[1]Includes private non-profit research organizations, primary industries and service industries.

Source: Based on data from the OECD.

and the university sector accounting for the bulk of the remaining two-thirds. This is in sharp contrast to most of the other major industrial countries where the manufacturing sector typically accounts for more than fifty percent of the total national R&D effort. Similarly, while Canada currently devotes about one percent of its GDP to research and development activities, most major industrial countries allocate a substantially higher proportion of the Gross Domestic Product to R&D activities. Indeed, in most industrial countries the manufacturing sector alone accounts for one percent or more of GDP as opposed to the 0.34 percent in Canada.

The size of the manufacturing sector relative to the total economy of a country has also to be considered when making international comparisons vis-a-vis R&D. In both Canada and the United States, manufacturing activities account for less than a quarter of the total national output. In the other industrial European countries and Japan considered here, manufacturing activities account for a higher proportion of the total output of these economies. As can be seen in Table 2, despite these differences, a comparison of the ratio of R&D in the manufacturing sector to manufacturing output again demonstrates that the other industrial nations invest substantially more in

TABLE 2

SOME INTERNATIONAL COMPARISONS
OF MANUFACTURING OUTPUT AND MANUFACTURING R&D
IN SELECTED OECD COUNTRIES — 1975

	MFG OUTPUT AS A % OF GDP	MFG R&D AS A % OF MFG OUTPUT
Canada	19.3	1.8
France	29.6	3.4
West Germany	38.6	3.3
Japan	34.4	3.1[a]
Sweden	28.9	3.8
United Kingdom	26.0	4.6
United States	23.0	6.7

[a] 1971

Source" Based on data from the OECD.

manufacturing R&D activities than is the case in Canada.

Although Canada clearly devotes much less to R&D activities in the manufacturing sector than other industrial countries, it is interesting to note that the R&D performed in the government and university sectors is more in line with R&D performance in these sectors in the other industrial nations.

Because other major countries invest more heavily in research and development in the manufacturing sector, the proportion of total manufacturing employment engaged in R&D is also higher than is the case in Canada. In fact, based on 1975 data from the OECD, in each of the six industrial countries shown in Tables 1 and 2, approximately two percent of manufacturing employment is engaged in R&D activities as opposed to about one percent in Canada.

II. SOME CHARACTERISTICS OF R&D PERFORMING FIRMS IN CANADIAN MANUFACTURING

Table 3 shows the number of manufacturing firms which do R&D relative to the total number of enterprises(2) for each industry. The industries are grouped into six major categories following Statistics Canada's classification scheme for R&D activities in Canadian industry. The industries are grouped in terms of chemical-based, wood-based, machinery and transportation equipment, electrical, metal-based, and other manufacturing industries.

In 1975 Statistics Canada, based on its annual survey of research and development in Canadian industry,(3) reported 727 firms in Canadian manufacturing which undertook R&D activities internally. As shown in Table 3, there were approximately 27,000 manufacturing enterprises. Thus, relative to the number of total enterprises, R&D performing firms represent only about 2.5 percent of total manufacturing. This situation is not unique to Canada and,

(2) An enterprise is defined as a firm or a group of firms under common control. Most enterprises however, normally consist of only one firm. Hence, the overall impression gained when comparing the number of R&D performing firms to the number of enterprises is reasonably accurate.

(3) Statistics Canada, Annual Review of Science Statistics, 1977, Catalogue No. 13-212.

TABLE 3

MANUFACTURING FIRMS PERFORMING R&D AS A PERCENT OF TOTAL MANUFACTURING ENTERPRISES BY INDUSTRY — 1975

INDUSTRY GROUPS	NO. OF R&D FIRMS	NO. OF ENTERPRISES	R&D FIRMS/ MFG ENTERP. (%)
CHEMICAL BASED			
Food, Beverage & Tobacco	75	4,021	1.9
Rubber & Plastic Products	14	641	2.2
Textiles	15	807	1.9
Petroleum Products	9	40	22.5
Pharmaceuticals	31	107	28.9
Other Chemicals	96	536	17.9
WOOD BASED			
Pulp & Paper	35	368	9.5
Other Wood	13	4,905	0.3
MACHINERY & TRANSPORTATION EQUIPMENT			
Business Machines	9	32	28.1
Other Machinery	101	893	11.3
Aircraft & Parts	14	81	17.3
Other Transportation Equipment	30	748	4.0
ELECTRICAL			
Electrical Products	120	542	22.1
Scientific & Prof. Equipment	29	798	3.6
METAL BASED			
Primary Metals (Ferrous)	10	113	8.8
Primary Metals (Non-ferrous)	14	133	10.5
Metal Fabricating	50	3,598	1.4
OTHER MANUFACTURING	62	8,506	0.7
TOTAL MANUFACTURING	727	26,869	2.7

Source: Based on Data from Statistics Canada Catalogue 13-212 and 31-203.

indeed, is similar to that existing in most industrial countries. For example, it is estimated that approximately three to four percent of U.S. manufacturing firms undertake research and development activities.

Firms which perform R&D activities are to be found in the majority of manufacturing industries.(4) However, although only a small percentage of manufacturing firms perform R&D, the pattern varies widely by industry. For example, the food, beverage and tobacco industry accounts for over ten percent of the number of total R&D performing firms, but less than two percent of the enterprises in this industry do any R&D. On the other hand, the nine R&D performing firms in the business machines sector represents only about one percent of the total number of R&D performing firms in Canadian manufacturing but, relative to the total number of enterprises in this industry, over twenty-eight percent of them perform R&D.

What emerges from Table 3, not surprisingly, is that, in the technology-intensive industries such as petroleum products, pharmaceuticals, business machines, aircraft and parts, etc., a much larger proportion of the enterprises in

(4) Four industries undertake no research and development activities. These are the leather, knitting, clothing, and printing and publishing industries.

these industries perform R&D as opposed to the more traditional or non-technology-intensive industries. Nevertheless, it is worthwhile bearing in mind that about thirty to forty percent of R&D performing firms in Canadian manufacturing are to be found in the non-technology-intensive industries, the implication being that R&D performing firms are not simply the preserve of high-technology industries.

The 727 R&D performing firms reported expenditures of $571.6 million for research and development during 1975. Table 4 shows the total R&D expenditures and the average R&D expenditure for each industry.

One industry, electrical products, spent close to $160 million on R&D and accounted for over a quarter of the total R&D expenditures in Canadian manufacturing. There were no other industries which reported R&D expenditures of over $50 million although the following five industries incurred expenditures of over $40 million: petroleum products, other chemicals, aircraft and parts, other machinery, and primary metals (non-ferrous). These five industries together with electrical products accounted for approximately seventy percent of the total R&D expenditures in manufacturing industries.

TABLE 4

AVERAGE EXPENDITURES OF R&D PERFORMING FIRMS
BY INDUSTRY — 1975

INDUSTRY GROUPS	NO. OF R&D FIRMS	R&D EXPENDITURES ($MILLION)	AVERAGE R&D EXPENDITURES ($THOUSAND)
CHEMICAL BASED			
Food, Beverage & Tobacco	75	24.6	328
Rubber & Plastic Products	14	5.6	400
Textiles	15	5.3	353
Petroleum Products	9	45.4	5,044
Pharmaceuticals	31	28.0	903
Other Chemicals	96	44.4	463
WOOD BASED			
Pulp & Paper	35	27.1	774
Other Wood	13	3.4	262
MACHINERY & TRANSPORTATION EQUIPMENT			
Business Machines	9	28.0	3,111
Other Machinery	101	45.6	451
Aircraft & Parts	14	49.3	3,521
Other Transportation Equipment	30	14.7	490
ELECTRICAL			
Electrical Products	120	158.7	1,323
Scientific & Prof. Equipment	29	7.4	255
METAL BASED			
Primary Metals (Ferrous)	10	13.4	1,340
Primary Metals (Non-ferrous)	14	49.6	3,543
Metal Fabricating	50	9.9	198
OTHER MANUFACTURING	62	11.2	181
TOTAL MANUFACTURING	727	571.6	786

Source: Based on data from Statistics Canada Catalogue 13-212 and 31-203.

A different picture emerges when we examine the average R&D expenditure of R&D performing firms in each industry. For instance, although the electrical products industry accounts for over a quarter of the total R&D expenditures in Canadian manufacturing, the average R&D expenditure of the 120 R&D performing firms in the industry is approximately $1.3 million. This is in sharp contrast to the petroleum products industry which accounts for only about eight percent of total R&D expenditures. However, the nine R&D performing firms in this industry have an average R&D expenditure of over $5 million. The R&D performing firms in business machines, aircraft and parts, and primary metals (non-ferrous) each had average R&D expenditures of over $3 million. Apart from electrical products, only one other industry, primary metals (ferrous), had an average R&D expenditure of over $1 million. The remaining industries had average R&D expenditures of less than $1 million and the overall average R&D expenditure for all 727 R&D performing firms in Canadian manufacturing was about $800 thousand.

The simple average R&D expenditures, while illuminating the differences amongst industries, nevertheless do not reveal anything about the average expenditures by size of firm. Unfortunately, because of data limitations, it is not possible to obtain average R&D expenditures by size of firm

for each industry.

Nevertheless, for the manufacturing sector as a whole, there is sufficient information available to determine the average R&D expenditure by size of firm. Table 5 shows the number of R&D performing firms and the associated R&D expenditure in terms of three size categories: small, medium and large. For the purposes of this paper, small firms are defined as having sales of less than $10 million, medium firms have sales between $10 and $50 million, and large firms have sales of over $50 million.

As shown in Table 5, approximately one-half of the 727 R&D performing firms in Canadian manufacturing are small but account for about ten percent of the total R&D expenditures. Over twenty-eight percent of the firms are medium-sized and account for about twenty percent of R&D expenditures. One quarter of the 727 R&D performing firms are large, but account for over seventy percent of the R&D. Thus, based on these data, the average R&D expenditure for small firms is $176 thousand, medium-sized R&D firms have an average R&D expenditure of over a half million dollars and the corresponding figure for large firms is over $2 million.

Further insight into the structure of R&D performing firms in Canadian manufacturing can be obtained by examining

TABLE 5

R&D PERFORMING FIRMS IN CANADIAN MANUFACTURING
BY SIZE OF FIRMS AND BY R&D EXPENDITURES — 1975

		SMALL[1]	MEDIUM[2]	LARGE[3]	TOTAL
R&D FIRMS	: Number	337	207	183	727
	: Percent	46.3	28.4	25.2	100
R&D EXPENDITURES	: $Millions	59.4	110.9	401.3	571.6
	: Percent	10.4	19.4	70.2	100
AVERAGE R&D EXPENDITURES	: $Thousands	176	536	2,193	786

[1]Sales of less than $10 million.

[2]Sales of $10 to $50 million.

[3]Sales of over $50 million.

Source: Based on data from the Science Statistics Centre, Statistics Canada.

the size of R&D program. Table 6 shows the distribution of the 727 R&D firms by size of R&D program. As is readily apparent from the table, well over half of the firms, irrespective of size, which undertake research and development activities have an R&D program of less than $200 thousand and account for about eight percent of total manufacturing R&D expenditures. A further twenty percent of the firms have an R&D program ranging from $200 thousand to $400 thousand and also account for another eight percent of total manufacturing R&D.

At the other end of the R&D size spectrum, approximately eleven percent of the total number of R&D performing firms in Canadian manufacturing undertake $1 million or more of R&D activities but account for about three-quarters of total R&D expenditures. The forty-five firms which had an R&D program of over $2 million and represented about seven percent of the total number of R&D performing firms, nevertheless accounted for approximately two-thirds of the total R&D performed in Canadian manufacturing in 1975.

Table 7 shows the distribution of funding from various sources for the R&D performing manufacturing firms for 1975. As can be seen from column four of the table, the R&D performing companies finance over three-quarters of their

TABLE 6

NUMBER OF R&D PERFORMING FIRMS IN CANADIAN MANUFACTURING BY SIZE OF R&D PROGRAM — 1975

	$0-199	$200-339	$400-999	$1000-1999	$2000+	Total
FIRMS						
Number	414	140	97	31	45	727
Percent	57	19	13	4	7	100
R&D[1]						
$Million	41	40	58	42	341	522
Percent	8	8	11	8	66	100

[1] Current intramural R&D expenditures.

Source: Based on data from Statistics Canada Catalogue 13-212.

TABLE 7

SOURCES OF FUNDS FOR R&D-PERFORMING MANUFACTURING FIRMS
PERCENTAGE DISTRIBUTION — 1975

		SMALL[1]	MEDIUM[2]	LARGE[3]	TOTAL
Reporting Company		69.5	69.3	80.0	76.2
Federal Government		21.7	13.5	10.9	12.5
Other[4]		8.8	17.2	9.1	11.3
TOTAL	: Percent	100.0	100.0	100.0	100.0
	: $Millions	59.4	110.9	401.3	571.6

[1]Sales of less than $10 million.

[2]Sales of $10 - $50 million.

[3]Sales of over $50 million.

[4]Includes other Canadian and foreign sources.

Source: Based on data from the Science Statistics Centre, Statistics Canada.

R&D expenditures with the federal government providing 12.5 percent of the funds. Large R&D firms finance eighty percent of their R&D with the comparable figure for both small- and medium-sized firms being approximately seventy percent. However, the federal government funds over one-fifth of the R&D activities of small firms but only slightly more than one-tenth of the expenditures for large firms.

A different perspective is gained, however, when one allocates the total federal government R&D contributions to small, medium and large R&D performing firms. Of the $71.5 million federal funding (12.5 percent of $571.6 million), eighteen percent went to small R&D firms, twenty-one percent to medium-sized R&D firms and over sixty percent to large R&D firms.

III. LEVELS OF R&D INTENSITY BY SIZE OF FIRM

Although, as indicated above, small R&D performing firms account for only about ten percent of total R&D expenditures in Canadian manufacturing, this does not necessarily mean that small firms are less R&D prone than large firms. Whether large firms spend more on R&D than their smaller counterparts is essentially an empirical question. One indicator which is often used to shed some light on this issue is the research intensity of a firm, i.e., R&D expenditures as a percent of sales. Table 8 shows company-financed R&D as a percent of sales in Canadian R&D performing manufacturing companies by industry and by size of company.

It is readily apparent from the table that small R&D performing firms devote a larger proportion of their sales to R&D activities than either medium or large R&D performing firms. Furthermore, medium-sized R&D performing firms in turn have a higher R&D intensity than their large counterparts. The same trend is evident in every industry with the exception of the textiles industry. In this industry, medium-sized R&D performing firms have a greater research intensity than small R&D firms.

The above relationship of R&D expenditures to sales by

TABLE 8

COMPANY-FUNDED R&D PER ONE HUNDRED DOLLARS OF SALES IN CANADIAN R&D-PERFORMING MANUFACTURING COMPANIES BY INDUSTRY AND BY SIZE OF COMPANY — 1975

INDUSTRY	SMALL[1]	MEDIUM[2]	LARGE[3]	TOTAL
Food, Beverage and Tobacco	5.02	0.80	0.17	0.25
Rubber and Plastic Products	2.88	0.96	0.41	0.51
Textiles	1.41	2.48	x	0.70
Wood Based	3.09	0.89	0.29	0.33
Primary Metals	x	1.15	0.65	0.66
Metal Fabricating	3.17	0.60	0.24	0.47
Machinery	4.05	2.54	0.50	1.03
Transportation Equipment	4.89	1.94	0.36	0.49
Electrical Products[4]	4.28	2.50	2.32	2.48
Non-metallic Mineral Products	3.36	x	0.26	0.31
Chemical Products	3.06	2.37	0.97	1.37
Other Manufacturing	2.73	0.88	0.12	1.12
Total Manufacturing	3.65	1.74	0.55	0.71

[1] Sales of less than $10 million.

[2] Sales of $10 - $50 million.

[3] Sales of over $50 million.

[4] Includes scientific and professional equipment.

x — confidential.

Source: Based on data from the Science Statistics Centre, Statistics Canada.

size of firm would appear to be unique to the Canadian economy. For example, Kamien and Schwartz in their survey article on market structure and innovation, concluded that "the bulk of the evidence indicates that, among firms engaged in R&D, relative effort tends to increase with size up to a point and then decline, with middle-sized firms devoting the most effort relative to their size".(5)

Similarly, Scherer, in discussing levels of research intensity amongst U.S. R&D performing manufacturing firms, found that "in every group but petroleum...companies with 5,000 or more employees invested more intensively in R&D than their smaller counterparts".(6)

Although the evidence is conflicting and indicates that there is no simple and straightforward relationship between R&D intensity and firm size, it is clear that, in the case of Canadian manufacturing at least, levels of research intensity are inversely related to firm size.

(5) Morton I. Kamien and Nancy L. Schwartz, "Market Structure and Innovation: A Survey", Journal of Economic Literature, American Economic Association, Vol. XIII, Number 1, March 1975. Page 3.

(6) F.M. Scherer, Industrial Market Structure and Economic Performance (Chicago: Rand McNally College Publishing Company), 1970. Page 359.

An obvious explanation for this phenomenon is the level and degree of foreign ownership in Canadian manufacturing. It is now well-established that foreign-controlled firms in Canada, in general, have a lower research intensity than their Canadian-controlled counterparts.(7) Furthermore, a substantial proportion of small R&D performing firms is Canadian-owned whereas the opposite is true for large firms. For example, it is estimated that less than thirty percent of the small R&D performing firms are foreign-controlled whereas the incidence of foreign control rises to over sixty percent among large R&D performing firms.(8)

(7) Herman P. Bones, "Are Foreign Subsidiaries More Innovative?", Canadian Business Review, Vol. 6, No. 2 (Summer 1979), page 16.

(8) Statistics Canada. Science Statistics Centre. Research and Development in Canadian Industry (Statistical Tabulations). Ottawa: October 1979. Page 10, Table 3.

IV. CONCLUSIONS

The above findings indicate that research and development performing firms only account for two to three percent of the total number of firms in Canadian manufacturing industries. Although R&D firms are to be found in the majority of manufacturing industries, the proportion of firms undertaking R&D activities is much higher in the technology-intensive industries. Similarily, the average R&D expenditure of R&D firms in the technology-intensive sectors is much higher than those in the non-technology-intensive industries.

Approximately half of the R&D firms in Canadian manufacturing are small, i.e., sales of less than $10 million, and account for only about ten percent of the total R&D expenditures. At the other end of the spectrum, a quarter of R&D firms are large, i.e., sales of more than $50 million, but account for over seventy percent of R&D expenditures. Small R&D firms have an average R&D expenditure of less than $200 thousand whereas large firms have an average expenditure of over $2 million. However, irrespective of size, the vast majority of the R&D performing firms have a relatively modest R&D program.

Although small firms finance about seventy percent of

their R&D activities, they receive over one-fifth of their R&D expenditures from the federal government. In contrast, large R&D firms finance eighty percent of their R&D and receive approximately one-tenth of their R&D expenditures from the federal government.

In comparing levels of research intensity by size of firm, it is clear that, in the case of Canadian manufacturing, small R&D performing firms devote a larger proportion of their sales to R&D activities than either medium or large R&D performing firms. This situation appears unique to Canada and can, in part at least, be explained by the level and degree of foreign ownership.

As indicated earlier in the paper, research and development expenditures in Canada, after taking into account the effects of inflation, have stagnated in both the total economy and in the manufacturing sector during the seventies. As a consequence of this, the ratio of GERD to GNP has declined from about 1.3 percent in 1970 to less than one percent by 1978. Similarly, the ratio of R&D in the manufacturing sector to GNP has also declined and currently only about one-third of one percent of the GNP is devoted to manufacturing R&D.

The technological progress of a nation is dependent, at

least in part, on its own R&D effort. Although, through the channels of international trade, an economy can obtain a large portion of its technological requirements, it is nevertheless a fact that the R&D conducted by industry establishes the fundamental technological base which in turn serves to increase a country's innovative capability by permitting the introduction of new production alternatives and also by facilitating the successful adaptation of technology developed elsewhere.

Viewed in this context, recent trends in R&D in the Canadian economy are cause for concern. This, of course, does not imply that the economy will stagnate altogether simply on the basis of insufficient domestic R&D activities. On the contrary, it is quite possible, and indeed likely, for an economy to continue to achieve "respectable" rates of economic growth by utilizing the technological innovations developed elsewhere. Although a nation can continue to meet its technological requirements through international trade, the effects of following such a strategy, either consciously or unconsciously, would in the longer run have deleterious implications on the ability of the nation to compete effectively both domestically and internationally. Clearly, no nation can be self-sufficient in terms of its technological requirements nor, on the other hand, can it

afford not to engage in innovative activities.

In a rapidly changing world economy, the pressure on Canada and, indeed, other industrial nations for continued growth and effective competitiveness will increasingly lie in those areas and industrial sectors which are the product and outgrowth of innovation, research and development and technological progress.