Report of the

Standing Senate Committee on

National Finance

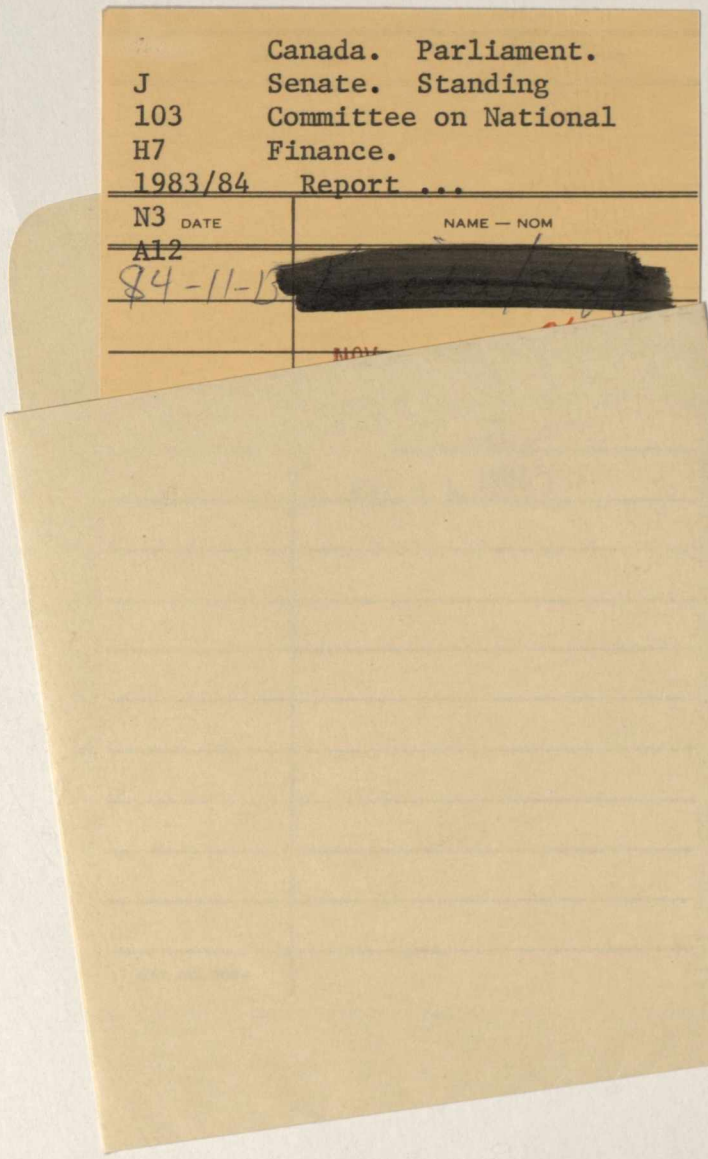
FEDERAL GOVERNMENT SUPPORT FOR TECHNOLOGICAL ADVANCEMENT: AN OVERVIEW

Chairman
The Honourable C. William Doody

Deputy Chairman
The Honourable Fernand-E. Leblanc

Second Session
Thirty-second Parliament

August 1984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Cat. No. YC13-322-1-01
ISBN 0-662-53227-9

Order of Reference

On Tuesday, March 13, 1984 the Senate resolved:

That the Standing Senate Committee on National Finance be authorized to complete its examination of the role of the Federal Government in generating economic development through technological change, begun under its examination of the Main Estimates 1982-83, tabled in the Senate on 23rd February, 1982;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be authorized to engage the services of such counsel and technical, clerical and other personnel as may be required for the said examination.

Members of the

STANDING SENATE COMMITTEE ON NATIONAL FINANCE

(as of 29 June 1984)

The Honourable C. William Doody, Chairman
The Honourable Fernand-E. Leblanc, Deputy Chairman
and
The Honourable Senators:

R.J. Balfour
***J. Flynn or D. Roblin**
L. de G. Giguère
J.M. Godfrey
H.D. Hicks
W.M. Kelly
***H.A. Olson or R. Frith**
O.H. Phillips
M. Pitfield
J.B. Stewart
D.G. Steuart
L.N. Thériault

**Ex officio Member*

Note: The Honourable Senators Austin, Barrow, Benidickson, Charbonneau, Everett, Lewis, Robichaud, Sinclair, Sparrow and Stanbury also served during the First and Second Sessions of the Thirty-Second Parliament.

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Acknowledgements

The Committee wishes to record its gratitude to the many witnesses from the federal government, the private sector and the universities who gave testimony.

It also wishes to acknowledge the strong staff support it received from: Mr. John Desmarais, the Clerk of the Committee; Mr. Jeff Greenberg and Mr. Peter Dobell of the Parliamentary Centre who acted as advisers; and Mr. Hugh Douglas of CPER Management Consulting Inc. who served as a consultant.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

- **Technology policy must be an integral part of economic development and international policy. (p. 6)**
- **Investment in advanced technology must continue to be an important area of government concern, not only in terms of the level of that investment but more importantly in terms of the quality of that investment. (p. 13)**
- **The Committee recommends that the newly established National Centre for Technology Employment and Productivity Growth examine if ways can be found to bring about a gradual reduction in the length of the work week and the relative merits of such action. (p. 18)**
- **Canada must develop and use technology to produce new and improved products, processes, and services that will create new jobs. Failure to meet the technology challenge will mean fewer jobs in the long run. Whatever problems of adjustment are encountered, they will be easier to resolve in an economy in which productivity and real income are growing. (p. 19)**
- **R&D is only a small part of the process of technological innovation. The Committee believes that more emphasis should be given to the other elements of the innovation process, in particular marketing and overall management. It also believes that Canada would be well advised to follow in this respect the example of the Japanese and pay more attention to acquiring technology from abroad, adapting it to its needs and diffusing it in Canada as quickly as possible. (p. 24)**
- **The Committee concludes that not all firms must engage in research, development and technological innovation, in order to survive. However, firms of all sizes and in all sectors of industry - resource, manufacturing and service - must adopt technological innovations that improve their productivity and competitiveness. (p. 27)**
- **The Committee considers that government policy on the subject of technology does not give sufficient attention to the importance of the general economic environment on decisions of firms to pursue technological innovation. Because government policy is developed in compartmentalized agencies, the emphasis has been on programs and policies to promote technological innovation and its diffusion and the importance of the larger picture tends to be overlooked. (p. 29)**

- **Policies and programs that try to meet too many different objectives run a serious risk of failing to meet any of them effectively, wasting valuable resources in the process. (p. 32)**

- **The expansion of foreign and domestic markets to which Canadian firms have unrestricted access will, in the long run, be one of the most effective ways to stimulate research, development and technological innovation in Canadian industry. This means that the Committee would encourage active participation by the federal government in future GATT negotiations and in bilateral discussions with the United States which could lead to a reduction in tariff and non-tariff barriers to trade. (p. 33)**

- **The industrial relations environment is of major importance to the introduction and application of new technology. Management and labour must co-operate if the productivity improvements and other benefits of technological innovation are to be achieved. (p. 33)**

- **Employers will have to meet some of their specialized manpower requirements through increased on-the-job training. (p. 34)**

- **A good network is required to collect information on science and technology developments in other countries and disseminate it in Canada. But since it is beyond the means of all but the largest companies to do this, the federal government should review the role of the science counsellors in Canadian missions abroad to ensure that they become part of an effective information gathering and dissemination network. (p. 34)**

- **Technical regulations and standards can have a significant impact on technological innovation. Wherever possible, the Committee believes that technical regulations and standards should be specified in terms of performance rather than design requirements. (p. 35)**

- **Industry is unlikely to make major investments in technological innovation, no matter how much direct support that government makes available for this purpose, unless the overall economic and social climate is generally encouraging to investment. (p. 35-36)**

- **Bearing in mind the relatively generous tax incentives now available, the Committee is hesitant to recommend a further increase in the level of tax incentives for R&D. (p. 40)**

- **The Committee commends the government for introducing the Scientific Research Tax Credit. This special research tax credit should be reviewed within two years of its coming into force to ascertain whether both small and start-up firms have benefitted from the scheme and to ensure that more R&D is performed as a result of the credit. (p. 41)**

- **The Committee agrees that, given the long-term nature of investment in research, development and technological innovation, government measures to support these investments must also be long-term and not frequently modified. (p. 41)**

- **The Committee suggests that consideration be given to modifying the present definition of scientific research for the purpose of the Income Tax**

Act to include market research undertaken in advance of a research and development project in order to define the specific requirements for new or improved products, processes or services. (p. 42)

- Grant and contribution programs to support research, development and innovation should be responsive to the needs of industry and the marketplace. (p. 42)

- The Committee is concerned about the proliferation of technology centres in Canada. It recommends that the federal government, as a matter of urgency, examine its policies with respect to the support of technology centres, taking into account provincial government initiatives in this area, with a view to ensuring that the centres it supports clearly meet existing or potential needs of industry. (p. 43)

- The Committee is concerned that the federal government is engaging in R&D that could be carried out and exploited by industrial firms. It recommends, therefore, that the intramural research and development programs of all departments and agencies, including the National Research Council, be reviewed to exclude from them any activities that could be more appropriately and profitably conducted in industry. (p. 44)

- The Committee recommends that the administration of the government's contracting-out policy be examined to ensure that greater emphasis is given to contracting-out where the potential benefits are greatest. (p. 44-45)

- Diffusion of technology is the most important element in any technology strategy. The government should increase its efforts, in co-operation with universities and the private sector, to strengthen mechanisms for collecting information on foreign technological developments and for disseminating it within Canada. (p. 46)

- Government efforts to promote R&D must begin with a concern to support reasonable efforts to enlarge the market for goods produced in Canada. Domestically this means resisting attempts by provincial governments to fragment the market with preference arrangements of one kind or another. Internationally it means pursuing efforts to reduce tariffs and non-tariff barriers. (p. 46)

- The Committee supports government efforts to encourage foreign multinationals to assign world product mandates to their Canadian subsidiaries. (p. 47)

INTRODUCTION

Progressive reductions in tariffs and improvements in transport technology since World War II have, at the same time, vastly increased opportunities for international trade and increased competition in world markets. As developing countries with low or relatively low labour costs have acquired the skills and capital to produce increasingly complex products, industrialized nations have been forced to find more efficient methods of producing the same products, or to develop more sophisticated products which compete on the basis of technical qualities rather than price. Comparative advantage in the market place is becoming more dependent on human knowledge and skill and less on natural resources. Technology has become, to a large extent, the key to industrial and economic growth.

Studies conducted by the Organisation for Economic Co-operation and Development (OECD) and others show that Canada's performance in developing and applying technology has been poor compared to other major industrialized countries. This is at present, a matter of concern in view of the unsatisfactory state of Canada's economy, in particular its low rate of productivity growth throughout much of the 1970s and early 1980s. Accordingly, the Standing Senate Committee on National Finance decided to review factors promoting investment in advanced technology and, in particular, federal government support of such investment.

To ensure that this review would be timely, the Commmittee decided to focus on broad, general issues rather than specific policies and programs, and to limit the number of hearings. In the end, ten meetings were held to hear witnesses from the federal government, the Economic Council of Canada, the Science Council of Canada, Canadian universities and business. A complete list of the witnesses is annexed to this report.

It should be noted that none of the witnesses represented the resource industries or labour. Although the Committee recognizes the great importance of the resource industries to Canada's economic well-being, a decision to extend the scope of the enquiry to include these industries would have extended considerably the time needed for hearings, and it would have been impossible to complete a report before the summer recess. This will remain a task for the Committee in the future. The Committee is also aware that no segment of society has a more vital role to play in the industrial application of technology or is more directly affected by technological change than labour. Accordingly, the Committee made several efforts to obtain the views of leaders of the Canadian Labour Congress or of major constituent unions during the course of

its review. However, the Congress informed the Committee that its many pressing commitments made it impossible to prepare a considered presentation before the hearings were concluded. This failure to obtain the views of the labour organizations is considered by the Committee to be a major shortcoming of its review.

This report provides an overview of the Committee's findings and conclusions as a result of its hearings. In general, the Committee concluded that, to be effective, **technology policy must be an integral part of economic development and international trade policy.**

TECHNOLOGICAL INNOVATION IN CANADA

Historical Background

Prior to World War I, most of Canada's activities in science and technology were focused on its natural resources. Agriculture, fishing, forestry and mining were of primary concern. The Geological Survey of Canada, which was created in 1841, laid the foundation of the mining industry. In 1885, the government took steps to establish a number of experimental farms to conduct scientific work in the field of agriculture. Concern for Canadian fisheries resulted in the formation in 1898 of the Board of Management of the Biological Stations. The Department of Agriculture and, later, the Forestry Branch of the Department of the Interior undertook some experimental nursery research which led to the establishment of the first formal forest experimental station in 1917. These early developments resulted in a major involvement by government in scientific activities to support the development of resource industries that has continued to this day. However, virtually no industrial research and development (R&D) was carried out in Canada before World War I.

World War I stimulated industrial activity in Canada and, with it, interest in industrial R&D. In 1917, the National Research Council (NRC) was established. Initially, the Council's mandate was to plan and co-ordinate research in the country, but not to conduct research itself. One of the Council's first tasks was a survey of industry which showed that only 37 firms in Canada had research laboratories. In effect, the Council found that there was very little research for it to co-ordinate. To remedy this situation, it sought government authority to establish its own research laboratories. After many years of debate, authority to do so was finally granted in 1929 and construction began the next year. However, by 1935, the Council had only 54 professionals on staff.

The period between the two wars saw little increase in the level of R&D activity in Canadian industry. To some extent, this was brought on by the low level of economic activity during the Depression of the 1930s. However, a major contributing factor was that much of the manufacturing activity was carried out by branch plants of foreign companies which had been established in Canada since the turn of the century to circumvent the high tariffs that prevailed them and to serve the Canadian market. In the 1930s, U.S. corporations also took advantage of the British preferential tariff to supply Commonwealth markets from Canadian plants. These branch plants were normally miniature copies of their foreign parents producing the same products, usually at lower volume and higher cost. They obtained most of the technology required from

their foreign parents and had little reason to engage in research and development or technological innovation in Canada.

World War II brought increasing demands for science and technology to support the war effort. Once again, these demands were met largely by government. During the war years, the National Research Council established 21 new laboratories. Canadian industry expanded rapidly and developed its technical skills to produce a wide range of military equipment. However, most of this production was based on imported technology. Industry continued to do little R&D.

The period after World War II was one of rapid technological change as technology acquired during the war was adapted and applied to the production of industrial and consumer goods to meet the heavy demands of the post-war years. Many companies were established, with some government assistance, to continue research and development work in which Canadian scientists had become involved during the war in such fields as atomic energy, synthetic rubber, radar and gas turbines, and to exploit market opportunities that were opening up in these areas.

The period following World War II also witnessed a dramatic growth in post-secondary education. The number of Canadian universities offering post-graduate degrees tripled over the next 30 years, and the quality of scientific research in many Canadian universities attained a wider level of international recognition.

In the late 1950s, the Canadian government began to adopt specific measures to encourage research and development in industry. Initially, these took the form of income tax incentives for research and development. However, following the cancellation of the Arrow aircraft project in 1959 and the signing of the Canada-United States Defence Production Sharing Agreement the same year, several programs to provide grants and contributions to industry for research and development were introduced together with policies for contracting out R&D. Today, there are a variety of measures designed to foster and promote research and development in industry administered by a number of different federal government departments and agencies. Under this stimulus, the number of firms in Canada engaged in R&D increased from 377 in 1955 to 1,200 in 1981.

Toward the end of the 1950s, the government also took a renewed interest in science policy in line with similar initiatives taken at the time by the OECD. The Royal Commission on Government Organization established in 1960 under the chairmanship of J. Grant Glassco considered scientific research and development as one of its "special areas of administration". In its report, the Commission recommended the establishment of a Central Scientific Bureau to act as a science secretariat to Cabinet, and also a National Scientific Advisory Council "with membership drawn from the scientific disciplines, the universities, industry and the community at large, to review and submit independent advice with respect to national scientific policy". In response to these recommendations, the government established in 1964 the Science Secretariat in the Privy Council Office and the Science Council of Canada. However, the debate on science policy continued in 1967 with the Senate Special Committee on

Science Policy, chaired by Senator Maurice Lamontagne, providing the main forum. Following publication of the first volume of the Committee's report, the Ministry of State for Science and Technology was created in 1971, replacing the Science Secretariat, to provide advice on science policy issues at Cabinet level. Other organizational changes followed. Among them was the establishment in 1978 of the Natural Sciences and Engineering Research Council, which took over from NRC responsibility for research grants in the natural sciences and engineering.

Major changes in the world's trading environment following World War II had significant implications for R&D and technological innovation in Canadian industry. Reductions in tariffs brought about by a series of multilateral trade negotiations under the General Agreement on Tariffs and Trade (GATT) made foreign markets more accessible to Canadian firms, providing many of them with opportunities to achieve significant economies of scale in their production as well as higher returns on investments in the development and application of technology. At the same time, reduced tariffs made the Canadian market more accessible to foreign industry.

Some foreign companies that had established branch plants in Canada to serve the Canadian and Commonwealth markets in the days of high tariffs found that they could now supply those markets more profitably from the parent plant or other plants abroad. Multinational companies in these circumstances sometimes faced difficult decisions. At one extreme, they could close their Canadian plant and supply the Canadian market from the parent or one of their other foreign plants. At the other extreme, they could assign their Canadian plant a world product mandate within the multinational company to develop and produce specific products and market them throughout the world. Under this latter option, the Canadian branch plant would produce a large volume of a narrow line of products for world markets, rather than a small volume of a wide range of its parent's products for the Canadian market as it had in the past. It would be responsible for the research and development as well as the production and marketing of new or improved products in that line, and for making the investments required therein. At the same time, it would have access through its foreign parent and affiliated companies to markets in other countries which would potentially allow it to maximize its return on these investments. A number of Canadian subsidiaries were assigned world product mandates by their foreign parent companies with some notable success. Among these subsidiaries were Westinghouse Canada Inc., Pratt & Whitney Canada Inc., Black & Decker Canada Inc. and Canadian General Electric Co. Ltd.

Notwithstanding reductions in tariff and non-tariff barriers to trade, foreign ownership and control of Canadian manufacturing, oil and gas and mining grew in the post-war years. Within the manufacturing industries, non-resident ownership continued to be greatest in transportation equipment, chemicals, rubber products, tobacco, petroleum and coal products. Concerns about the effects that this foreign ownership and control might have on the future growth and viability of Canadian industry, including its technological capability, caused the government to launch a study in 1970 of foreign direct investment in Canada. As a result of this study, the Foreign Investment Review Agency (FIRA) was established in 1974 to assess the benefit to Canada of proposals by

non-Canadians to acquire control of Canadian business enterprises or to establish new businesses in Canada.

Recent Developments

Despite developments since World War II, Canada's technological innovative performance is generally considered to be poor compared with other industrialized countries.

Technological innovation however, is much more than research and development. It includes all activities needed to transform an idea into a new or improved marketable product or service or commercially useable process. Ideally, it should be possible to measure innovative performance of an industry or the whole country in terms of specific outputs by identifying contributions of specific inputs to productivity growth or to the development of new products and processes. However, statistical methods have not yet been developed for measuring the inputs to the total innovative process, let alone the outputs. Accordingly, expenditures on research and development have traditionally been used as a proxy for measuring technological innovation.

Canada's Gross Expenditures on Research and Development (GERD) in the natural sciences over the past 20 years, in current and 1971 dollars and as a percentage of its Gross National Product (GNP), are shown in Table 1. Expen-

Table 1:
Gross Expenditures on Research and Development (GERD) in the Natural Sciences in Canada, 1963 to 1983

Year	Current Dollars	1971 Dollars	Per Cent GNP
	— millions —		
1963	463	619	1.01
1964	554	723	1.10
1965	665	841	1.20
1966	754	913	1.22
1967	854	994	1.29
1968	910	1,026	1.25
1969	1,002	1,082	1.26
1970	1,068	1,097	1.25
1971	1,160	1,160	1.23
1972	1,192	1,135	1.13
1973	1,284	1,120	1.04
1974	1,504	1,138	1.02
1975	1,686	1,152	1.02
1976	1,834	1,144	0.96
1977	2,055	1,193	0.98
1978	2,349	1,278	1.01
1979	2,694	1,329	1.02
1980	3,204	1,428	1.08
1981	3,953	1,587	1.17
1982	4,591	1,674	1.29
1983	4,969	1,706	1.28

Source: Science and Technology Statistics Divsion, Statistics Canada

ditures on research and development increased rapidly from 1963 to 1967, reaching 1.29 per cent GNP in that year. It remained more or less stable as a percentage of GNP for the next four years and then dropped sharply. By 1976, R&D expenditures as a percentage of GNP had dropped to 0.96. This was a lower percentage than Canada had spent in 1963 and was considerably lower than the percentage of GNP spent on R&D in most other major OECD countries.

Furthermore, the distribution of R&D expenditures among the funding and performing sectors in Canada was markedly different than that of most of these countries. Whereas industry in Canada provided about one-third of the R&D funds and performed about 40 per cent of the total R&D, industry in most of these other countries financed 40 to 50 per cent of the R&D and performed between 50 and 65 per cent of it.

In an effort to rectify this situation, the federal government, in June 1978 announced several new measures aimed primarily at strengthening and encouraging research and development in Canadian industry. It also established a national target for expenditures on R&D of 1.5 per cent GNP by 1983.

In April 1981, after assessing developments since 1978, the government set back the date for meeting this target to 1985. At the same time, it established a planning framework for achieving the target which was designed to bring the distribution of R&D expenditures among the funding sectors in Canada more in line with that in other countries. This planning framework specified the share of the target for R&D expenditures of 1.5 per cent GNP which each of the major sectors was expected to finance, as shown in Table 2.

Table 2:
Planning Framework for Achieving the Target of 1.5 per cent GNP for Expenditures on R&D in the Natural Sciences

	% GNP	% TOTAL
Federal Government	0.50	33-1/3
Industry	0.75	50
Provincial Governments, Universities and Others	0.25	16 2/3
Total	1.50	100

The latest available statistical data show that Canada's gross expenditures on R&D in the natural sciences increased from 1.01 per cent GNP in 1978 to 1.28 per cent GNP in 1983. However, this was still substantially less than the percentage spent by most other major OECD countries, as shown in Table 3.

Table 3:
Comparison of Gross Expenditures on R&D (GERD) in the Natural Sciences in Major OECD Countries

	Year	GERD % GDP
Belgium	1979	1.33
Canada	1983	1.28
France	1981	1.97(1)
Germany	1979	2.30
Japan	1981	2.13
Netherlands	1979	1.69
Sweden	1979	1.86
Switzerland	1979	2.34
United Kingdom	1978	2.11
United States	1981	2.54(1)

(1) Includes some expenditures on R&D in the social sciences.
Source: OECD, and Science and Technology Statistics Division, Statistics Canada

The distribution of R&D expenditures in Canada in 1983 by funding and performing sectors is shown in Table 4.

Although industry's share of total R&D expenditures both as a source of funds and as a performer has increased in recent years, it is still less than in other industrialized countries.

Professor K. Palda and Professor B. Pazderka of the School of Business, Queen's University, told the Committee that their studies indicated a number of reasons why the level of research and development activity in Canadian industry is low compared to industry in other countries. These include the following:

Table 4:
Distribution of Gross Expenditures on R&D (GERD) in the Natural Sciences in Canada by Funding and Performing Sectors, 1983

Funding Sectors	Performing Sectors				
	Government	Industry	Higher Education	Private Non-Profit	Total
	— per cent of total —				
Government	27	7	10	—	
Industry	—	41	—	—	41
Higher Education	—	—	9	—	9
Private Non-Profit	—	—	1	1	2
Foreign	—	4	—	—	4
TOTAL	27	52	20	1	100

Industrial Structure — Manufacturing industry, which accounts for most of the R&D performed in industry, is a smaller proportion of total industry in Canada than in some other countries. Within the manufacturing sector, the proportion of output contributed by research intensive industries such as aircraft and electronics in Canada is less than in other countries.

Defence R&D — Canada does not spend proportionately as much on defence R&D as countries such as the U.S., U.K., Germany and France. This is included in the Gross Expenditures on R&D (GERD) shown in Table 3. Even Sweden, with a population and GNP only about one-third of Canada's spends two-and-a-half to three times as much as Canada on defence R&D. In per capita terms, Sweden's expenditures on defence R&D is therefore at least six times greater than Canada's.

Market Size — Canada lacks a large domestic market such as that enjoyed by Japan and the United States, or unrestricted access to a common market or free trade area such as the European Economic Community. Among other industrialized countries, only Australia faces the same problem. Without assured access to a large market, the risk faced by Canadian firms in earning the return required to justify investment in R&D is greater than that faced by firms in other industrialized countries.

Foreign Ownership — A large percentage of the output of Canadian manufacturing industry, especially in the technology intensive sectors such as transportation equipment, machinery, chemicals and chemical products is accounted for by foreign-owned or controlled firms, which rely to a large extent on their foreign parent companies for the technology required, rather than conducting R&D in Canada.

The Committee concludes from this survey, that, although there has been a commendable increase in Canada's Gross Expenditures on R&D in recent years and in the proportion of those expenditures which are financed and spent by industry, Canadian industry's performance in this area remains low compared to industry in other industrialized countries. Canada's small domestic market, multinational corporate structure, and low expenditures on defence set Canada apart from almost all other industrialized countries, and increase the difficulties Canada faces in promoting and achieving technological innovation. The Committee concludes that **investment in advanced technology must continue to be an important area of government concern, not only in terms of the level of that investment but more importantly in terms of the quality of that investment.**

ROLE OF TECHNOLOGY

The Committee was struck by a disturbing paradox. On the one hand, Canada's overall productivity today is close to record levels. Among OECD countries, it ranks second only to the United States. On the other hand, the average annual rate of productivity growth in Canada over the past decade was zero. [1] This is lower than at any other time in Canada's history, and also lower than the productivity growth rate in any other major OECD country.

Of all the economic problems that Canada has faced over the past decade, none is more serious in the long term than this dramatic decline in productivity growth. This point was emphasized by several witnesses who appeared before the Committee.

Dr. David Slater, Chairman of the Economic Council of Canada, pointed out to the Committee that the importance of productivity growth lies in its contribution to the creation of wealth and rising standards of living. If there was no increase in productivity for a prolonged period of time, real income and living standards would not only fail to increase but might even decline. Dr. Slater said,

> I think the central point to the Canadian position, both in terms of size and persistence, which drives or permits an increase in living standards, is an increase in productivity. If we do not have an increase in productivity over the next while, we will have low increases in living standards or practically no increases in living standards (1-32-6:7 and 8). [2]

Without a growing economy, Canada's ability to meet the needs and aspirations of its people would be seriously circumscribed. Any increase granted to one group in society would be at the expense of another. If salaries and wages were to increase they would be subsequently eroded by increases in the general price level. If more was spent on health care, old age pensions, education or unemployment insurance, for example, less would be available to spend on other goods and services. Productivity growth is therefore essential to the resolution of Canada's current economic problems and to the country's long-term

[1] In 1983, the increase in the rate of productivity growth was 2.2%. At this stage it would seem that this growth is a result of operating at a low level of capacity utilization and simply increasing production without increasing employment or changing the way things are being produced.

[2] The numbers refer to the session, Parliament number, the proceedings of the Committee or Subcommittee and the page number. For example, 1-32-6:7 and 8 refers to the first session of the thirty-second Parliament, proceedings of Subcommittee number 6, pages 7 and 8.

economic and social prospects. Ultimately, a failure to make economic progress will also generate political problems across the country and between the two levels of government in Canada.

The process which brings about growth in productivity is complex and not well understood. Until 40 years ago, most economists accepted the so-called classical theory that productivity growth was attributable mainly to quantitative increases in capital, that is plant and equipment. However, studies undertaken in the late 1950s and early 1960s by such economists as Edward Denison, John Kendrick and others showed that only 10 to 20 per cent of the productivity growth in the United States since the turn of the century could be accounted for by capital accumulation, leaving a residual of 80 to 90 per cent to be attributed to changes in technology, including improvements in organization and management and in the level of worker education. It was concluded, therefore, that productivity growth did not depend so much on the quantity of capital as on the quality of capital and labour inputs in terms of the technology they brought to the production process. Similarly, comparative advantage in international trade was not determined primarily by natural resources and other static endowments of a country, as had been generally thought in the past, but rather by the technology and know-how incorporated into a product or applied in its production. As a result of these studies, economists have come to recognize technology as a major source of productivity growth. While its precise contribution is still a matter of debate, few deny that it is a key factor. Dr. Slater told the Committee, "What is common to all of the analyses of productivity growth is that technological advancement is a critical element in the process of getting productivity improvements. If you want to get better productivity improvements, technology advancement is a key element". (1-32-6:8)

Dr. James Gilmour, Director of Research, Science Council of Canada, and some other witnesses tended to see the role of technology in somewhat more pragmatic terms. To them, technology was simply the key to competitiveness in the market place. In the so-called mature industries such as textiles and furniture, in which many firms produce similar products, competition is based largely on price. For firms in these industries, the application of new production technologies, such as those that have resulted from recent developments in microelectronics, could spell the difference between success and failure. In the so-called high technology industries such as aircraft and electronics, products compete more on the bases of technical quality, performance and reliability than on price. For firms in these industries, the technology incorporated into their products is vital to their survival. "Regardless of which way you look at it", Dr. Gilmour told the Committee, "whether you want to be competitive in mature industries or competitive in high technology industries, technology is vital to industrial success". (1-32-3:6) In addition to benefiting industries that already exist, advances in technology can create new industries not only to produce new products such as computers and word processors, but also to use those new products and to sell, service and repair them.

Dr. Stuart L. Smith, Chairman of the Science Council of Canada, told the Committee that, "Technology must be the central part of an economic strategy". (1-32-3:16) The Honourable Donald Johnston, Minister of State for Economic Development and Minister of State for Science and Technology,

agreed. He said, "In other countries, as well as in Canada at the federal and provincial levels, there has been a recognition that technology is central to economic development in today's world". (1-32-11:10) He went on to say, "The scientists cannot remain segregated from the economists. Technology and basic research - but moving into, if you like, technology, innovation and diffusion - are fundamental to where each country has to go as a nation in this industrialized world, a world which is becoming increasingly competitive". (1-32-11:11)

It was evident from testimony presented to the Committee that the benefits of technology cannot be gained without social as well as economic cost. Speaking on behalf of the Canadian Manufacturers' Association (CMA), Mr. Bernard Ness, President and Chief Executive Officer, Canada Wire and Cable Limited, made the following statement to the Committee:

> Technology is a competitive weapon, one which is both exciting and frightening at the same time. Technology is exciting because we know that technical advance will bring increasing employment and better living standards in the years ahead, just as it has always done. But technology is also frightening because it always brings change and uncertainty. History tells us that this change has usually been change for the better, but many people are uncertain what change will bring this time. (2-32-3:9)

Productivity improvements brought about by the introduction of new technology, such as computer-aided manufacturing and robotics, will inevitably eliminate jobs in many industries that exist today. As manufacturing industry becomes more efficient, the proportion of the working population engaged in this activity may well decline in the same way that the proportion employed in agriculture declined as a result of productivity growth in that sector over the past century. Whereas jobs lost in agriculture were offset over time by new jobs in manufacturing and more recently in the service sector, there is no assurance that growth in service industries will be able to replace all jobs lost in manufacturing. Recent technological innovations such as computers and word processors are already eliminating jobs in the service industries as well and this process is likely to become more marked. To some degree, technological innovations can be expected to create new industries and new jobs as they have in the past. Several witnesses noted that it is always easier to identify existing jobs that will be eliminated by the introduction of new technologies than it is to envisage new jobs that do not exist today, which will be created. As Professor Fergus Chambers of the School of Public Administration, Queen's University told the Committee, "Someone looking ahead to the 1980s back in 1970 would not have imagined many of the jobs that are available today". (1-32-1:13)

The Honourable Donald Johnston summed up his views on this issue as follows:

> As in most areas of economic debate, there are at least two schools of thought on this issue. The optimistic scenario is that technological change will not only produce more jobs, but also more lucrative jobs. This, in fact, has been our experience in the past.
>
> However, other economists look to the future through a somewhat murkier crystal ball and, like many of the more gloomy futurists of

the past, cannot visualize the professions of the future. These more pessimistic philosophers suggest that we may indeed have more wealth, but we will have fewer jobs.

My own view is that no matter which of these scenarios is correct — either more better paying jobs, or more wealth but fewer jobs — we have the means at our disposal to address these problems because society as a whole will be richer through technological development.

The challenge for the government is to devise the policies and programs which encourage future-oriented jobs and, at the same time, offer opportunities for displaced workers to develop the appropriate skills. The challenge is also to address this highly-charged issue in a spirit of realistic optimism.

Training, and retraining, is vital if Canada is to maintain the versatility required by the work force to support technological development. (1-32-11:18)

The Committee considers there is a reasonable possibility that, in the long term, new jobs will be created to replace those that will be eliminated by the introduction of new technology. Improvements in productivity brought about by the application of new technologies may also make it possible to reduce the work week. Speaking on this point, Professor Chambers referred to an article by Professor Wassily W. Leontief in the September 1982 issue of *Scientific American* in which Professor Leontief wrote as follows:

> The reduction of the average work week in manufacturing from 67 hours in 1870 to somewhat less than 42 hours must also be recognized as the withdrawal of many millions of working hours from the labor market. Since the end of World War II, however, the work week has remained almost constant. Waves of technological innovation have continued to overtake each other as before. The real wage rate, discounted for inflation, has continued to go up. Yet the length of the normal work week today is practically the same as it was 35 years ago. In 1977 the work week in the U.S. manufacturing industries, adjusted for the growth in vacations and holidays, was still 41.8 hours.

Whatever the long term outcome, the Committee recognizes that in the short term there will be serious problems of adjustment which will have to be addressed. Among possible developments the Committee recognized that, as in the past, one step toward finding a solution may be a further reduction in the average work week. Movement in this direction would have to be cautious, since it would have to be phased in gradually to avoid any reduction in Canadian international competitiveness to allow time for wage adjustments between sectors to take place and to avoid industrial unrest. **The Committee recommends that the newly established National Centre for Technology Employment and Productivity Growth examine if ways can be found to bring about a gradual reduction in the length of the work week and the relative merits of such action.**

However onerous is the responsibility for managing the introduction of new technologies and because of its uncertain impact on employment, witnesses were agreed that Canadian industry can only survive in the face of growing competition from industries in other countries if its technology is as good or better than theirs. Canada must apply the latest manufacturing and processing technologies, such as computer-aided manufacturing and robotics, to increase its productivity and so preserve existing jobs. As Professor Chambers put it, "It is a case of whether half the jobs are lost or all of them are lost". (1-32-1:13) At the same time, **Canada must develop and use technology to produce new and improved products, processes, and services that will create new jobs. Failure to meet the technology challenge will mean fewer jobs in the long run. Whatever problems of adjustment are encountered, they will be easier to resolve in an economy in which productivity and real income are growing.**

In the view of the Committee, the course which Canada must follow is clear. In order to compete in the markets of the world and sustain the economic growth required to meet its social goals, Canada must take advantage of the advances which are being made in technology as rapidly as other countries with which it competes.

THE PROCESS OF TECHNOLOGICAL INNOVATION AND DIFFUSION

Definition of Technological Innovation

The term technological innovation may be defined as the application of discoveries in science and technology to develop and commercialize new or improved products, processes or services. Some examples of recent technological innovations are word processors, communication satellites, microcomputers, industrial robots, automatic bank tellers and the universal product code.

Technological innovation, however, is much more than research and development. It comprises all of the activities needed to transform an idea into a marketable product or service, or into a commercially usable process. In addition to research and development it includes market research, design and engineering, prototype and pilot-plant construction and testing, tool design and production, manufacturing and process engineering, and the startup of manufacturing and marketing. Indeed, a firm does not have to engage in research and development at all in order to undertake a technological innovation. It may simply use existing technology to design and develop a new or improved product, process or service to meet a perceived market need. But a technological innovation is not complete until the product or service has been sold, or the process has been used commercially. Technological innovation is not an end in itself. Whether it is undertaken in response to market pull or technology push, the results must be marketed or used commercially.

Basic Research

This is not to say that research is not important. On the contrary, several witnesses pointed out that technological innovation depends on a world-wide pool of scientific knowledge that is the product of basic research. Some took the view that Canada has an obligation to contribute to that pool; others argued that Canada should emulate Japan and exploit the research of other countries. But the Committee believes there are other more cogent reasons why Canada must, in its own economic interests, engage in some basic research. If Canada is to draw on this world-wide pool of scientific knowledge, it must have scientists and engineers who are able to access and understand what is contained in that pool, and to assess and adapt it to Canada's needs. To acquire this ability, scientists and engineers must themselves engage in some basic research. Research activities are also important for the training of scientists

and engineers. Research centres are "...notorious for spawning entrepreneurs", (1-32-16:5) as Mr. Franz Tyaack, President and Chief Executive Officer of Westinghouse Canada Inc., informed the Committee, citing the number of innovative companies that sprung up in the 1950s around Lincoln Laboratories in Boston. He also drew attention to the potential of the research in artificial intelligence that is being carried out at the University of Waterloo.

Technological Innovation

Scientific knowledge resulting from basic research is generally not patentable and is freely available to anyone. However, as the commercial potential of a scientifc discovery or invention is identified and enhanced through applied research and development, proprietary interests come into play along with patents, copyrights and trade secrets.

Transforming a scientific discovery or invention into a marketable product, process or service is a complex, expensive, extensive and risky undertaking. The total cost of technological innovation has been estimated to be anywhere from two to ten times the cost of the R&D on which it is based. A number of witnesses stressed that management and marketing were no less important than research and development to the succcess of a technological innovation. While a firm must be technically capable, this is not enough. As Mr. Tyaack pointed out in his brief, "The technological leader can be out-produced, or out-marketed, or out-invested". (1-32-16A:5) This means that a technological innovation must be well managed. Since the return on investment in technological innovation also depends on the sale of the resulting products or services, good market research and marketing are also essential.

Importing Technology

Research and development can be vital to a firm's competitive position. However no country can expect to excel technically in every field or to generate all the technology it needs. Nor can it afford to duplicate technology developed elsewhere. Every country must therefore import technology from other countries and adapt it to its needs. Speaking for the CMA, Mr. Lewis Chow, Manager, Government Contracting, Pratt & Whitney Canada Inc., put it this way:

> Technology has no nationalism. In all parts of the world, firms are anxious to put in place the best technology available regardless of its place of origin. Canadians conduct less than one percent of the world's research and, of course, we are not going to invent everything we need in this country. We must buy, lease, license or otherwise borrow the 'best-practice' technology we need to be competitive when we cannot create it ourselves. (2-32-3:7)

To illustrate this point, several witnesses noted that the remarkable development of Japanese industry since World War II was based largely on technology that had been acquired under licence from other countries and further developed in Japan. The dominant position that Japan enjoys today in the

markets of the world for such products as automobiles, motorcycles, cameras and transistor radios attests to the success of this strategy of taking an established product and, in effect, presenting it in such a way as to develop an essentially new and very much larger market than previously existed.

The terms and conditions under which technology is imported can determine the extent to which it can be commercially exploited by the recipient. If, for example, technology is acquired in the form of production drawings without any other design or engineering information, the recipient may not be able to produce any product other than that specified in those drawings. He is confined to "...metal bending", (1-32-1:16) as Professor Chambers called it.

Professor Chambers also identified two other conditions that restrict the benefits that can be derived from imported technology. He said:

> There are two conditions that are often put on the transfer of technology, which are, in a sense, very harmful to economic industrial development. The Japanese were very careful not to accept those two conditions.
>
> One condition is that you cannot export from Canada to foreign markets. In other words, the technology is to be exploited only in Canada. You limit your market. That is a very serious limitation which came along with a lot of technology coming into Canada.
>
> The second condition is that any ongoing development or any ongoing knowledge resulting from the application or from the research activities of the licensing firm must go back and is owned by the original foreign company. In virtually all cases you find that kind of arrangement. In other words, all knowledge developed by the Canadian subsidiary goes to the foreign owner and is owned by the foreign company. (1-32-1:17)

When importing technology, Canadians should follow the example of the Japanese and endeavour to obtain engineering and other information that will allow them to further develop the technology, together with the rights to keep those further developments and to market products or services produced with the technology anywhere in the world.

Diffusion of Technology

Firms in the so-called high technology industries such as aerospace, electronics and machinery whose products compete in the marketplace primarily on the basis of their technical quality, performance or reliability, must normally engage in research, development and technological innovation in order to survive. However, not every firm must engage in technological innovation in order to avail itself of the productivity improvements and other benefits to be derived from technological innovations. Many firms in the so-called mature industries, such as textiles, food products, and furniture, whose products compete largely on the basis of price can acquire much of the technology they require by purchasing it in the form of machinery, equipment, materials and

supplies which they use in their production process. Similarly, firms in the service industries such as transportation, communications, health care and office services, depend largely on the technological innovations made by their equipment suppliers. In many instances, the benefits that accrue to the user of the product or process resulting from a technological innovation may exceed by many times the benefits that accrue to the innovator. Whether the technological innovation is made in Canada or is made abroad and the results are imported into Canada, the extent to which Canada will benefit from it will depend largely on how widely and quickly the results are diffused in Canada.

Conclusions

The Committee concludes from its examination of the process of technological innovation and diffusion that **R&D is only a small part of the process of technological innovation. The Committee believes more emphasis should be given to the other elements of the innovation process, in particular marketing and overall management. It also believes that Canada would be well advised to follow in this respect the example of the Japanese and pay more attention to acquiring technology from abroad, adapting it to its needs and diffusing it in Canada as quickly as possible.**

INDUSTRIAL APPLICATION OF TECHNOLOGY

Industry Sectors

The ability of firms in some sectors of industry, such as aerospace, electronics and machinery, to compete in the markets of the world depends, as Dr. Gilmour pointed out in his testimony, largely on the technical excellence of their products. Firms in these sectors should therefore normally engage in research, development and innovation if they are to remain competitive. However, firms in other sectors of industry can acquire most of the technology they need from suppliers of machinery, equipment, materials and services to that industry sector. For example, the agricultural industry relies on the agricultural implement industry for machinery and equipment and on the chemical industry for fertilizers, herbicides and insecticides. The textile industry relies on the machinery industry for spinning, weaving and knitting machines. The telecommunications industry relies on the electronics industry for telephones and radio transmitters. Industry is interdependent. Every sector depends to some extent on other sectors for the technology it requires to improve its productivity and competitiveness. Whether or not it engages in research and development to generate technology, every sector of industry uses technology. The Committee believes that it is just as important for firms in the resource industries such as agriculture, fishing, forestry and mining and in service industries such as communications, retailing and banking, to adopt technological innovations that improve their productivity and competitiveness as it is for firms in the manufacturing industries. All sectors of industry must take advantage of advances in technology.

Firm Size

Major technological innovations to develop complex systems such as satellites, military aircraft and communication systems that incorporate the results of scientific advances in several different fields of technology, usually require resources which only large firms can afford. In some areas of research and development, a certain critical mass may be required to sustain a continuing stream of technological innovations which only large companies can attain. However, it was evident to the Committee that technological innovation is by no means the preserve of large companies. They do not have a monopoly on ideas for technological innovations. On the contrary, many of the most innovative companies are small. Under the management of an entrepreneur, they are often able to perceive and adapt more readily to the needs of the market for

technological innovations than larger firms with their more complex organizations and procedures. Examples of such firms are Gandalf Data Ltd., MacDonald Dettwiler & Associates Ltd., and Lumonics Inc.

The Committee believes that even if they do not engage in research and development or technological innovation themselves, small firms — to remain competitive — must adopt those technological innovations in the machinery, equipment and materials they use which can lead to improvements in their productivity. If, as some witnesses anticipate, recent developments in computer-aided manufacturing and robotics make short production runs as productive as long production runs using older production technology, small manufacturing firms may well be able to compete in areas they have been unable to in the past. Speaking of these developments, Mr. Tyaack said, "So we are in the process of loosening that thing up, getting away from the linear flow assembly line and literally freeing ourselves from the old notion that the longer the run the more productive it is. That is going on now. The Japanese have done it. They have done a lot with short production runs to get very high productivity". (1-32-16:22) These developments may be very important to Canada because of the small size of the domestic market.

Research Centres

Technological innovation is an industrial process. Only industry is able to carry out the production and marketing required to transform an invention into a saleable product or process. However, research centres operated by government, universities or non-profit organizations can play an important role in fostering and assisting technological innovation in industry.

First, research centres can undertake fundamental research in technologies of interest to industry such as materials, artificial intelligence, aerodynamics, tribology and bioengineering, and make the results available to industry. Mr. Tyaack noted that research centres in which government, universities and industry co-operate had been particularly successful in producing entrepreneurs and promoting technological innovation. As an example of such a centre, he and other witnesses cited the research in artificial intelligence being conducted at the University of Waterloo.

Second, research centres can undertake applied research and development for industries such as agriculture and fishing which are comprised of enterprises that are too small to undertake research and development on their own. The research institutes and stations that have been established across Canada by Agriculture Canada are examples of such centres.

Third, research centres can provide research and development and other technical services to industry on request. Such services are of particular importance to small firms that cannot afford to establish and maintain their own research and development capability. The Committee noted that a number of Canadian universities, with initial financial assistance from the Department of Regional Industrial Expansion, has established Industrial Research Institutes and Centres of Advanced Technology to provide research and development and other technical services to Canadian industry on a contract basis.

Conclusions

From these considerations, **the Committee concludes that not all firms must engage in research, development and technological innovation**, in order to survive. However, **firms of all sizes and in all sectors of industry — resource, manufacturing and service — must adopt technological innovations that improve their productivity and competitiveness**. Government and universities can play an important role in fostering and assisting technological innovation by undertaking basic research in technologies of interest to industry and by providing research and development and other technical services to industry.

ROLE OF GOVERNMENT IN SUPPORTING INVESTMENT IN TECHNOLOGY

In May 1983, Mr. Johnston, Minister of State for Economic Development and Minister of State for Science and Technology, announced *A Technology Policy for Canada.*

The general objectives of this policy are:

- To strengthen the Canadian economy through the development of new technologies for producing goods and services and the widespread adoption of new and existing technologies;
- To manage the process of technological development so as to ensure that Canadians are aware of both the opportunities and the problems that might arise;
- To ensure that the benefits to technology development are shared equitably among all Canadians in every region; and,
- To create a social climate that places a premium on scientific and technological excellence, curiosity and innovation.

Environment for Technological Innovation

While these are fine-sounding general statements, **the Committee considers that government policy on the subject of technology does not give sufficient attention to the importance of the general economic environment on decisions of firms to pursue technological innovation.** Mr. Johnston, in his appearance before the Committee, did agree that, "Any policy that addresses technology development must act with, and through, economic, industrial, social and science policies". (1-32-11:6) But perhaps **because government policy is developed in compartmentalized agencies, the emphasis has been on programs and policies to promote technological innovation and its diffusion and the importance of the larger picture tends to be overlooked.**

The Committee decided to pay particular attention to identifying environmental factors which effect technological innovation. Ten of them are of sufficient importance to be mentioned.

Stable Economic Environment

Investment in technological innovation, like most investments, involves risk. But, in addition to the risks associated with industrial investments such as those in production plant and advertising, investment in technological innovation involves technical risk. Only a small proportion of research and development projects lead to commercially successful products, processes or services. Where they do, the payback period is typically much longer than it is for most other investments. Whereas an investment in new production machinery will begin to earn a return soon after the machine is installed, an investment in technological innovation will not start to pay off until the resulting product or service is sold in significant numbers, which may be several years after the initial investment in research and development is made. If industry is to assume the long-term risks associated with investment in technological innovation, it must be able to anticipate with some confidence the market and other business conditions that will prevail over this period of time. Building a competent R&D team is a long and expensive process. Accordingly, no factor is more important in encouraging industry to invest in technological innovation than a stable economic environment.

Dr. E.P. Neufeld, Senior Vice-President and Chief Economist, Royal Bank of Canada, told the Committee:

> ...that government, first of all, must put tremendous emphasis on getting the environment right — not so much getting details right, but the environment. There must be an environment of price stability and, therefore, a decent level of rates of interest, and an environment in which business can dare to plan ahead, and one in which there is incentive for investment with a hope that there will be a decent return. (1-32-12:22 and 23)

He said, "While estimates are difficult, I judge that about half of our productivity growth potential might well be achieved simply by creating and maintaining a stable macroeconomic environment". (1-32-12:7)

Incentives for R&D

A stable economic environment is essential but not enough. Investment in technological innovation must be as attractive as other investment opportunities. Tax incentives or other support such as government contracts, grants or contributions are required to compensate for the higher risks and longer payback periods that are characteristic of investments in technological innovation, if investment in innovative research and technology is to compete successfully with other opportunities for investment funds. The Report of the Business Council on National Issues and the Canadian Manfuacturers' Association Joint Committee on Industrial R&D in Canada commented on this issue as follows:

> An expenditure on R&D is an investment, comparable to any other business investment made with the expectation of improving existing products or of developing new products and processes which will

increase future profits. The amount to be invested in R&D is determined by comparison with other investment opportunities available to the firm. The attractiveness of R&D is influenced by its characteristics as an investment in comparison to these other opportunities.

While government policies which improve the economic climate in Canada will of themselves promote R&D, special tax incentives are also needed to decrease the cost of R&D so that its inherent risk is lowered and the prospect of profitable return is improved.

Financing

The cost of undertaking a technological innovation combined with the long payback period frequently makes it necessary for a firm to seek outside financing. In addition, funds are often required to finance the cost of adopting and applying technological innovation. It is essential therefore that debt and equity financing at reasonable cost be readily available. This may not happen if regulations prohibit the investment of pension, insurance and similar funds in technological innovation. Moreover, the financing of government deficits or consumer debt absorbs funds that might otherwise have been used to finance the development and application of advances in technology.

Dr. Neufeld told the Committee that "fiscal deficits in the years ahead must be reduced substantially so as to leave adequate room for private sector financing, including that needed to put in place new technology". (1-32-2:8) In its submission to the Royal Commission on the Economic Union and Development Prospects for Canada, the CMA wrote as follows:

> The availability of debt and equity financing has been curtailed by the growing competition from consumer and government borrowing. The pool of savings in Canada has been increasingly used to finance consumer debt (in part encouraged by government policies), and to support growing government deficits. In addition, tax policies and pension regulations have limited the access of private and public funds to high-risk, high-profit investment opportunities. Thus, funds available to industry have become more costly, and many high-risk, high-profit investment opportunities have been starved for financing.

Whether one agrees or not that fiscal deficits have already resulted in "crowding out" in the area of debt and financial inequities, the Committee is concerned that future sources of financing may not adequately meet the needs of technological investment opportunities in Canada, in particular those involving exceptionally high risks and long payback periods.

Conflicting Objectives

Conficting government objectives were identified by several witnesses as a deterrent to investment in technology. Speaking on this point, Dr. Neufeld said:

Yet further impediments for improving productivity are the conflicting objectives that have been imposed on Canadian industrial policy. I mentioned earlier that industrial policy must seek to enhance the efficiency of the Canadian economy in production and distribution, and in the creation of new products and services. In reality, individual federal and provincial industrial policy initiatives have sought other objectives as well. Some of these conflict with each other and many conflict with the economic efficiency objective. These other objectives include: reduced foreign ownership; increased provincial ownership; regional development; development of Canadian culture; export promotion; import minimization; assistance to small business, to agriculture and to particular industries and companies; protection of employment in labour intensive industries and in particular regions; increased short-term employment.

In the abstract, and taken by themselves, most of these objectives are laudable; but when they conflict with the objective of increased national efficiency and competitiveness they have a very real cost attached to them, namely, lower standards of living for average Canadians in future years. (1-32-12:8)

Dr. Michael Walker, Director, Fraser Institute, expressed essentially the same view when he told the Committee that "...as long as we consciously use economic policy to achieve political and regional objectives which involve frustrating the natural market process we are engendering economic instability". (1-32-9:7)

In the Committee's view, **policies and programs that try to meet too many different objectives run a serious risk of failing to meet any of them effectively, wasting valuable resources in the process.**

Market Access

In order to earn a return on investment in technology, the product or service produced with that technology must be sold. It is of major importance, therefore, that firms have access to markets that are large enough to enable them to amortize their fixed costs of developing or adopting new technology and earn a reasonable return on their investment. The smaller the market, the riskier the investment becomes; or put differently, the chances of making a significant profit if the investment succeeds are much smaller if the market is limited. This means that Canadian entrepreneurs are at a disadvantage compared to competitors in other industrialized states. Only Canada and Australia, among industrialized states, lack unrestricted access directly or through free trade arrangements to a market of at least 100 million people.

Mr. Walker told the Committee that:

The marketplace in Canada, by and large, is simply not big enough to warrant even the investment in sales team or in a manufacturing facility of the kind that would be necessary. From the point of view of government activity, the most significant point is that we should be

fostering trade relations with, for example, our neighbour to the south. We should be approaching the development of something like a continental free trade policy, I suppose, with regard to these and other matters, in order to make that market large enough so that Canadian manufacturers can make the kind of investment in the sales infrastructure that is necessary in this particular field. (1-32-9:19)

Apart from limitations on access by Canadian exporters to foreign markets as a result of tariff and non-tariff barriers, the actions of provincial and local governments further restrict the domestic market that is available to Canadian companies. With regard to provincial procurement practices, Mr. Ness told the Committee that "...many of the larger companies have gone to great lengths to spread manufacturing facilities across the country, possibly for the wrong reasons in many instances. They need to deal with provincial preference buying and that is not helping Canadian industry one little bit to be competitive on a world wide basis". (2-32-3:19 and 20) An example mentioned to the Committee was in the field of wire and cable production.

The Committee believes that **the expansion of foreign and domestic markets to which Canadian firms have unrestricted access will, in the long run, be one of the most effective ways to stimulate research, development and technological innovation in Canadian industry. This means that the Committee would encourage active participation by the federal government in future GATT negotiations and in bilateral discussions with the United States which could lead to a reduction in tariff and non-tariff barriers to trade.**

Industrial Relations

The industrial relations environment is of major importance to the introduction and application of new technology. Management and labour must cooperate if the productivity improvements and other benefits of technological innovation are to be achieved. The reorganization, retraining and other adjustments required to take advantage of technological advances will be difficult to undertake in an atmosphere of confrontation. The attainment of long-term objectives such as efficiency, growth and job security may be thwarted if short-term objectives such as maximizing profits and dividends or retaining existing jobs are given priority.

In its submission to the Royal Commission on the Economic Union and Development Prospects for Canada on September 6, 1983, the CMA observed that, "Labour-management relations in Canada over the past 20 years have been poor in comparison with our major competitors". It went on to note that whereas Canada placed "...an impressive third in human resources among 22 countries whose international competitiveness was assessed by the European Management Forum (EMF) in 1982—in quality of industrial relations, we ranked 21st".

The Committee regrets that it was not able to obtain the views of the Canadian Labour Congress on this important issue. However, it agrees with Dr. Neufeld that, "A quantum improvement in Canada's industrial relations is a prerequisite for better productivity performance", (1-32-12:8) and it hopes

that the new Canadian Labour Market and Productivity Centre will help to achieve this objective.

Highly Qualified Labour Force

Technological innovation is a knowledge-based activity. It depends on people who are well educated and trained in science and technology. However, people who are skilled in management, finance and marketing are also required to transform an idea into a marketable product, process or service. It is essential, therefore, that industry has available to it a pool of people highly qualified in management, finance and marketing as well as in science and technology in order to succeed in technological innovation.

Although the quality of human resources in Canada ranks high in comparison with other countries, the Committee is concerned that this might change if the current financial problems facing Canadian universities and colleges are not satisfactorily resolved. Furthermore, the Committee noted that it is frequently difficult to find qualified Canadians to fill specialist jobs, and it questioned, therefore, whether Canadian educational institutions were training people for the right jobs.

The Committee also noted that industry must share in the responsibility of training people to meet their specialized requirements. In the past, employers relied largely on immigration to make up for scarcities of qualified manpower. With high unemployment, immigration is no longer a feasible solution and **employers will have to meet some of their specialized manpower requirements through increaseed on-the-job training.**

Access to Technology

No country, let alone an individual firm, can possibly develop all of the technology it needs. Firms must be able to acquire the technology they require from domestic and foreign sources. **A good network is required to collect information on science and technology developments in other countries and disseminate it in Canada. But since it is beyond the means of all but the largest companies to do this, the federal government should review the role of the science counsellors in Canadian missions abroad to ensure that they become part of an effective information gathering and dissemination network.** There should also be a good technological infrastructure comprised of industrial firms, university and government laboratories on which firms can draw for the scientific and technical information and for the machinery, equipment and material they require to develop and apply tehcnology. In addition, good transportation and communication services are essential.

In the Committee's view, Canada has a relatively good infrastructure to support technological innovation. However, it has not systematically monitored technological developments in other parts of the world and applied them to meet its needs as well as some other industrialized countries have done.

Protection of Technology

In addition to an adequate market, the protection afforded the results of a technological innovation and the technology on which it is based will frequently determine whether an investment is justified. A firm will usually have a difficult time recovering the fixed costs of developing a new product, process or service if it is faced with direct competition from imitators which have not had to incur these costs. It is important therefore that there be a sound system for patenting inventions, and for registering industrial designs, copyrights and trademarks. On this point, Dr. Walker said, "...I believe that property rights ought to be more securely protected in terms of intellectual property, or anything else, rather than the opposite". (1-32-9:20)

The Committee noted that Canadian patent laws do not currently provide protection for new varieties of seeds. It was interesting to learn from Dr. Lewis A. Slotin, Director, Policy, Planning and Program Development, Medical Research Council of Canada, that the Federal Task Force on Biotechnology recommended the immediate adoption of Plant Breeders Rights. The Committee believes that Canadian patent law should strive to strike a balance that will encourage invention on the one hand and technological innovation and diffusion on the other.

Technical Regulations and Standards

Technical regulations and standards can have a significant impact on technological innovation. Technical regulations, codes and standards that specify products or processes in terms of design characteristics can stifle the development of new products or processes. In this regard, the Economic Council made the following recommendation, in its recent report entitled *The Bottom Line*:

> We recommend that the practice of setting performance standards rather than material specifications be more widespread. Federal departments, whenever possible, should define the ends and leave the technical means by which performance standards are met up to the firm(s) involved in the project. The extent to which this is possible will be constrained by need for co-ordination when more than one is involved in a project.

The Committee agrees with this recommendation, noting that Canada has legislated technical standards and specifications more extensively than most other countries. **Wherever possible, the Committee believes that technical regulations and standards should be specified in terms of performance rather than design requirements.**

Conclusions

The Committee concludes that **industry is unlikely to make major investments in technological innovation, no matter how much direct support government makes available for this purpose, unless the overall economic and social**

climate is generally encouraging to investment. The Committee generally agrees with Dr. Neufeld who told it that:

> The first lesson to be learned from the past is that policies directed specifically towards productivity improvement are unlikely to show good results if the general economic environment is one of substantial instability...
>
> Viewed in this way it is apparent that a policy of maintaining a stable macroeconomic environment should be regarded as essential for achieving the industrial policy objectives of greater efficiency and product innovation. (1-32-12:7)

Technology Policy

The Committee recognizes that there is a need for government financial support to encourage industry to invest in the development and application of technology, although witnesses were divided both on the need for such measures and on their effectiveness. At one extreme, Dr. Walker told the Committee that, "It may come as no surprise to any of you to learn that I am deathly opposed to subsidies of any kind. But I am particularly opposed to subsidies and special tax treatment for high technology industries. The main reason is because of their perverse distributional nature", (1-32-9:8) which he went on to explain "involves a redistribution from low-income taxpayers to high-income taxpayers". (1-32-9:9) He also questioned the effectiveness of present subsidies and the way they are administered. "I am convinced", he told the Committee, "that much of the research and development subsidy provided by the Government of Canada is absorbed and, hence, wasted, by imperfections generated by government and non-government institutions elsewhere in our economy". (1-32-9:6) He favoured policies that promote and facilitate the normal process of the marketplace and adaption to its changing requirements.

Dr. Stuart L. Smith, Chairman of the Science Council, represented the other extreme. He said, "When you look at the low R&D, most of the low performance is in our industrial sector. That is, in my view, because of the fact that our industrial sector is not oriented to the marketplace in the way I outlined earlier. A pull is not occurring from the international marketplace to our industrial sector to keep up with competitors and to anticipate the market changes". (1-32-3:12) He noted that, with the exception of the United States, most other industrialized countries have some form of planning mechanism, and it was his view that Canada should have one also. He said:

> We have to plan. That word, of course, drives people up the wall. Economists flinch when the word 'planning' is mentioned, because there is a belief among a certain school of economists that there is a cosmic force known as the market, and that any attempt to second-guess the market - which works in mysterious ways - can only cause wrath on the part of those in charge of the cosmic force and that, in any event, a bunch of bureaucrats can never make the right decision. (1-32—3:14)

Many witnesses were skeptical of the effectiveness of an industrial strategy which selects industry sectors, and possibly firms within those industry sectors, that are most likely to prosper in the future and gives them special treatment. On this point, the Honourable Ed Lumley, Minister of Industry, Trade and Commerce and Minister of Regional Economic Expansion said, "...regarding industrial planning, I have never been one to believe that any minister, or any collection of political people and bureaucrats, can set up a so-called 'industrial strategy'. I have always thought it should be market led, because the expertise is in the markets". (1-32-7:22) Dr. Neufeld reflected the same view when he told the Committee that "...picking 'winners' often involves picking individual companies within industrial sectors that are most likely to adapt, survive, and prosper. This is a near impossible task in most cases". (1-32-12:9)

Professor Chambers maintained that "It is not difficult to see the losers". (1-32-1:26) However, Mr. Lumley pointed out that there are a number of Canadian firms in the so-called soft sectors, such as textiles, clothing and shoes, which are very competitive in export markets. Mr. Tyaack noted, in this regard, that "...technology tends to spread itself across sectors. It rarely has an industrial label. It is extremely difficult to predict the impact technology might make on an industry when all of the data one has respecting that industry pertains to industry as it is now". (1-32-16:6)

Dr. Neufeld told the Committee that both industrial policy and technology policy had the same two objectives. He said:

> Industrial policy, as I see it, must seek to enhance the efficiency of the Canadian economy in production and distribution, and it must help in the development of new products and services that future buyers, at home and abroad, will want to buy. If it is successful in this, it will help protect and enhance the economic well-being of the Canadian population.
>
> Technology policy must have precisely the same double objective. If properly applied, it has great potential for improving Canadian industrial efficiency and competitiveness, and for helping to create new products and services. (1-32-12:6)

In order to be meaningful and effective, technology policy must be formulated in consultation and co-operation with all concerned, including provincial governments and universities as well as industry. Mr. Johnston told the Committee that, "A comprehensive technology policy must look beyond the immediate sphere of the federal government and take into account the contribution each sector of the economy makes to technology development". (1-32-11:6) Dr. Neufeld said, "...in the area of industrial policy and technology policy the costs of inadequate co-ordination and co-operation are much greater than in the lack of such co-operation and co-ordination in macroeconomic policy". (1-32-12:13)

Dr. Neufeld thought that more emphasis should be put on what he called "target-neutral" industrial policy rather than "target-specific" industrial policy. He explained that "'Target-neutral' industrial policy aims at establish-

ing the general conditions and broad parameters conducive to industrial development and enhancement of productivity, such as general levels of capital formation, research and development, technical and scientific education", whereas "'Target-specific' policy is designed to ameliorate conditions in specific sectors, industries, companies, communities, regions and various population subgroups". (1-32-12:9) He noted, in this regard, that:

> ...the 'target-specific' measures are the ones replete with conflicting objectives, and so most likely to be in conflict with the objective of enhanced efficiency, productivity and innovation.
>
> In addition, in the few cases where the impact of 'target-specific' measures have been analyzed, the results, while tentative, were not encouraging in terms of enhancing economic efficiency.
>
> It also seems that the nature of the policy-making process is such that 'losers' are more likely to be helped by 'target-specific' measures than 'winners'. It is the 'losers' that make the strongest representations for specific action and the 'winners' are not even at the discussion table. (1-32-12:9 and 10)

The Committee believes that technology policy should be co-ordinated with all sectors concerned - federal and provincial governments, industry, universities and other non-profit organizations. Its objectives should be to support the development and application of technology in firms of all sizes and in all sectors of industry with a view to improving Canadian industry's productivity and competitiveness and to developing new and improved products, processes and services that can be exploited commercially in domestic and export markets.

Rationale for Government Support of Technology

Our hearings indicated that government supports research, development and innovation for two main reasons. The first is to serve its own requirements. These may range from requirements of government regulatory functions, such as the administration of the Food and Drugs Act, to requirements arising from the provision of government services, such as national defence.

The second reason government supports research, development and technological innovation is to promote industrial development. Without some support, individual firms will only invest in research and development projects that offer potential benefits to the country as a whole on those rare occasions when firms can expect to secure a sufficiently large portion of those benefits to make the investment more attractive than other competing investment opportunities.

There are several reasons why an individual firm may not be able to secure sufficient benefits from an investment in research, development or technological innovation to make it worthwhile. For example, a firm may not have the financial or other resources required to exploit fully the results of an innovation, or it may not have markets that are large enough to earn a reasonable return from doing so. It may not be able to patent the results of a research and

development project or a technological innovation or otherwise prevent its competitors from using those results without compensation. However, even if an individual firm can expect to capture sufficient benefits to earn a return on investment in a technological innovation, it still may not make that investment if the return is not substantially better than the return it can earn from other investments such as investments in a new plant or equipment, where the risks are typically much less and the payback periods much shorter.

The Committee concluded that government should support research, development and technological innovation in order to promote economic development. However, government support should be confined to projects which offer potential benefits to the country that exceed their costs and which the government is convinced would not be undertaken by industry without such support. Other policies should not be allowed to conflict with these objectives. Research, development and other activities undertaken in pursuit of these objectives should, whenever possible, be conducted by industry where they are subject to the discipline of the marketplace.

Government Measures to Support Investment in Technology

The Committee examined the range of specific measures employed by the government to encourage industrial innovation. These included:

1. Offering income tax incentives for R&D which compensate companies with taxable income for the higher risks and longer payback periods normally associated with R&D projects and makes them more attractive in comparison with other competing investments;

2. Providing grants and contributions to assist industrial firms in undertaking selected R&D projects, including new and growing firms that have no taxable income and that may not therefore be able to take advantage of income tax incentives;

3. Making available grants and contributions to assist universities, industry associations and other non-profit organizations in establishing centres that provide research and development, and other technical services to industry;

4. Conducting R&D in government establishments and making the results available to industry;

5. Contracting-out to industry to meet government requirements for R&D and technological innovation;

6. Providing scientific and technical information to industry.

Income Tax Incentives

The income tax incentives for research and development were seen by many witnesses, both governmental and non-governmental, as a primary instrument of support for technological innovation. Several witnesses preferred them to grants and contributions because they cost less to administer and are

not discretionary, applying to all firms in every industry sector, which are free to make their own decisions.

Mr. Johnston informed the Committee that even before the recent amendments to the Income Tax Act to enhance the R&D investment environment, "Canada's tax incentives have been among the world's richest". (1-32-11:6) While acknowledging that Canadian tax incentives for R&D are more generous than those in most other countries, the representatives of the CMA told the Committee that:

> Our research indicates that present support for industrial technology development in Canada is not competitive with that available in other countries. Combined tax and non-tax support covers only 19 per cent of industrial R&D expenses in Canada, compared to 38 per cent in the United States and on a scale between 25 and 34 per cent in Germany, France and the United Kingdom. (2-32-3:9)

For this reason they said, "CMA continues to press the government to increase its support for industrial R&D. In particular, we believe that the R&D tax credit should be increased from 20 to 40 per cent to compensate partially for the relatively low levels of support offered by the Canadian government." (2-32-3:10)

The Committee notes that in all of the other countries cited by the CMA, the proportion of gross expenditures on R&D spent on defence is much higher than in Canada, and probably accounts for a substantial percentage of industrial R&D supported by government through contracts and other non-tax measures in these countries. This being the case and **bearing in mind the relatively generous tax incentives now available, the Committee is hesitant to recommend a further increase in the level of tax incentives for R&D.** It notes, in this regard, that the Minister of Finance, in his April, 1983 paper on *Research and Development Tax Policies*, pointed out that excessively generous tax incentives for R&D could actually be counterproductive. He wrote as follows:

> Incentives should not be used, or set at a level, to promote R&D activities that do not conform to sound business practice. Investments in R&D use scarce Canadian resources - manpower, capital equipment and financial resources. If incentives to R&D were made too generous, Canadians could be led to over-investing in R&D and as a result under-investing in other more productive activities. Improved use of technologies can occur, for example, by firms buying state of the art equipment just as much as by investing in R&D. At some level of tax incentive, R&D activities that were unprofitable, in a business sense, would become attractive to investors solely because of the tax treatment. The result would be waste of valuable resources. While incentives should be used to promote R&D, the basic profitability of R&D, as determined by the marketplace, should be the prime determinant of what and how much industrial R&D is done.

Despite its dissatisfaction with the current level of R&D tax incentives, the CMA strongly supported the recent amendment to the Income Tax Act

that permits firms to transfer to outside investors all or part of the tax credits they earn on their R&D investments. Mr. Ness told the Committee that this amendment is a "...big step forward". (2-32-3:32) In a letter dated June 30, 1983 to the Minister of Finance, the CMA commented on the proposal to introduce this amendment:

> This will allow firms to obtain new and imaginative financing which is likely to be of particular benefit to start-up firms unable to otherwise secure support through traditional means. Also, those firms unable to immediately use their R&D tax incentives could now elect to transfer these credits to investors and thereby obtain support for current R&D activity.

The Committee agrees with the CMA and **commends the government for introducing** this innovative measure, know as **the Scientific Research Tax Credit.** It notes that the Minister of Finance reported recently that more than $1 billion of R&D has been funded in the first three months since this amendment came into force, a development which could significantly increase the total expenditure on R&D in Canada this year. This unanticipated and overwhelming response suggests that the program is being used in ways which were not intended. Accordingly, the Committee recommends that **this special research tax credit should be reviewed within two years of its coming into force to ascertain whether both small and start-up firms have benefitted from the scheme and to ensure that more R&D is performed as a result of the credit.**

The CMA also stressed the importance of providing long-term consistent support for R&D, in order to create an environment that is conducive to investment by industry. Mr. Ness said, "As an industrialist and a representative of an industrial association, we believe that stability in long terms and not the changing of the goalpost up and down the field, will contribute substantially to an enriched R&D activity in Canada". (2-32-3:10)

The Committee agrees that, given the long-term nature of investment in research, development and technological innovation, government measures to support these investments must also be long term and not frequently modified.

Mr. Walker suggested that the definition of R&D in the Income Tax Regulations be broadened to include other essential elements of the innovative process such as market research. While inviting the Committee's views of this matter, Mr. Johnston pointed out that the present definition is designed to focus on the elements of greatest risk and uncertainty, where the incentive is most needed. The Committee noted that in his paper on *Research and Development Tax Policies*, the Minister of Finance commented on this matter as follows:

> ...sometimes it is argued that the definition of scientific research should be expanded to include costs of marketing and commercialization. However, such activities, in common understanding, are not scientific research. They often occur as part of normal business operations and not as the outcome of an R&D project.

It should be noted, however, that the representatives of the CMA and some other witnesses were not so much concerned about the definition of R&D as they were about the way it is being interpreted by Revenue Canada, particularly in the area of computer software.

The Committee recognizes that one of the basic reasons for government support of research and development is that it involves technical risks of a magnitude not normally encountered in other industrial activities such as production and marketing, and it would be inconsistent, therefore, to provide the same support for these other activities. However, with a view to ensuring that industrial research and development is market oriented, **the Committee suggests that consideration be given to modifying the present definition of scientific research for the purpose of the Income Tax Act to include market research undertaken in advance of a research and development project in order to define the specific requirements for new or improved products, processes or services.** Furthermore, the Committee suggests that the government review its programs for the support of marketing new products and services resulting from technological innovations.

Grants and Contributions

In addition to tax incentives, most witnesses recognized the need for R&D grants and contributions to assist firms that do not have taxable income and so cannot take advantage of R&D tax incentives. Grants and contributions were also seen as necessary to support R&D in areas of particular importance which would not be undertaken without direct financial assistance from government, and in areas such as defence in which industry in other countries that compete with Canadian industry receive government support for R&D. The CMA and other witnesses emphasized, however, that grant and contribution programs should respond to the needs of industry. To this end, responsibility for proposing projects should rest with industry because of its familiarity with the marketplace rather than with government. The role of government should be limited to choosing among requests for support.

The Committee agrees that **grant and contribution programs to support research, development and innovation should be responsive to the needs of industry and the marketplace.** It suggests that the funds required to finance these programs in future should be reassessed when the impact of recent amendments to the Income Tax Act, in particular the Scientific Research Tax Credit, can be determined.

Technology Centres

Sponsorship of technology centres that provide R&D and other technical services to industry is another important way in which governments assist technological innovation and its diffusion in Canadian industry. Mr. Tyaack thought that centres in which universities and industry co-operate were most effective in this regard. He favoured government support of such centres over government contributions to industry. Mr. Chow, Manager, Government Contracting, Pratt and Whitney Canada Inc., speaking for the CMA, said, "These

government-sponsored centres often act as showcases to help Canadian industry learn about new technologies and their application in the workplace and they provide information which is often not available elsewhere". (2-32-3:8) However, Mr. Chow went on to say that the CMA was "shocked" (2-32-3:8) by the recent proliferation of these government sponsored centres. He told the Committee that "Hundreds of skilled researchers have been taken out of productive employment to work in these centres, creating selected manpower shortages at a time when the country is experiencing record high unemployment". (2-32-3:8) He continued:

> The CMA believes that these centres and institutes should continue to provide services to industry, but they should all strive to become self-supporting within an agreed timeframe. Market and private sector links are essential if these centres are to contribute to and not put a drain on Canada's future economic and employment growth. Freed from the burden of excessive dependency on government, we expect that there will be improved co-ordination of activities and the centres will become more responsive to the real, not perceived, needs of industry. (2-32-3:8)

In the face of this evidence **the Committee is concerned about the the proliferation of technology centres in Canada** supported by federal or provincial governments that may not be meeting identified needs. **It recommends that the federal government, as a matter of urgency, examine its policies with respect to the support of technology centres, taking into account provincial government initiatives in this area, with a view to ensuring that the centre it supports clearly meets existing or potential needs of industry.**

Conduct of R&D in Government Establishments

Government expenditures on R&D conducted in its own establishments account for 27 percent of gross expenditures on R&D in Canada. Some of these expenditures are for basic research and the maintenance of a core of expertise in technologies of strategic importance to Canada's development such as fifth generation computers, robotics, fibre optics, biotechnology and cold water technology, so that government and industry will be aware of developments in these technologies and their potential implications for Canada. Other expenditures are for research and development to meet the government's own requirements arising from the administration of regulations or the provision of services. Still other expenditures are for research and development to meet the needs of such industries as agriculture and fishing in which few, if any, individual enterprises are capable of conducting R&D for themselves and where it is appropriate, therefore, for the government to conduct it for them.

However, the government also conducts R&D in other areas such as communications and chemical engineering, which could be performed in industry where it would be more subject to the discipline of the marketplace. Even if the results of such R&D are subsequently made available to industry for further development and exploitation, there are the inevitable difficulties of transferring the technology. The problem with conducting industrial research and development in government or university laboratories was outlined to the Com-

mittee by Professor Chambers who pointed out that "...unless the priorities... are somehow influenced by some view of the major areas of new demand in the Canadian and world markets, then the output of that research stands a good chance of being quite irrelevant to the performance of the economy", and "...even if it is relevant, it raises the vexing question of the transfer of the new knowledge". (1-32-1:11) Mr. Chow noted that the "...framework for R&D put forth by the government suggests further large increases in the amount of research and development to be conducted by the federal government", which he said, "will escalate the competition for the highly-trained human resources needed by industry". "We believe," he told the Committee, "that these large increases should not be undertaken, except where necessary for the provision of appropriate government services. Specifically, the planned growth for the National Research Council in developing technology for industry should not continue", he said. (2-32-3:9)

The Committee recognizes that the government must conduct some R&D to meet its own requirements, to develop and maintain a core of knowledge in strategic technologies and to serve the needs of industries that are not in a position to conduct their own R&D. However, **the Committee is concerned that the federal government is engaging in R&D that could be carried out and exploited by industrial firms. It recommends, therefore, that the intramural research and development programs of all departments and agencies, including the National Research Council, be reviewed to exclude from them any activities that could more appropriately and profitably be conducted in industry.**

Contracting-Out R&D

Instead of meeting its requirements by conducting R&D in its own establishments, the government may contract with industry or universities to conduct the R&D on its behalf. Large off-shore procurements of materiel, such as aircraft and satellites, sometimes provide opportunities for the government to negotiate industrial offsets which involve research and development and the transfer of advanced technology to Canadian industry. Where the technology can be applied to the development of new products or processes that can be commercially exploited, this contracting-out of R&D by the government can be a powerful instrument for promoting technological innovation.

When the Senate Special Committee on Science Policy (Lamontagne Committee) recommended in 1972 more contracting-out to stimulate private R&D, it did not distinguish among types of projects. The Economic Council of Canada recently examined this issue and reported in *The Bottom Line* (1983) that contracting-out:

> has not increased in areas where there are potential benefits but that it has increased where there are few such benefits. No great gains have been made in the amount of federal mission-oriented R&D performed in the private sector. The situation remained the same in 1980 as in 1972.

Consequently, as part of the proposed review of federal intramural R&D programs, **the Committee recommends that the administration of the govern-**

ment's contracting-out policy be examined to ensure that greater emphasis is given to contracting-out where the potential benefits are greatest.

Scientific and Technical Information Services

Every firm uses technology, regardless of whether it engages in R&D or technological innovation itself, and can potentially benefit from advances in technology. All the evidence heard by the Committee led to the conclusion that no technical activity probably deserves the attention of government more than the diffusion of technology.

Dr. Slater informed the Committee of studies undertaken recently by the Economic Council which indicated that Canada has been slow compared to other countries in adopting and diffusing technological innovations, whether they have been made in Canada or abroad. The Council found that the median lag in the adoption by Canadian firms of a number of technological innovations made abroad was five years, and in several cases exceeded ten years.

Mr. Johnston informed the Committee of the initiatives the government has taken recently to establish centres of technology and to expand the NRC's Field Advisory Service and its Technical Information Service, which are expected to assist greatly the diffusion of technology to all companies in Canada.

Mr. Chow advised the Committee of the steps which industry is taking to improve its knowledge of advances being made in technology. He told the Committee that, "More and more firms have now begun to establish or expand mechanisms used to monitor technology developments underway around the world. An extension of this important corporate effort is the CMA's manufacturing advanced technology forum which will provide a new forum for sharing information about the latest developments in manufacturing technology". (2-32-3:7 and 8)

Mr. Chow also drew the Committee's attention to the important role that multinationals play in facilitating the transfer of technology into Canada from abroad. He said:

> Foreign multinationals also provide Canada with important access to technology developments elsewhere. Canada has an inherent advantage in this process because there are so many major foreign controlled firms operating in the country. The transfer of technology between a foreign parent and its Canadian subsidiary gives Canada a unique advantage in many respects. Public policies in Canada too seldom recognize and support the facilitative role that multinationals play in the transfer of technology. (2-32-3:8)

On the same subject, Professor Palda noted that, "Many Canadian subsidiaries benefit from what we might call invisible research and technology transfers from headquarters, from the United States or Switzerland or Germany and so on". (1-32-2:10) He referred to a study made by the Ministry of State for Science and Technology in 1978 which estimated that, in 1976, about $600 million worth of so-called invisible R&D was transferred from foreign headquarters to Canadian subsidiaries.

Canada must appreciate that recognizing a good idea and making sure that it is adopted as widely as possible is frequently more important than creating an idea itself. The Committee is in full agreement with the witnesses that **diffusion of technology is the most important element in any technology strategy. The government should increase its efforts, in co-operation with universities and the private sector, to strengthen mechanisms for collecting information on foreign technological developments and for disseminating it within Canada.** When importing technology, however, every effort should be made to avoid impediments to further developing the technology and to exploiting it in both domestic and export markets.

Importance of Market Access

Witnesses repeatedly drew attention to a special difficulty which Canadian industry faces accounting, in part, for the relatively low expenditure by industry on R&D — namely, the limited size of the Canadian market. Because the application of new technology is an economic decision undertaken in a reasonable expectation of making a return on the capital invested, the size of the market has a critical effect on the risk calculation. The smaller the market, the larger must be the potential profit per unit sold to justify the risk taken. This is a factor which the Committee believes has been insufficiently recognized by government and the concerned public.

In policy terms, the implication of this analysis is that **government efforts to promote R&D must begin with a concern to support reasonable efforts to enlarge the market for goods produced in Canada. Domestically this means resisting attempts by provincial governments to fragment the market with preference arrangements of one kind or another. Internationally it means pursuing efforts to reduce tariffs and non-tariff barriers** through agreements reached multilaterally, and bilaterally when appropriate, and resisting attempts in Canada and abroad to gain special protection.

World Product Mandates

Foreign ownership of industry in Canada has become a controversial policy issue. In response to a situation of extensive foreign ownership one objective of the government in the last decade has been to encourage the Canadianization of industry. However, several witnesses maintained that foreign ownership has some potential advantages which could be exploited. Some thought that the government should introduce measures to encourage foreign multinationals to assign to their Canadian subsidiaries world product mandates, giving them responsibility for the research, development and production of a specified product or line or products and for marketing it world wide. By rationalizing their operation and specializing in specific products, Canadian subsidiaries would be more efficient and competitive. With access to foreign markets through their foreign parent and affiliated companies, they would be able to achieve economies of scale and earn a sufficient return to justify their investments in R&D and technological innovation.

Mr. Tyaack described to the Committee the experience of Westinghouse Canada Inc. in persuading its parent to assign it world product mandates. In his brief to the Committee, he wrote, "We would categorically state today that if a subsidiary can play a role in the worldwide activities of the multinational firm it will be more productive, and provide a better return on investors' money than it would were it to remain a branch plant". (1-32-16A:2)

With regard to the government's role in encouraging foreign multinationals to assign world product mandates to their Canadian subsidiaries, Mr. Tyaack told the Committee that Westinghouse Canada Inc. had availed itself of government grants to make its proposals for world product mandates look better than they otherwise would have, and had persuaded its parent to accept its proposals over four other possibilities the parent was considering at the time. Dr. Smith went further and argued that "World product mandates can be encouraged by making them obligatory if companies wish to do business with the government, or if companies wish to obtain some other advantage of the Canadian system". (1-32-3:15)

The Committee concluded that multinational enterprises can make a major contribution to Canada's economic growth and that government policy should be designed to promote this objective. **The Committee supports government efforts to encourage foreign multinationals to assign world product mandates to their Canadian subsidiaires.** However, a major incentive would be the reduction of trade barriers through international negotiation. Providing that trade can move freely, it will be in the interest of multinational firms to promote specialization within each combined company through the use of world product mandates and other similar arrangements.

ANNEX

WITNESSES WHO APPEARED BEFORE THE COMMITTEE

Issue Number	Date	Witness
First Session, Thirty-second Parliament, 1980-81-82-83		
1	February 15, 1983	Professor Fergus Chambers, School of Public Administration, Queen's University
2	February 17, 1984	*From the School of Business Queen's University* Professor K. Palda; Professor B. Pazderka.
3	March 1, 1983	*From the Science Council of Canada* Dr. Stuart L. Smith, Chairman; Dr. James Gilmour, Director of Research.
6	March 17, 1983	*From the Economic Council of Canada* Dr. David Slater, Chairman; Dr. Patrick Robert, Director; Dr. Peter Cornell, Director; Dr. Neil Swan, Senior Project Director, CANDIDE.
7	March 24, 1983	*From Department of Industry, Trade and Commerce/Regional Economic Expansion* The Honourable Ed Lumley, P.C., M.P., Minister; Mr. Robert C. Montreuil, Deputy Minister; Mr. P.P. Proulx, Assistant Deputy Minister, Regional and Industrial Policy and Small Business.

Issue Number	Date	Witness
9	April 26, 1983	Dr. Michael Walker, Director, Fraser Institue, Vancouver.
11	May 11, 1983	*From the Ministry of State for Science and Technology* The Honourable D. Johnston, P.C., M.P., Minister Dr. David Low, Acting Secretary,
12	May 12, 1983	Dr. E.P. Neufeld, Senior Vice-President and Chief Economist, Royal Bank of Canada.
16	September 29, 1983	Mr. Franz Tyaack, President and Chief Executive Officer, Westinghouse Canada Inc.

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3	March 22, 1984	*From the Canadian Manufacturers' Association* Mr. Bernard Ness, President and Chief Executive Officer, Canada Wire and Cable Limited; Mr. Lewis H. Chow, Manager, Government Contracting, Pratt & Whitney Canada Inc.; Mr. Paul Kovacs, Chief Economist CMA.

Notes for presentation to the Committee

3	March 22, 1984	Notes for a Presentation to the Senate Sub-Committee on Estimates Under the Authority of the Standing Committee on National Finance by Dr. Lewis A. Slotin
Appendix "NF-3A"		