The handicaps of Canadian innovators

THE HANDICAPS TO CANADIAN INNOVATORS

A Study of the handicaps that are faced by firms operating in Canada attempting technological innovation

Prepared for the

Ministry of State

For Science and Technology

By

Peat, Marwick and Partners

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THE HANDICAPS TO CANADIAN INNOVATORS

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I - STUDY APPROACH AND THE INNOVATION PROCESS

In this section we discuss the terms of reference and our approach to the study of handicaps to Canadian innovators. Since it is a complex concept, we also make some definitional statements about the innovation process.

TERMS OF REFERENCE

As a basis for commissioning this study, the Ministry of State for Science and Technology (MOSST) stated as a preamble:

> "In recent years there has been growing concern over the apparent weakness in the innovative performance of Canadian manufacturing industry upon which its future competitiveness depends.....
>
> More particularly, in assessing the effectiveness of existing Federal government programs for the stimulation of technological innovation and in formulating new or revised policies in this regard, it is essential to identify the specific handicaps experienced by different segments of Canadian industry in successfully executing and exploiting technological innovations, and wherever possible to quantify these effects.
>
> While there have been many theoretical studies on the general subject of technological innovation, the intent should be to provide a pragmatic overview of the specific handicaps facing industrial innovators in Canada as compared with their competitors. In particular, attention should be directed toward the problems of undertaking original innovation in Canada as compared with the acquisition of foreign designs or technology."

The specific terms of reference for the handicaps to innovation study were as follows*:

" - identify the specific handicaps experienced by different segments of Canadian industry in executing and exploiting technological innovations, and wherever possible quantify these effects

- factors to be considered would include:

  access to technology; access to capital; access to markets; scale effects; industrial structure; availability of suppliers and services; availability of manpower; environmental factors such as taxes, tariffs, government policies

- provide a pragmatic overview of the specific handicaps facing industrial innovators in Canada as compared with their competitors, in particular with regard to problems of undertaking original innovation in Canada

- the following are specific issues to be addressed in the study:

  1. To provide a definitive statement of the handicaps faced by Canadian firms in undertaking technological innovation including, where possible, quantitative data on their impact.

  2. To examine the real or perceived impediments, as viewed by the firm, which affect their decision concerning whether to initiate a technological innovation.

  3. To determine whether the significance of the handicaps is affected by factors such as ownership, size, type of industry, type of innovation and geographical location within Canada.

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* In addition to the study of handicaps to Canadian innovators, Peat, Marwick and Partners was also commissioned by MOSST to undertake a companion study, entitled, "The Extrinsic Benefits of Technological Innovation in Canada". That study is the subject of a separate report.

4. To estimate the implications for the Canadian economy of failure to redress the handicaps that are found to exist.

5. To suggest means by which public policy could reduce the severity of handicaps in order to improve the incentive to innovate and the possibility of success.

6. To suggest further studies which might clarify some of the issues which are raised in a quantitative or qualitative sense."

STUDY APPROACH

These terms of reference suggested many categories of handicaps to innovation. They evoked several "cuts" at examining handicaps.

First, we examined the handicaps by type of innovator - inventor/R & D firm, small entrepreneur, medium to large Canadian-owned company and foreign-controlled company. This involved interviews with 51 different companies. The results were most logically presented by type of handicap - financial, managerial, technical/manufacturing, marketing and government - for each type of innovator. The findings and conclusions by type of innovator and the approach to that part of the study, are described in Appendix A.

Company officials, as well as government officials interviewed about their views on the handicaps to innovation, had general and specific suggestions on how to overcome handicaps to innovation. These views and our preliminary interpretative comments are summarized in Appendices B and C.

EXHIBIT I-1

STUDY APPROACH

"CUT" # 1

PERSPECTIVE OF THE INNOVATOR

	FINANCIAL	MANAGERIAL	TECHNICAL / MANUFACTURING	MARKETING	GOVERNMENT
INVENTOR/R & D LAB					
ENTREPRENEUR					
MEDIUM / LARGE CANADIAN CONTROLLED COMPANY					
FOREIGN-CONTROLLED COMPANY					

"CUT" # 2

PERSPECTIVE OF THE INDUSTRY

- ELECTRONICS
- PULP AND PAPER AND MINING MACHINERY
- LARGE AND SMALL APPLIANCES

"CUT" # 3

ANALYSIS BY HANDICAP FACTOR

- MANAGEMENT
- ACCESS TO CAPITAL, TECHNOLOGY, MARKETS
- FOREIGN OWNERSHIP
- GOVERNMENT POLICIES AND PROGRAMS AND REGIONAL STRUCTURE
- CONSERVATISM OF CANADIANS

→ IMPACT, IMPLICATIONS AND RECOMMENDATIONS

Second, we deliberately selected companies to interview in three specific industries - electronics, pulp and paper and mining machinery, and large and small appliances. We analyzed the handicaps to innovation as they pertained to these specific industries and drew conclusions as to the industry variable as a handicap to innovation. Appendix D provides these findings and analysis.

Third, we drew on the company and government interviews and reviewed existing literature to assess the handicaps to innovation by specific factors - management, access to capital, technology, markets, foreign ownership, government policies and programs, regional structure, conservatism of Canadians. The handicaps to Canadian innovators are basically analyzed through these factors and this analysis forms the main content of this report. The report documents conclusions about each of the factors, states how unique each handicap is to Canada and discusses possible future directions by government.

Finally, we assess the importance of the handicaps and the implications of inaction toward overcoming them. Then we recommend what the Federal Government should do, based on our analysis.

This study framework and the three "cuts" are diagrammed on Exhibit I-1.

CLARIFICATION OF THE INNOVATION PROCESS

The definition of innovation provided by MOSST is:

> "The successful introduction on a commercial scale of a new improved product, process, system or service."

The Ministry further defines relevant innovation as that taking place in Canada and not simply a first introduction of new technology into Canada which has already been successfully introduced from abroad.

To elaborate on this definition in terms of the study, we make several points about the innovation process,

1. Innovation is not scientific research or invention, although they can have an indirect relationship to the early stages of the innovation process. R & D is part of the innovation process, but does not include the commercialization aspects of the innovation process.

2. The innovation process can be perceived as a series of interrelated phases, commonly including invention, prototype testing, design engineering, tooling up for production, manufacturing, and marketing. Handicaps can occur at each of these phases.

3. Innovation should be distinguished from diffusion of technology. This is difficult in cases where a company makes marginal adjustments to existing technology to produce a slightly different product or process - is it marginal innovation or simply diffusion of technology? Access to existing technology is very important to the technological capability of a firm, and therefore diffusion of technology is in effect a precondition to innovation.

4. The study is about large and small companies, since each has its role in the innovation process. Many significant innovations are the result of efforts of small technologically based firms, but only medium to large firms can afford large scale innovation and continuous technological development. Small and large firms are also very interdependent in the innovation process, since each is important as a supplier or customer, and each often exploits the technology of the other.

5. The Canadian content of an innovation is becoming more difficult to define due to the increasing number of joint ventures and multi-organizational projects. The technological development and commercialization may be shared by several parties, both domestic and foreign.

6. Innovation very much depends on entrepreneurship, and industrial development depends on innovation and entrepreneurship. However, we realize there can be entrepreneurship and no innovation, and that industrial development includes more than technological innovation. This interrelationship is recognized but the study is primarily on innovation, and only secondarily on the other two subjects.

HANDICAPS FACTORS

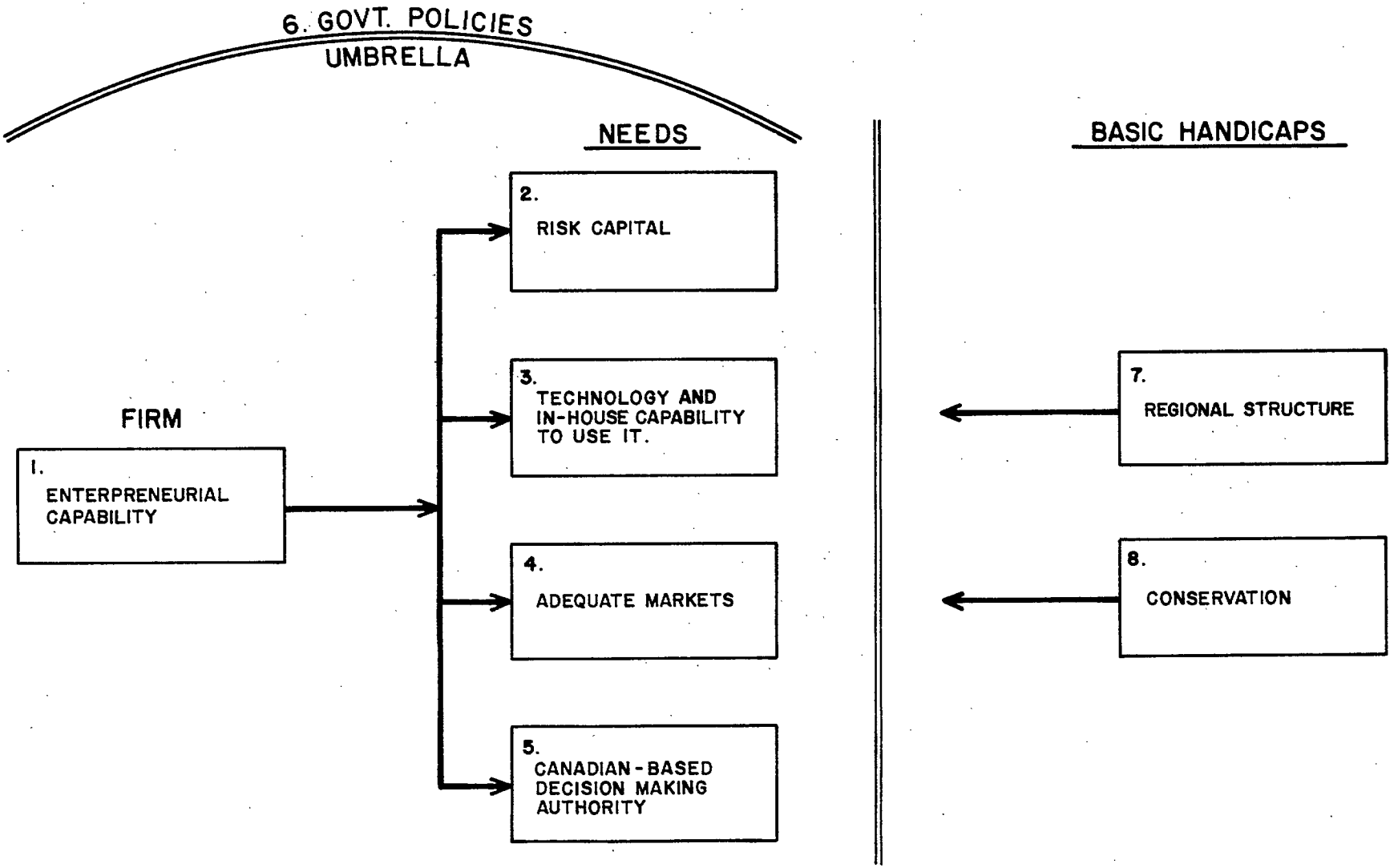
The major portion of this report is devoted to the analysis of handicap factors.

How we present the analysis is outlined graphically on Exhibit I-2. It represents the needs of the firm to be capable of innovating and the environmental factors affecting its chances of success.

First, if management capability of the firm is deficient, then that is a handicap. Therefore, we examine the unique Canadian handicaps in terms of lack of management skills.

EXHIBIT I-2

CATEGORIZING HANDICAPS TO INNOVATION



THERE ARE HANDICAPS UNIQUE TO CANADA IN EACH OF THESE AREAS

Second, the firm needs (a) risk capital, (b) technology and the in-house capability to use it, (c) adequate markets to recover the innovation investment, and (d) if foreign-controlled, sufficient innovation resources and responsibility in Canada. These factors we examined.

Third, government policies and programs impinge upon the firm; they influence the availability of risk capital, technology, markets, and domestic responsibility that are the innovation needs of the firm.

Fourth, there are handicaps to innovation in Canada that are basic to the economy. They are defined as the regional structure of the country, and the alleged conservatism of its people.

These areas, in each of which there are handicaps unique to Canada, are discussed in the following sections.

II - LACK OF MANAGEMENT CAPABILITY

An innovating firm requires the skills of the entrepreneur, whether individual or in a management team. Entrepreneurs are risk-takers who have the ability to draw together the financial, marketing, technological, and production factors to innovate successfully. In Canada, however, we have found that:

- Innovation by technically oriented firms in Canada is often handicapped by a lack of sufficient entrepreneurial management skills.

Firms in both Canada and the U.S. lack management capability. In Canada, however, we found that the manager in the typical technically-oriented firm had fewer entrepreneurial skills than his U.S. counterpart.

SMALL COMPANIES

After interviewing about 20 small companies we judged that although their technical abilities seemed quite adequate, their entrepreneurial capabilities were often limited.* This is also confirmed by Litvak and Maule's research into Canadian Technologically-oriented entrepreneurs.**

Many researchers have interviewed venture capitalists, who have found that Canadian inventors/innovators are less skilled in management knowhow than Americans. The typical demonstration of proof

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* See Appendix A.

** Litvak, Dr. I.A. and Dr. C.J. Maule, A Study of Successful Technical Entrepreneurs in Canada, University of Toronto, September, 1972.

EXHIBIT II-1

COMPONENTS OF A BUSINESS PLAN

1. Description of the business and its product or service.

2. Management organization, including functional responsibilities and resume of key personnel.

3. Market survey, assessment of total size of market, competition, and risks.

4. Development plan for product and service, including schedule and cost projections.

5. Manufacture plan, including schedule and cost projections.

6. Marketing and service plan, including schedule and cost projections, market penetration and pricing strategy.

7. Cash flow and earnings projections.

8. Financial requirements and proposed method of raising funds.

SOURCE: Grieve, Alan, "Venture Capital Sources and the Entrepreneur" The Business Quarterly, Spring 1972.

is that their business plans (see Exhibit II-1) are not usually as well prepared.* While documentation on this subject is not conclusive, it seems that there is a capability gap in small Canadian firms.

LARGE COMPANIES

The small number of Canadian-controlled firms which have grown through technological innovation compared to the country's relatively advanced new technology consumer state, is the most obvious testimony to lack of entrepreneurial skills at the management level. Our interviews found that some of these firms must seek management outside Canada, since they perceive a lack of real talent available in this country.

Other studies conclude that there are management deficiencies in medium to large Canadian-controlled firms. For example, Canadian-controlled companies are reported to be particularly weak in industrial marketing, a necessary skill in innovating in industrial products.**

Foreign-controlled firms seem to be generally better managed than Canadian-controlled firms.*** However, their management strength is in control systems, and the management of foreign-controlled firms seem to lack entrepreneurial skills, and are thereby not innovation-oriented, as documented by:

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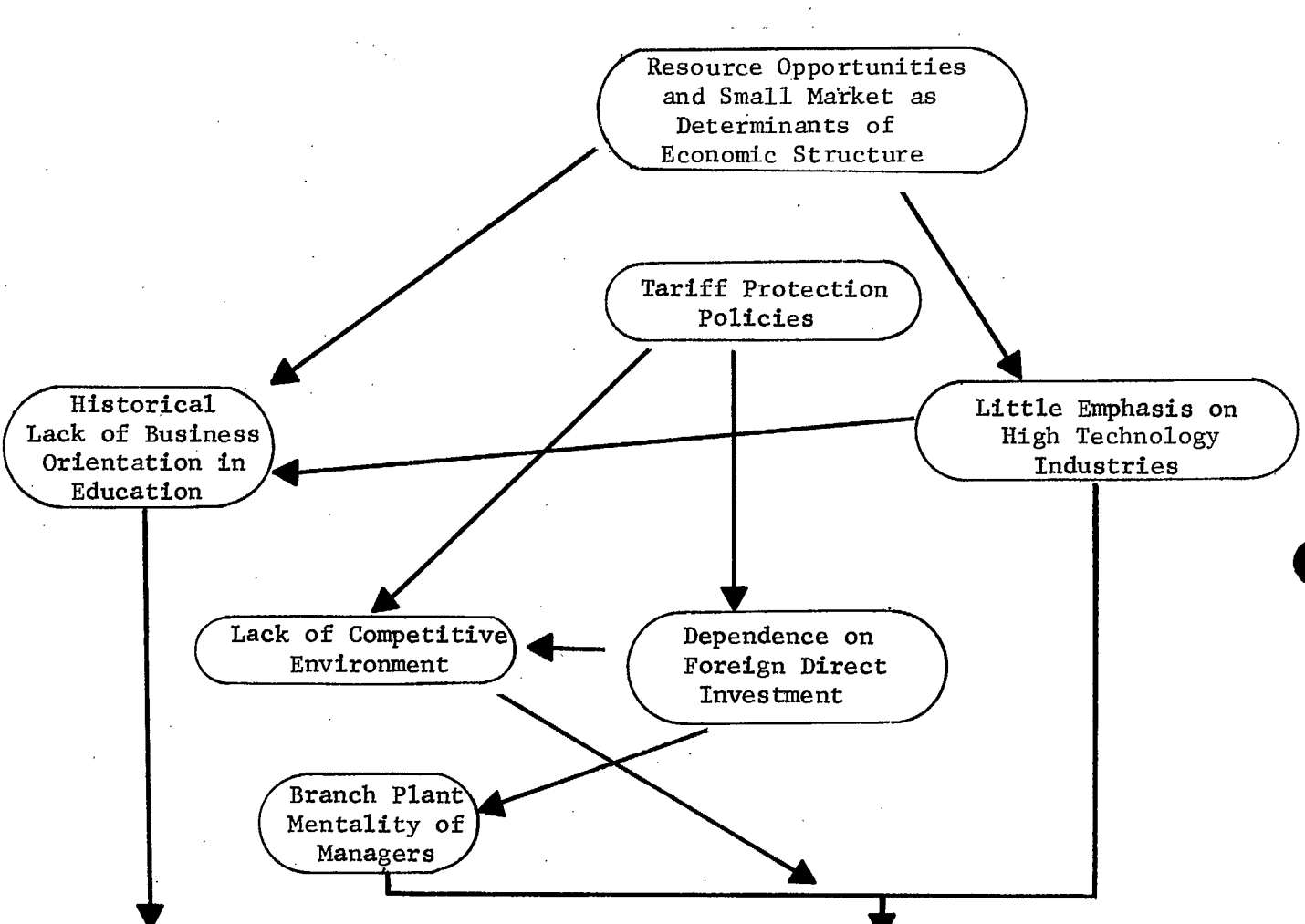
* Baillie, A.C. "Promoting Entrepreneurship in Canada", Business Quarterly, Summer 1972; McCloud, I.H., "Can Canadians be Successful Entrepreneurs"; Grieve, A. "Venture Capital Sources and the Canadian Entrepreneur", Business Quarterly, Spring 1972.

** Little, Blair et al "Putting the Market into Technology to get Technology into the Market", The Business Quarterly, Summer 1972.

*** See Hecht, M.R. & J.P. Siegel, "The Study of Manufacturing Firms in Canada", Office of Science and Technology, Dept. of Industry, Trade and Commerce, August 1973.

EXHIBIT II-2

FACTORS PRODUCING INNOVATION/MANAGEMENT GAP



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- the conclusion by Litvak and Maule that foreign-controlled companies are staffed by "foreman" type of management, since they lack sufficient decision-making authority in key areas*

- the finding by Bourgeault that the Canadian R & D Division often reports not to his management team in Canada but directly to the U.S. parent.**

From Peat, Marwick and Partners' earlier studies comparing foreign-owned with Canadian-controlled firms, and from our interviews of foreign-controlled firms in this study, it is our judgment that management is generally strong. In some industry sectors, many firms do innovate. Nevertheless, management is directed in many cases toward maximizing the advantages that accrue to a subsidiary in terms of product development, engineering, capital and marketing support from the parent. These are factors that do not generate entrepreneurial skills.

REASONS FOR LACK OF ENTREPRENEURIAL MANAGEMENT SKILLS

The reason for entrepreneurial management deficiencies is twofold: First, there is the lack of opportunity and environment to acquire entrepreneurial experience, and second, on the supply side of human resources - the educational system - has not been oriented to entrepreneurial management. We have attempted, in Exhibit II-2, to illustrate the relationship between the various factors producing this innovation/management gap.

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* Litvak, Dr. I.A. and Dr. C.J. Maule, "Branch Plant Entrepreneurship", The Business Quarterly, Spring 1972.

** Bourgeault, Pierre L. Innovation and the Structure of Canadian Industry, Study No. 23, Background Study for the Science Council of Canada, 1972.

Lack of Opportunity

There are Canadian entrepreneurs. Many of them, however, achieve success in real estate, retailing, resource development, or other non-technological innovation areas.

The resource development and cost-minimizing, rather than performance-maximizing* orientation of industry means little entrepreneurial opportunity in technologically-based product categories. Foreign direct investment in developing manufacturing in Canada has been a substitute for local entrepreneurial development. In addition, since the Canadian economy has historically been developed as a small, protected market, competition among manufacturing firms has not been as keen as in the United States, and thus there has been less stimulation for innovation.**

Another perspective is the historical means by which capital has been generated in the Canadian economy. Canadians imported venture capital from London and New York while developing a financial system to respond to the capital demands of the more mature corporation.*** Hence, there was a lack of need, and thus opportunity, for the development of entrepreneurial financial institutions like venture capital firms and market banks. This deficiency in the capital markets industry has compounded the underdevelopment of entrepreneurial management skills.

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* Following the classification of W.H.C. Simmonds, cost-minimizing refers to industries in which cost reduction is the key competitive factor, sales-maximizing where marketing is most important, and performance-maximizing where the quality of the product provides the competitive edge. See Simmonds, W.H.C. "Toward an Analytical Industry Classification", Technological Forecasting and Social Change, 1973.

** Documented among others by Robidoux, Jean and Gerard Garnier, Facteurs de Succes et Faiblesses ...., Faculté d'Administration, Sherbrooke, 1973.

*** "Some Implications of the Modern Business Entreprise for Government Policies", Prepared in the Office of the Special Advisor to the D.M. of IT&C, August, 1972.

Orientation
of Education

In terms of the educational system, there are a number of historical orientations that have not been conducive to the preparation of entrepreneurs. They include:

- lack of a business orientation in formalized courses, in spite of the recent emergence of MBA programs in Canada; course material has only recently been directed toward Canadian business problems and innovation activities
- there has been little incentive for business faculty to market their skills to existing management in small- or medium-sized Canadian companies
- the work study and business assistance programs which provide practical experience to students, have not been developed to the same extent that has been the case in the United States.

Essentially, the climate has not been very favourable for the development of skilled entrepreneurial management.

AREAS OF
GOVERNMENT INITIATIVE

There are two ways of focussing on improving the skills of the Canadian manager. One is to provide him with the needed financial, marketing, technical, and general management expertise. The other is to work directly on his own entrepreneurial capability.

Although they can be helpful in many situations, government efforts to provide outside assistance through CASE, the Technical Information Services, subsidization of private consultants, and similar

provincial assistance programs do not instill entrepreneurial skills. For example, businessmen should be able to prepare business plans themselves, not have outside experts do everything for them.

Government can help by:

- assisting university and community colleges to upgrade curriculum content to include an entrepreneurial focus for large and small business management
- provide incentives to educational establishments to market courses to businessmen and technically-oriented companies
- make a special effort to appeal to potential immigrants who have the entrepreneurial skills to innovate in technological areas.

In summary, Step 1 in improving the climate for technological innovation in Canada is to upgrade the entrepreneurial capability of small and large firm management.

III - SHORTAGE OF RISK FINANCING

Following an examination of the financial needs and availability of risk financing, we have concluded that:

- There is very little risk capital available from institutional sources for small-scale start-ups, and almost none for larger scale start-up situations.
- A major handicap is the communications gap between the start-up company and the potential source of funds; fund sources claim there are few opportunities, while potential innovators claim there are few fund sources.
- Small- and medium-sized firms that are already going concerns face equity and debt capital shortages, particularly for technological innovation projects.

Lack of risk financing is not unique to Canada. However, there are relatively fewer sources for financing start ups and innovations by going concerns in Canada than in the U.S.

RISK CAPITAL GAP: START UPS

The greater availability of risk capital for start up operations in the U.S. is due to the following:

- more absolute wealth in private hands in the U.S. (the richest one million Americans have an average net worth of $600,000),* and greater flexibility in U.S. tax rules to allow losses to be deducted

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* Smith, James D. and Steven D. Franklin, "The Concentration of Personal Wealth 1922-1969", American Economic Association, May, 1974. Unfortunately, there is no Canadian equivalent study to compare private wealth between Canada and the U.S.

- greater range of financial institutions with risk capital; the unit banking system in the U.S.; a large number of venture capital firms, particularly in specific regional locations in the U.S.; more active securities markets.

- greater possibility of high paybacks to the investor due to a larger domestic market in the U.S., and greater motivation to invest following large number of spectacular success stories.

Newspapers in Canada periodically document case histories of inventors or entrepreneurs with innovation projects that cannot find financial backing for a start up, or find it from U.S. sources. Our interviews uncovered more potential innovators with the same problem.

Various American studies have pointed to a lack of seed money in the U.S. for start up capital. In Canada the situation is worse, for there are very few institutional (primarily venture capital) sources of start up capital at all. About $660,000 to $800,000 per year is available for start up funds for technological ventures, sufficient to establish only about four to eight new firms in Canada per year.*

New ventures requiring an equity investment of, say, half a million to a million dollars or more, would normally be unable to do so in the Canadian financial community. Start ups of this larger scale can only hope to raise such investments from venture capital sources in the U.S.**

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* Grasley, Robert H, A Study to Examine Capital Markets in Canada for Technological Innovation, Commissioned by MOSST, Publication pending.

** Grieve, Alan, "Venture Capital Sources and the Canadian Entrepreneur", The Business Quarterly, Spring 1972 and Wilson, Andrew H, "The Day They Put The 'Made in Canada' Nameplate Back in Place". Physics in Canada, May 1972.

That there is an absolute shortage of risk capital in Canada for start ups is clear. However, with better venture capital firms in Canada claiming a before tax return of only about 16% of the limited number of investments they do make, it is unclear as to how many actual good opportunities are missed. Certainly, some opportunities by Canadian firms must be overlooked if venture capital for Canadian projects is obtained from the U.S. This paradox is presented in Exhibit III-1.

Inventors' stories make good newspaper copy. As shown in the preceding section, however, inventors and small firms are often poor entrepreneurs, especially in Canada, and generally do not approach venture capital sources with sound business plans. Some Canadian entrepreneurs have found that U.S. firms virtually put together a business plan for the entrepreneur; it could be referred from this that Canadian venture capitalists are not as aggressive in assisting Canadian firms to formulate their proposal.

The venture capital environment is not as mature or promising in Canada as in the U.S. Inventors and entrepreneurs have problems in even finding venture capital companies, and generally do not appreciate that because they have a technological advance, it does not automatically follow that they should retain most of the equity. Venture capital companies also shy away from too risky investments, particularly start up situations.* With little chance of early payback,** and few spectacular successes among technologically-oriented companies, the tendency is to give harsh scrutiny to such project proposals.

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* Grasley, Robert, op. cit.

** The Foreign Investment Review Act has had a negative psychological effect on venture investment, since selling out to a foreign-controlled firm is one of the better ways to get back an investment.

EXHIBIT III-1

SMALL SCALE RISK CAPITAL : DIFFERENT PERCEPTIONS

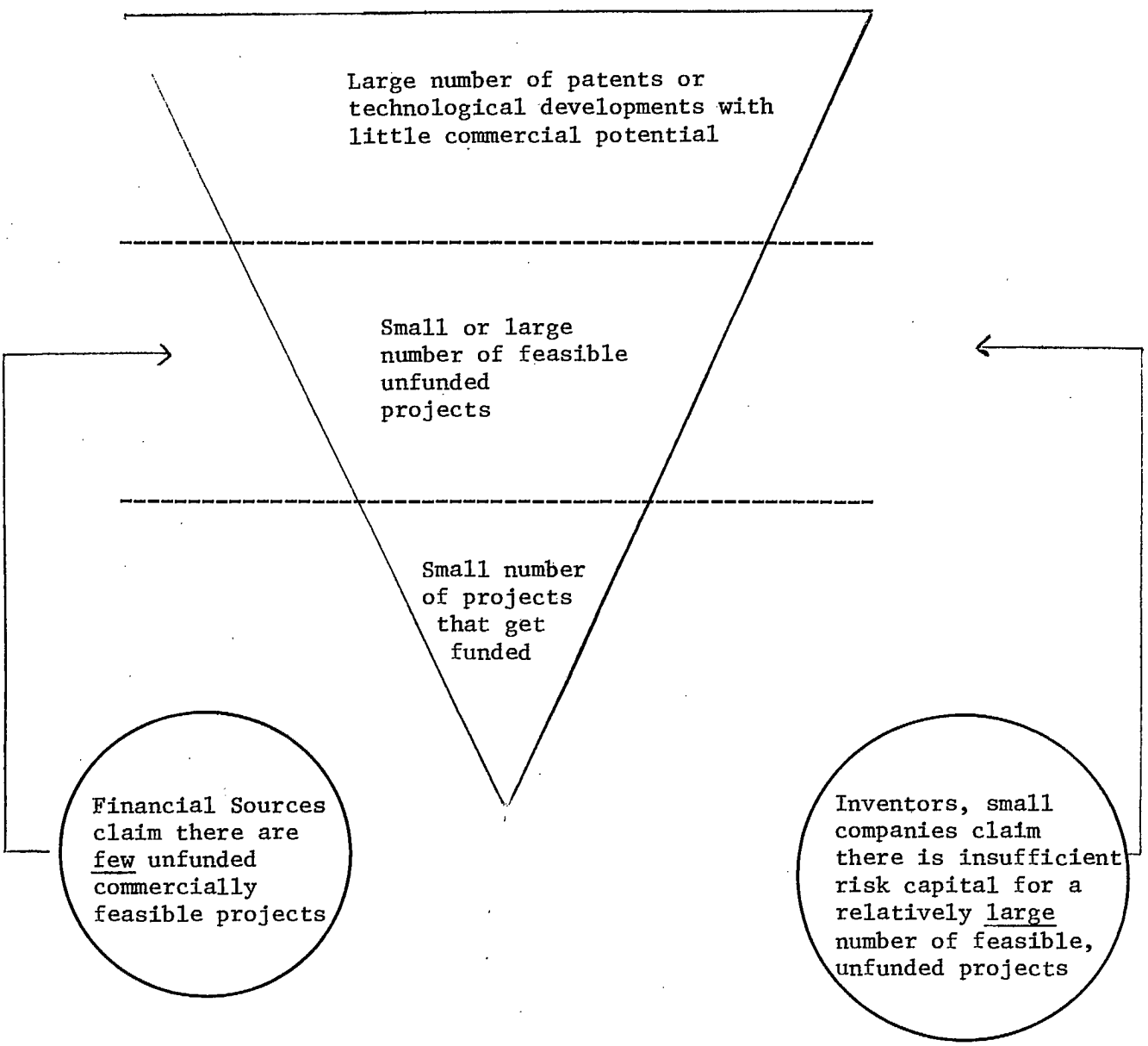

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EXHIBIT III-2

INSTITUTIONAL SOURCES OF CAPITAL FOR INNOVATOR

SOURCE	DEBT AND TERMS OFFERED	RATIO OF DEBT TO EQUITY INVESTMENTS	LIQUIDITY OF EQUITY	COMMENTS
chartered banks	0-3 yrs. (up to 10 yrs. for term loans in Small Business Loans Act)	100% debt	no equity except through subsidiaries	- branch banking system reduces loan competition at local level; Bank Act restricts equity investments. - only $30-40 million has been invested in the Small Business Loans Act formula.
foreign banks	0-3 yrs.	100% debt		- generally "suitcase" money investing in short term money markets
caisses populaires, credit unions	0-5 yrs.	100% debt	no equity investment	- credit unions restrict lending to members, caisses don't.
trust companies (excluding mortgages)	2-5 yrs.	100% debt	no equity investment	
finance companies	0-7 yrs.	100% debt	no equity investment	
term leaders, including IDB	5-10 yrs.	100% debt	no equity investments thus far	- IDB has power to invest in equity, and new legislation (Vir. FBDB) encourages it but still remains only potential.
insurance companies	10-20 yrs.	80-20%	little equity is non-liquid	- investments are generally conservative and with large organizations, hence very liquid.
pension funds (including government)	5-15 yrs.	80-20%	about 5% is non-liquid	- investments are generally conservative and with large organizations, hence very liquid.
mutual funds	5-15 yrs	20-80%	under 1½% is non-liquid	- investments are generally conservative and with large organizations, hence very liquid.
CDC, provincial development corporation	various	some 100% debt some largely equity	equity mostly non-liquid	- many provinces "burned" by equity investments; also susceptible to large companies providing jobs - CDC has invested in 3 V-C firms, but generally will not invest less than $2 million in equity.
merchant banks	3-15 yrs.	60-40%	most of equity is non-liquid	- few merchant banks in Canada and role is not well accepted by businessmen.
venture capital firms	3-15 yrs. (typically up to 10 years)	40-60%	most of equity is non-liquid	- venture capital firms are "riskier banks" and very few funds are available for start-ups.

Source: Compiled by Peat, Marwick and Partners Study Team

RISK CAPITAL GAP: EXPANSIONS

In our survey of companies the small entrepreneurial firm seeking to launch a new product line typically claimed he faced equity and debt risk capital shortages. Similarly, our interviews of medium sized Canadian controlled firms showed that borrowing money for expansion purposes was very difficult.

A tone that permeates company comments is the conservatism of Canadian banks and financial institutions. This is the general attitude of companies interviewed in other studies.* Another way of expressing it is that the overall financial environment in Canada is not sufficiently entrepreneurial, and is too much oriented towards the conventional balance sheet accounting approach to financing.**

Private sector risk capital availability has been compiled by source of funds on Exhibit III-2. Most institutions want to have either high liquidity or very safe investments for their equity holdings. Term lenders and other institutional investors in long-term debt instruments are also very risk averse. Thus, any examination of the different types of firms shows that they are not geared toward risk investment.

WHY LACK OF RISK CAPITAL

There are a number of interrelated reasons for the lack of risk capital environment in the financial community:

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* Litvak and Maule, Canadian Entrepreneurship: A Study of Small Newly Established Firms, Carleton University, October, 1971; Robidou, op. cit.

** Interim Report of the Select Committee of the Ontario Legislature on Economic and Cultural Nationalism, Capital Markets, Foreign Ownership, and Economic Development, 1974.

1. There has traditionally been a very small investing middle class in Canada,* and most Canadians are generally predisposed toward insurance and bank deposit savings.** The Federal Government encourages this form of investment through tax incentives - toward relatively risk free registered retirement and home ownership savings plans for example.

2. The historical development of a centralized branch banking system, has concentrated capital in Canada. The interlocking business arrangements between the banks, large corporations, (foreign- and Canadian-controlled), holding companies, and other financial institutions leads to most of this capital being used to finance the day-to-day operations of large companies. Although banks have recently been attempting to encourage loans to small companies, there is little incentive to support the more risky technological innovations of small to medium-sized entrepreneurs.

3. Canadian governments, primarily federal, have tended to regulate the financial institutions in a highly protective manner. This has segmented the financial structure and restricted the forms and patterns of investment or asset accumulation.***

4. Added to the environment of concentrated capital and government regulation is the relatively non-competitive nature of the banking and business throughout Canada's history. From our discussions in the venture capital industry, the "old boy" network of the Vertical Mosaic is still very much a factor.

These factors are part of the Canadian business and social context, past and present, and definitely contribute to handicaps to financing technological innovations in Canada.

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* Porter, John, The Vertical Mosaic, University of Toronto Press, 1965.

** Grasley, Robert, op.cit.

*** Ontario Select Committee, op.cit.

AREAS OF GOVERNMENT INITIATIVE

Should government directly assist innovators by providing risk capital or encourage individual and financial institution investors to be more entrepreneurial? In our view, such initiative would be complementary and both are necessary.

First, the Federal Government should examine tax and regulatory policies to provide incentives to (a) individuals and (b) institutions, to increase risk capital availability.*

Second, a quasi-government organization could be established to assess and financially assist investors' and prospective innovators' proposals. Such a mechanism would be oriented to technological developments, as opposed to traditional venture capital firm activities. This is proposed as a more direct way to assist technological entrepreneurs than a program to increase incentives for private investors.

Third, to assist larger scale innovation, governments should support companies directly, rather than through development company intermediaries. In this way, a judgement could be made whether to use financial or other government policy and program leverage. Governments traditionally have invested in bail-out situations, for regional development policy reasons, or in super-technologies (e.g. Bricklin, Kraus Maffei, Glace Bay heavy waterplant). Governments have generally a horrendous track record with direct investment, but it is likely that there will be a tendency to do more rather than less of it in the future, and their effectiveness must be improved.

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* See Grasely, Robert, op. cit. for several proposals in this area.

Fourth, there should be a more vigorous government role in the improvement of the overall management capability of the entrepreneur or inventor starting up a company, as suggested in the previous section. Financial and management development assistance could be handled, for example, through the existing IDB structure, or its successor.

In summary, Step 2 in overcoming handicaps would be a variety of programs and regulatory approaches to provide more risk capital and a more entrepreneurial environment in the financial community.

IV - LACK OF TECHNOLOGICAL CAPABILITY

From our interviews and research into other empirical studies about the technological capabilities of primarily medium and large Canadian firms, we have found that:

- Firms in Canada are generally too limited in development and production engineering capability of the type that is required to undertake technological innovation.
- There is generally poor transfer of technological know-how within Canada. Although there is excellent transfer of high technology products and processes to Canada from outside the country, there is poor transfer of capability to carry on further product or process development in Canada.
- The transfer of technological capability is a prerequisite to technological innovation; the lack of it is a barrier to innovation.

On the whole, firms in Canada are relatively weak in technological capability, compared to those in the U.S. and small and large Western European countries.

LACK OF IN-HOUSE CAPABILITY

As pointed out by several observers, Canada has few indigenous firms of medium to large size with strong engineering capability. In fact, there were only about 15 firms with 50 or more professionals in R & D departments in Canada, indicating to some extent the lack of breadth in in-house technological capability.* The strong engineering firms we do have seem to chafe under the taxation, procurement, and economic policies of the federal government. Tariff policies designed to shelter basically uncompetitive

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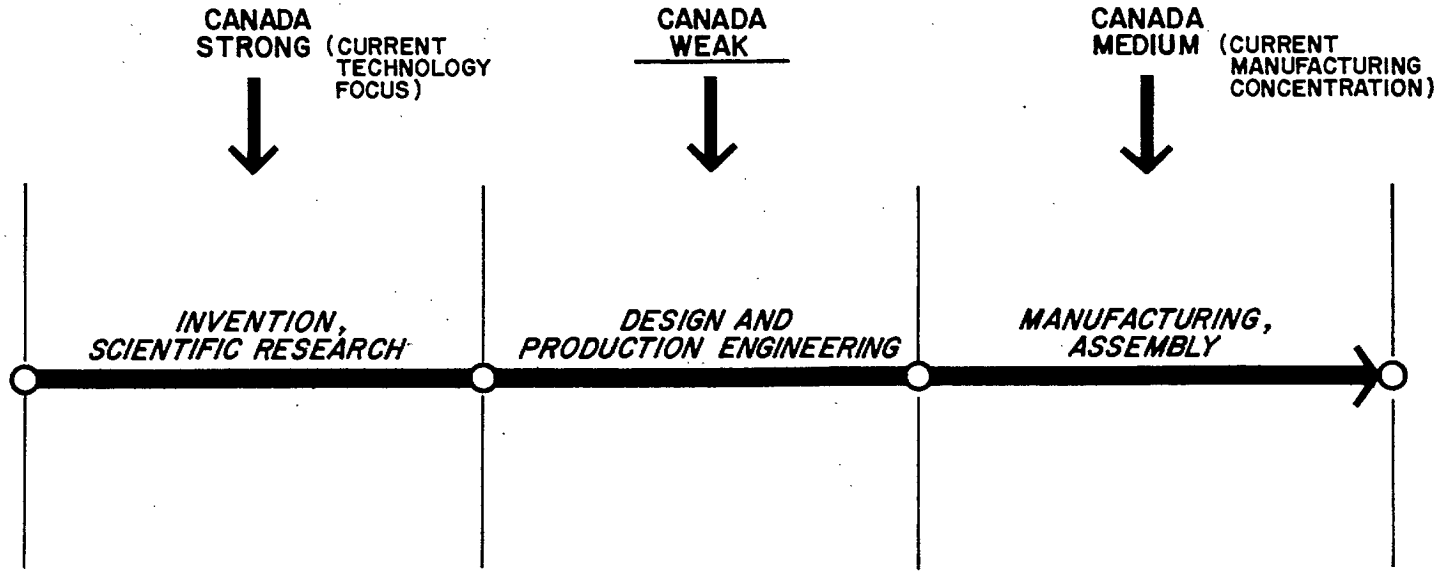
* Kelly, Frank, "Prospects for Scientists and Engineers in Canada", Study No. 20. Science Council, March, 1971.

EXHIBIT IV-1

LOCUS OF CANADIAN TECHNOLOGY



TECHNOLOGICAL STAGES IN INNOVATION PROCESS

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secondary manufacturing in Canada, hamper the development of firms with technological capability, since their parts costs can be higher than for their foreign competitors.*

As a result of a heavy emphasis on government and university R & D, Canada is comparatively strong on the research but weak in development. Also, as a result of tariff and other policies there is a basic "assembly" capability, but a lack of design and production engineering among firms in Canada.

Exhibit IV-1, shows that this basic weakness is a severe handicap to innovation - both by large firms and their small firm suppliers. Canada does have significant design and production engineering experience in a few components of technologically oriented industries, such as steel, pulp and paper mill design and equipment, communication electronics, nuclear energy, food processing, some aspects of aviation, and ship building, among others. However, there is little of it in many key industries, such as machine tools, pharmaceuticals, automotive, aerospace, chemicals and oil processing.

POOR DIFFUSION OF EXISTING TECHNOLOGY

The barriers to the transfer of existing technology to Canadian firms - the diffusion of technology - handicap innovation efforts in Canada. The diffusion problem is summarized graphically on Exhibit IV-2.

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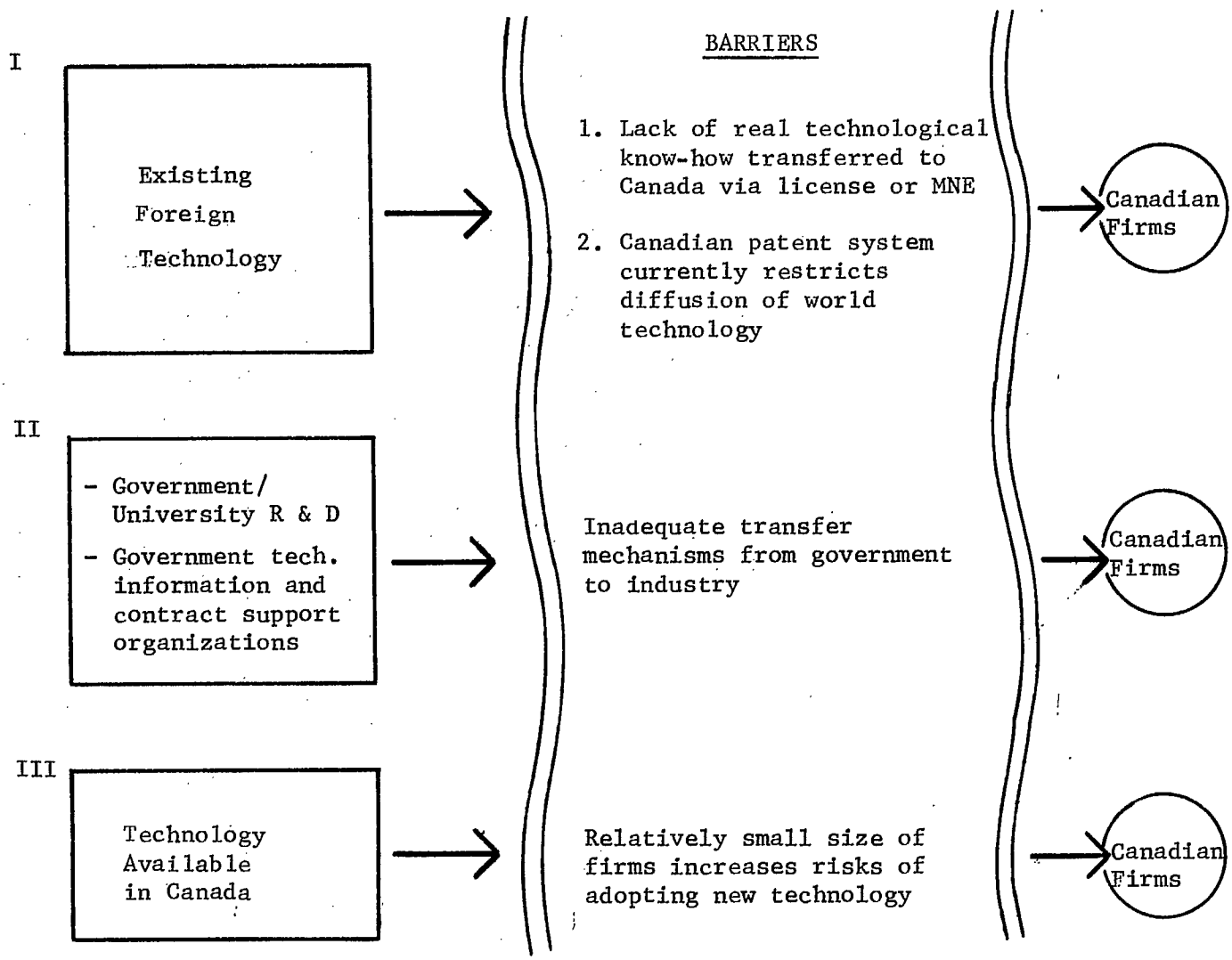
* See the Financial Post, (November 10, 1973, Second Section), article showing Husky Tools comparison of establishing a plant in the U.S. as compared to Canada.

EXHIBIT IV-2

BARRIERS TO THE DIFFUSION OF NEW TECHNOLOGY



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Barriers to the Import of Technology

Licensing

Licensing foreign technology is one important means of acquiring existing technology. However, it does not generally support innovation efforts. First, it is difficult for Canadian firms to acquire more than the Canadian rights to new technology, mainly because the company selling the new technology perceives Canada as a poor base to exploit North American or world rights from the licence.* Second, the technology that Canadian-controlled firms do secure is up to nine years old, hardly conducive to maintaining technological leadership.**

Third, foreign-controlled firms import the lion's share of licenced technology to Canada ($110 million in 1972, compared to $6.2 million paid in royalties by Canadian-controlled firms). However, as described in Section VI, the technological knowhow is not generally imported and Canadian subsidiaries do not have the capability or authority of developing upon this technology.

Patents

A similar situation exists with respect to patents. Ninety-five percent of the patents granted in Canada are taken out by foreign owners,

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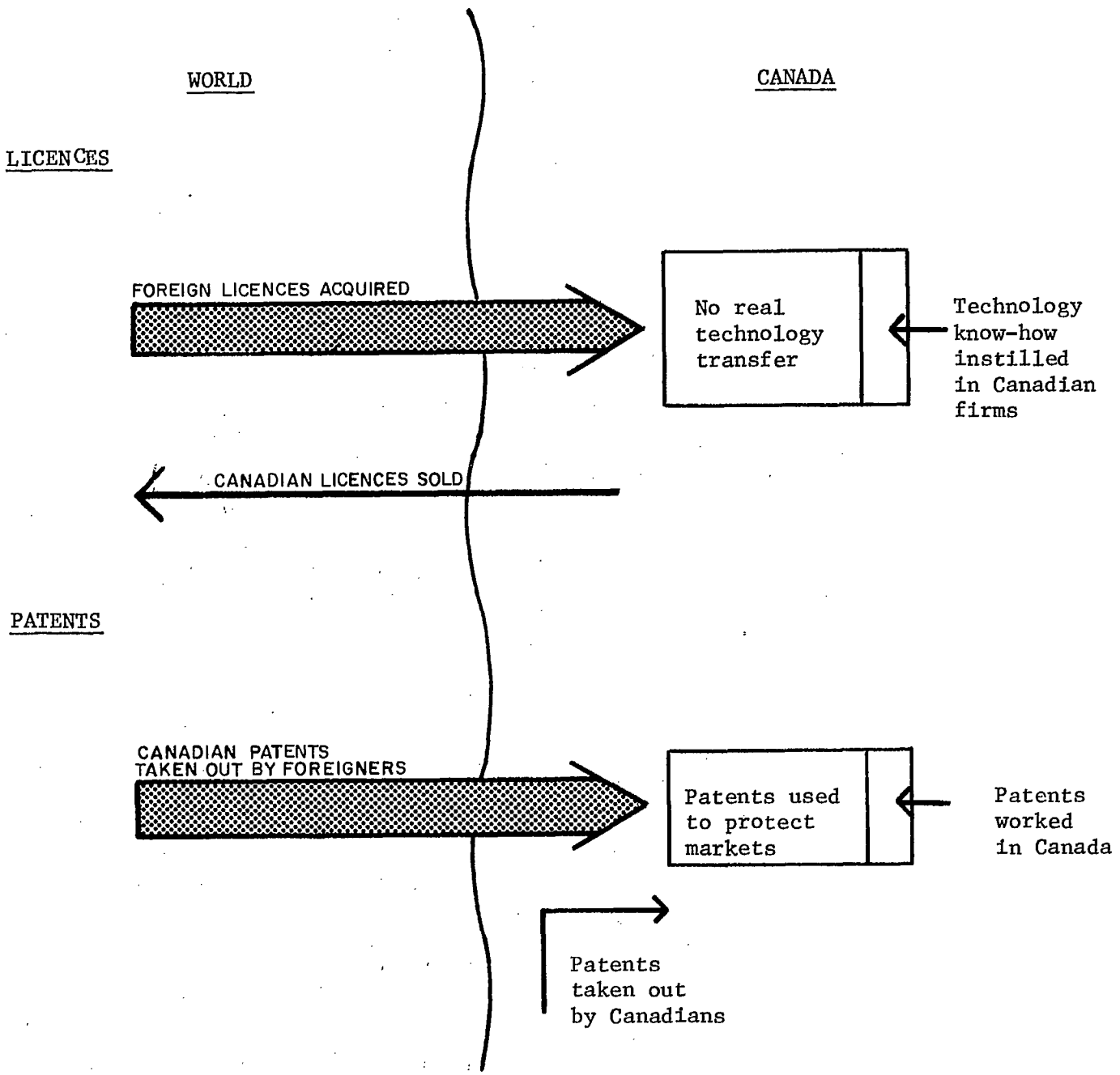
* Statistics Canada, Quarterly Estimates of the Canadian Balance of International Payments, Third Quarter, 1973. In 1972 about 65% of licences acquired by Canadian firms allowed market access to all countries; however, most of the unrestricted licences are reputed to be cases where there is little feasible opportunity for Canadian firms to develop export markets.

** Firestone, O.J., "Innovations and Economic Development - The Canadian Case", Review of Income and Wealth, No. 4, December, 1972.

EXHIBIT IV-3

LITTLE DIFFUSION OF TECHNOLOGY THROUGH IMPORTS OF PATENTS, LICENCES



Peat, Marwick and Partners

and very few of these patents lead to a transfer of technological knowhow to Canada. In Canada only about 1/6 of patents are worked, versus 1/2 in the U.S.*

The Economic Council of Canada study's criticism of the Canadian patent system as being too restrictive and unduly impeding competition has not been effectively countered despite the lobbying of Canadian companies.** A recent United Nations study also concludes that a strong patent system works to the disadvantage of industrially underdeveloped countries - which includes Canada in this case. It concluded that an overwhelming majority of patents granted to foreigners, have been used as "import monopolies", and that those that are worked result in high royalty payments and restrictive practices.***

A graphical illustration of the Canadian situation with respect to licences and patents is shown on Exhibit IV-3. Neither has been an effective means for developing broad technological capability through diffusion of existing technology in and into Canada.

Barriers to the Use of Government Technology

Roughly two-thirds of Canadian R & D has historically been undertaken (not financed, but actually worked on) by governments and universities as opposed to only about one-third in the U.S. and the U.K.

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* ibid.

** Firestone, O.J., Economic Implications of Patents, U. of Ottawa, 1971.

*** The Role of the Patent System in the Transfer of Technology to Developing Countries, prepared by the U.N. Dept. of Economic and Social Affairs, the UNCTAD Secretariat and the International Bureau of the World Intellectual Property Organization, July 1974.

Corporations have difficulty commercializing on their own R & D. The barriers to the commercialization of government and university R & D are even more pronounced, since it generally requires a transfer of technology from government institutions to industrial firms in the first place. Government personnel policies encourage continuous government service rather than fostering spinoff situations where employees set up their own firms to commercialize government research results.

Contracting out R & D to companies is one way of improving the diffusion of government R & D. In spite of announced policy by the federal government to contract out a substantial portion of its scientific research, less than five percent (about $30 million) is now done so, It is proving difficult however, partly because of a natural tendency for departments to keep R & D in-house, and also because the nature of government R & D as developed over the years does not lend itself to commercialization.

Federal and provincial governments are involved in supporting various research organizations. Some of these are research institutes, which focus on areas identified jointly by government and industry, while others try to market their technical services to existing industrial firms. Both types perform useful functions; however, their projects seldom result in successful commercialization of new technology.

Fragmentation of the Industry

One of the major barriers to the diffusion of existing technology is the small size of firms in specific industries - small in part

because of their small market share.* Gearing up to develop a technological capability is expensive, and where an industry is fragmented and sales limited to Canada it cannot be justified. Consequently, further development of that technology is inhibited.

WHY LITTLE ENGINEERING CAPABILITY

The lack of the development of strong Canadian based engineering capability can basically be traced to the industrial structure of Canada. As pointed out earlier there has been little historical emphasis on performance maximizing industries.

The foreign subsidiary operating in Canada is dependent upon foreign technology and, therefore, does not need to develop it in Canada in most cases. Thus, import of foreign technology through the subsidiary has pre-empted the need for its development by Canadian-controlled firms in Canada.

There has been no coherent government policy to maintain engineering capability in Canada. The classic case was the dissolution of the Avro Arrow in 1958. Another example is the case of the automotive engineers who left the country following the Auto Pact.

Lack of qualified or skilled manpower was cited by many firms interviewed as a serious handicap to innovation. However, manpower

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* Globerman, Steven, Technological Diffusion in the Canadian Tool and Die Industry; An Empirical Study of Inter-Firm Diffusion for a Sample of Canadian Textile Firms; Technical Diffusion in the Paper Industry, these papers prepared for the Office of Science and Technology, Industry, Trade and Commerce, 1974.

specialists and engineers have conflicting views on whether there is an actual shortage of engineers and skilled technicians. They feel that most engineers in Canada do not develop skills required in design and production engineering. This lack of skills is partly the result of a natural tendency for universities to orient their curricula to the jobs that were available to their graduates, i.e. mostly government or university.*

POSSIBLE GOVERNMENT INITIATIVES

To improve the technological capability of industrial organizations there are a number of areas of government initiatives.

In-House Capability

In terms of improving in-house capability of firms in Canada, incentive grants could be oriented toward making a much more substantial impact on particular firms. Grants could be used to finance continuous technological development to bolster firms that are or have the potential to be competitive in international markets, based on Canadian technological capability. To avoid political ramifications of sponsoring one firm over another, the Federal Government should consider part equity participation to gain future returns from its investment.

Second, in-house capability can be fostered by upgrading engineering and production design skills. Education institutions should be encouraged

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* See Boyd, A.D. and A.C. Gross, Education and Jobs, Study #28, Science Council of Canada and Kelly, Frank, Prospects for Scientists and Engineers in Canada, op.cit.

to provide a more practical and manufacturing orientation to their teaching programs.

Third, manpower and immigration policies should be more co-ordinated with innovation policies. Pools of specialized labour should be monitored on an industry sector basis, and assistance given to retain them in Canada and transfer them to other industries if necessary.

Other federal policies can favour the development of in-house technological capability. The financial and management areas have been discussed above. Steps to reduce fragmentation, improve Canadian firm competitiveness and foster parent/subsidiary technology transfer are discussed in subsequent sections.

Diffusion
of Technology

Policies and programs to foster the transfer of existing technology should be viewed as part of the process to upgrade the in-house capability of firms. There are several potential initiatives in this area in addition to those suggested immediately above.

First, stepping up the off-loading of intermural government R & D would facilitate the transfer of technology to technologically-oriented firms. Hiring by contract professional and technical staff for provincial and federal research organizations, and providing them with incentives to spinoff to form their own private organizations, would help achieve results in an R & D contracting-out policy.

Second, the federal government could implement the thrust of the Economic Council's recommendations to free up the patent system, largely through compulsory licencing and more limited durations of patents. Care would have to be taken (as the ECC report says), to maintain the use of the patent system as an encouragement to domestic innovation. However, reducing the monopoly of foreign-held patents would increase competition and thus be a stimulant to innovation.

Third, in the area of licencing, there should be a registration of licences. At the same time there should be an examination of regulatory or assistance programs to encourage firms to obtain licences under more favourable terms for the purpose of exploiting technology in international as opposed to strictly Canadian markets.

Fourth, a mechanism to support the commercial exploitation of patents of inventors and small R & D firms was suggested above as a means of overcoming management and financial handicaps. The same quasi-public agency could assess the technical merits of an idea or patent and, by helping to develop it (possibly after the filing but before the granting of the patent), local advances in technology would be diffused more widely.

Thus, Step 3 in overcoming handicaps to innovation in Canada is to develop in-house capability of firms in Canada and help diffuse existing technology. To do this requires direct stimulation of technological capability and interventions in the market place to make the economic environment of the firm more conducive to developing this capability.

V - MARKET SIZE AND STRUCTURE HANDICAP

Based on empirical studies of industries and interviews with company officials regarding the size and structure of the Canadian market we conclude that:

- Innovation is often inhibited by the limited size of the Canadian market, the large number of producers in the market, or the large number of product lines in broad product categories; sometimes, it is a combination of two or three of these factors.
- The "threshold" costs of maintaining innovative capability are expanding rapidly in many industries, outstripping the resources of the Canadian firm, and often the total productive resources of all companies in an industry.
- When a Canadian firm does innovate, it generally does not gear up production fast enough or to sufficient volume to fully capitalize on world market prospects.

The limited size of the Canadian market (relative to the U.S. or the EEC) and its fragmentation are unique features of the Canadian economy.

SIZE AND MARKET STRUCTURE IMPACT ON SEVERAL INDUSTRIES

One of the handicaps frequently mentioned by companies interviewed was "the small Canadian market". They were in effect saying that the total market share they felt they could gain was not large enough to justify the R & D, production engineering, and marketing costs required to innovate.

In most cases, innovators felt they had to export to achieve successful innovation. Moreover, they faced many competitors in the Canadian market, which gave them too small a sales base to generate attempts to innovate.

Various industry studies document the impact on size and structure of market, as follows:

1. In examining the impact of scale of production or manufacturing efficiencies, Daly found fragmentation of product lines in certain industries inhibited specialization and hence innovation.*

   - in the rubber tire industry, the large number of product lines inhibited the use of the "merry-go-round", a specialized piece of equipment.

   - in the garment industry Canadian manufacturers use more versatile machinery than their U.S. counterparts to produce a large number of product lines.

2. In the construction industry innovation is inhibited in part due to the complexity and fragmentation of markets, equipment suppliers, and regulations.**

3. In the computer industry a strategy aimed at development of peripherals rather than main frames, was recommended, largely because of the smaller Canadian market not being able to support the development of the high cost of innovation for main frames.***

4. In the chemical industry the increasingly high capital costs are becoming too much for the Canadian market to justify innovation investments.****

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* Daly, D. J. et al. Scale and Specialization in Canadian Manufacturing, Staff Study #21, Economic Council of Canada, March, 1968.

** Wilson, A.H., and A.D. Boyd, Technology Transfer and Innovation in the Construction Industry in Canada, Economic Council of Canada, April, 1973.

*** Science Council of Canada, Strategies of Development for the Canadian Computer Industry, Report No. 21, September, 1973.

**** Streight, H.R.L. "The Climate for Research in the Seventies", Chemistry in Canada, May, 1972.

5. In a study of the telecommunications industry, it was concluded that there were too many carriers and suppliers of transmission equipment for the Canadian market, and that the Canadian market is simply too small to justify the development costs of the next generation of terminal equipment, even for a producer for the total Canadian market.*

6. Bourgeault cites figures for television receivers, appliances, and pharmaceuticals as consumer products where there are a large number of producers and product lines. **

These scattered references illustrate two features of the Canadian market structure. First, industry is fragmented due to regional and other factors, and hence, firms are often small. Therefore, most cannot afford technological sophistication let alone attempt major innovation. Second, even if the productive capacity were rationalized into one or two firms in a specific product line, the increasing high cost of innovation in some cases would make it questionable whether innovation should be attempted.

Three Industries Surveyed by PM&P

The firms we surveyed provide more insight into the market size/structure to innovation relationships. Briefly, the results for the three industries surveyed are reviewed in the following paragraphs.

In many electronics subsystems innovations, companies have to penetrate the international market to achieve a sufficiently large profitable return on a new product, although the development, production, and marketing costs of innovation are relatively low. However, basic or fundamental electronics developments, such as transistors and semiconductors, require a much higher level of investment, while access to export markets is also a requirement. Hence, there are many subsystem innovations in specialized areas of electronics in Canada, but

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* Communications Canada, Working Paper Canadian Telecommunication Carriers and Their Suppliers, National Telecommunications Branch, June, 1974.

** Bourgeault, Pierre, L. op.cit.

only large companies with a large domestic market share (such as Northern Electric) can attempt to compete in basic communications electronics developments.

While there is a relatively large market for mining and pulp and paper machinery in Canada (compared to the U.S.), there has been a traditional dependence on imports and what goods are produced in Canada are most often licenced designs; R & D and production facilities costs are also relatively high. The Canadian innovators have to find niches in the market for smaller size, specialized machinery products, which do not require huge investments in innovation costs. Generally, export sales are counted on for innovation success.

Large appliances are consumer goods which require large marketing expenditures to establish brand identifications either for domestic or export markets. Major foreign-controlled firms enjoy spill-over marketing advantages from the United States in brand identification (although spill-over advertising is not a large factor in the promotion of specific new products in Canada), and thus the entry costs of other firms are high.

For small appliances, R & D and production costs are relatively low, although marketing entry costs are high. One way of keeping down innovation costs (i.e. the marketing costs) is for a company to sell through a larger company's established distribution channels.

Thus, from our own survey, we learned that R & D and other market entry costs are high, when related to potential return for firms that want to attempt innovation. Also, international sales appear very important to the commercial exploitation of an innovation. These findings tend to confirm that the fragmentation of the already limited Canadian markets impose considerable barriers to innovation, given the substantial investments required to innovate.

HIGH COST OF INNOVATION

A consequence of the relatively small and fragmented Canadian market is the difficulty of firms being able to afford competing through innovation. This is the result of the so-called "threshold" level of R & D expenditures - the minimum expenditure level required by firms to sustain a competitive innovative capability in performance maximizing industry.

The threshold expenditure level concept is described by Freeman* as:

> "a minimum level of R & D work in progress, sufficient to keep abreast of the technical changes in components, to introduce a flow of improvements and to launch completely new models when forced to do so by the competition."

It therefore follows that a firm in an industry must commit an absolute minimum level of resources appropriate to the needs of the product lines to remain competitive in that industry. Below this level of R & D commitment, it will normally be impossible to develop new products with lead times short enough to survive.

Threshold R & D expenditures vary with the product line, but sample ones used by Freeman, as shown on Exhibit V-1, illustrate that maintaining an innovative capability can be very expensive.

There are many indications that innovation is becoming even more costly at geometrically progressing rates. For example, Simmonds** examined the scale of investment of several industries, concluding that

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* Freeman, Christopher, The Economics of Industrial Innovation, Penguin, 1974.

** Simmonds, W.H.C., "The Analysis of Industrial Behavior and its Use in Forecasting", NRC Published in Technological Forecasting and Social Change, 3, Pages 205-224, 1973.

EXHIBIT V-1

EUROPEAN DEVELOPMENT THRESHOLDS AND LEAD TIMES

EARLY 1960'S[1]

- Pounds Sterling -

Product[2]	Threshold Development Cost (000)	Lead Time (Years)	Derived Annual R&D Expenditure[3] (000)
Radio communications receiver	80-150	2	40-75
VHF transmitter	240-360	4	60-90
Laboratory oscilloscope	300-450	3	100-150
Marine radar set	100-200	3	33-66
Spectrum analyzer	100-200	3	33-66
Machine tool control equipment	300-600	3	100-200
Small scientific computer	1000-2000	3	333-666
Research satellite	500-1500	4	125-375
TV colour camera	1600-3000	4	400-775
Small quasi-electronic telephone exchange	2000-4000	5	400-800
Large fully electronic telephone exchange	6000-9000	6	1000-1500
Range of EDP computers, software and peripherals	8000-16000	4	2000-4000
Communication satellite	10000-40000	5	2000-8000

1 Although these figures bear some relation to the actual orders of magnitude, they are not intended to be an accurate representation.

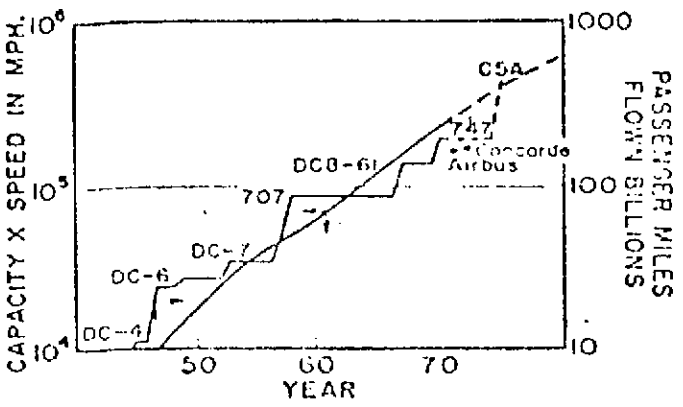
2 Except in the case of computers, these are single products. In practice, of course, a firm would usually be involved in a range or in several products.

3 Excluding preproduction expenses, investment in tooling and market research.

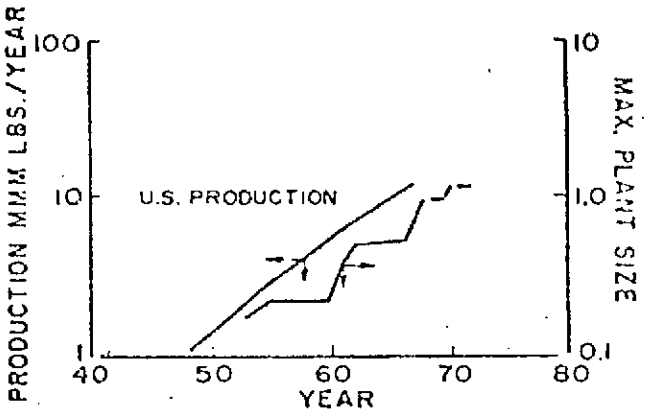
SOURCE: Freeman, Harlow and Fuller (1965) from P. 155, Freeman, 1974, op.cit.

EXHIBIT V-2

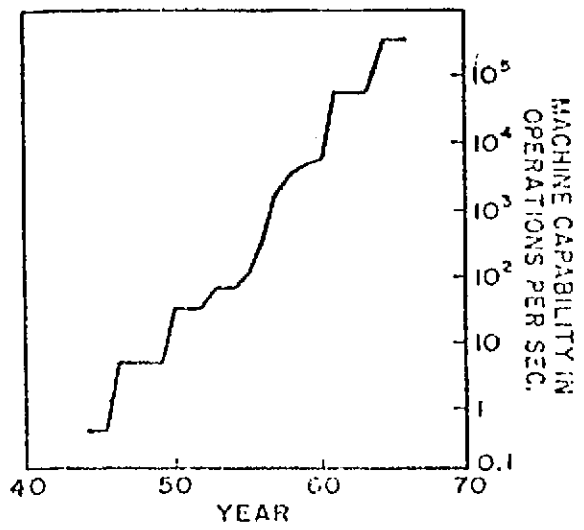
EXAMPLE OF INVESTMENT FACTOR
OF LARGEST UNITS IN SELECTED
HIGH TECHNOLOGY INDUSTRIES



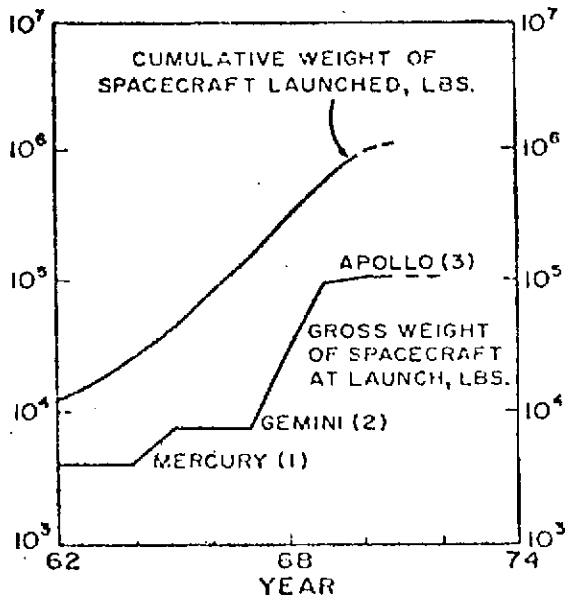
PASSENGER AIRCRAFT



ETHYLENE



COMPUTERS



SPACE MODULES

SOURCE: W.H.C. Simmonds op. cit.

scale of production jumps in a step-wise manner in the science-based industries, i.e. that the cost of innovation of each new technological generation of a product is far greater than the previous cost of innovation. Exhibit V-2 shows this historical step-wise development of the scale of capacity.

Fewer and fewer companies can afford the threshold R & D expenditures in science-based industries. Freeman provides examples of British and other European companies which could not sustain threshold expenditures in competition with American firms. He concludes that European countries have to rationalize certain industries to provide one company the resources to meet the threshold challenge (i.e. virtually designating a manufacturer for a specific product/process category). To compete with American giants, he suggests such rationalization on an EEC scale in the really expensive areas of high technology.

This threshold consideration is also the subject of analysis in other studies. For example, an American study of the commerical aviation industry* demonstrates how fewer and fewer companies could afford the innovation race. The study concludes that only one corporation really survived as an independent, viable concern.

The implications for Canada of increasingly higher threshold costs are severe, since there are few firms with sales larger than the total domestic market in Canada. That means that with some exceptions, there are few Canadian firms that are giants in international terms, and

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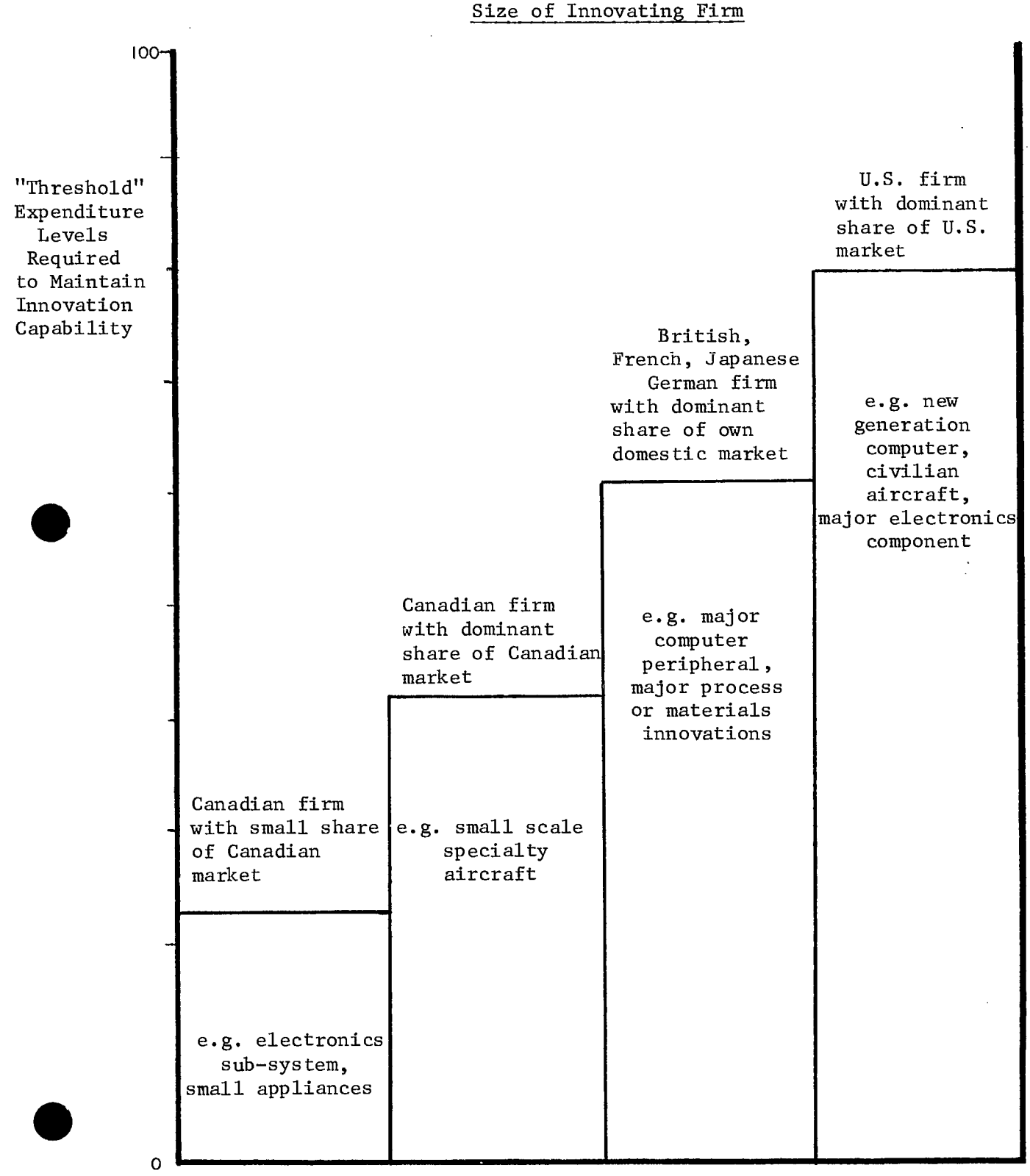
* Phillips, Almaria, Technology and Market Structure. A Study of the Aircraft Industry, The Rand Corporation, 1971.

EXHIBIT V-3

ILLUSTRATION OF HOW HIGH COSTS OF
INNOVATION OUTSTRIP CANADIAN CAPABILITY



which have threshold resources required. Exhibit V-3 illustrates the relative Canadian market size problem by way of examples in comparison with other countries with larger domestic markets.

In some product or process categories, the threshold expenses for maintaining an innovation capability are relatively low, and a large market share is not critical to the innovation process. In others, a Canadian company must have a dominant market share in Canada to sustain the threshold expenditures required. However, in many areas, the high cost and risk of innovation simply outstrip Canadian resources, even if the industry were rationalized.

If a firm grows in sales well beyond the market size of the country (e.g. Massey-Ferguson, Phillips in Holland, Volvo in Sweden), then the small domestic market barrier can be overcome. The point is that it would be unrealistic to expect such a sustained R & D capability out of proportion to the domestic market for more than a few companies.

The implications of the increasingly high cost of innovation are several. First, Canada will have to learn how to identify more effectively niches in high technology areas. Second, in some industries Canada requires rationalization of productive capacity in fewer firms. Third, Canada should be very selective as to which large scale efforts should be attempted at any one time.

There are implications also that Canada will have to increasingly explore joint venture arrangements with other countries. The Canadian government and Canadian firms will probably have to cooperate with foreign organizations to participate in maintaining the sustained innovative capability required for high-technology industries.

NATIONAL ECONOMIES OF SCALE

Market size and structure, with the attendant problem of scale economy in Canada, have been the subject of much economic discussion. It is often suggested that Canadian firms have too short production runs or too small plants to be competitive in international markets or in domestic markets without tariff protection. In this case, the economies of scale brought about by the longer production run or the larger plant size must be supported by large markets.

There are additional factors at work in high technology industries, which achieve economies of scale as defined somewhat differently. Basically, there are production efficiencies, i.e. lower cost for each unit of output, associated with cumulative production, rather than from larger production lot sizes that are normally considered to be central to the economies of scale concept. This interpretation is sometimes referred to as "dynamic" economies of scale, and described as follows:

> "Dynamic economies of scale arise from adaptive learning of the labour force and management engaged in the production process. They are additional to, but intimately related to, improvements arising from R and D, and from the normal "static" economies of scale - reduction in unit costs arising from the spread of fixed costs over a larger production and sales volume".*

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* Freeman, op.cit. P.151

Corporations in high technology industries appreciate the results of dynamic economies of scale. As they acquire R & D and production experience, they can advance to the next technological stage more rapidly, and make improvements in the production process that lower unit costs. Such decreases in unit costs are actually quite predictable. Typically, as shown by empirical study, a doubling of cumulative output in a changing technological environment results in 20 to 30 percent unit cost reductions.*

The predictability of the dynamic economies of scale effect in rapidly changing technologies has led to the development of the experience curve as a planning tool for companies.** In a typical product life cycle, an innovation results in a product/process with a superior performance that will sell by the very nature of its superiority. However, other producers begin to manufacture an imitation of the innovation; as the accumulated volume of production grows for the innovating producer and its imitators, the unit production cost drops for all producers. Producers can then lower prices in anticipation of their own or their competitors' capability to reduce per unit costs, as determined by the experience curve for each product line.

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* Abernathy, William J. and Kenneth Wayne, "Limits of the Learning Curve", Harvard Business Review, September-October, 1974. The authors state that: "Evidence on cost decreases in a wide range of products, including semiconductors, petro-chemicals, automobiles, and synthetic fibres, supports the notion that total product costs, as well as manufacturing costs, decline by a constant and predictable percentage each time volume doubles." See Also: Chemistry in Canada, "Strategies for Maturing Industry: Using Experience Curves as Planning Tools", 1972.

** There is a similarity between the "learning curve" and the "experience curve", but the distinction between them is as follows:

"The learning curve (also called the progress function and start-up function) shows that manufacturing costs fall as volume rises. It has typically been developed for standardized products like airframes and cameras.

"The experience curve traces declines in the total costs of a product line over extended periods of time as volume grows. Gas ranges and facial tissues are two major product lines on which experience curves have been developed."(ibid)

EXHIBIT V-4

ILLUSTRATION OF EXPERIENCE CURVE EFFECT

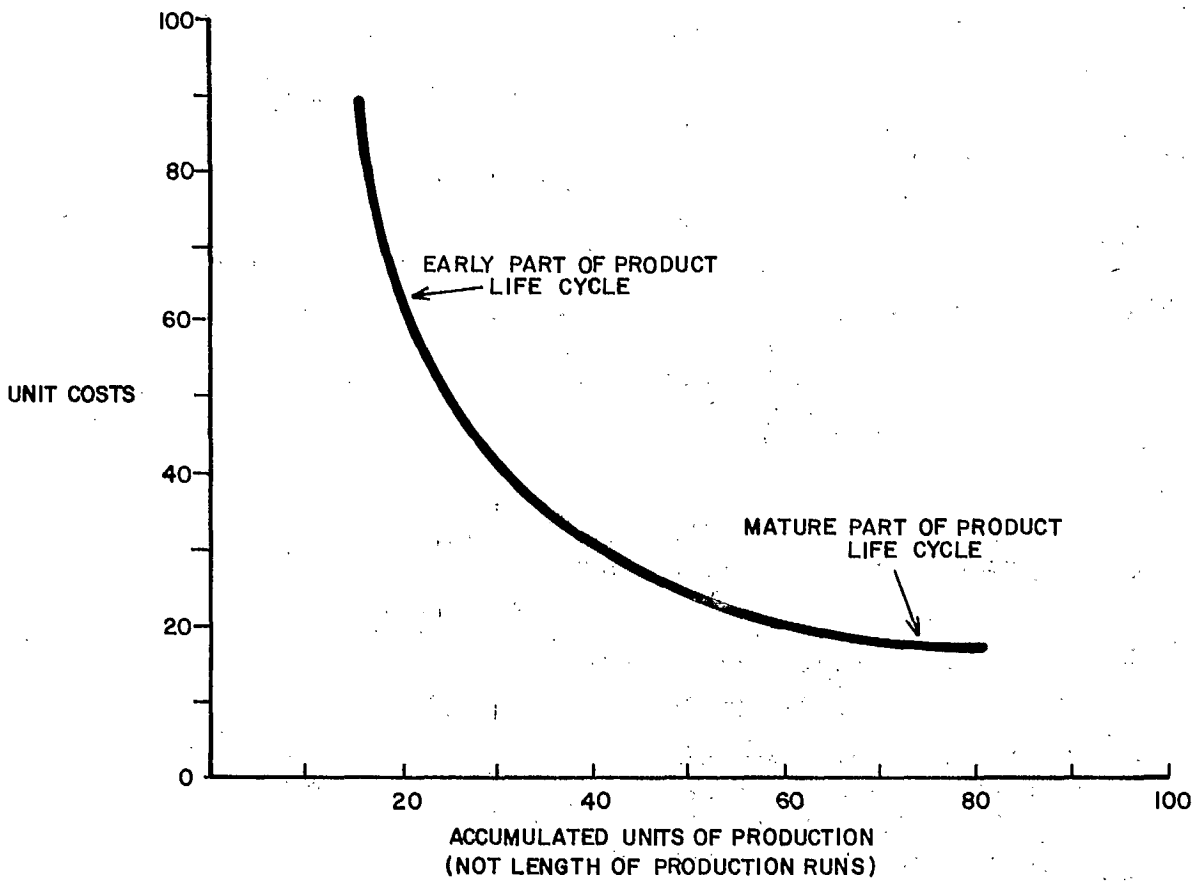

Exhibit V-4 graphically shows the experience curve. The slope is steep for new products, that is, the costs drop very sharply as accumulated production brings improved technology and other efficiencies. Normally, the strategy of companies in fast-changing technological areas is to try to dominate the market to achieve large volumes; as a result of the accumulated production experience, they can then reduce unit costs. As a product matures, the slope of its experience curve becomes more flat. At that point no producer can reduce his price simply based on future decreases in per unit costs, since the cost is relatively stable.

What happens to Canadian firms in this process? A Canadian firm may innovate, but does not usually get the full value of its innovation because there are constraints to full exploitation of the innovation. The constraints are primarily as follows:

1. Canadian firms tend to produce only in a volume equivalent to their expected market share in Canada. This is because of tariff barriers against entry into foreign markets as well as the protective Canadian tariff barrier which produces the necessity to achieve international competitiveness.

2. Because there are too many producers and product lines in many product categories, the Canadian company is too small to develop production capacity quickly enough to dominate the world market.

If the product is a good one, large foreign companies will tend to imitate the product and develop in a volume large enough to swamp the Canadian company - by reducing the product cost sharply, thereby

undercutting the Canadian company. Alternatively, the foreign company will leapfrog ahead of the Canadian company by developing a superior product.*

There are two basic implications to this dynamic economies of scale effect associated with high technology industries. First, Canadian firms should more frequently gear production to penetrate the world market, and thus quickly develop considerable accumulated production experience. Second, if the production capacity to fully exploit the innovation through large volume production is not available in Canada, the innovation could be licensed to foreign producers or otherwise developed as joint ventures with foreign firms. The latter strategy should only be adopted if the capacity does not exist or cannot be developed rapidly in Canada.

As discussed above, the experience curve is used as a planning tool by companies to determine strategy. To be more competitive, a company can reduce prices in anticipation of future per unit cost reductions and can plan production volumes large enough to ensure that cost reductions are achieved. It is also used by countries like Japan in relation to the country's <u>total</u> cumulative R & D and production experience. As such, it is a tool to evaluate and suggest national competitive strategies in high technology product lines. Although Canada does not have the same degree of industry consensus planning as is the case in Japan, the experience curve can be used to demonstrate the potential merit in greater rationalization of production in high technology industries in this country.

Thus, more understanding of the experience curve for particular product lines is required to assess the possibility for Canadian companies <u>in toto</u> rapidly accumulating production experience.

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* In this context, it is interesting to speculate on the fate of the Candu reactor or the STOL aircraft developments.

GOVERNMENT INITIATIVE:
TECHNOLOGY EVALUATION CAPABILITY

Since the private sector has not developed a technological base in very many industries in Canada, the Federal Government has not had to be concerned with understanding the relationship of market size, structure and its innovation implications in maintaining threshold expenditures and achieving dynamic scale economies.

One result is a tendency to jump into prestigious "big science" projects, without examining their implications. Other countries (particularly France) also commit the strategic error of neglecting the analysis of the high costs of innovation.

Two examples will demonstrate the importance of having a capability to evaluate technology in terms of product life cycle, and the production/marketing decisions stemming from it. The first example concerns STOL; we are aware of how lead time has been lost in this particular product development. However, do we know the effect of the loss of lead time, the market potential, or the state of technological development in other countries?* In the second example, the Science Council recommended a strategy to develop peripherals in the computer industry. However, while decisions as to computer industry strategy are being formulated, the competitive efforts of other countries or foreign companies may be foreclosing Canadian options.**

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* The Federal Ministry of Transport is undertaking an assessment of this particular program.

** Other examples could be drawn from most high-technology companies in which the Federal Government has made large investments, particularly in electronics and aerospace.

The Federal Government in conjunction with industry should consider developing a continuous capability to evaluate new technology through examination of experience curves for new product lines. Such capability should have the following features.

- the evaluation must be a continuing process, since the technological capability of competitors is constantly changing
- it must be outward-looking in terms of monitoring and forecasting technological development internationally
- it must examine the individual and collective production capability of the different Canadian industry sectors
- it must determine the timing and volume of production to fully exploit the innovation that is committed to production.

Canada's position with respect to the experience curve on a national basis will assist government and industry decision-makers in:

- possible ventures into new technology or new product areas
- go/no go decisions in continued development and production of a product line
- rationalization of productive capacity into fewer firms
- further support to selected companies in technological development

Decisions based on such technology evaluation should be made rapidly enough to meet the timing requirements of changing technology.

Such decisions require a far more coordinated government/business decision-making environment than has been the experience in Canada. However, as a beginning, the technology evaluation capability is required.

Step 4 in overcoming handicaps to innovation in Canada, then, is government action based on specific product and industry analysis of threshold R & D expenditures and experience curves showing what can be achieved through dynamic scale economies.

VI - FOREIGN OWNERSHIP AS A HANDICAP TO INNOVATION

We examined whether foreign ownership had an overall inhibiting effect on innovation in Canada, and whether on an individual basis parent ties inhibited or enhanced innovation in the Canadian subsidiary. We found that:

- Foreign ownership has had an overall inhibiting effect on innovation in Canada as a result of its impact on market structure, competition, capital markets and Canadian entrepreneurship.

- Foreign-controlled firms have acted as an efficient conduit for transmitting the fruits of new technology to Canada in the form of finished products and processes, but have not generally transmitted the capability to innovate.

The existence of such extensive foreign ownership in the economy is quite unique to Canada among Western industrialized countries.

OVERALL IMPACT ON INNOVATION

Foreign-controlled firms dominate the performance maximizing industries where much of the R & D and innovation should occur in Canada. Chemicals (including pharmaceuticals), aircraft, electrical and electronics, and machinery are the industries in which most of the R & D expenditures occur and the foreign ownership is 75% plus in all of them. In other industries the foreign-controlled component generally has the technological leadership in the industry.*

The overall impact of foreign ownership on the Canadian economy engenders continuing debate.

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* Peat, Marwick and Partners, Foreign Ownership and Corporate Behaviour, Ontario Select Committee on Economic and Cultural Nationalism, 1974.

In terms of impact on innovation, the arguments that its impact is negative are*:

1. Through patent protection, market power, and other entry barriers, foreign-owned companies have inhibited competition in several industries (e.g. automobiles, soft goods), and this reduced competition inhibits innovation.

2. In other industries (e.g. telecommunications, consumer durables, engineering construction) foreign ownership tends to fragment the market and introduce excessive product differentiation for the Canadian market.** Fragmentation is partly the natural business drive of multi-nationals to obtain their market share in Canada, but it impedes the development of innovative capability in individual firms.

3. One comparative advantage of a multinational firm is partly based on transmitting continuous technological development to its subsidiaries, which reduces the need for technological development in Canada.

4. Direct foreign investment has replaced the need for entrepreneurship in financial institutions and in many manufacturing sectors.

There are positive arguments for foreign ownership, although seldom is it argued that foreign ownership has stimulated innovation in Canada. In certain circumstances, foreign-owned companies have stimulated competition and thereby innovation.*** As well, foreign-controlled firms have contributed to the amount of R & D in Canada. However, policies to stimulate foreign direct investment in Canada have not generally been conducive to technological innovation in this country.

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* Primarily drawn from the "Gray Report" - Foreign Direct Investment in Canada, 1972, and the Peat, Marwick reports, op.cit.

** One study shows a particularly strong correlation between foreign ownership in an industry and product differentiation (Eastman, H.C. and Skykolt, The Tariff and Competition in Canada; Macmillan, Toronto 1967 pp. 96-100).

*** For example in the advertising industry, see Peat, Marwick and Partners, Foreign Ownership and the Advertising Industry, Ontario Select Committee on Economic and Cultural Nationalism, 1973.

BARRIERS TO THE TRANSMISSION OF TECHNOLOGY

One apparent advantage of foreign direct investment in Canada is the transmission of new technology to Canada. However, evidence shows that in most industries new product development capability is not transmitted. New technology is introduced as imports or fully developed product lines that need only short production run capability in Canada. For example:

- in the mining equipment, there is little new product development work undertaken in Canada and most equipment is imported directly or merely assembled in Canada*
- in the scientific instrument industry foreign-controlled firms innovate much less in Canada than do Canadian-controlled firms**
- in appliances, Canadian subsidiaries relate to product divisions in the U.S. and not to the parent's R & D facilities that could result in innovation***
- in a comparative study of foreign and Canadian-controlled firms, Safarian concluded that foreign-controlled firms do not make the most of their access to parent technology.****

The research of Professor Crookell at the Western Business School seems to confirm that the foreign-controlled firm does not acquire a real understanding of the technology of its product lines from its parent.

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* Richardson, P.R. et al The Role of Innovation in the Mining and Mining Supply Industries, prepared for the Mineral Resources Branch of the Department of Energy, Mines and Resources, July, 1974. Also, See Peat, Marwick and Partners, Foreign Ownership and the Mining Industry, Ontario Select Committee on Economic and Cultural Nationalism, 1973.

** MOSAIC op. cit.

*** Crookell, Harold, op.cit.

**** Safarian, A.E., The Performance of Foreign-Owned Firms in Canada, Canadian-American Committee, 1969.

Product divisions in the home country interact with the corporate R & D centre, while the Canadian subsidiary does not interact in this way since it must carry all product lines. Where the Canadian subsidiary is given product responsibility there is more development of Canadian innovative capability.

Another problem can occur when the R & D labs established in foreign-controlled subsidiaries in Canada relate primarily to the parent rather than product development divisions in Canada.* This can mean that most of the innovation cycle takes place outside Canada.

However, interviews of foreign-controlled firms in this study led to the conclusion that innovative capability can develop in the following situations:

- when the parent's product line is different from that of the subsidiary
- in cases of exceptional, entrepreneurial Canadian management
- in some cases where companies have had a long presence in Canada.

In some industries, such as electronics, these factors are more prevalent than others. The individual firm impact on technological innovation does not always follow the dominant pattern, and suggests that an examination of the individual firms and industries in each case should be carried out.

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* Bourgeault, Pierre, L. op.cit.

PRIVATE
SECTOR BEHAVIOUR

Companies in the private sector, whether foreign- or Canadian-controlled, tend to be governed by the economic determinants of their industry. There is much more in common between Canadian- and foreign-controlled firms than their differences.* Therefore, governments must be concerned about the behaviour of all companies, rather than exclusively with foreign-controlled companies.

Innovative capability will be located where it appears most in the interests of the company - Canadian- as well as foreign-controlled firms will locate R & D operations in the U.S. if it suits them (e.g. some aspects of agricultural machinery, construction, electronics). In other cases Canadian- and foreign-controlled firms will exploit Canadian R & D in the U.S. (e.g. in pharmaceuticals, transit vehicles, equipment electronics).

In fact, there is Cordell's "iron law" that the head office functions will drift to the larger market area.** This phenomenon is very much industry-specific, since Canada's technological base varies by industry. The advantage to Canada of Canadian-controlled firms is that, while they are growing, much of the innovation is at least initially located in Canada. Nevertheless, in terms of Canada capturing a substantial part of the innovation cycle, both Canadian- and foreign-controlled firms should be subject to the same scrutiny and policy influence.

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* See the conclusion of Peat, Marwick and Partners, Foreign Ownership and Corporate Behaviour, op.cit.

** Cordell, Arthur, The Multinational Firm, Foreign Direct Investment and Canadian Science Policy, Special Study, No. 22, Science Council, 1971.

An emerging development is the joint project arrangement between foreign firms and Canadian firms or government agencies. In some cases Canadian firms hope to acquire foreign technology (e.g. Bombardier reliance on a French firm for transit technology). In other cases foreign firms expect to commercialize on Canadian research. In both cases it is in the interests of Canada's technological development that Canada not simply be used as a market or a research base with no additions to innovative capability.

AREAS OF GOVERNMENT INITIATIVE

The Gray Report favoured selective bias in favour of Canadian-owned companies. To the extent that the Canadian-controlled firm can be relied on to retain its innovative capability in Canada, this approach should be followed. Canadian-controlled company efforts to develop innovative capability in-house should be favoured with government making active use of a 10% to 15% price differential option. However, an opportunistic policy should be supported and advantage taken of potential capability in foreign-controlled firms.

The first problem in trying to promote innovation in Canadian-based firms is to assess whether the Canadian capability can be developed at all. As discussed in the previous section, this requires assessment of the Canadian and international experience curve for a particular product line.

The second problem is how to get foreign-controlled firms (and sometimes Canadian-controlled firms) to develop Canadian capability. The Federal Government has had considerable experience in the negotiation process involved, usually with financial incentives or purchases as an inducement. With the Foreign Investment Review Act the Federal Government has another lever to affect the behaviour of foreign-controlled firms. Such leverage should be used where appropriate as well as the other means of public intervention over all firms.

The third problem is how to guarantee that supporting innovative efforts in foreign-controlled (and Canadian-controlled) firms will be rewarded by the development and maintenance of bona fida innovative capability in Canada. Several hundreds of millions of dollars of support by the Federal Government in a few technology oriented foreign-controlled firms shows that such support does not always buy continued support by the parent organization of innovative capability in Canada, (e.g. United Aircraft, de Havilland). Therefore, the support must be more conditional or backed up by other forms of government leverage.

A final aspect of foreign-controlled corporate behaviour is its relationship to foreign national governments. Negotiations can be conducted more effectively at two levels - with the foreign government and foreign-controlled subsidiary - if the relationship between the two is properly understood. For example, in negotiating resources contracts with a foreign country (e.g. Japan), Canada could seek as a quid pro quo that Japanese firms innovate in Canada.

Government will have continuing negotiations with private sector firms - both Canadian- and foreign-controlled - to increase Canadian technological development capability and innovation. Therefore the Federal Government must acquire a more active understanding of product life cycles, international technological transfer, MNE strategy, as well as experience curve assessment. A greater understanding will strengthen its ability to exact Canadian-based innovation from foreign-controlled firms.

Step 5 in overcoming handicaps to innovation - in addition to supporting the management, financial, and technological needs of the firm, and developing experience curve assessment capability - is for government to be a more astute negotiator with foreign-controlled firms.

VII - SHORTCOMINGS IN GOVERNMENT POLICIES AFFECTING INNOVATION

Government policies (primarily federal) have had a significant direct or indirect influence on the capability of firms to undertake technological innovation. Government macro-economic policies, regulatory activities, procurement policies, science policies and programs, and industrial development policies and programs were investigated to determine how they affected innovation. Some of the findings of this review are as follows:

- Resource development, regional development and manufacturing policies have emphasized immediate job generation to the detriment of stimulating technological capability and innovation in Canadian industry that would have longer term benefits.

- The principal economic regulatory activities of the federal and provincial governments have been set without regard to their impact on the achievement of other objectives, specifically technological innovation.

- Procurement policies have not been used as a conscious instrument of policy to strengthen technological capability and innovation in Canadian industry.

- Despite the stated science policy favouring the support of industrial technological innovation, there has only been marginal implementation in terms of federal support for industrial research and development.

- There is a lack of effective mechanisms to coordinate federal, provincial and company programs in devising and implementing specific industrial policies, which are essential to stimulating innovation.

Broadly compared to other countries, Canada's failure to effectively utilize government policy to foster industrial development and innovation is unique.

The single exception would be the lack of business/government coordination in the United States as well.

ECONOMIC POLICIES

The main economic policy areas are discussed below.

Resource Development Policies

Historically, Canada's resource development objectives have been rapid exploitation of natural resources to create job opportunities and earn foreign exchange. To assist such development, few impediments were placed on the importation of equipment and know-how to support these industries. For example, a free trading zone was established for agricultural machinery and implements between the United States and Canada; and there has been little tariff protection to Canadian manufacturers of equipment for the oil, mining and forestry industries.

Such economic policies have not prevented innovation from taking place in Canada in some of these industries, but they have had an inhibiting effect in others. Briefly, the effects have been as follows:

1. Early strong entrepreneurial effort by one company in particular (Massey Ferguson) and innovative efforts by other firms in the agricultural industry have produced considerable technological capability and innovation in Canada. This technological capability appears to be weakening, however.

2. In the oil industry, refinery development technology has been strictly an imported technology, although recently the Province of Alberta has focused on this aspect of oil industry development.*

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* For a description of how little technological capability Canadian engineering consulting firms have, see Foreign Ownership: Architects and Engineering Consultants, op. cit.

3. The lack of a mining equipment industry and technological development capability in Canada was referred to in a previous section.

4. In the pulp and paper industry, while there has been significant technological innovation among suppliers of pulp and paper machinery, the federal and provincial governments have not had as an effective, coordinated approach to making the industry as a whole respond to industrial development objectives, compared to, for example, Sweden and Finland.*

5. Provincial governments and their Power Commissions have historically purchased hydroelectric generating equipment from the lowest bidder, rather than seeking to develop Canadian technological capability.

Canadian governments are now becoming more concerned about the manufacturing end of the resource business, but past policies have constituted a "government barrier" to innovation. Based upon the discussion of the experience curve in section V, Canada should not attempt to innovate in all these areas, but should at least try in some of them.

Tariff Policy

In general, tariff protection has become a way of life in much of Canadian manufacturing. Companies gear their production to the Canadian market based on tariff protection, and are thus unable to compete in world markets. Tariff policy that has been used to protect manufacturing jobs has not helped foster technological capability.

The MOSAIC study compared a high tariff industry (industrial

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* See the conclusions to this effect in Price Waterhouse Associates, A Study of Taxation Practices Related to the Pulp and Paper Industry, Summary, August, 1973.

EXHIBIT VII-1

COMPARISON OF EFFECTIVE

RATES OF TARIFF PROTECTION

	Nominal Tariff	Effective Tariff[2]
"HIGH TECHNOLOGY" INDUSTRIES[1]		
Tire and Tube	18.4%	41.2%
Printing, Publishing and Engraving	9.7	10.8
Machinery and Equipment	6.4	4.9
Refrigeration, Office and Store Machinery	13.2	18.5
Aircraft and Parts	.5	-3.3
Electrical Appliances	17.0	36.7
Communications Equipment	16.0	26.1
Electrical Industrial Equipment	11.4	15.5
Petroleum and Coal Products	6.7	41.2
Explosives and Ammunition	8.3	11.5
Plastic Resins	4.0	4.4
Pharmaceuticals	12.4	25.4
Industrial and Other Chemical	6.4	8.9
"LOW TECHNOLOGY" INDUSTRIES		
Poultry Processors	17.4	150.9
Breakfast Cereal	18.4	50.4
Biscuit	9.0	11.5
Process Cheese	6.9	10.2
Soft Drink	15.7	27.7
Breweries and Wineries	24.3	61.9
Tobacco Products	25	105.5
Rubber Footwear	22.1	42.9
Shoe Factories	24.3	63.0
Linoleum and Coated Fabrics	22.3	62.3
Veneer and Plywood Mills	15.0	47.4
Paper Box and Bag	19.1	43.4
Boiler and Plate Works	11.3	18.0
Motor Vehicles and Trailer	11.2	37.1
Electrical Appliances	17.0	36.7
Cement and Lime	7.1	11.5
Toilet Preparations	23.1	87.1

Notes:
1. "Low" and "High" technology categories are based on fairly arbitrary selection criteria and are relative terms only.
2. Effective rate of tariff as defined by the author is "the percentage increase in value added per unit of output that is made possible by the tariff structure".

Source: Chard, U.K., "The Effective Rate of Tariff Protection in the Canadian Economy for 1961", Working Paper 7101, Economic Development Division, Department of Finance, 1969. For data the author used the 1961 input/output table prepared by Statistics Canada.

control system) with a low tariff industry (scientific instruments) and concluded that more innovation resulted from industries in which tariffs were lower.* In the former industry, foreign-controlled branch plants imported new product developments, and in the latter, the foreign competition stimulated innovation in Canada.

Tariffs and non-tariff barriers are, however, used by other countries to protect technological development capability. This is apparently the case in the U.S., Japan and Great Britain among other countries. Canada on the other hand, applies high effective tariff rates for many low technology industries, higher than effective tariffs for some high technology industries.

We attempted to compare high and low technology industry effective tariff rates, as shown on Exhibit VII-1. The results, based on a crude assessment of the technology content of specific industries and on 1961 data, cannot be used to confirm that there is a consistent pattern to protect low technology industries more than high technology ones. However, there appear to be somewhat more extreme cases of protection among low technology industries.**

It may seem a paradox that low tariffs can lead to the production of more innovation, while high tariff protection has been used by other countries to protect indigenous technological capability. It is a question

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* MOSAIC, The Effects of Tariffs and Sales Taxes on the Scientific Instruments Industry, op. cit.

** In another tariff paper committee on Trade in Industrial Products, "Preliminary Reports of the Working Party or the Tariff Study", Addendum, General Analysis of Industrial Tariffs and Trade, BTN Chapters 25-99, the nominal tariff averages generally tended to rise from unprocessed materials to advanced finished products for Canada and other Western countries. However, the paper recommended a comparative study of effective protection as being more meaningful.

of timing - e.g high tariffs for a specific period of time with a phased tariff reduction, and of the strength of Canadian firms - re whether they can survive low tariffs. The main point is that Canadian tariff policy has not been set with a view to fostering technological capability.

Some examples will illustrate how tariff policy can specifically pervert the objective of fostering technological innovation. First, a Canadian manufacturer trying to be competitive internationally has to absorb tariffs on supplies that are part of the value added to his manufactured product.*

Second, a Canadian manufacturer of medical or scientific equipment, where there is little tariff protection, has difficulty obtaining tariff protection rulings for specific items. Thus, he cannot gain a foothold in the market and his survival is threatened.** Third, there are cumbersone duty drawback procedures, whereby a firm should be able to obtain rebates on the duty he had had to pay for imported components to his own manufactured product.***

These examples illustrate that tariff policies can hinder innovation, and that overcoming these barriers will require coordination of tariff and other policies.

Taxation Policies

From available studies, it has not been conclusively proved that the general taxation level in Canada has been detrimental to Canadian firms,

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* See the specific complaint of Husky Manufacturing and Tool Works Ltd. referred to above.

** See Atherton, David L. "A Canadian Enigma: Why do we Discriminate Against our own Products?", Science Forum, August 1973.

*** Duty drawback procedures were mentioned by Atherton and in the MOSAIC and our own company interviews.

and hence inhibit innovation efforts in comparison to other countries. However, there is some supporting evidence to this effect. For example, Husky claims the effective corporate tax rate in Canada at 41.6% is higher that the United States at 35.4%. Others refer to the DISC incentives as effectively lowering the U.S. tax rate even more.

In a comparative study of pulp and paper industry taxation practices among four countries, it was concluded that:

> "...the overall Canadian tax system imposes a significantly higher burden on the Canadian pulp and paper industry than do the tax systems of the other jurisdictions on their respective industries..."

Small companies, particularly start-ups attempting technological innovation, have their own problems with tax policies. Their problems are not being able to carry forward losses for more than five years, and not being able to take advantage of depreciation tax shelters (since a small company might take years to generate positive net earnings).

Regional Development Policies

The most flagrantly contradictory federal policies are the technological improvement incentives versus job creation incentives in regionally depressed areas. The federal government's incentive grants to industry are highly concentrated in the industrial heartland of Canada, which tend to increase the disparity between regions in Canada. On the other hand, regional development grants to companies in disadvantaged regions lead to a fragmentation of industry.* Problems with these policies are more fully discussed in the next section.

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* See Bourgeault, Pierre, op. cit., and Peat, Marwick and Partners, Foreign Ownership and the Pulp and Paper Industry, op. cit.

REGULATORY ACTIVITIES

The impact of the federal government's regulation of the financial markets is that specific regulations, particularly in the insurance and banking industries, inhibit the availability of risk capital.

Although we did not select regulated industries for review, such as the food and drug industries, we did hear about cases in which the application of regulations in these areas inhibited specific innovation efforts. Little examination has been undertaken to date of how regulatory activities may hinder the performance of companies, and thereby their innovative activities. Such examination is being undertaken in the United States under the federally-sponsored Experimental Technological Program and would be worthwhile in Canada.

PROCUREMENT POLICIES

There is evidence that, historically, Canadian procurement policies have generally been based on low price and delivery times. They have not been consciously or systematically used to promote the development of Canadian technological capability. Canadian firms still feel that the position of the federal and provincial governments is that "if Americans are using it, it must be good".

Several companies interviewed mentioned cases of orders being placed with foreign-controlled subsidiaries where the technological development then took place outside Canada rather than within the operations of the Canadian subsidiaries. Other firms complained that American

specifications were used by the government, there by biasing procurement toward established products, rather than encouraging innovation.

Various studies confirm the lack of policy to use procurement to stimulate innovation. In the telecommunications industry, firms studies could not understand how one government agency could offer financial incentives to innovate, while another awarded an offshore contract in the same technological field.* In a study of the electronics industry, it was concluded that the Canadian government had not used its procurement policies to the same extent that other national governments had in fostering technological capability and innovation in Canada.** Defence procurement has also been criticized in this way.***

There is some apparent change in procurement practices at present. Specifically, we refer to the attempts being made to brief Canadian producers on future government requirements in electronics. This should respond to a long standing complaint that no notice of needs is given. Another example related to us by a Department of Supply and Services official was the use made of government purchasing of office equipment to foster innovation in that industry in Canada.

While initiatives have been made in certain industries, the Department of Supply and Services has not made significant use of the 10% rule that is at its discretion - to permit the acceptance of other than the lowest tender. Although the application of this and other procurement policies is "under active consideration", the lack of concrete application continues to depress Canadian innovative activity.

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* Communications Canada Working Paper, op. cit.

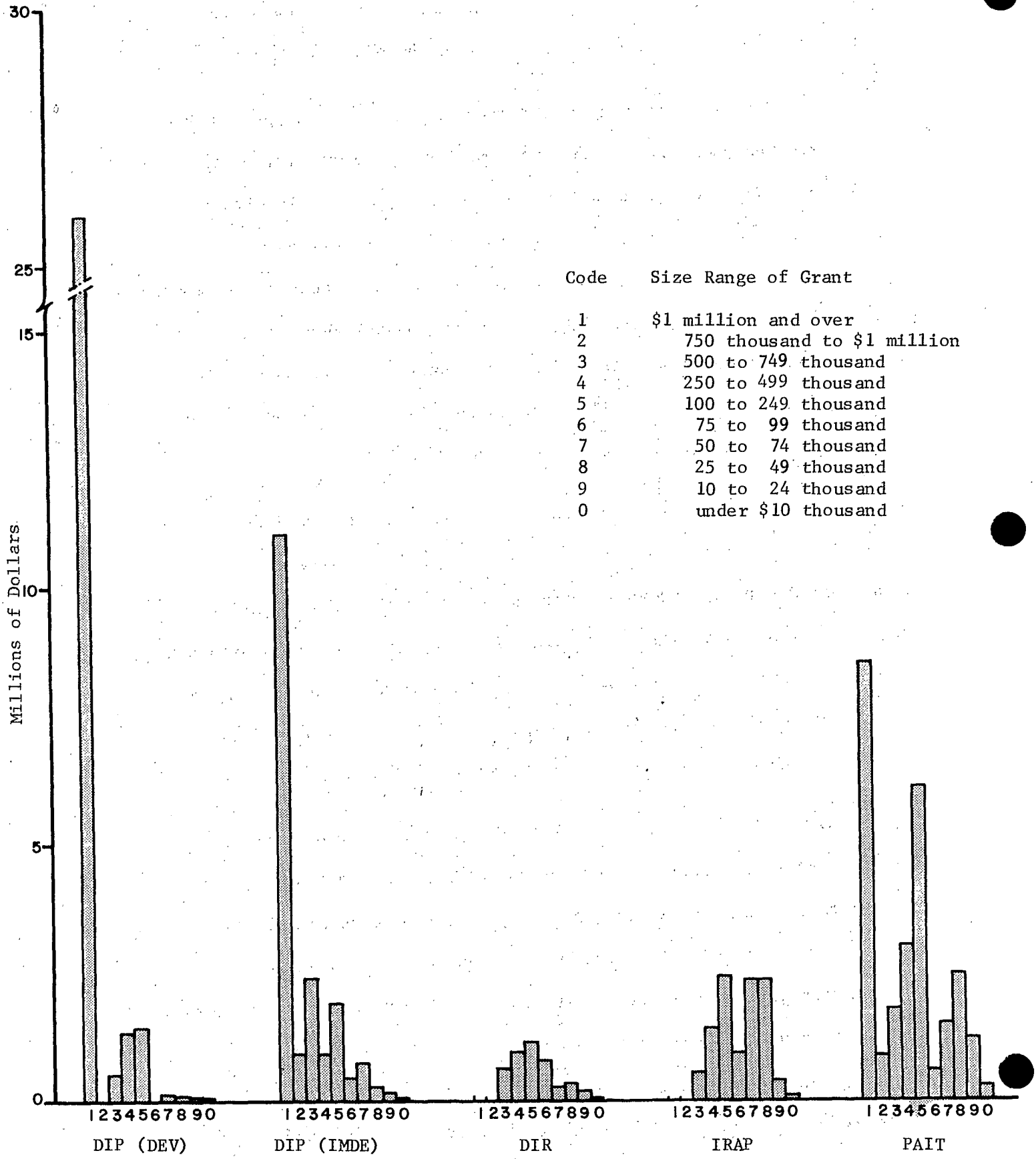
** Peat, Marwick and Partners, Foreign Ownership and the Electronics Industry, op. cit.

*** Pound, C.F.W., The Defence Program and National Industrial Development, Defence Research Analysis Establishment, Report No.34, April 1973.

EXHIBIT VII-2

ALLOCATION OF FUNDS UNDER INDUSTRIAL ASSISTANCE PROGRAMS BY SIZE OF GRANT

1972 / 1973



Source: Dines, G.H., Assistance Grants to Manufacturing Industries 1968-72, MOSST Working Paper, Sept. '74.

SCIENCE AND TECHNOLOGY POLICIES

As the result of several studies in the area of science and technology policies, the federal government has, over the last several years, increased support to technological innovation in industry. However, such policies have had limited impact. This is documented by examining the research contracting-out policies, direct financial incentive programs, and technical assistance services:

1. Research Contracting-out Policies. Although important initiatives have been taken to contract-out scientific research, the dollar value of this research remains at approximately $30 million out of a total intramural federal scientific research and development budget of about $350-$400 million. Government officials have not determined what should be a target proportion for contracting-out research, but emphasize that it would not be as high as 50% of R & D expenditures.

2. Financial Incentive Programs. Government financial incentive programs have likely led to a substantial increase in R & D labs since they account for almost 50% of all private sector R & D expenditures. However, these incentive programs probably do not in themselves more than marginally affect innovation in Canada. The reason is suggested from examining Exhibit VII-2, showing the allocation of funds for five assistance programs by size of grant. Considering the relatively high "threshold" level of investment needed to fund sustained innovation capability, most incentive grants (say those under $1 million), have had only marginal impact on sustained innovating effort.

   A second problem with incentive grants is the complaint often raised by smaller companies, that the incentive programs are not designed to be of help to small companies.

3. Technical Assistance Services. Technical assistance by federal and provincial governments provides useful support services, particularly in the diffusion of existing technology. However, as explained in Section IV, such technical assistance and research and development is not sufficiently integrated with the other operations of the company in the crucial commercialization stage.

The science and technology policies and programs generally leave an impression of being piecemeal, without overall substantial impact. While they could be improved, however, overcoming innovation handicaps involves coordinating industrial strategies as well.

INDUSTRIAL STRATEGIES

The federal and provincial governments have various industry specific programs and regulations. For example, the federal government is developing industry "sector" policies; few, however, are as yet pursued through a coordinated series of specific support programs, regulatory activities, and economic policies. This lack of coordination in industrial strategies among government agencies and between the provinces and the federal government is a handicap to innovation, among other industry objectives.

The federal government seems to act only when an industry is in trouble, as in the garment, shoe and aircraft industries. This is in part a consequence of industry tolerating such intervention only when there is no other alternative. Industry's general resistance to intervention possibly stems from many reasons, including foreign-owned companies' lack of identification with development and from all companies in Canada trying to preserve their own market position.

The lack of a cooperative and supportive government/industry environment hampers efforts to evolve industry strategies. This is unique to Canada and in some respects to the United States, and generally impedes the evolution of innovation strategies as well.*

GOVERNMENT INITIATIVES

In previous sections we have oriented the discussion to what is "missing" in the economy that handicaps innovation - entrepreneurial management, risk capital, adequate technology, and failure to understand the dynamics of technological development and MNE operation. This Section started with the premise that government had already developed a set of policies and programs, and described how they inhibited innovation.

The major government impediment to innovation is fundamental. Government economic policies were designed, out of necessity perhaps, to foster resource development and basic industrialization. To overcome its own handicap government must orient economic policy toward developing technological and innovative capability. Preventing the government from doing so is a lack of an effective industrial - including technological - strategy planning process. Therefore, the major government initiative to overcome its own policy shortcomings which inhibit innovation is to establish such a process. This involves an upgrading of its own technological evaluation capability as discussed above.

Within the umbrella of industrial strategy implementation are specific government instruments. They should be coordinated with these strategies, not planned and implemented independently.

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* This was the particular conclusion of the pulp and paper industry study report (Price Waterhouse, op. cit.). In that industry, Sweden and Finland carry out an assessment and performance review of the economy and the contribution of individual firms within it, and frame an industrial strategy around this process.

Industry strategies are very important in another sense as well. Government policies to improve technological capability and innovation can easily be conflicting, since both (a) consolidating technological strengths and (b) fostering competitive environment are required. In terms of consolidation, government/industry should consider within each industry strategy the following:

- bias of procurement and increased contracting-out to develop Canadian strength
- financial and procurement incentives, tariff and regulatory protection and foreign ownership screening to develop in-house capability in Canada
- technological development leadership through direct undertaking of specific innovation projects.

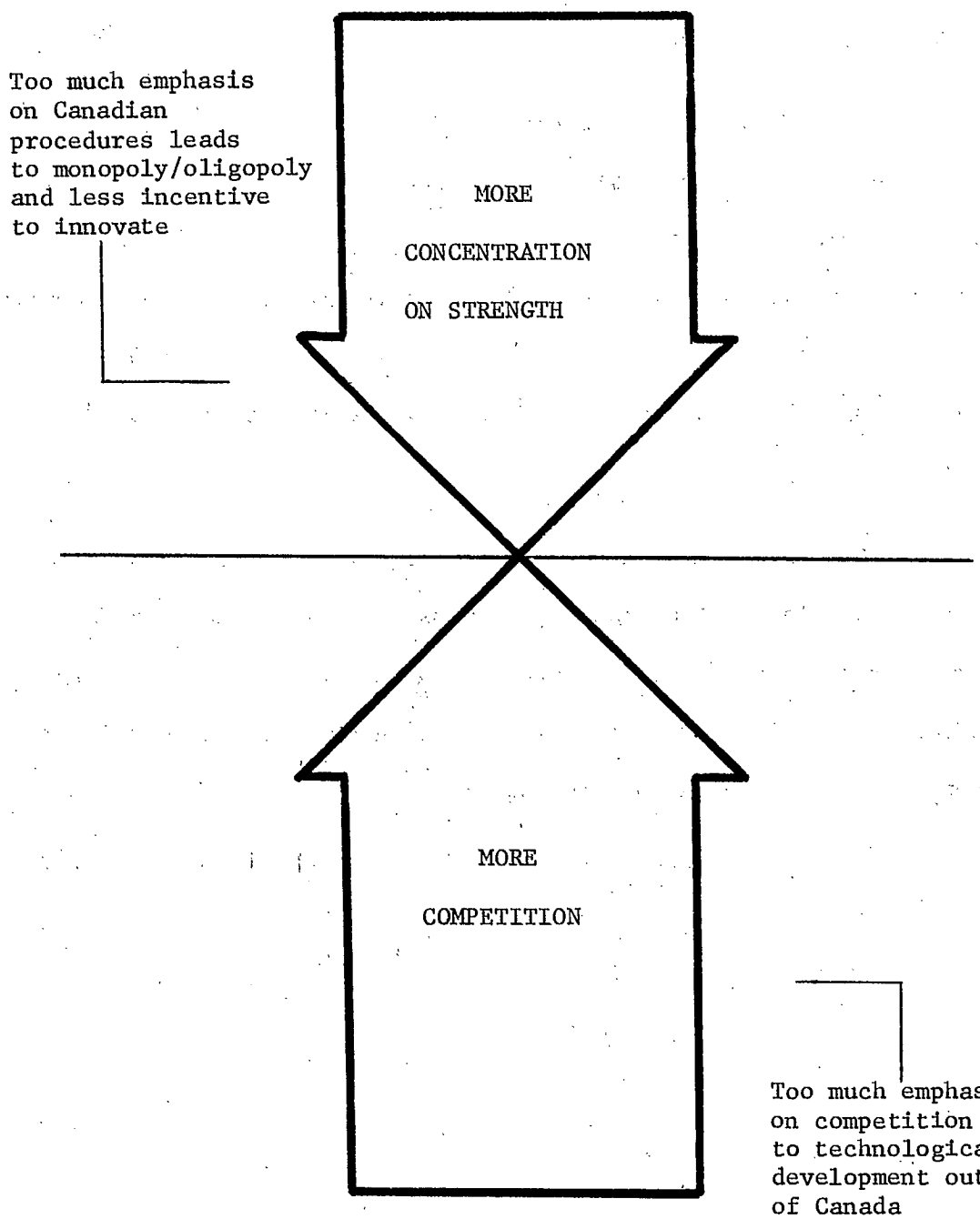
In terms of fostering competition, the following should be examined for each industry:

- use of foreign ownership restrictions to reduce market power of foreign-owned companies in some industries
- planned lowering of selective tariffs to force down Canadian prices and to reduce the large number of models in product lines
- loosening of regulations (including patents, licences) to allow more competitive product development
- more vigorous application of competition policy.

The conflicting policy problem, graphically presented on Exhibit VII-3, must be resolved on an industry basis. In the past the conflicting policies were protection to create jobs versus laissez faire competition.

EXHIBIT VII-3

BALANCING OF CONFLICTING POLICIES



Peat, Marwick and Partners

In the future they should be carefully resolved within each industry in terms of using competition and protection to promote, among other things, technological development.

There are difficult decisions to be made within each industry. However, it is not simply a question of giving one industry priority over another. A government/industry consensus can be reached as to whether the country and individual firms should pursue the development of specific technological capabilities, but each industry will have its own strategy and establishing priorities does not necessarily mean "winding down" another industry.

Step 6 in overcoming handicaps to innovation is to evolve innovation strategies in the context of industrial strategies. More inter- and intra-government coordination, a better understanding of the role of technological innovation in industrial growth, and more effective government/industry cooperation are required.

VIII - HANDICAPS TO REGIONAL INNOVATION

Innovation requires ready access to markets, technology, skilled labour, and financial resources. One of the basic facts of life about Canada is its geographic spread; in investigating the problems of innovation in the "non-heartland' areas of Canada we found that:

- Innovation is more difficult away from the main centres of economic activity than in the industrial heartland. The severity of the constraints to technological innovation increases with remoteness from the industrial heartland.
- Although more severe than in the industrial heartland, innovation barriers can be, and sometimes are, overcome in major centres across Canada.

The regional factor is present in most industrialized countries but the degree to which it is a factor is unique to Canada.

EXISTING SITUATION: LITTLE NON-HEARTLAND INNOVATION

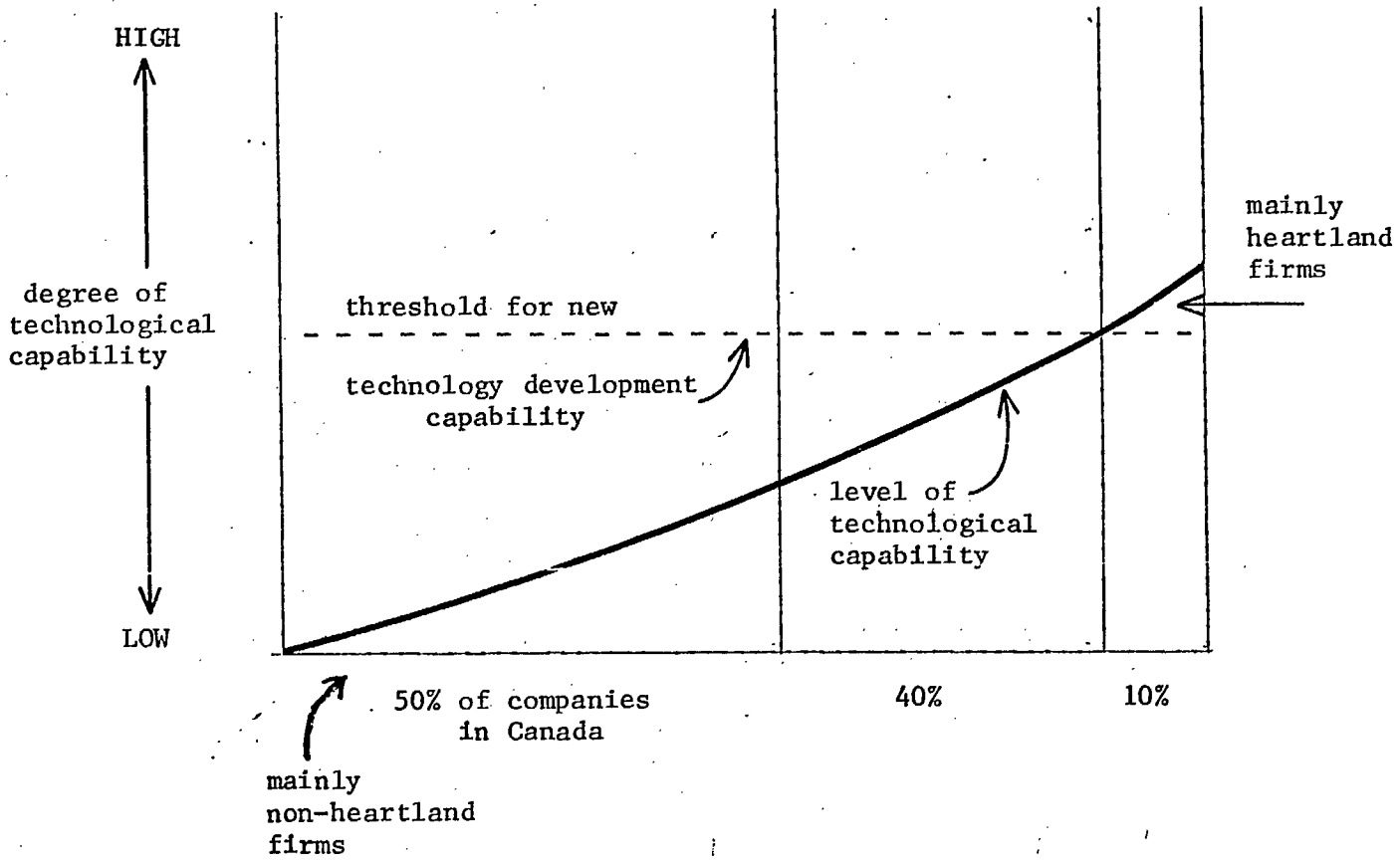
Company officials mentioned a variety of regional factors that impeded their innovation efforts, including:

- the difficulty in obtaining supplies and services in communities distant from major centres
- the burden of shipping rates that reduced overall profitability, and
- the lack of neighbouring companies in the same technological field which mitigates against developing a pool of skilled personnel.

Government officials have recognized this fact and some conclude that diffusion of existing technology is far more important than fostering

EXHIBIT VIII-1

DISTRIBUTION OF TECHNOLOGICAL
DEVELOPMENT AMONG MANUFACTURING FIRMS*



Notes:

- 10% of manufacturing firms are capable of new technological development, i.e. are prepared and able to innovate, and can build on ideas and state-of-the-art technology.
- 40% of these firms are only potential innovators, with many day-to-day technical problems and perhaps only an understanding of their manufacturing process.
- 50% of the firms in the manufacturing sector are simply surviving with only rudimentary technological capabilities.

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* The figures are estimates only based on the experience of the Technical Information Service of NRC and not on a systematic review or study of its client firms.

innovation in regional Canada. Exhibit VIII-1 illustrates how few companies are capable of technological innovation. Most of these are located in the heartland.

There is further documentation that little innovation occurs in disadvantaged regions of Canada. In New Brunswick, for example, none of the grants given by the N.B. Development Corporation are for innovative projects, although some tend to stimulate the transfer of technology to the Province.* An examination of the R & D activities in the Province of Saskatchewan shows that there is perhaps only one firm that is undertaking technological innovation in that province.**

Finally, Exhibit VIII-2 shows that industry and industrial R & D is heavily concentrated in the heartland. In addition, even in relation to its industry Quebec has a disproportionate share of industrial R & D and government R & D incentive grants.

Government Policy
Acknowledgement

Federal and provincial practices seem to reflect the difficulties in technological innovation outside the heartland, as demonstrated by:

1. The tendency of Federal grants for technological development to be awarded in central Canada, as shown on Exhibit VIII-2, matching the tendency for manufacturing to be concentrated there. (There is a conversely disproportionate allocation of DREE funds, but they are not aimed at technological innovation.)

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* New Brunswick Development Corporation, Opportunity New Brunswick.

** Lampart, Alvin, Research and Development Activities in Saskatchewan, Dept. of Regional Economic Expansion, September 1973.

EXHIBIT VIII-2

REGIONAL COMPARISON OF INDUSTRIAL R & D AND FEDERAL SUPPORT

	Demographic, Industry Structure				R&D Intensity in Industry and Federal Support					
	Population ('71) (000,000)	%	Manufacturing Value Added (000,000)	%	Research and Development Establishments Total No.	%	R&D Expenditures by Private Sector ('71) ($000,000)	%	Five I T & C Grant Programs (72-73) ($000,000)	%
Atlantic Provinces	2.1	10	800	4	12	2	2	0.5	0.5	0.5
Quebec	6.0	28	6,100	28	147	27	126	34	37	44
Ontario	7.7	36	11,500	54	308	57	207	56	42	50
Western Provinces	5.7	27	3,100	15	72	13	36	10	4	5
TOTAL	21.5	101%*	$21,500	101%	539	99%	$371	1005%	83.5	99.5%

* Rounding accounts for the per cent figures not equalling exactly 100%

Source: Dines, George, Provincial Disparities in Industrial, R & D, MOSST Working Paper, August, 1973.

2. Until recently, little study of or assistance to technological innovation by the provincial governments.* This is demonstrated by:

   - a large number of grant programs, but little money provided, e.g. $1 million in 1970/71

   - combined expenditures of provincial research councils in 1971/72 was $18 million of which only 41% was work undertaken on a contract basis for private firms

   - industrial loan programs that mainly dovetail DREE programs with little orientation toward technological development.

More recently, some provincial governments have been initiating assistance programs to inventors and small entrepreneurs for technological development. However, this is limited to Ontario, Quebec, and Alberta, which hardly suggests a switch away from the "have" provinces.

The prevailing emphasis of research institutes in non-heartland regions is for "pre-industrial research: rather than "contract research"; the latter implies more direct assistance to private companies and is particularly common in Ontario. The regional emphasis has also been on developing a climate for "entrepreneurs" of all kinds, rather than technologically oriented entrepreneurs.

INNOVATION POTENTIAL IN NON-HEARTLAND

We have shown that there is little innovative industrial activity and little attempt by governments to sponsor it in non-heartland regions in Canada. What makes it so difficult to innovate there?

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* Carmichael, Ted, Provincial Government Industrial Assistance Programs: The Effect of Innovation in Canada, MOSST Working Paper, August 1973.

The "fertile" regions in the U.S. provide some indication of what constitutes a good innovative climate. For example, the Santa Clara Valley alone (near San Francisco in California) has 150 venture capital firms, a high propensity for spin-offs from universities and companies, a very open communications network and high mobility among technically oriented people, and a high propensity for entrepreneurship. The area is strong in semi-conductors, lasers, biology, and medicine, and cross-functional innovation in these fields abounds.

It would first seem that such an environment is very difficult to reproduce in Canada. However, an examination of the innovative environments in the United States shows that innovation is not correlated with population, can change very rapidly, and is very localized. For example, the comparison study of Boston versus Philadelphia showed an innovative climate in the former and not in the latter.* Innovative climates seem to require entrepreneurs, venture capitalists used to technologically oriented proposals, and institute or university technology centres that encourage spin-offs.**

As we have pointed out above, Canada is weak in entrepreneurship. Also, venture capitalists are heavily concentrated in major centres, as the following indicates:***

Location	Number of V-C Firms
Vancouver	5
Calgary	3

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* Deutermann, Elizabeth P., "Seeding Science-Based Industry", Business Review, May 1966

** See the conclusion of U.S. Dept. Commerce, Technological Innovation: Its Environment and Management (the "Charpie Report"), 1967

***McQuillan, Peter and Howard Taylor, Sources of Venture Vapital: A Canadian Guide; Information Canada, 1973.

Toronto	24
Montreal (region)	18

Canada does have, however, a more regionally based R & D infrastructure within the federal government and universities, compared to the private sector. This is shown by Exhibit VIII-3. Given this base of technical skills, there is a potentially hospitable climate for innovation in at least one centre in every Western province, and one or two centres in the Maritimes (besides the heartland areas).

Recent scientific research contracts to small companies by the Department of Supply and Services have demonstrated that there are small firms in non-heartland regions with innovative capability. The federal official interviewed called innovative activity in these small firms a "Canadian Route 128" (comparing it to the innovative environment of the area surrounding Boston) polarized around several centres strung across the country.

If, through increased federal contracts (which provide the all-important "demand pull"), an infusion of venture capital can pull research out of the universities and government into the market place, then regional innovation is possible in at least several major centres across Canada.* If not, then new firms will not start and Americans will continue to commercialize the brightest research products of our university people.

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* This potential has also been suggested by John Hodgins, "Academic Spin-offs and Canadian Entrepreneurship", Business Quarterly, Spring 1972

EXHIBIT VIII-3

COMPOSITION OF R & D BY REGION ('71)

($000,000)

	Total	Atlantic		Quebec		National Capital		Ontario		West	
Private Sector	$371	$ 2	0.5%	$111	30%	$ 40	11%	$182	49%	$36	10%
Federal Government	288	26	9	17	6	132	46	51	18	62	22
Universities	237	11	5	60	25	8	3	96	40	62	26

Source: Extracted and rounded from Table #1, Regional Research and Development Expenditures, 1971, Science Statistics Section, Education, Science and Culture Division, Statscan, Apr. '73.

It is encouraging to note that a number of innovative electronics firms located in the Toronto area are successfully carrying out innovative development of solid state components and products, a small scale version of "Silicon Valley" in the Santa Clara area which was referred to earlier.

LARGE SCALE INNOVATION

Although it is possible to conceive of an attractive scenario based on development of the Canadian route 128, large scale innovation might seem destined to be restricted to the heartland region. As shown above, R & D is even more concentrated in central Canada than is the manufacuring sector of the economy. Since there appear to be so many natural forces working against large-scale innovation in regional Canada, the logical conclusion is to continue to emphasize the strong areas, and thus the heartland of Canada.

Aspirations in the East and West, however, are different. There is a fairly even proportion of college and engineering students across Canada, although there is considerable variance among the provinces.* The Province of Manitoba wants to stimulate innovation in the transit and and aircraft business, based on two strong local firms; the Province of Saskatchewan wants at least to establish technological capability in meat food packing and processing; Alberta wants to process as well as produce oil; New Brunswick, automobiles.

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* For more details, see Table 2, Some Indicators of Provincial Scientific Activities, and the Scientist Statistics Section Report, Statistics Canada, op. cit.

Innovation and technological activity by large firms is desirable to sustain the demand pull for innovation by smaller firms. Direct government contracts must be balance by private sector purchasing. However, there is no incentive for larger corporations to chase suppliers in non-heartland regions. More large scale technological development capability located outside the heartland would be required to stimulate small, innovating suppliers.

While there is no easy way to promote technological development, one possible direction is for specialization agreements among provinces. In this way, some support could be given to technological development away from the heartland. However, regional specialization is only a limited answer, in that in many parts of the country there is little opportunity to achieve specialization in any major technology.

POSSIBLE GOVERNMENT INITIATIVES

There will be a continuing conflicting policy focus in Canada - regional versus technological development. However, the elements of a strategy to create the opportunities for some innovation dispersion were suggested above. In essence, they are:

1. Stimulate technologically-oriented entrepreneurship among government and university researchers, and promote risk-capital availability in regional centres.

2. Examine the potential for some regional specialization and promote the development of specific technologies, based on provincial strengths as well as aspirations.

The provinces may well take care of the problem themselves, based on economic and political resurgence in the West, Maritimes and Quebec. The federal government should continue to support technological strengths, but recognize that they are perhaps not all in heartland Canada.

Step 7 in overcoming handicaps is to ensure that innovation policies are adjusted to capitalize on human resources strengths across the whole of Canada.

IX - CONSERVATISM AS A HANDICAP TO INNOVATION

We examined whether conservatism was a factor in the relative lack of innovation in Canada, and found that:

- Self-image and other indicators of conservatism tend to show that Canadians are conservative as consumers, investors, lenders, and businessmen, and that this conservatism inhibits innovation.
- It is impossible to determine whether this conservatism is justified since risks are higher than in the U.S., or whether this is an inherent Canadian characteristic.

Compared to Americans, Canada's self-image of conservatism is high. Comparisons with other countries are not made.

CANADIANS AS CONSUMERS

In a study of the attitudes of Canadian and American business executives toward risk-taking, Canadians were deemed to be more conservative consumers than Americans.* Thirty-one per cent of the Canadian versus 1% of American respondents agree with the statement that "people in this country are less willing to try new products and services than people in other countries". In our interviews, some firms also mentioned that Canadians show a greater product resistance than Americans. However, this could be because:

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* MacCrimmon, Kenneth et all, Risk Attitudes of Business Executives Interim Report, University of British Columbia, 1974.

- Canadians as a whole have less disposable income than Americans
- there are fewer products or models from which to choose
- there is a much lower rate of advertising and in expenditures in Canada on a per capita basis than in the United States.

Therefore, when Canadians are termed "conservative" in their consumer behaviour, it is possibly more attributable to the lower level of disposable income, selection of goods, and advertising and promotion compared to the United States.

CANADIANS AS INVESTORS

The amount of money Canadians have invested in life insurance is astonishingly close to the amount the Americans have in life insurance (about $94 billion compared to $159 billion).* This, and other indicators of our propensity to make relatively safe investments (e.g. we have about $25 billion in bank savings accounts) is being used to argue that Canadians are conservative investors. Possibly, once again it reflects our tendency to place our relatively limited disposable income in safe investments, given the lack of attractive alternative opportunities.

INSTITUTIONAL LENDERS

Based on our interviews and the results of other studies,** we would conclude that Canadian lenders are more conservative than

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* Grasley, Robert, op. cit.

** See Litvak and Maule, op. cit. and Robichand, op. cit.

merican lenders. This conservatism is attributed by some to differences in the banking system.*

The performance of Canadian versus American bankers as lenders is difficult to compare, since the structure of the two banking systems is quite different. The Canadian bank manager in a branch banking system will have somewhat less authority than his U.S. counterpart in a unit banking system, and thus be a more conservative lender. The answer may also be that it is easier to appear to be less conservative in the United States where there are better investment opportunities than in Canada.

CONSERVATISM OF BUSINESSMEN

There are some specific indications that Canadians are conservative as businessmen relative to Americans.

One example of apparent conservatism is in the question of hiring new personnel. It was the opinion of an experienced technical placement officer that Canadian companies are extremely conservative in gambling on the ability of an engineer if his experience is not quite applicable to the job opening. This kind of "Canadian disease", as he called it, obviously lessens the versatility of the skilled work force.

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* MacCrimmon, found little difference between Canadian and American business executives on this subject. In response to the statement "if a small business has a good idea with a significant market potential, the necessary financing can be obtained", 76% of Canadians and 82% of Americans agreed. However, the key words of "with significant market potential", and the respondent group being business executives, means that the results are not quite appropriate here.

Another example is the conservatism of professions. The engineering profession, in particular, remains at a comparative disadvantage with U.S. and British counterparts because of its reluctance to accept changes. For example, Canadian engineering professions have been slow to accept the practices of the engineering consultant also being the engineering contractor, thus losing out on important contracts.*

The conservative attitude of many Canadian businessmen was confirmed in MacCrimmon's study. About 90% of both Canadian and American business executives agreed with the following statement: "Canadians exhibit a lower level of entrepreneurship and business initiative than Americans." There was at the same time an almost unanimous response to the general proposition that "Americans are more likely to accept risk than Canadians".**

Again, these findings may also show that there is a lack of similar opportunities as in the U.S.A. to reap adequate financial rewards from the risks.

CONCLUSION

It can be argued that the development of social mores of Canada has led to a more conservative society. The Canadian industry can be characterized as more stable, evolutionary, traditional, and class- or ethnic-structured than the United States. It is also possible that reliance on our natural resources development and foreign ownership has

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* Peat, Marwick and Partners, Foreign Ownership: Architects and Engineering Consultants, op. cit.

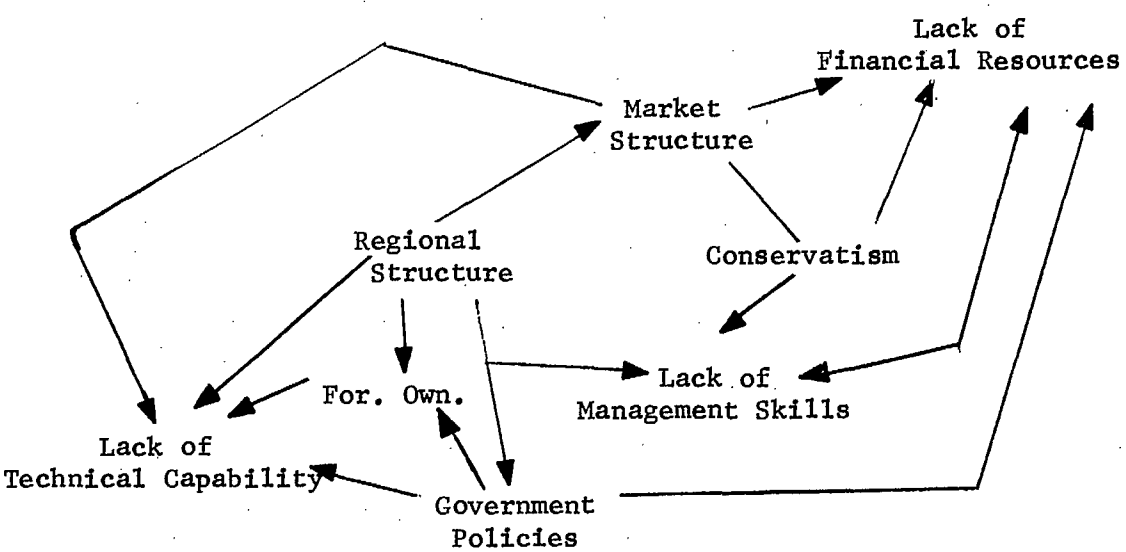
** MacCrimmon, op. cit.

dampened the challenge to innovate. However, general hypotheses of this nature are very difficult to substantiate.

While there may be evidence that Canadians are conservative, it is more difficult to prove that there is anything inherent about this characteristic. Rather, economic realities have dictated a conservatism among individuals and institutions with respect to innovation. Real handicaps, then, may be basically more economic than social, and should be approached from this point of view.

EXHIBIT X-1

INTER-RELATIONSHIPS OF BARRIERS TO INNOVATION



Peat, Marwick and Partners

X - HANDICAPS: RELATIVE AND CUMULATIVE IMPORTANCE

In previous sections, and in the appendices, we have described handicaps to innovation in a number of ways, as well as discussing how to overcome them. This section addresses their relative importance and assess the implications of not overcoming handicaps.

OVERALL AND RELATIVE IMPACT OF HANDICAPS

In our view attempting to isolate the quantitative impact of specific handicaps would be spurious. The handicaps are too inter-related, as discussed throughout this report and as illustrated in Exhibit X-1.

Overcoming one handicap area will only marginally affect innovation in Canada. This conclusion means that attempts to stimulate innovation through one set of policies or programs will not work. For example, the intricate set of incentive grant programs over the last decade have perhaps increased R & D, but have not succeeded in substantially increasing innovation in Canada. They have been swamped by the various handicaps to innovation.

On an overall basis, there are perhaps some rough benchmarks which show the cumulative effect of the barriers to innovation. First, several performance indicators of innovative activity all show Canada to be well down on the list of industrially advanced countries. Exhibit X-2 reproduces data from the Gray Report and establishes that we must have more than our share of handicaps.*

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* Much of the data is ten years old, but more recent figures on patent royalty receipts and number of patents, shown in Section IV, and in trade figures, shown below, suggest Canada's position has not improved.

EXHIBIT X-2

FOUR PERFORMANCE INDICATORS OF TECHNOLOGICAL INNOVATION IN TEN INDUSTRIALLY ADVANCED COUNTRIES*

Indicators / Country	Number of Industrial Employees ('000)	I. Location of 100 Significant Innovations since 1945			II. Monetary Receipts for Patents etc., 1963–64			Percent Share of 10 Countries' Mfd. Exports	III. Number of Patents Taken Out in Foreign Countries, 1963			IV. Export Performance in Research-Intensive Product Groups 1963–65			Composite Rank
		Absolute No.	With USA Base 100	Rank	Absolute $ million	With USA Base 100	Rank		Absolute No. (000's)	With USA Base 100	Rank	% Share of 10 Countries	With USA Base 100	Rank	
Belgium	1,645	1	20.6	5	7.9	34.2	5	5.8	1.8	12.4	10	3.0	37.6	10	8
Canada	2,428	0	0	10	6.2	18.3	8	5.5	1.9	13.9	9	2.0	38.3	9	10
France	7,940	2	8.5	8	46.3	41.9	4	9.8	9.3	38.1	6	6.5	48.2	8	6
Germany	12,385	14	38.3	4	49.4	28.7	7	18.1	29.9	64.7	2	21.1	84.7	2	3
Italy	7,776	3	13.2	7	9.9	9.1	9	7.5	4.6	24.6	7	5.7	55.2	6	7
Japan	17,129	4	7.9	9	5.9	2.4	10	8.1	3.5	17.4	8	5.9	52.9	7	9
Netherlands	1,847	1	18.3	6	26.0	101.2	1	5.9	6.4	43.6	5	5.9	72.7	5	5
Sweden	1,535	4	88.4	2	7.1	33.3	6	3.5	3.8	43.7	4	4.0	83.1	3	3
U.K.	11,798	18	51.8	3	76.1	46.4	3	13.2	15.2	45.2	3	13.9	76.5	4	2
U.S.A.	25,063	74	100.0	1	386.7	100.0	2	22.6	56.3	100.0	1	31.1	100.0	1	1

*SOURCE: OECD Document SP(7) 1, Table A.1.

NOTE: For indicators I and II the ranking was derived by dividing the absolute values by the number of industrial employees to correct for country size. For indicators III and IV the ranking was derived by dividing the absolute values by the percentage share of the ten countries' manufactured exports.

Source: P. 119 of the "Gray" Report

A second important indicator is the seemingly underdeveloped level of expenditures on the manufacturing and commercialization phases of the innovation process. Statistics Canada has been attempting for a few years to obtain better data on the breakdown of expenditures for technological innovation. Although the data base is not yet totally adequate, there is a persistent tendency for R & D expenditures to be about half total innovation costs. For example, in 1973, $420 million was spent by industry on R & D, while the combined expenditures from the other phases of the innovation process (defined as marketing, patent, finance and organization, production engineering, tooling, and manufacturing start-up) were reported as $351 million.* R & D expenditures vary by industry but are supposed to be accounted for only a small part of innovation costs.** While companies may be under-reporting innovation costs, the initial survey results show at least a substantial shortfall in downstream innovation expenditures relative to what one would expect from the R & D expenditures.

How can a quantitative measure of the impact of the handicaps be expressed? One very crude way would be to compare Canada's industrial R & D with other industrialized countries, speculate how much more Canada would do if the major handicaps were overcome, and how much more would be spent on the other phases of innovation.

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* Statistics Canada, Estimates Based on Preliminary Data from Unfinished Survey, 1973.

** In the "Charpie" Report, op. cit., the figures of 5% to 10% were used.

EXHIBIT X-3

TOTAL EXPENDITURE ON R & D AND INDUSTRIAL R & D AS PER CENT OF GNP AND RANK ORDER

1971

Country	Total R & D	Rank Order	INDUSTRIAL R & D	
			Total	Rank Order
Canada	1.13%	7	0.46%	8
Denmark (1970)	0.92	9	0.44	9
Germany	2.05	4	1.39	3
Japan	1.70	5	1.13	5
Netherlands	2.11	3	1.27	4
Norway (1970)	0.98	8	0.49	7
Sweden	1.49	6	0.96	6
United Kingdom (1970)	2.18	2	1.40	2
United States	2.63	1	1.75	1

Note: Based on OECD figures (preliminary) and Gross Domestic Product figures from United Nations.

SOURCE: MOSST, Statistics on Canadian Research and Development, May, 1974

Exhibit X-3 shows Canada in comparison with other countries. If R & D expenditures were doubled to $840 million from the existing $420 million, then Canada's per cent total would also double from .46% to .92% of GNP as per Exhibit X-3. Canada's rank would then be approximately that of Sweden, but still below U.K., U.S., Germany, and Japan. Also, suppose that R & D represents one-quarter of all innovation expenditures (instead of half as it now appears to be, but not as low as 5% to 10% supposed to be typical according to the "Charpie" report). Then, if the $840 million is a quarter of the innovation costs, the expenditures on the other phases of innovation would be roughly $2.5 billion (as opposed to the $351 million as presently reported).

The impact of the handicaps to innovation is two to three billion dollars, if these additional R & D and other phases of innovation expenditures are assumed. Again, it is stressed that such calculation is very crude and does not consider secondary economic or trade implications. A closer approximation might result from a sector-by-sector examination of the impact through input/output tables; however, the whole exercise is somewhat artificial unless it is pursued in the context of the implication of future programs and policies.

Relative Impact of Handicaps

While it is impossible to estimate on a quantitative basis the impact of specific handicaps, there are some handicaps which appear more significant than others.

First, the fundamental handicaps to innovation in Canada are the most important. They are:

- the lack of incentive through reliance on natural resources exploitation to finance our high standard of living, without our having had to compete technologically for it
- national policies fashioned out of our small population base vis-a-vis the United States, which has led to a protected secondary industry with high foreign ownership
- fragmented, socially parochial populations bottled up by geographic and political barriers as compared to the United States.

A proper articulation of these handicaps would possibly follow a thorough historial political/social/economic analysis. However, in terms of explaining today's handicaps to innovation, these historical forces are most important and fundamental.

We can also comment generally about the relative importance of overcoming the handicaps discussed in this report, as follows:

- the lack of management capability handicap is crucial
- creating more risk capital is important, although it must be accompanied by more entrepreneurial management; in fact, more entrepreneurial management will lead to more capital being invested in technological innovation
- developing a better technological base in specific industries through diffusion of technology is fundamental to large scale innovation
- overcoming the small, fragmented market handicap is interdependent with developing technological capability and thus fundamental

- foreign ownership in general as a consequence of Canadian economic policy is a pervasive barrier; acting to increase Canadian innovative capability in these firms is necessary due to the high foreign ownership in technologically-oriented industries

- overcoming the chief "government" barriers of lack of coordination and poor industry/government consensus mechanisms is a pre-condition to effective action

- regional barriers are an important handicap but not crucial to technological innovation in Canada

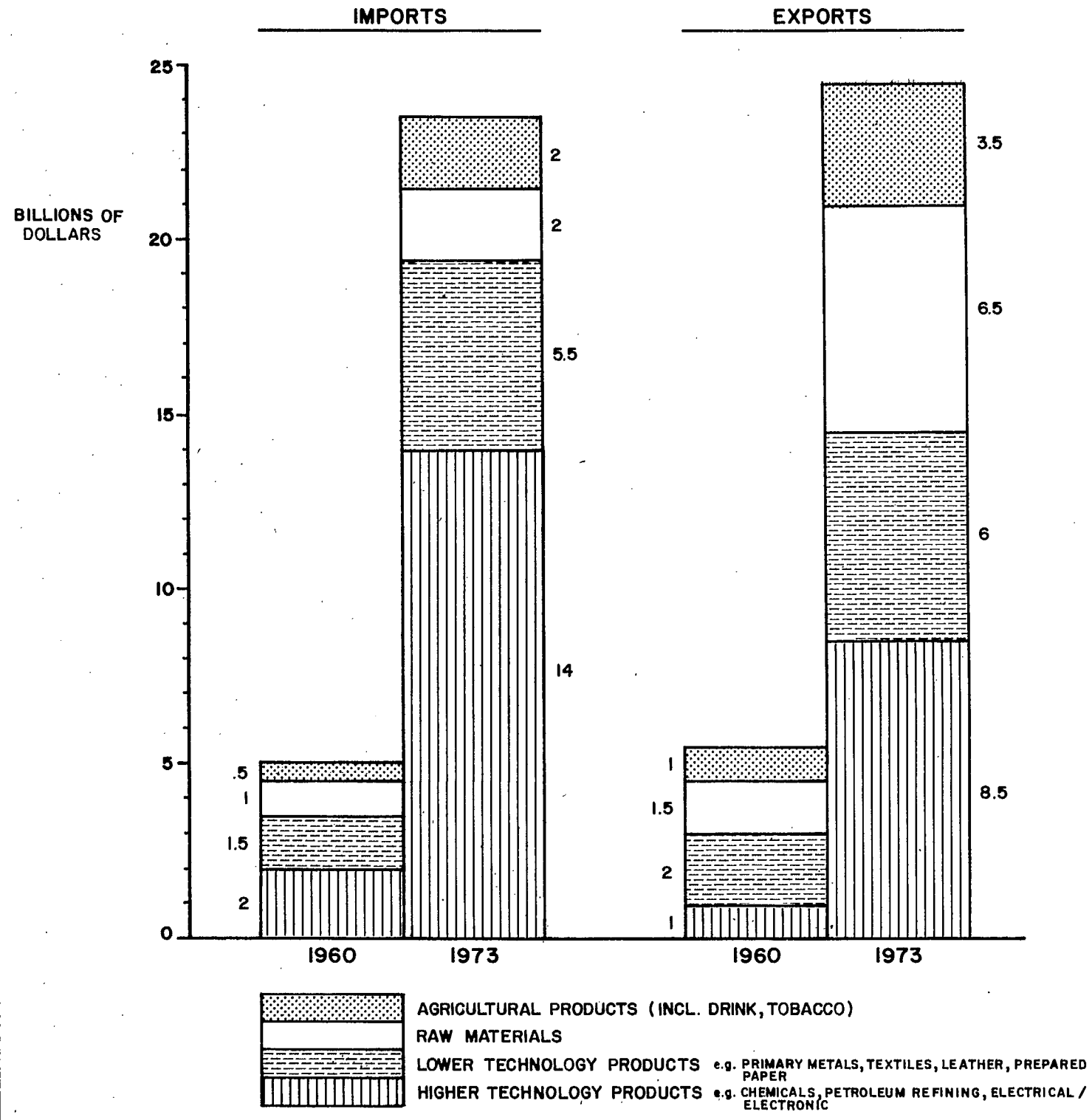
- the conservatism of Canadians will tend to fade as risk taking becomes more successful, but a persistent conservative self-image will continue to have a pervasive impact.

The relative importance of handicaps, then, is judgmental. However, the essential handicaps can be restated as: (a) the lack of competitive forces to drive down prices and indirectly costs of production in Canada, resulting from the protected manufacturing environment, (b) the "dumping" (not in its strict economics sense) of technology into Canada by foreign-owned firms, and (c) the lack of adequate nurturing of technological development capability in Canada through government procurement, financial incentives, and induced mergers.

As explained in section VII, there is a conflict between increasing competition and consolidating the technological base in Canada. The <u>real</u> handicap is the inability of government and industry to develop strategies on an industry by industry basis to overcome handicaps through complementary - not conflicting - policies and programs.

EXHIBIT X-4

COMPOSITION OF CANADA'S IMPORTS & EXPORTS 1960 & 1973*

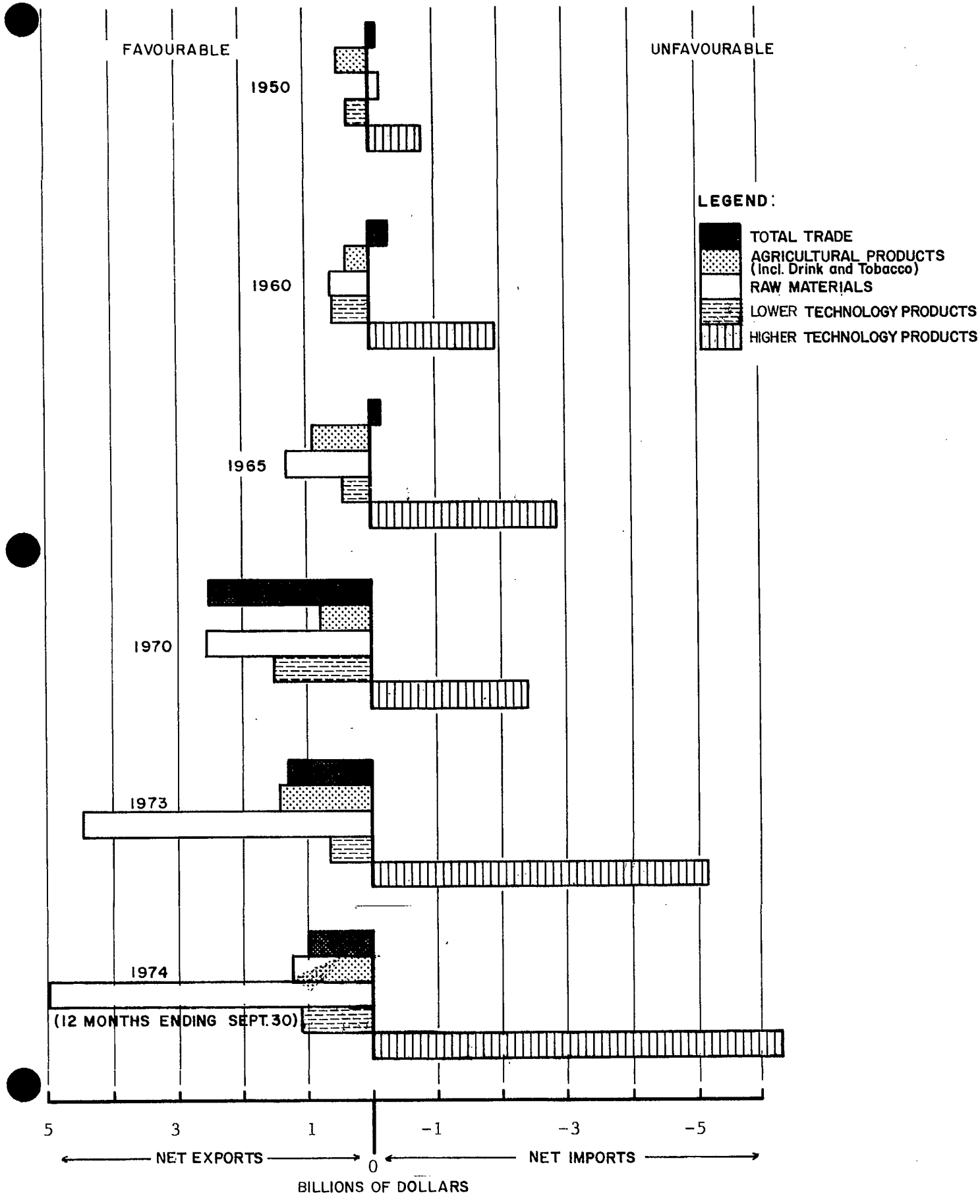


Source: Dines, G.H.O. The Impact of Technology on Canadian International Trade, MOSST Working Paper, Sept. 1974.

*Figures are rounded from graphs presented; dollars are not constant.

EXHIBIT X-5

CANADIAN INTERNATIONAL TRADE BALANCE IN MERCHANDISE GOODS



IMPLICATIONS IF HANDICAPS NOT OVERCOME

Technological innovation - as well as the diffusion of existing technology - is important to the international competitiveness of Canadian industry (and services). Therefore, the implications of a failure to overcome handicaps to industrial innovation are linked to the implications of not being internationally competitive.

Any number of possible scenarios could be drawn about the future Canadian economy/society if innovation handicaps are not overcome to any significant degree. To begin with, we might examine the overall economic situation of Canada.

First, in the service sector Canada has an increasingly unfavourable balance of payments. Although recent data on the composition of the service sector trade imbalance is not available, it appears especially unfavourable in "knowledge-based" services.*

Second, Canada's merchandise goods trade position has been deteriorating in terms of higher technology products. Exhibit X-4 shows how important trade in higher technology products has become in the composition of imports and exports, and Exhibit X-5 portrays the growing unfavourable balance of trade in this category.

While these figures might be interpreted as positive signs of technological development - since higher technology exports have risen dramatically - the composition of higher technology exports and imports

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* See MOSST, Canadian International Trade Statistics, May, 1974: in 1969 the "knowledge-based" services formed $460 million out of a services unfavourable balance of $600 million, in a total trade of $3.1 billion.

bears further examination. About $6 billion of both imports and exports can be attributed to the Auto Pact.* Therefore, excluding autos and auto parts, Canada exports roughly $2 billion of higher technology products and imports around $8 billion.

It would be rash to draw a trends conclusion that Canada is becoming more of a "hewer of wood and drawer of water". Nevertheless, it is not implausible to argue that the Canadian economy is heading into some structural problems which can have distrubing consequences.

The scenario of an increasingly unfavourable balance of trade in higher technology products if that continues to happen, is as follows:

- Canada will be in a more unfavourable negotiation position in terms of international trade, and will have to export more resources, agricultural products, or lower technology products to pay for higher technology products

- increased resource production (energy, agricultural and mining) will require investment from foreign sources. Accompanying this imported capital, whether it is debt or equity, will be foreign technology and control

- the impact of a more resource oriented economy will be felt in terms of job distribution: few unskilled "clean" or skilled jobs, but some increase in "dirty" jobs**

- national price in technological development, control over the ecology, and ability to focus on specific technological development would also suffer.

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* Dines, G.H.O. op. cit.

** A Federal Government official ranked the following types of employment in terms of Canada's preference: unskilled "clean", skilled, white collar, engineering/professional, scientific, unskilled "dirty".

Canada has constraints on her options, in the sense that other countries will demand we export resources, and will unload very competitive higher technology products in return. However, Canada still should be in a better bargaining position with a sounder technological base than in the present case.

There are other less macro-economic implications for not overcoming handicaps. It is quite possible that progressively fewer companies will innovate independently from direct government stimulation. That is, although government might contract out more R & D, the private sector will increasingly attempt innovation only in response to substantial government incentive.*

A consequence to such increasing direct government intervention, could be continued expensive experiments in glamour technological development. Projects are largely pursued on an ad hoc basis at present. If government fails to assess its ambitious undertakings without first an experience curve or similar analysis, many costly decisions will be made with little chance of reaping benefits from international sales.

In summary, there are two basic potential implications for not overcoming innovation handicaps, (a) serious, structural and economic problems, and (b) reduced technological development capability, which can foreclose economic options.

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* To be noted too is the rather jarring prediction of IBM that industry participation in R & D expenditures by 1980 might be only 7% of the total as opposed to 38% in 1967. See Streight, H.R.L. "The Climate for Research in the Seventies" op. cit.

XI - STRATEGIC IMPLICATIONS AND IMPLEMENTATION

In the previous section we have described the implications of not overcoming the handicaps to technological innovation. Since these handicaps are inter-related and extremely deep-seated in our society, it requires a coherent and far-reaching strategy to overcome them. To this end we reommend the following initiatives:

- Establish mechanisms with risk capital resources and technical/managerial assistance to stimulate innovation at the inventor and small entrepreneur level.
- Create a supportive environment which encourages small- and medium-sized firms to respond to innovation opportunities.
- Establish technological evaluation capability, and monitor the Canadian technological base and international technological changes.
- Develop with companies, industry technology strategies which will be integrated with overall industry strategies.
- Exercise leadership in promoting substantial Canadian innovation and technological development using government and industry resources.

Canada could establish the following institutional mechanisms to carry out the initiatives described above:

(a) A quasi-public organization to stimulate and support inventors and small entrepreneurs.

(b) A technological analysis and evaluation function that can assist industry in identifying technological development opportunities which are realistic from a Canadian perspective, and identify opportunities which may need to be taken up by the public sector.

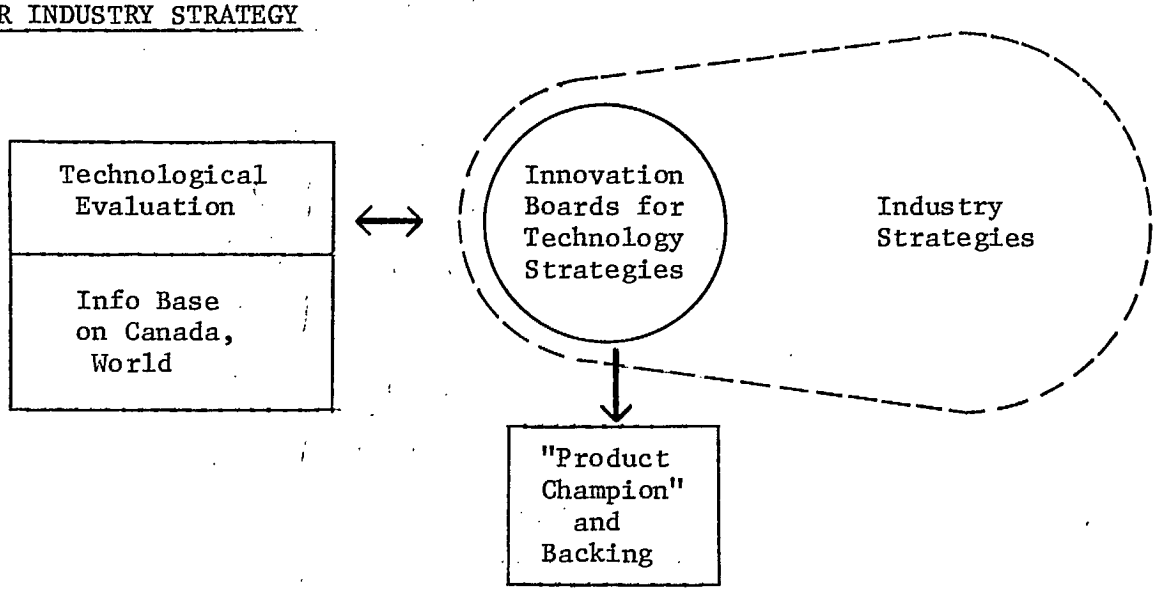
(c) Innovation Boards with public and private representation to determine technology strategies on a sectorial basis.

EXHIBIT XI-1

STRATEGIC IMPLICATIONS TO OVERCOME INNOVATION

STRATEGY OF ENCOURAGEMENT AND DIRECT ASSISTANCE TO INNOVATORS

INNOVATION WITHIN BROADER INDUSTRY STRATEGY



Peat, Marwick and Partners

(d) A "Product Champion" function with proper backing to exert leadership in specific innovation and technological development programs.

The basic elements of this strategy and its implementation are sketched on Exhibit XI-1.

FOCUS OF STRATEGY

Attempts to reduce handicaps to innovation should, of course, be compatible with overall government objectives. The economic objective of innovation could be stated in terms of international competitiveness, and thus job diversity and greater autonomy in industrial decision-making. The point is not to define government objectives but to situate innovation in its role related to economic objectives rather than isolate innovation as an end in itself.

Industrial innovation strategy can be viewed from two dimensions, as shown on Exhibit XI-1. First, an environment should be created to at least encourage innovation wherever it may be attempted in Canada, with specific assistance provided where appropriate. Second, Canada requires technological development strategies, which must be related to industry strategies. Therefore, the overall strategy to overcome handicaps should focus on both the innovator and his efforts, and on the role of innovation in promoting industry specific objectives.

ENCOURAGEMENT AND DIRECT ASSISTANCE TO INNOVATORS

To overcome innovation handicaps, there should be mechanisms to seek out and respond to Canadian creativity and technologically-oriented entrepreneurs.

Support for Inventive Creativity

An analysis of the handicaps to inventors and potential entrepreneurs points to the need of a supportive mechanism with the following features:

- it should have its own "seed" money, and capability to act as the financial broker between financial institutions and inventors and small entrepreneurs
- it should have technical review capability to evaluate project potential and act as the broker to seek means of exploiting the ideas or inventions
- it should help establish entrepreneurial training for inventors and potential entrepreneurs.

This supportive mechanism should be a quasi public organization, drawing on private sector business and technical expertise. Although funded by government, it should be apart from it and readily accessible to inventors and small entrepreneurs. Organization models of other countries should be studied to determine how it should be established including, the NRDC in the United Kingdom, the Swedish National Development Corporation, the Japanese Research Development Corporation Associates, and the Connecticut Development Corporation.

In this context the experience and advice of Canadian Patents and Development Ltd. would be useful. In fact, since CPDL is undertaking a similar responsibility with federally-owned patents, it should be considered whether this agency could extend its services to the private sector. Potentially, CPDL could be adapted to become the supportive mechanism suggested.

Support for
Small Entrepreneurs

No special mechanism is suggested to support small technologically-oriented entrepreneurs. The proposed Federal Business Development Bank (FBDB) will provide increased financial and management training assistance to small firms. Therefore, if it can truly promote delivery of capital and management skills, it has the potential to be of substantial assistance to small firm innovation efforts.

Besides encouraging the fulfillment of the FBDB's objectives, there are specific courses of action which are recommended for further consideration, as follows:

1. Encourage university and government staff spin-offs, in order to commercialize government and university R & D. This would require (a) altering the way in which scientific personnel are hired (possibly by contract) and (b) through the quasi public mechanism outlined above to assist their start-up operations.

2. Provide an increased "market" for small entrepreneurs by an aggresive R & D contracting-out policy and use of government procurement.

3. Work with financial institutions to liberalize the regulatory framework and increase private sector financial and managerial support to small entrepreneurs, particularly but not exclusively technically oriented.

4. Examine how technological development incentive grants and government lending institutions can shift more risk financing support to small entrepreneurs.

5. Support the development of entrepreneurial training packages in the university or private sector market (considerable support will possibly be forthcoming from the FBDB).

These specific approaches are distilled from the analysis of handicaps and are still a rather scattered set of proposals. Nevertheless, there are many avenues of support (the handicaps being so numerous), and what is really required is a decision to focus on the small technological entrepreneur and to design more detailed programs and policies to overcome his handicaps.

INNOVATION AND INDUSTRY STRATEGIES

In terms of large-scale innovation, the federal government should upgrade its analysis capability and information base, and establish an industry-by-industry technology strategy planning process and implementation mechanism.

Technological Evaluation Capability

In view of the complexity of the process of technological development, as discussed in earlier sections, the federal government should have strong technological evaluation capability - including experience curve analysis. The line branches of IT&C and some other federal departments have been developing increased understanding of the technological

and industry structure of specific industries. However, these developments are only a start of an experience curve evaluation capability, whose purpose is:

- to evaluate technological opportunities in terms of investment cost, market potential, and target production volume for industries and major product lines
- to identify where rationalization of the productive resources of an industry is required to innovate successfully.

The Federal Government should have the analytical capability and information base to carry out technological evaluation. However, no more than a core group is necessary, for specific technical expertise could be drawn from industry and government staff in particular technological fields.

In view of the increasingly high cost of innovation, Canada must be very selective in large-scale innovation efforts. An evaluation capability can be used to examine the feasibility of innovation efforts in which there is substantial public participation. With capital intensive spending pressures in energy development, northern development, transportation, and other public concerns, this technological evaluation capability will increase in importance.

Technology
Strategies by Industry

Technology strategies should have the following characteristics:

- technology strategies are required rather than strictly innovation strategies due to the inter-relationship of diffusion of technology and innovation

- technology strategies should be integrated with industry strategies, but should not be over-shadowed by other factors in the formulation of industry strategies

- technology strategies should be developed industry-by-industry, due to the wide variations in impact of the market structure, government policies, and technological capability in Canada.

As discussed in the section on government handicaps, sorting out which points of government leverage (procurement, regulations, tariffs, etc.) should be used to develop technological capability is a difficult and continuous process. Therefore, we recommend that "Innovation Boards" be established to develop coherent industry technology strategies.

These Boards would interact with the overall industry strategy planning process. They would suggest the investments (and controls) required to develop the technological base in the industry and seek to avoid scatter-gun approaches in government initiatives.

The Innovation Boards would consist of government officials, both federal and provincial, and representatives from each industry, backed up by the technology assessment staff described earlier. Government officials would contribute knowledge about the impact of different policy

instruments, while corporate officials would be representative of the different sizes of the technologically-oriented firms of the industry.

"Product Champion"

In innovation literature, the point is often made that wherever there is a major innovation in a large organization, one can usually identify a "product champion" or prime mover, who has aggresively promoted the innovation over a long period. In government, too, one can usually associate innovative change with the determination and strength of an individual.

Innovation leadership cannot always be relied on to come from an individual company; innovation may require the participation of several companies, as well as active cooperation by government. Thus, there will be government as well as company officials who will act as product champions. We recommend that the concept of product champion be more widely recognized and legitimized, and government officials designated as product champions if that kind of initiative is required of government.

For the product champion concept to work, the individual identified (or "designated") must operate from a position of leverage to influence other organizations to go along with the innovation activity. What is required is the commitment from the organization that wants the innovation, whether government department or private sector organization. Therefore, the product champion must be lodged within the line department that has the most vested interest in the innovation's success.

To carry out these innovation promotion responsibilities, the product champion must enjoy access to provincial capitals, financial circles, federal departments and industry. The innovation product champion would not be institutionalized as a permanent part of the federal public service, although the concept should be. It is the nature of innovation for the product champion to phase in and out following the successful introduction of the innovation.

STRATEGY
DEVELOPMENT PROCESS

As described above, it appears that Canada does not have a good record in coordinating government actions and enjoining industry cooperation in devising and following industry strategies. This kind of process is essential to overcome innovation handicaps, since technology and industry strategies must be integrated.

We have suggested a process to integrate technology and industry strategies through the Innovation Boards. However, if (a) government efforts remain uncoordinated and (b) government/industry consensus mechanisms do not work, there is no viable industry strategy setting process. Therefore, to be realistic about overcoming handicaps to innovation, we must discuss the problem of industry strategies.

The Senate Committee on Science Policy recommended the straightforward approach of government/industry task forces and the establishment of an office of industry reorganization. Such a process has not yet proven effective. If this or a similar process cannot be made to work, there are two scenarios

for guiding Canada's economic development that might be considered. These are:

1. "Laissez-faire" approach toward technological development.*
2. Increasingly direct intervention by federal/ provincial governments.

Laissez-Faire Scenario

In this scenario, the government would play a relatively passive role toward technological development. It would seek to create an economic environment where, hopefully, innovation would flourish.

To some extent, this scenario would be an extension of existing piecemeal policy, with some contracting out of R & D now conducted in-house by the government, injecting more risk capital into the economy, and supporting innovation opportunities of Canadian content that occur to the private sector.

Since it is an extension of existing policies, it is perhaps a palatable scenario in terms of acceptance by the private sector. However, its two main problems are:

- the government still has the problem of trying to ensure that the innovation occurs in Canada, particularly by the foreign-controlled firm
- it does not respond to the basic market structure and tariff policy handicaps to innovation, in that industries would remain fragmented and uncompetitive.

Therefore, in a laissez-faire scenario Canada's innovation record would perhaps only marginally improve, while the technological

* In this context, "laissez-faire" is not used as a strict economic term, but rather to describe the current convention that North America has a largely private enterprise economy.

base and industrial structure of the country could gradually deteriorate if present trends continued.

Increased
Intervention Scenario

As opposed to the laissez faire scenario outlined above, the government could adopt a much more interventionist position vis-à-vis the economy. The federal government could design its own industrial and technology policies, seeking industry participation, where possible, but not depending upon it, and then using its leverage to induce compliance with these policies.

Federal and provincial governments have an enormous amount of control and influence over private sector decisions. These are accepted by industry as an extension of the government's role as a regulator and provider of essential services functions in the economy. However, these powers and controls could be used far more frequently to influence corporate behaviour to develop in prescribed ways. A random selection of industries shows the power of government influences:

- through the control of feed stock supplies, the government can influence chemical company decisions
- in the television industry, the government could license reception as well as broadcast, thus having enormous influence over allocations of markets
- as purchaser of health services and medical supplies on behalf of the public, the government could exercise more control over the pharmaceutical and medical equipment supply industry.

What this amounts to is enormous leverage that could be used to influence economy activity. In fact, at present government is not even using existing leverage that would be acceptable, particularly in the area of procurement and regulations as documented earlier.

Along with increased intervention, the government could play a greater role in applying the "demand-pull" to innovation. That is, through Crown corporations or private sector companies, over which it has controlling influence, the government could undertake the role of an end-product manufacturer in the innovation process in key industries. In that case, the suppliers could all be private sector companies and would tend to innovate in response to government purchasing power as expected.

The problem with too great an interventionist posture is that it is very unattractive politically and largely unworkable. Innovation requires flexibility and ability to capitalize quickly on emerging opportunities. Although it can organize technological development capability, government basically cannot hope to imitate corporate innovators. Therefore, the increasingly interventionist scenario is not entirely appropriate.

Conclusion

While there are many scenarios which could be drawn between the extremes discussed above, the purpose was to demonstrate the potentially unfavourable consequences to the Canadian economy. The point is that neither

the private sector nor the government on its own can improve the industrial and technological base.

The conclusion is that consensus planning involving both business and government is a necessary precondition to the setting of industry strategies. It is incumbent upon government to initiate the process more forcefully than has been the case.

In some industries, initiating consensus planning through discussion and negotiation, would be sufficient. In others (e.g. aircraft) government must initiate largely through adopting a more interventionist scenario discussed above. Thus, for each industry a different mix of intervention and negotiation is required.

The government mechanism for taking the initiative in the short term must be through the line departments, where purchasing, regulatory trade negotiating and other levers specific to industries are paramount. Such leadership by line departments will also help achieve a greater co-ordination of government activity (at least federally).

In the longer term, a more satisfactory means of inter-departmental policy setting should be developed. In the interim, departments with the most impact on that industry's constituency should assume the leadership in industry strategies.

With an improved process of industry and technology strategy setting, more of the preconditions to innovation can be developed. With

definite industry and technology strategies, more Canadian innovators will be able to obtain the financial, managerial, technical, and customer support required for technological innovation.

XII - FURTHER RESEARCH

In this section we describe briefly where it seems most appropriate for further research to be conducted.

QUANTITATIVE DATA

One of the more difficult problems in this assignment has been to find appropriate data which quantifies the impact of specific handicaps. Some comments are appropriate here in terms of further research.

First, substantial accounting data by product line from a large sample of firms in several firms would be required to quantify more fully the impacts of specific handicaps. Additional data would also have to be generated by each firm. Even then, it would be difficult to relate success or failure in innovation to specific variables.

Second, companies have little patience in spending an inordinate amount of time providing additional data to government-sponsored research, They already feel overburdened in the amount of information they already provide to government agencies. This resistance could not be easily overcome in a research assignment.

Statistics Canada has gradually improved over recent years attempts to collect data pertaining to innovation at the level of the firm. However, Statscan has not made an attempt to quantify the impact

of handicaps, and procedures to do so would require several developmental years in data collection. Given the interpretative problems and lack of company cooperation, we do not recommend that Statscan do so.

There is one area in which further quantitative data might assist the understanding of the constraints to innovation in Canada. In Section X, we provided global trade statistics in support of a conclusion that Canada is not improving its technological base. Further analysis of existing trade statistics would add precision to an understanding of the technological content of Canadian-made merchandise. To do so would require Canadian value added data, developed on a product-line basis within industries.

IMPLICATIONS OF LACK OF INNOVATION CAPABILITY

The collection of more refined trade statistics data, as suggested above, should provide greater potential for researching the implications of a relative decline in Canada's innovation capability. It was proposed in Chapter X that, if present trends in high technology manufacturing continue, we could by our lack of technological capability be foreclosing our future economic options.

Further research as to the implications of high technology product trade patterns might generate scenarios which identify more clearly the consequences of present policy decisions (or lack of them). Such a study would of a scope similar to the controversial investigation by the Economic Council of Canada of more liberalized trade arrangements.

RESEARCH ON IMPLEMENTATION PROCEDURES

Rather than further research into specific handicaps, we recommend that efforts should now be diverted toward implementation mechanisms and procedures to overcome handicaps.

First, the government should institutionalize the federal government technology evaluation capability. To some considerable extent such capability already exists at IT&C, MOSST, and line departments. A further research recommendation is its continued development toward a better understanding of the behaviour of multi-national operations, the "threshold" R & D expenditure requirements in specific industries, and developing technology evaluation capability.

Second, in support of efforts to overcome handicaps, more research should be undertaken on the impact of government regulatory responsibility on innovation. Such research would be focused on (a) the financial institutions and their regulatory framework, and (b) other industry-specific regulatory activities of government.

Third, further research could be undertaken on the design and implementation of the suggested organizational arrangements. This would include the development of a quasi-public agency to respond to inventors, the establishment of "Innovation Boards" to develop technological strategies, and design of a product champion function.

To summarize, we recommend further research in the following areas:

- more documentation and further analysis of the implications of a worsening trade balance in high technology product areas
- further development of government technology evaluation capability in line and policy departments
- research of the impact of government regulatory functions on innovation
- more detailed organizational design of the institutional mechanisms proposed to help overcome innovation handicaps.

Thus, the design of <u>implementation procedures and mechanisms</u> is the underlying further research recommendation of this study.