INNOVATION ELEMENT EVALUATION

VOLUME II: TECHNICAL REPORT

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Canada

INNOVATION ELEMENT EVALUATION

VOLUME II: TECHNICAL REPORT

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Program Evaluation Branch
ITC/DREE

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INNOVATION ELEMENT EVALUATION

EXECUTIVE SUMMARY

The departmental Senior Management Steering Committee (SMSC) recommended in December 1982 that a short-term, narrowly focussed evaluation be conducted on innovation assistance programs. This report contains the findings of that study and is intended to provide information to departmental decision-makers on the experience of previous ITC/DREE innovation assistance programs which will have potential usefulness in the design, implementation, and strategic and operational planning of the new Industrial and Regional Development Program (IRDP).

The study focussed on the past regional suitability of innovation assistance in terms of users and user requirements, the possible effects of regionally skewing financial assistance in the future, and the impacts and effects of past innovation assistance in terms of firm investment and employment. The majority of the study's findings are derived from interviews and project file reviews for 110 Enterprise Development Program (EDP) projects. These findings are complemented by expert and project officer interviews and by data from other studies.

The study's major findings include:

Regional Suitability

- EDP product development was used by a fairly small portion of the business community.

- program usage was more closely related to firm sector than to firm location.

- EDP product development funding favoured projects (and therefore sectors) with high current (expensed as opposed to capital) costs.

- EDP users tended to be medium-small firms with lower than average financial strength.

- While EDP was suitable for innovation projects with a high proportion of R&D costs because of the program's eligible cost structure, there were significant gaps in the funding of the total product development cycle in terms of capital and marketing costs which were sometimes filled by either bending EDP rules or by using other programs.

- Program delivery was perceived by users as too slow and uncertain.

- Sectoral expertise was considered very important in program delivery.

- The contribution assistance format was generally found to be suitable because it addressed many firms' major problem, cash flow. This was particularly significant for small firms.

- Market assessment was found to be a critical success factor to product development projects.

Regional Skewing

- Enriched contribution levels in favour of disparate regions for innovation assistance will likely have negligible impacts on regional innovation activity since new firms would not be induced to move into disparate regions for one time product development assistance and since most EDP assisted firms were already receiving maximum assistance levels because of their small size.

- Enriched contribution levels in favour of disparate regions as envisioned in IRDP carried a significant risk that the overall impact on program effectiveness will be negative.

Impacts and Effects

- EDP projects show significant signs of incrementality at a firm level.

- All impacts and effects were highly variable among projects.

- Investment impacts in terms of product development in firms were positive in the short term.

- Long term investment impacts in terms of innovation capability are negligible.

- Firms perceived significant qualitative impacts as a result of EDP funding including both technical and management benefits.

- Some impacts were realized in terms of facilities expansion.

- Employment impacts were positive, particularly in terms of production workers.

- Employment impacts tended to be related to project financial success.

- The incremental cost per job was estimated at between $10,000 and $22,000.

Based on the study's findings, the following recommendations are made with regard to IRDP design, implementation, strategic and operational planning.

IRDP Program Design

- IRDP should be expanded to make the full innovation process eligible for assistance. Assistance should be expanded to include capital costs, manufacturing start-up and marketing start-up. Particular emphasis should be placed on the proper conduct of market assessment.

° Innovation funding levels should not be skewed regionally. (The innovation element should be exempted from the tier system.)

° The continuation of financial skewing on a firm size basis should be considered since small firms have significantly larger financial burdens than large firms when performing product development. Also regional equity considerations could be met via a firm size skewing since the vast majority of past users in disparate regions were small firms.

IRDP Program Implementation

° Delivery efforts should be focussed on increasing firm certainty with regard to application procedures and turnaround times.

° Efforts to streamline delivery should continue. (This is especially important for small firms.)

° Market assessment activities should be stressed in the delivery of innovation projects.

° Access to sectoral expertise should be maintained in regional program delivery.

° Proactive promotion of the program should be used to increase usage.

° Coordination among other Federal Government, Provincial Government and research council innovation assistance programs should be attempted in order to pick up areas where programs serve complementary functions in product development assistance.

Strategic and Operational Planning

° The contributions instrument should be used to assist private sector product development but should not be used in isolation to attempt to increase innovation capabilities, especially in disparate regions.

° Innovation product development assistance should be viewed for its potential to enhance product development, job creation and and firm growth more than for its potential to induce long term investment in R&D and innovation capability.

In summary, the contribution instrument of EDP for innovation assistance has had positive impact on product development activity and the IRDP has moved in the right direction with its increased funding flexibility and recognition of the corporate life cycle; however, efforts to skew funding on the basis of firm location do not address the important determinants of innovation activity and therefore are not likely to have the positive impacts desired. Emphasis should more effectively be placed on continuing to expand the scope of eligible costs, coordination with other innovation programs, promotion, and streamlined delivery involving sectoral experts.

INNOVATION ELEMENT EVALUATION

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1.0 INTRODUCTION

1.0 INTRODUCTION

1.2 PURPOSE AND SCOPE OF STUDY

1.3 STRUCTURE OF REPORT

1.0 INTRODUCTION

1.1 Introduction

In January, 1982, the Federal government announced a major re-organization of its economic departments resulting in the amalgamation of the Department of Regional Economic Expansion and the industrial development portion of the Department of Industry, Trade and Commerce. The resultant department, ultimately to be named the Department of Regional Industrial Expansion (DRIE), was provided with the mandate to facilitate and support industrial development and adjustment processes in the economy in order to reduce economic disparities among regions and to increase the economic prosperity of Canadians in all areas of the country.

Subsequently, the department has considered the program structure inherited from the founding departments and proposed a revamped program structure aimed at assisting private sector businesses and based upon the corporate development cycle. At the core of departmental programming will be a new program, to be called the Industrial and Regional Development Program (IRDP) which incorporates a majority of the objectives and features of previous programming. However, the IRDP adds several new features and provides for a common administrative procedure.

Additionally, departmental management established several operating imperatives for the new department. Policy and program activity would be designed to facilitate industrial development and renewal in accordance with identified needs in all regions. DRIE would provide a facilitating role in support of private sector initiatives taking into account regional industrial development priorities. Finally, support would be targetted where government involvement would be likely to have greatest impact and yield maximum return on resources while recognizing strategic objectives, regional funding envelopes and the industry mix and stage of corporate and product development.

In December 1982, the departmental Senior Management Steering Committee (SMSC) considered how program evaluation techniques could be applied in the short term (6-8 months) to assist in the decision making relating to program design, program implementation and strategic and operational planning. Given that innovation was a top departmental priority and that an evaluation had not been conducted previously on the majority of ITC or DREE innovation programs, the SMSC recommended, and the Deputy Minister subsequently approved, that a narrowly focussed evaluation study be undertaken relating to the innovation element of the new IRDP.

1.2 Purpose & Scope of Study

The purpose of this study is to provide timely data useful in program design as the terms and conditions of the innovation element of the IRDP are tailored to a regional perspective and to assist senior management in the targetting of resources. Based upon the experience of previous ITC/DREE innovation programs, information is provided on how innovation programming designed on a national basis can be implemented in a number of regions of possibly differing industrial development and innovation needs.

The scope of the study is purposely limited to four issues relating to:

1) regional suitability
2) regional skewing
3) investment generation
4) employment creation

Emphasis is placed on the experience of ITC/DREE programming and the clientele served by the departments rather than on innovation policy in a more general sense.

Focus of the study is thus primarily on the ITC Enterprise Development Program (EDP) which most closely resembles innovation programming in the new IRDP, although some consideration is given to other innovation programs such as MSA, DIPP, STEP and IERD.

1.3 Structure of Report

The final report of the Innovation Element Evaluation consists of two volumes. The first volume is a summary of findings and recommendations. The second, this volume, is a technical report which provides detailed information on methodology and findings.

This report is divided into five major sections. Section 2.0, Study Background, provides a brief history of innovation programming in ITC and DREE. Section 3.0 provides an overview of the evaluation design.

Sections 4.0 - 7.0 address each of the four study issues in turn providing the results of data collection and analysis, and observations, conclusions and recommendations which can be drawn therein.

Appendices provide more detail on the concepts and information provided in the body of the report.

2.0 BACKGROUND

2.1 CANADIAN INNOVATION ENVIRONMENT

2.2 INNOVATION PROGRAMMING IN ITC/DREE
- 2.2.1 EDP
- 2.2.2 Other ITC/DREE Innovation Programs
- 2.2.3 IRDP

2.0 STUDY BACKGROUND

2.1 Canadian Innovation Environment

A convenient measure of a nation's commitment to research and development is the ratio of gross expenditure on research and development (GERD) to gross domestic product (GDP). In 1979, Canada had the lowest GERD/GDP ratio (1.12 per cent) among the top eight OECD countries, compared with 2.41 per cent for the U.S. During the same period, R&D activity undertaken by the industrial sector and expressed by R&D as a ratio of domestic product of industry (DPI) was lowest in Canada at 0.6 per cent.

A detailed analysis of the R&D situation in Canada today is beyond the scope of this report and has previously been studied by the Science Council of Canada and the Economic Council of Canada (see Appendix I). Suffice it to say that low Canadian R&D performance is a result of a multiplicity of interelated variables including:

- the historical foundation and structure of Canadian industry
- a relatively small population and industrial base dispersed over a vast geographical area
- a high dependence on foreign capital and technology

Canadian industry, on the whole, faces a formidable challenge if it is to compete successfully in international markets for high technology products, or to improve Canada's position through import substitution. While improving technological capability and increasing investment in manufacturing R&D may not be the whole answer, they certainly are important ways in which Canadian industry can significantly improve its productivity and competitive position.

2.2 Innovation Programming in ITC/DREE

Innovation in Canada was fostered in ITC/DREE through 3 major types of activity: influencing government policy; provision of infrastructure; and direct assistance to business. The subject of this report relates to the last category: the programs of which are described as follows.

2.2.1 Enterprise Development Program

The objective of the Enterprise Development Program is to enhance the growth and international competitiveness of the manufacturing and processing sectors in Canada. In meeting this objective, the program offered, among other forms of assistance, non-repayable contributions towards product development projects in the manufacturing and processing sectors particularly to small and medium-sized firms.

To qualify for a contribution, firms were required to demonstrate the project was viable yet contained significant technical risk, that the project represented a significant financial burden on the company's resources and that the company was capable of exploiting the results of the project.

EDP found its greatest usage within the small to medium sized company population and more particularly within the chemical, electronics, transportation and machinery sectors. Approval of projects took place at the regional and central levels, depending on the value of the contribution, by EDP Boards made up of private and public sector members.

Central provinces accounted for the bulk of EDP projects with only approximately 15% approved in Western and Atlantic provinces.

Actual expenditures for the innovation portion of EDP in 1981-82 was approximately $45 million psread over 265 active projects.

Given the regional delivery of EDP, its general applicability to most sectors and the variety of product development activities supported, this program was chosen as the best proxy for the new IRDP program innovation element.

2.2.2 Other Innovation Programs

Where the new program offered assistance to product development activities beyond the scope of EDP but which were featured in an established ITC/DREE program, such programs were also examined particularly from the viewpoint of the user. Below is a brief description of these programs and their relevance to the study.

a. Defence Industry Productivity Program (DIPP)

The objective of DIPP is similar to that of EDP except that the program is oriented towards promoting reliable defence or defence related products for export. The program is also intended to provide an industrial base for defence products and to develop and maintain a defence technological capability.

Contributions are provided for virtually all phases of the product development process from applied research through to prototype development. Clientele for the program consequently consist of high technology industries in the aerospace, avionics, transportation and electronics sectors located almost exclusively in Ontario and Quebec. Though available to companies regardless of size, most program funding is received by a handful of large firms specializing in the development, manufacture and export of defence or defence related products. In contrast to EDP, significant burden of the project on corporate finances was not a consideration in DIPP.

Recipients of DIPP funding are favoured with access to international markets through defence sharing arrangements negotiated by the Canadian government with the U.S and several NATO countries. Market evaluation and support for defence exports is provided by ITC, DND, CCC and the Trade Commissioner Service.

Product development projects are occassionally jointly funded by DIPP and the ultimate customer for the product, thus relieving somewhat the burden of market risk.

Authorizations for the R&D portion of of this program were approximately $99 million over 23 projects in 1981-82.

The wide range of eligible product development costs, particularly in the area of applied research, combined with the technological sophistication of DIPP clientele resulted in the decision to examine this program in the light of the IRDP. Of particular interest were the perceptions held by DIPP users of the product development process and how and where contributions could be best used to facilitate this process.

b. Industry Energy Research and Development Program (IERD)

IERD was established to support the national objective of energy conservation by assisting industry in research and development projects leading to energy conserving products and processes. While universally available, clientele have tended to come from large processing firms in resource-based industries.

The program was able to assist applied research projects provided the applicant possessed adequate technical and financial resources. Technical risk was expected to be relatively high and the technology developed through the project of general applicability to industry. However, unlike EDP, applicants were not required to demonstrate that the project represented a significant burden upon their financial resources.

Actual expenditures for this program in 1981-82 were $709,000 over 2 projects.

IERD was of interest to the study for two reasons. Firstly, the program assisted projects involving applied research as well as other product development activities similar to the new program. Secondly, the clientele were usually ineligible for other funded programs because of significant burden requirements, yet technically capable of performing successful product development.

c. Support for Technology Enhanced Productivity Program (STEP)

Though similar in many respects to EDP, this program is intended to increase competitiveness of Canadian industry through the development, manufacture and use of micro-electronic devices in existing products. Product innovation from technology diffusion was considered. Funding has been approximately $28 million over 36 projects since the inception of the program. The two largest projects in STEP were excluded from this total as these were special projects intended for major new product development work and were valued at $21 million and $7 million respectively.

d. Montreal Special Agreement (MSA)

Although this agreement did not directly assist new product development, assistance was made available to technology transfer (licenses, patents etc.) and research facility projects. The extent to which support to these areas ultimately improved the ability of companies to perform product development was considered. Also considered was the alternative to innovation, that is, purchasing product technology as opposed to developing new products from the idea stage. Funding has been $4 million over 2 approved projects since the program's inception.

2.2.3 Industrial and Regional Development Program (IRDP)

Designed along the lines suggested by the Progam Review Task Force Report, the new IRDP offers within the R&D/Innovation element assistance to the following product development activities:

- consultant services relating to project feasibility, technology transfer, market research or venture capital sourcing

- new product/process development entailing high technical risk

- design of mass-producible durable products which necessitate expansion of industrial design programs

- expansion of technological capability involving technical risk but not leading directly to identifiable sales

- new product/process development of low technical risk

- pollution reduction development projects

It is intended that these allowable activities will encompass the majority of product development projects in both the manufacturing and processing sectors. Contribution level will depend on the location of the applicant and the extent of assistance required to induce the firm to commence the project. Other elements of the program may be utilized, where appropriate, to improve the prospects of successful commercial exploitation of the project.

IRDP drew upon the features of current innovation programming in ITC/DREE while eliminating gaps and overlaps of support existing between these programs.

3.0 EVALUATION DESIGN

3.1 ISSUES

3.2 OVERALL METHODOLOGY

3.3 SAMPLE DESIGN

3.4 CONSTRAINTS AND LIMITATIONS

3.0 EVALUATION DESIGN

3.1 Issues

The study addressed four basic issues:

(i) Regional Suitability of Innovation Programs

The essential question for study was:

"Are the terms and conditions of all element programs suited to the industrial development needs of all regions?" A number of issue sub-questions followed from the above, for example:

- will the terms and conditions of the IRDP Innovation Element meet the innovation objectives established by the Department and the various needs of the regions in light of their industrial capabilities and opportunities?

- do the innovation element funded activities meet the needs of firms to commence innovation?

(ii) Effect of Regional Skewing

The essential question for study was:

"What is likely to be the effect of regional skewing on the usage and effectiveness of the innovation element?" A number of issue sub-questions followed from the above, for example:

- will the additional funded support level generate R&D from existing plants in designated regions (i.e., overcome perceived disadvantages)?

- is a 25% differential between national and disparate region support enough to influence activity in disparate regions when the previous differential under former DREE programs was higher and not available on a national basis?

(iii) Innovation Investment and Incrementality

The essential questions for study were:

"Have companies increased their overall investments in innovation? Has the investment been incremental?" A number of issue sub-questions followed from the above, for example:

- with regard to differences in regional industrial base, are there differences by region/industrial sector in the impacts of constituent program elements?

- has innovation program assistance had qualitative impacts on product development?

(iv) Employment Opportunities

The essential question for study was:

"What type and number of employment opportunities have been created through the use of constituent programs?" A number of issue sub-questions followed from the above, for example:

- what has been the duration of employment gains made as a result of program assistance?

- what are the incremental employment impacts at the firm level by region/sector?

Appendix A contains a summary of the rationale underlying each of the major study issues described above.

3.2 Overall Methodology

The general study approach emphasized the elicitation of opinions and the analytical abilities of private and public sector experts in relation to the study issues. The experts were interviewed using open-ended questions to obtain their comments, perceptions and analyses.

The survey data was analysed in conjunction with other databases including:

- EDP project files
- aggregated program data
- Statistics Canada R&D expenditure data
- Dun and Bradstreet financial and employment data
- other related R&D studies (i.e. Economic Council of Canada)

The principal stages in the study design, implementation and analysis were:

- extensive literature and documents review of: IT&C/DREE innovation and innovation-related programs; previous program studies (e.g. EDP evaluation assessement; DIPP evaluation); innovation literature; previous evaluative methodologies;

- development and pilot testing of questionnaires;

- modification of the study questionnaires in the context of refined issues and expected outputs;

- industrial and government sample selection strategy and implementation, which included both telephone and personal interviews;

- field data collection from industrial firms which were previously supported by constituent programs;

- analysis of survey findings, especially firm data, for national, regional and sector perspectives;

- data quality assessments, both internal and external to the survey, especially using complementary databases or sources; and,

- synthesis of findings, conclusions, implications and recommendations.

Additional details on various information sources used in the study are contained in Appendix J.

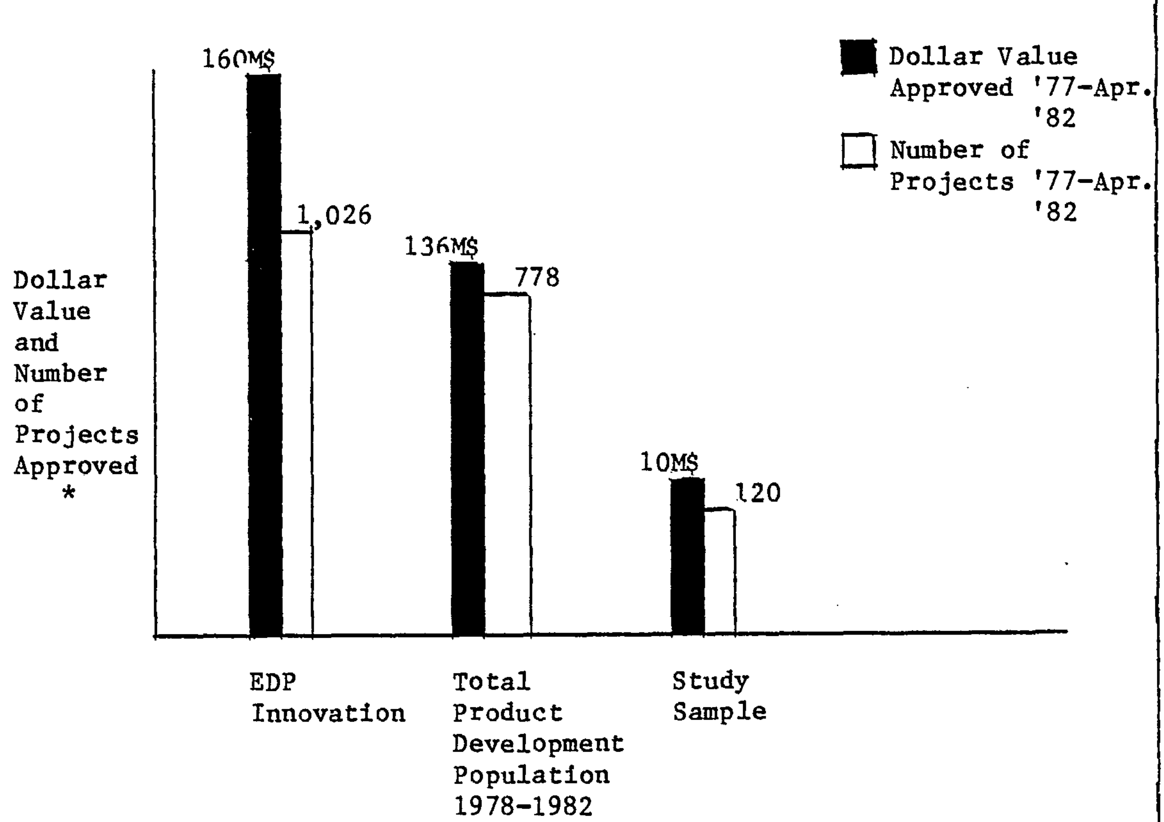
3.3 Sample Design

The targetted population from which data was collected was limited to companies in the manufacturing/processing sectors who had used either the EDP, MSA, DIPP, IERD or STEP programs during the past five years (i.e. 1978-1982). Detailed program profiles were initially constructed from the ITC/DREE internal databases to assist the specification of the actual populations for field implementation.

EDP was chosen as the central program for the development of a sample design for the study, since it closely resembled the new innovation element of IRDP (i.e. regional scope; served all sectors; largest innovation program in terms of total support dollars and number of projects). Exhibit 3.1 demonstrates the significance of the EDP survey sample relative to the EDP population. Exhibit 3.2 is a profile of the EDP population upon which the design was based.

Exhibit 3-1

Study Sample versus Population



* Graph is for illustrative purposes and is not drawn to scale.

Exhibit 3-2

Refined EDP Population by Sector, Province and Company Size*

REGION	MAJOR INDUSTRY CLASS. (SIC)	CHEMICAL			WOOD			METAL			MACHINERY			ELECTRICAL			OTHER/MINERALS			GRAND TOTAL			
		TOTAL	(S)	(L)**	TOTAL	(S)	(L)	TOTAL	(S)	(L)	TOTAL	(S)	(L)	TOTAL	(S)	(L)	TOTAL	(S)	(L)	TOTAL	(S)	(L)	
	(TOTAL)																						
B.C.	(82)	10	(7)	(3)	5	(5)	(0)	3	(1)	(2)	25	(22)	(3)	30	(18)	(12)	9	(8)	(1)	82	(61)	(21)	10.3%
Alta.	(50)	7	(6)	(1)	2	(0)	(2)	4	(3)	(1)	22	(19)	(3)	10	(7)	(3)	5	(4)	(1)	50	(39)	(11)	6.2%
Sask.	(38)	1	(0)	(1)	0	(0)	(0)	1	(0)	(1)	22	(13)	(9)	11	(9)	(2)	3	(3)	(0)	38	(25)	(13)	4.7%
Man.	(53)	10	(9)	(1)	6	(6)	(0)	7	(5)	(2)	12	(11)	(1)	14	(13)	(1)	4	(3)	(1)	53	(47)	(6)	6.6%
Ont.	(267)	25	(16)	(9)	12	(7)	(5)	23	(15)	(8)	79	(46)	(33)	97	(70)	(27)	31	(17)	(14)	267	(171)	(96)	33.5%
Que.	(253)	35	(17)	(18)	21	(14)	(7)	30	(22)	(8)	60	(31)	(29)	63	(37)	(26)	44	(34)	(10)	253	(155)	(98)	31.7%
N.B.	(11)	4	(4)	(0)	1	(1)	(0)	2	(2)	(0)	3	(3)	(0)	0	(0)	(0)	1	(1)	(0)	11	(11)	(0)	1.3%
N.S.	(18)	5	(2)	(3)	1	(1)	(0)	1	(1)	(0)	4	(3)	(1)	6	(4)	(2)	1	(1)	(0)	18	(12)	(6)	2.3%
P.E.I.	(18)	9	(7)	(2)	0	(0)	(0)	2	(2)	(0)	0	(0)	(0)	5	(5)	(0)	2	(2)	(0)	18	(16)	(2)	2.3%
Nfld.	(8)	4	(3)	(1)	0	(0)	(0)	0	(1)	(0)	2	(2)	(0)	1	(1)	(0)	0	(0)	(0)	8	(7)	(1)	1.0%
GRAND TOTAL	(798)	110	(71)	(39)	48	(34)	(14)	74	(52)	(22)	229	(150)	(79)	237	(164)	(73)	100	(73)	(27)	798	(544)	(254)	100%
		100%	(65.)	(35.)	100%	(71.)	(29.)	100%	(70.)	(30.)	100%	(65.)	(35.)	100%	(70.)	(30.)	100%	(73)	(27.)	100%	(68.)	(32.)	
	100%	13.8%			6.0%			9.3%			28.7%			29.7%			12.5%						

* Includes all product development/design contributions for projects commenced subsequent to 1978, for which the development was completed by March 1982, and for firms which are still in operation.

** Company size: (S) is Small companies with sales less than 2 million; (L) Large companies.

The four study issues were integrated under this main EDP coverage theme. The other innovation programs (i.e. MSA, IERD, STEP, DIPP) were studied as separate sub-themes, where useful information was sought on aspects of design, adjustment and resource allocation.

The sample selection strategy was based on a highly stratified sample design that:

- concentrated on EDP coverage
- utilized telephone and personal interviews
- provided equal regional participation on a project basis
- chose 80% small companies versus 20% large companies
- provided coverage to four major sectors.
- the sample did not include those companies gone bankrupt since the government assistance, and those companies with incomplete, recently commenced or out-of-scope projects.

The sample allocation scheme is shown in Exhibit 3.3.

A primary objective of the sample allocation scheme was to ensure equal regional representation. Secondly, the sample coverage focused on a large/small firm split (based on the Small Business Secretariat's working definition of $2 million in annual sales as a general breakpoint between large and small Canadian companies). Thirdly, the sample coverage focused on the key industrial sectors as represented by utilization of EDP in each province.

The rationale for the choice and prioritization of "size of business" and "sector" representation derived mainly from discussions with the study team's Advisory Committee. Sector representation, for example, was supported by the new

Exhibit 3-3

Sample Allocation Scheme

Program	# Firms	Method	Firm Size	Region/Sector*
EDP	120	Personal (20) Telephone (100)	10 Big 10 Small 80 Small 20 Big	1/region; sector #1 1/region; sector #1 8/region; sector #1(2) #2(2) other (4) 2/region; sector #2,#3
DIPP	3	Personal		1 Ontario 1 Quebec 1 B.C.
MSA	3	Personal	2 Big 1 Small	Quebec
IERD	3	Personal	1 Big 2 Small	Quebec East, West
STEP	3	Personal	2 Big 1 Small	Ontario, Quebec West

* Sector relates to the sector of predominant EDP usage (#1) and those sectors of decreasing usage rank (#2), (#3). The numbers in brackets refer to the number of firms to be chosen.

Exhibit 3-4

Actual Distribution of EDP Firms Surveyed

Province	NFLD	N.S.	N.B.	P.E.I.	QUE	ONT	MAN	SASK	ALTA	B.C.
	6	11	5	8	10	29	11	6	11	13

Sector	Chemical	Electrical	Machinery & Transportation	Metal Fabri.	Wood	Other
	28	26	30	4	6	14

portfolio management approach to resource management and by the fact that innovation itself differs significantly by sector and should be accounted for in the interpretation of the study results.

Due to the difficulty of interviewing (i.e. collecting detailed information) large firms by a telephone survey, it was decided to interview all of them personally. The non-EDP interviews were oriented to "higher level" opinion/commentary-type information from selected firms.

A six-sector classification was used in the delineation of each company for interviewing. This system was a collapsed version of the 25 industry groupings used internally at IT&C, and was cross-referenced to the Standard Industrial Classification System (SIC) for subsequent comparative analyses with external database information.

In implementing the sample allocation scheme via the telephone and personal interviews, the study team was constrained by too few eligible firms which could be contacted in provinces such as Newfoundland and Saskatchewan. As shown in Exhibit 3-4, the majority of "freed" interviews were allocated to Ontario to partially reflect the high concentration of EDP projects in that province. Similar allocations were not made to Quebec as that DRIE regional office had undertaken a similar study to this one.

Additional data gathering activities involved:

• DRIE policy and program delivery officers	(30 personal interviews) (3 per region)
• R&D experts including provincial governments	(10 personal interviews) (1 per region)
• extensive EDP file search and compilation of data	(160 companies)
• external data	(ECC, SC, D&B)

3.4 Constraints and Limitations

Given the limitations of both time and scope of the study it is emphasized that the Innovation Element "Evaluation" study is not a broad evaluation. It was designed for a specific, detailed examination of four major issues which were related to implementation of new innovation programs. The study does not, for example, attempt to estimate macro-economic effects on Canada or any of the regions or evaluate the old programs against their objectives.

The innovation programs (EDP, MSA, IERD, STEP and DIPP) were used as a tool to address the study objectives - the programs themselves are not being evaluated. For example, by studying the old programs it is hoped to draw inferences or find indicative results about the new program (IRDP), so that required enhancements or revisions may be acted upon in the near future. Such a study should also raise the level of consciousness (awareness, attention and understanding) of the new program design and implementation in meeting the innovation support needs of the regions.

The technical (reliability) limitations of the interview data, for example, due to sample stratification, is treated in Appendix J (Information Sources) and in Appendix G (Validity of Study Findings).

Further limitations of the study deriving from the constraints imposed upon the study are that the sample is not statistically significant in provinces of high EDP usage and that non EDP users were not included in the sample.

4.0 ISSUE I — REGIONAL SUITABILITY

4.1 BACKGROUND

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- 4.2.2 Innovation Levels
- 4.2.3 Innovation Requirements of EDP Firms
- 4.2.4 Previous Implementation
- 4.2.5 User Perception
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4.8 DRIE INNOVATION OBJECTIVES AND APPLICABILITY OF IRDP
- 4.8.1 Perception of Achievement of Past Objectives
- 4.8.2 Expert Opinion on Future Program Direction
- 4.8.3 Ability of IRDP to Meet Regional Innovation Objectives

4.9 RECOMMENDATIONS

4.0 ISSUE I REGIONAL SUITABILITY

4.1 Background

Issue I was formally posed in the following terms: "Are the terms and conditions of all element programs (EDP, MSA, IERD, STEP, DIPP) suited to the industrial development needs of all regions".

Innovation needs in the provinces are considered from several viewpoints. Firstly, the previous usage of the programs is considered as a proxy for the usefulness of the programs. This is then backdropped against the total innovation levels which exist in the provinces. Secondly, the characteristics of EDP and IRDP are compared with the apparent needs of businesses in their conduct of innovation. Against this general background, the suitability of programs is then considered from the perspectives of previous program implementation, the recipient firms' perception of the programs and the ability to meet governmental objectives and plans.

This information is contained in the following sections:

4.2 Major Findings and Conclusions
4.3 Program Usage by Region
4.4 Regional Innovation Levels
4.5 Requirements for Business Innovation
4.6 Previous Program Implementation
4.7 User Perception of Programs
4.8 DRIE Innovation Objectives
4.9 Recommendations

Key data sources for the analysis of this issue were the firm, government and expert interviews. These were complemented by external data sources such as Statistics Canada, Economic Council and Dun and Bradstreet.

4.2 Major Findings and Conclusions

This section summarises the major findings of the study with respect to the regional suitability of the programs.

4.2.1 <u>Usage</u>

- the typical user tends to be a medium-small, labour intensive, cash strained firm
- industry sector is a very important determinant of usage
- requirements for innovation differ considerably by sector and size of firm

4.2.2 <u>Innovation Levels</u>

- Ontario dominates the Canadian product development scene
- the electrical sector is currently the largest R&D performer

4.2.3 <u>Innovation Requirements of EDP Firms</u>

- market demand/accessibility and technological capacity are the major factors which motivate product development
- the demands and needs for product development in industry vary depending on sector, size or location
- the greater portion of funds are spent on engineering development
- government accounts for a significant portion of product development funds
- current/direct costs represent 75% of research costs

4.2.4 Previous Implementation

- the EDP program has not been utilized to its fullest extent as a result of lack of promotion and also regional industrialisation factors
- the maximum level of funding was made in a majority of cases
- programs were interpreted and implemented slightly differently in the various regions on the basis of specific companies and industries
- government incentives do not likely play a significant role in furthering long term product development
- information sharing amongst federal and provincial programs, departments and institutions currently appears to be minimal

4.2.5 User Perception

- the EDP program was generally found to be very suitable
- the main area of complaint was with program delivery
- it would appear that the application procedures were not clearly enough defined or explained
- the range and level of eligible costs were generally reasonable with the exception that a broader coverage of marketing costs is required

4.2.6 Innovation Objectives & IRDP Applicability (DRIE Impression)

- EDP contributed to the economic viability of regional industry but was not fully utilised
- government programs should be directed towards companies ("winners") and sectors based on regional priorities and implementation
- the most effective form of government R&D assistance is grants and contributions
- broadening of the scope of eligible costs would increase the utility of the program
- the program delivery process should be streamlined
- experts are optimistic about the IRDP in terms of achieving their regional objectives
- expert concerns about the IRDP center around:
  - changing of maximum limits
  - paperburden for application
  - ability to meet increased program demand

4.2.7 Regional Suitability Summary

The Enterprise Development Program, the only regionally delivered program of those considered, could be judged as to its suitability in assisting industrial innovation in terms of the following criteria; i) market penetration - usage ii) delivery mechanism and iii) cost coverage. When judged by these criteria, EDP was found to be very suitable to specific firm types and less suitable to others.

In terms of market penetration, the overall level of usage is quite low (2.4% of the population of firms). Nevertheless, the distribution of projects has reflected regional industrial concentration with usage per eligible firm across provinces being quite consistent. The program was most suitable for medium-small firms with high development costs who were in a worse-than-average position to finance the project. In general then, suitability as judged by usage was low but consistent given differing industrial bases among regions.

The contribution instrument as a delivery mechanism was found to be heavily favoured by firms and experts over other instruments such as tax and procurement policy due to its direct assistance to cash flow, especially to small firms, and it was seen as a needed complement to infrastructural assistance. The contribution instrument would seem to be a suitable delivery mechanism for innovation assistance.

Cost coverage of EDP was found to be generally suitable by user firms, however, in order to broaden the user base, a wider range of eligible costs might have been more suitable. On average, about 60% of assisted firms' total product development costs were eligible for assistance. At an average sharing ratio of 66%, this translates into an actual average contribution level of 40%. Firms with a higher proportion of direct development costs, as opposed to capital costs, generally benefitted more from funding since only direct costs were eligible for assistance. This phenomenon is reflected in sector usage, actual contribution levels, and success rates. The EDP would have been more suitable for innovation among sectors if a broader range of costs, reflecting the total product development process, was eligible for assistance.

The new IRDP's accent on flexibility and the incorporation of a corporate life cycle approach should enhance program suitability by broadening the eligible firm base and by including more of the total product development costs into its assistance framework.

4.3 Program Usage By Region

The purpose of this section is to provide information on the nature of previous EDP program usage in terms of regional and sectoral dispersion and characteristics of individual firms using the program.

Data and observations are presented on EDP users in the study sample with respect to:

- 4.3.1 Usage Versus the Population
- 4.3.2 Typical Company Age
- 4.3.3 Typical Company Size
- 4.3.4 Form of Operation
- 4.3.5 Financial Position of Firms
- 4.3.6 R&D Intensity
- 4.3.7 Sales/Employee Ratio

In summary, it appears that:

- industry sector is a more important determinant of program usage than location
- regional patterns of EDP usage/manufacturing base are similar
- EDP-supported firms generally have an established track record
- a high proportion of EDP users tend to be owner operated, "main plant" businesses
- the EDP user tends to be a medium-small, labour intensive, cash strained firm making sales despite limited assets

Exhibit 4-1

EDP Projects Compared To D&B Firm Population of Comparable Sector

	CHEM %	WOOD %	METAL %	MACH %	ELEC %	OTHER %	TOTAL %
BC	* 10/82 = 12	5/107 = 4	3/417 = .07	25/513 = 5	30/78 = 38	9/2932 = 03	82/4129 = 1.9
ALTA	7/75 = 9	2/57 = 3	4/264 = 1	22/329 = 6	10/34 = 29	5/2571 = 02	50/3330 = 1.5
SASK	1/16 = 6	0/12 = 0	1/65 = 1	22/102 = 21	11/11 = 100	3/1246 = 02	38/1452 = 2.6
MAN	10/21 = 47	6/29 = 20	7/123 = 5	12/131 = 9	14/27 = 51	4/1082 = 03	53/1413 = 3.7
ONT	25/396= 6	12/190 = 6	23/1611= 1	79/2573= 3	97/476= 20	31/7758= 04	267/13004= 2
QUE	35/244= 14	21/211 = 10	30/720 = 4	60/1092= 5	63/212= 30	44/5218= 08	253/7697 = 3.2
NB	4/14 = 28	1/14 = 7	2/31 = 6	3/45 = 6	0/4 = 0	1/488 = 02	11/596 = 1.8
NS	5/19 = 26	1/14 = 7	1/39 = 2	4/60 = 6	6/4 = 150	1/659 = 01	18/795 = 2.2
PEI	9/2 = 450.	0/2 = 0	2/8 = 25	0/10 = 0	5/1 = 500	2/82 = 2	18/105 = 17
NFLD	4/3 = 133.	0/5 = 0	1/11 = 9	2/6 = 33	1/1 = 100	0/269 = 0	8/295 = 2.7
TOTAL	110/872 =12.6	48/642 = 7.4	74/3293 = 2.2	229/4863 =4.7	237/848 =27.9	100/22355=0.4	798/32874 = 2.4

*i.e. 10 is number of product development EDP's authorized since 1978 and completed prior to March 1982 in firms which are still in operation (study population)

82 is number of firms in comparable SICs reported by Dun and Bradstreet.

4.3.1 EDP Usage vs the Population

Regional suitability of the product development and design portions of the EDP program are in part reflected by the degree of penetration achieved in various industrial sectors across the provinces.

In order to assess the degree of penetration of EDP, the 798 projects in the study population were compared to the total population of firms in the same major industrial categories as provided by Dun and Bradstreet statistics.

It is observed in Exhibit 4-1 that EDP program usage differs significantly by sector vis à vis the population, while usage by province shows lower variability.

This exhibit shows that program usage has varied significantly by sector (almost 28% penetration for electrical and more than 12% for chemical based industries versus less than 5% for metal fabrication, machinery, and other industries).

Sectoral variance in the percentage of innovation projects receiving government assistance was also shown in a 1980 study by the Economic Council (See Appendix I). The findings showed that innovations partially funded by government ranged from over 30% in telecommunications to less than 5% for smelting and refining.

Overall provincial usage has been relatively consistent when normalized by firm populations by sector and region.

From the spatial and sectoral distributions outlined above it may be concluded that:

- Provincial usage of EDP when normalized to relevant firm populations has been relatively consistent.
- Penetration of EDP into the population of firms varies significantly by industrial sector.
- Firm sector is an important determinant of program usage.

Exhibit 4-2

Age Of Company By Company Size

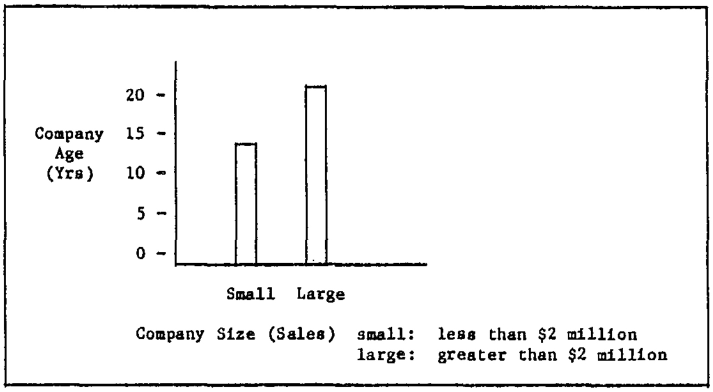


Exhibit 4-3

Age of Company By Province

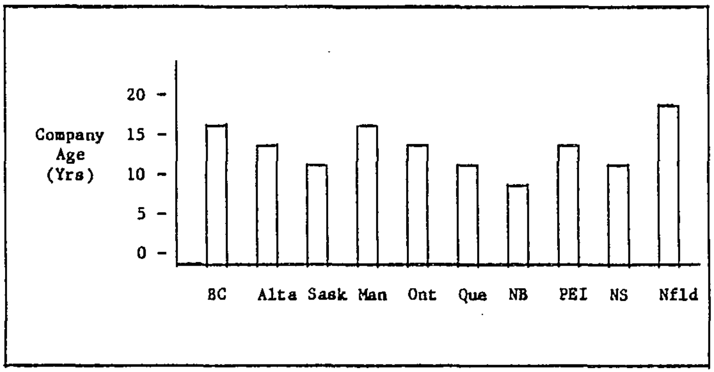
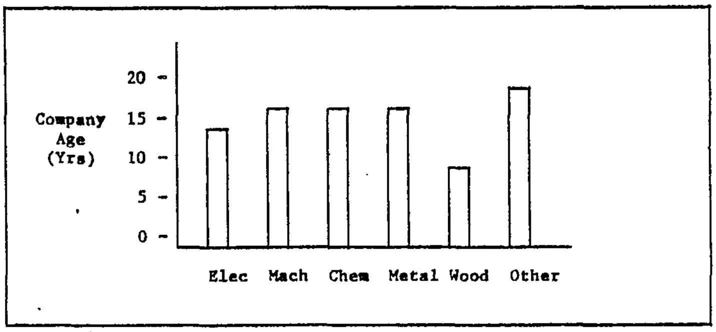


Exhibit 4-4

Age of Company By Sector



4.3.2 Typical EDP Company Age

One of the informal criteria utilized by EDP program delivery personnel was that applicant firms have an established track record that would lend credibility to the firm's proposition that it could successfully complete a product development project.

It is thus not surprising that the average age of even small companies supported by EDP is 10 years or more. As shown in Exhibit 4-2 the average age of larger companies in the sample which have received EDP assistance is even higher than that for the small companies. As shown in Exhibits 4-3 and 4-4, regional and sector differences are minimal. However, Maritime companies tend to be a little younger.

Exhibit 4-5

Employees By Company Size

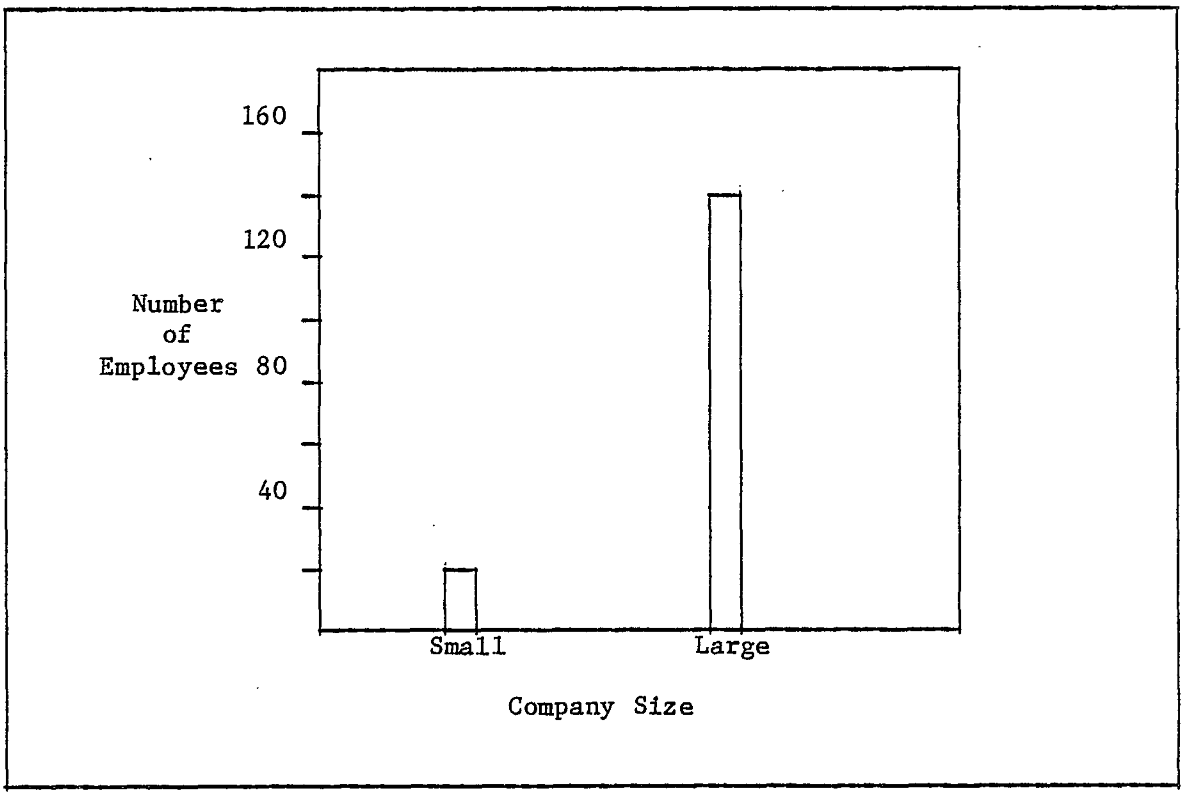
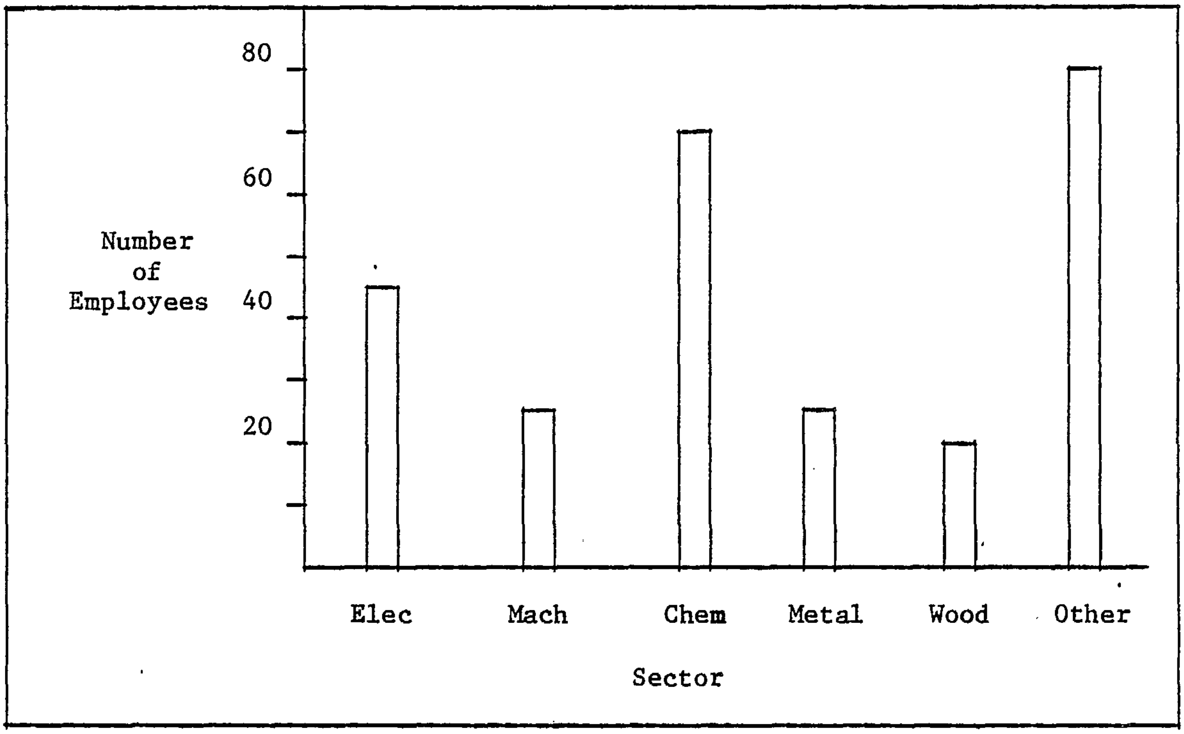


Exhibit 4-6

Employee By Sector



4.3.3 Typical Company Size by Employment

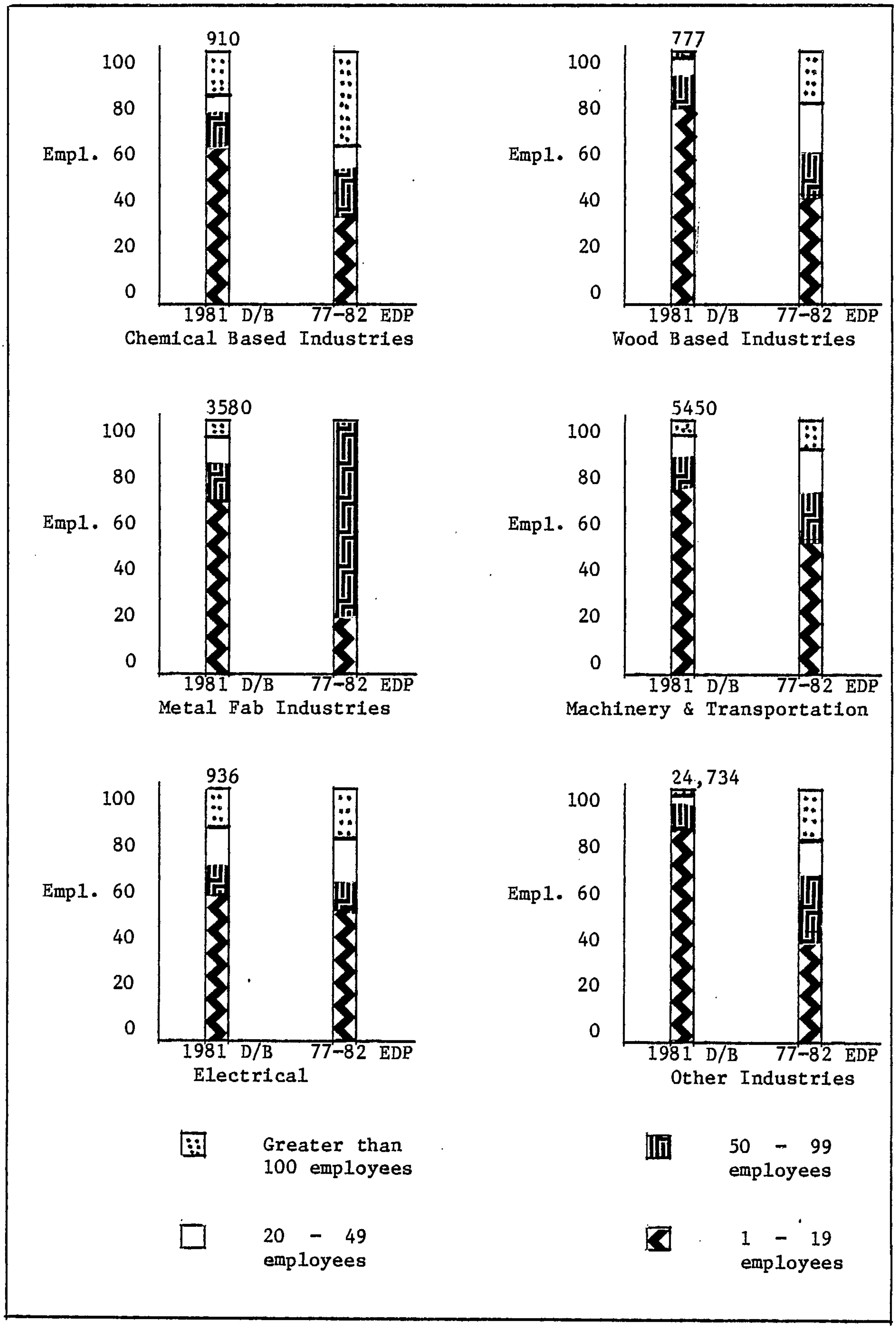
The EDP program by virtue of its significant burden criteria was targetted at small and medium sized businesses.

For the population sampled, which included firms of both a small and large size based upon a cut-off of $2 million sales, the average small firm had 15-20 employees and the average large firm had 120-130 employees. The median EDP firm size is 25 employees (mean = 40)

On a sectoral basis, it appears that firms in the electronics and chemical sectors that received EDP assistance employed more people than other sectors.

Exhibit 4-7

EDP User Employee Levels vs D/B Population For All of Canada by Sector



However, when a comparison is made between EDP users and the D & B population, it is noted that EDP program users have tended to have more employees than firms in their corresponding sectors in Canada. Differences in employee groupings between EDP users and the general population are least extreme for electrical based firms and most extreme for metal fabrication (EDP lacks medium-large users) chemical and other industries (fewer small users as a proportion of total EDP than as a proportion of the population). This is shown in Exhibit 4-7.

EDP, it may be concluded, has been appropriate assistance for firms which generally have already become established and which may need some product development at an intermediate growth stage.

In the case of metal fabrication, it would appear that this capital-intensive sector does not require EDP type assistance beyond a certain firm size.

For chemical and other industries (and to a lesser extent for machinery, wood and electronics) it would appear that EDP assistance has not been appropriate for some smaller firms.

It should be noted that the number of firms surveyed in each sector varied as shown in Section 3.3. Thus some caution is required in drawing conclusions about firms in the metal fabrication (4 firms) and wood based (6 firms).

Exhibit 4-8

Financial Position of EDP Firms vs Population

i) Liquidity (cash position)
Current Ratio: Current Assets/Current Liabilities

D & B Survey	=	1.61	(1978)	n = 27,473
	=	1.68	(1980)	n = 30,548
EDP Firms	=	1.40		n = 98

ii) Turnover of Capital
Sales over tangible net worth

D & B Survey	=	2.92	(1978)	n = 27,473
	=	3.12	(1980)	n = 30,548
EDP Firms	=	3.14		n = 98

Sales to Total Assets

D & B Survey	=	.74 - 1.67 (range for all mftg 1978)	
EDP Firms	=	2.17	n = 98

iii) Debt Capacity

Current Debt to Tangible Net Worth*

D & B Survey	=	.706	(1978)	n = 27,473
	=	.689	(1980)	n = 30,548
EDP Firms	=	.80 - .90	(range)	n = 98

* It is noted that in the D & B explanation of the current debt to tangible net worth ratio they state "Ordinarily, a business begins to pile up trouble when this relationship (current debt/tang. net worth) exceeds 80%."

4.3.4 Form of Operation

A high proportion of EDP users are small, owner operated businesses. This is reflected in the fact that 95% of all users contacted in the survey considered themselves to be the "main plant".

4.3.5 Financial Position of Firms

The financial position of the EDP users sampled was compared to the general Dun and Bradstreet population with respect to:

(i) liquidity;
(ii) turnover of capital; and
(iii) debt capacity

It is observed in Exhibit 4-8 that EDP-assisted firms tended to be cash poor vis-a-vis the general population while relative turnover of capital ratios were medium-high (sales/assets, sales/tangible net worth), and current debt capacity was a problem.

Exhibit 4-9

Cash Position and Turnover Ratios by Sector

	Cash Position (Current Assets/Current Liabilities)			Turnover of Capital (Sales/Assets)	
	D & B		EDP	D & B	EDP
	'78	'80	77 - 82	1978	77 - 82
CHEMICAL	i)* 1.82 ii) 2.23	1.60 1.89	1.26	i) .74 ii)1.63	4.44
WOOD	1.08	1.37	1.22	1.35	1.78
METAL FAB	1.61	1.67	1.23	i) 1.65 ii) 1.22 iii)1.40 iv) 1.60 v) 1.61	1.60
MACH & TRANSP	i)* 1.56 ii) 1.18	i) 1.59 ii)1.19	1.43	i) 1.32 ii) 1.67	2.08
ELECT	i) 1.66 ii) 1.75	i) 1.70 ii)1.46	1.54	i) 1.38 ii) 1.47 iii)1.53	1.37
OTHER IND	--**	--	--	--	--
TOTAL	1.61	1.68	1.40	not available	2.17

D & B '78 n = 27,473

D & B '80 n = 30,548

EDP 77-82 n = 98

* Representative sub-sectors
** Not reported due to matching problems.

In looking at the cash position and turnover ratios on a sector basis as shown in Exhibit 4-9, it can be seen that all EDP sampled sectors show a tendency to be more "cash poor" than the D & B population (current assets/ current liabilities are less than the D & B population) and have generally higher turnover of capital (sales/assets) rates.

Thus EDP assisted firms tend to conform to a conceptual model of EDP users as medium-small, labour-intensive, high R & D, cash-strained firms making sales despite limited assets. These companies would tend to be high credit risks from a bankers' point of view.

Exhibit 4-10

R & D/Sales Ratios
EDP vs Statistics Canada

	STATS CAN '79	OECD '77	ECC '70 - '80	EDP '77 - '82
CHEMICAL	i)* .8	i) 1.3	-	-
Petr. Prod	ii) .4	ii) -	ii) 2.3(.5)**	-
Rubber & Plast.	iii).7	iii)2.6	iii)1.3 (.8)	-
WOOD	i) .3 ii) -	-- paper .4	-- --	- -
METAL FAB	.5	--	--	3.3
MACHINERY & TRANSPORTATION	i) 1.4 ii) .8 iii) 9.8 iv) .3	1.1	--	3.3
ELECTRICAL				
Telecom	i) 8.3		i) 9.6 (3.3)	12.3
Other	ii) 1.2	ii) 2.9	ii)3.2 (1.7)	
Scient + prof	iii) 1.5			
TOTAL MFTG	.8	-	5.8 (2.4)	8.0***(2.2)

* i) = Representative subsectors to those of EDP

** ( ) = Median values

*** Subject to change due to highly variable data input.

Note that although the median values of the ECC R&D/sales ratios and the EDP R&D/sales ratios are very similar it should be recognized that the ECC study was more heavily weighted towards R&D intensive industries. (ECC sample contains 64% telecomunications and electrical firms while the EDP sample contains 32%)

4.3.6 R & D Intensity

It is noted that EDP program users have tended to be more R & D intensive than the general population of manufacturers.

EDP program users have shown an overall R & D/sales ratio median of greater than 2% at the time of assistance application. This level is higher than the overall average of R & D/Sales in Canada which is less than 1% as shown in Exhibit 4-10.

Calculations were performed on the Economic Council of Canada study database to determine whether government assisted firms (primarily PAIT and IRAP) had significantly different R&D/ sales ratios from non-assisted firms at the time of innovation project commencement.

The only sector which had a large enough sample to form two statistically significant groups was telecommunications. The median R & D/sales for government assisted firms was .069 (mean = .109, n = 34) while the median for non government assisted firms was .0366 (mean=.077, n=49). The government assisted group clearly had higher R & D/sales ratios than the non-assisted group.

From the EDP surveyed firms, small companies had annual research expenditures of $30 - $50,000/yr while large companies had research budgets of $65 - $140,000/yr. Small firms tended to have larger R & D/Sales ratios than large firms. (For firms with sales less than two million dollars per year R & D/Sales averaged 20%; for larger firms the average was below 5%.

4.3.7 Sales/Employee Ratio

Sales/Employees ratios for EDP firms tend to be lower on average than Sales/Employees ratios in the D & B population for similar sectors.

Average sales to employee ratios for EDP assisted firms have been in the range of $33,000 - $40,000 per employee compared to the average in the D&B population of $91,000 per employee for the years 1977 to 1982.

The data seems to indicate that the manufacturing/processing activities carried out by EDP user firms are highly labour intensive. (Low volume, high value-added products tend to have high technological input but relatively labour intensive production processes.)

4.4 Regional Innovation Levels

The purpose of this section is to provide a backdrop to innovation programming in the department by providing information on the nature and extent of R & D being performed in Canadian industry.

The major source of data in this section is Statistics Canada. As the R & D definition utilized by Statistics Canada is somewhat narrower than the product development/innovation definition of this study, it is important to note the context of the statistics which follow.

Data and observations are presented in:

4.4.1 R & D expenditure by region
4.4.2 R & D expenditure by sector
4.4.3 Number of firms performing R & D
4.4.4 R & D employment
4.4.5 Experts perceived priority of R & D

In summary it appears that:

- Ontario is responsible for 50% to 60% of all R & D performed in Canada. Quebec is the second highest R & D performer accounting for 25%

- the electrical sector is the largest performer of R & D with the chemical and machinery/transportation industries following

- there are distinct regional differences in R & D performance which are related to industry sector presence

Exhibit 4-11

Total Intramural R & D Expenditures
In Canada By Region, 1977, 1979, 1981

(capital plus current expenses)

Region	1977	1979	1981
	- $ 000,000 - (current)		
Atlantic provinces	7	41	18
Québec	232	314	449
Ontario	463	670	1,073
Manitoba & Saskatchewan	15	29	49
Alberta	80	150	284
British Columbia	36	54	98
TOTAL (1)	857	1,269	2,004

(1) Includes Yukon & Northwest Territories

Source: Statistics Canada

4.4.1 R & D Expenditure By Region

Total intramural R & D expenditures (ie conducted inside the firm as opposed to contracted out) in manufacturing industries have increased in current dollars every year since 1963. In 1977, manufacturing industries spent $857 million on R & D. That total increased to $2,004 million in 1981.

As shown in Exhibit 4-11, Ontario manufacturing firms are responsible for over 50% of all R & D expenditures, followed by Quebec with a little less than 25%.

Since 1977, the share of the Western provinces' R & D expenditures have increased. Quebec's share has gone from 27.1% in 1977 to 22.9% of the total in 1981. Ontario maintained its share during that period. The share of the Atlantic provinces fluctuated, increasing four-fold in 1979 to 3.2% of the total but reverting to a share of less that 1% by 1981. The rapid increase in 1979 was associated with increases in oil and gas exploration in the region.

Exhibit 4-12
Current Intramural R & D Expenditures
By Industry Group, 1977, 1979, 1981

Industry Group	1977	1979	1981
	- $ 000,000 - (current)		
Chemical based	168	211	377
Wood based	34	48	67
Metals	67	81	100
Machinery & Transportation	167	252	389
Electrical	177	252	398
Other Industries	175	231	400
TOTAL	788	1075	1730
Percent Change	(24%)	(36%)	(61%)

Source: Statistics Canada

Exhibit 4-13
Current Intramural R & D Expenditures
By Industry Group And By Region, 1981

Industry Group	Que	Ont	Alta	BC	Other * Provinces	TOTAL
		- $ 000,000 - (current)				
Chemical based	61	190	93	3	31	377
Wood based	27	19	---	18	2	67
Metals	24	70	x	1	x	100
Machinery & Transportation	168	199	1	4	17	389
Electrical	73	304	4	13	4	398
Other Industries	56	163	120	34	11	400
TOTAL	409	945	219	73	85	1730

Source: Statistics Canada
* Includes the Yukon and the Northwest Territories
x Confidential to meet secrecy requirements of the Statistics Act but amounts included in "TOTAL".

4.4.2 Current R & D Expenditures By Sector

Trends in industrial R & D activity are conveyed more accurately by current intramural expenditures than by the total which includes capital expenditures. The reason is that capital expenditures fluctuate considerably since individual companies do not purchase land, buildings or major R & D equipment on a regular basis. Current intramural expenditure indicates the level of commitment to R & D by the firm since it covers the cost of wages and consumeables for workers who are usually permanent employees.

In the seventies, current R & D expenditures (current dollars) increased at at a rate of approximately 16% per year. But since 1977, as shown in Exhibit 4-12 the increase has been around 24% per year.

In the sixties and seventies the electrical industry had consistently been the largest performer of industrial R & D. However, since the eighties the chemical and machinery and transportation groups have increased their current R & D expenditures to the point where they are almost at par with the electrical group.

Segregating the above industry sector current R & D expenditures by province provides a useful backdrop of regional R & D levels for this study. As shown in Exhibit 4-13, the electrical and machinery/transportation sectors are the major R & D spenders in Ontario, while the machinery/ transportation sector is the single largest R & D spender in Quebec. Alberta does more chemical R & D than any other province with the exception of Ontario.

Exhibit 4-14

Number of R & D Performing Establishments vs. Total Number of Establishments

Industry Group	1978		1979		1980	
	Number of Estab.	R & D Perform	Number of Estab.	R & D Perform.	Number of Estab.	R & D Perform
Chemical based	7,680	236	8,077	245	7,964	283
Wood based	3,627	37	3,940	41	4,127	47
Metals	4,898	94	5,303	99	5,546	108
Machinery & Transportation	2,401	132	2,707	135	2,903	148
Electrical	1,752	143	1,967	152	2,083	188
Other Industries	11,605	260	12,584	277	12,890	348
TOTAL	31,963	902	34,578	949	35,495	1,122

Source: Statistics Canada

Exhibit 4-15

Percent of R&D Performers To Total Industrial Population By Industry Group

Industry Group	1978	1979	1980
Chemical based	3.1 %	3.0 %	3.6 %
Wood based	1.0	1.0	1.1
Metal	1.9	1.9	2.0
Machinery & Transportation	5.5	5.0	5.1
Electrical	8.2	7.7	9.0
Other Industries	2.2	2.2	2.7
TOTAL	2.8 %	2.7 %	3.2 %

4.4.3 Number of R & D Performers

As an indication of the prevalence of firms conducting R & D, Exhibit 4-14 shows the number of establishments by industry group and the number of firms within each group which are R & D performers by the Statistics Canada definition.

Exhibit 4-15 demonstrates several points:

- The propensity to perform R&D coincides closely with the usage of EDP assistance by firm sector. (see Exhibit 4-1)

- In the last few years the trend in the number of R & D performers in industry has been one of increase.

Exhibit 4-16

Number of Persons Engaged In R&D, By Province And By Category, 1981

	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
Professional	25	5	45	35	3,355	8,530	135	150	775	700
Other	20	10	60	35	4,160	10,500	285	200	805	705
Total	45	15	105	70	7,515	19,030	420	350	1,580	1,405

Source: Statistics Canada

Exhibit 4-17

Number Of Persons Engaged In R&D, By Industry Group And By Region, 1981

Industry Group	Que	Ont	Alta	BC	Other * Provinces	TOTAL
			- Person Years -			
Mines & Wells	105	345	715	x	x	1,430
Chemical based	1,510	3,870	510	70	155	6,110
Wood based	590	420	-	330	45	1,385
Metals	510	1,240	x	20	x	1,800
Machinery & Transportation	2,285	4,370	20	75	435	7,190
Electrical	1,500	5,635	70	380	70	7,650
Other Manufac-turing	55	345	x	x	x	400
Services	955	2,805	260	395	240	4,655
TOTAL	7,515	19,030	1,580	1,405	1,100	30,630

* Includes the Yukon and the Northwest Territories

x Confidential to meet secrecy requirements of the Statistics Act

\- Nil or amount too small to be expressed

Source: Statistics Canada

4.4.4 R & D Employment

Size of R & D labour force may be an approximate measure of the depth and direction of a region's R & D effort even though it does not indicate capabilities such as level of sophistication, utilization or productivity of R & D personnel.

In terms of regional concentration, slightly over 60% of all R & D professionals are engaged in Ontario and approximately 25% are employed in Québec. Less than 1% are located in the Atlantic provinces while 13% are engaged in the West as shown in Exhibit 4-16.

As would be expected most R & D workers are engaged in the high technology sectors such as electrical, machinery and transportation, and chemical based as shown in Exhibit 4-17.

Exhibit 4-18

Perceived Technological Leadership
In Economically Important Sectors

	BC	Alta	Sask	Man	Ont	Que	NB	NS	PEI	Nfld
Electrical				A–	AY	A–		A–		
Mach/Trans		A–	AY	A–	AY	AY		AN		
Chem./Food Proc.		AY	AY	A–	AY	A–		AN		AN
Metals										
Wood	AY			A–				AN		A–
Other (Mines, Oils)	AY	AY								
Related Service		AY								

A = Important sector

Y = Technological leader

N = Not a technology leader

– = Uncertain as to world technology position

4.4.5 Regional Perception of Priority of R & D

Regional DRIE officials and regional experts were asked to comment on the industrial sectors considered most economically important to their regions and the degree to which these sectors demonstrated technological leadership.

As illustrated in Exhibit 4-18, only the Maritime provinces considered their most economically important sectors as lagging in innovation although many DRIE officials were uncertain of the relative world standing of their industries.

The degree to which the program was seen to encourage a continuous innovation capability also tended to be minimal in the Maritime provinces but increasing through Central and Western Canada. In any case, the effect on overall innovation capability resulting from carrying out DRIE assisted product development was not viewed as dramatic in any province.

With the exception of Ontario, experts believed product development was not a prominent activity within their region. However, even in Ontario, despite industry awareness of the benefits of product development, there is still room to improve the ability of companies to follow-through from idea generation to the marketplace.

4.5 Requirements for Business Innovation

The purpose of this section is to consider the requirements of innovation programming from the perspective of the innovation process as experienced by the firm.

The major source of data in this section is the firm survey augmented by EDP file review and external data sources.

Highlighted in this analysis are the following:

4.5.1 Firm Innovation Motivation Factors
4.5.2 Major Factors in Screening Projects
4.5.3 Risk Factors
4.5.4 Technology Sources
4.5.5 Product Development Cycle
4.5.6 Basis for Annual Product Development Expenditure
4.5.7 Funding Availability
4.5.8 EDP assistance as a Proportion of Total Costs
4.5.9 EDP Funded Activities
4.5.10 Funded Costs Relative to Normal Product Development Costs
4.5.11 Product Development Cost Trends
4.5.12 Product Development Financial Burden

In summary this section shows that:

- market accessibility is of prime importance in the motivation of product development and the eventual success of the products. Technological competence or capability is the second most important product development motivating and success factor

- these motivational and success factors differ according to region, sector and firm size

- the perception of risk varies according to industry sector and firm size

- the source of technology is generally internal but may vary by region or sector (i.e. Maritimes and chemical industries use more external technology sources)

- despite the users' perception of markets as being the major motivational and risk factor, companies spend the least of their development budgets on market research or marketing start-up. The greatest portion of funds is spend in engineering development

- the distribution of product development funds varies significantly according to regions, sector and size of firm

- companies set their budgets for product development on an annual basis or a project by project basis. This varies depending on sector and company size factors.

- government accounts for a significant portion of firms source of product development funds. Most companies rely heavily for the rest of the funding on internal sources. Smaller firms are more apt to use external financing as compared to large firms.

- the amount of government assistance is linked to sectoral and firm characteristics rather than to cost sharing ceilings. Therefore assistance based on specific direct cost factors tends to favour some firms over others regardless of the percentage assistance.

- current costs represent almost 75% of the total product development cost. Labour is the major factor in current costs.

Exhibit 4-19

Motivating Factors In Business Innovation

Motivational Factor	% of Total Responses
• Perception of a new market gap	32%
• To take advantage of new technological advances	17%
• To improve quality of a product thereby increasing marketability	12%
• Response to foreign competition	10%
• Interactions with customers	8%

4.5.1 Firm Innovation Motivating Factors

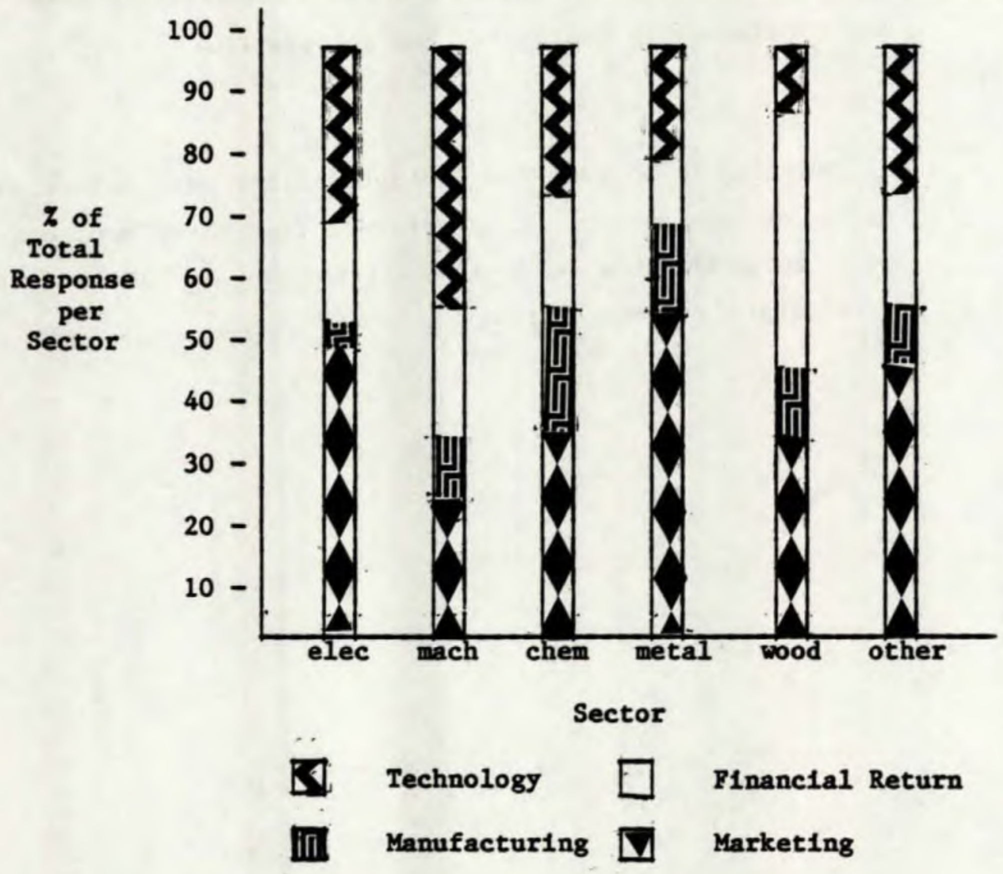
When EDP users were asked what was the principal factor leading them to undertake the product development project, perception of a new market gap was the most prevalent response followed by taking advantage of new technology advances. Other important stimulants as shown in Exhibit 4-19 were interactions with customers, and competition.

In considering whether the EDP innovations were market driven or technology pushed, it is apparent that these projects were very much in line with the literature in terms of being predominately market driven.

Exhibit 4-20
Major Factors in the Decision to Undertake Product Development Projects

	% of total responses
Technology	27%
Financial Return	20%
Manufacturing	13%
Marketing	40%
	100%

Exhibit 4-21
Innovation Decision Factors by Sector



4.5.2 Major Factors in Screening Projects

The successful design and implementation of government support to innovation in the firm must be cognizant of the factors in innovation considered important by the firms. These factors can provide guidance as to the focus of eligible costs and in the analysis of applications.

When asked via the study questionnaire, EDP users stated that the major factors upon which product development funds are allocated are primarily market-oriented. However, as shown in Exhibit 4-20, technology availability and capability also play an important role.

On a sectoral basis, as shown in Exhibit 4-21, electronics and metalworking sectors highly emphasize the importance of marketing as a factor in undertaking product development. Machinery companies indicate that technology is more critical.

Exhibit 4-22
Innovation Decision Factors
By Company Size

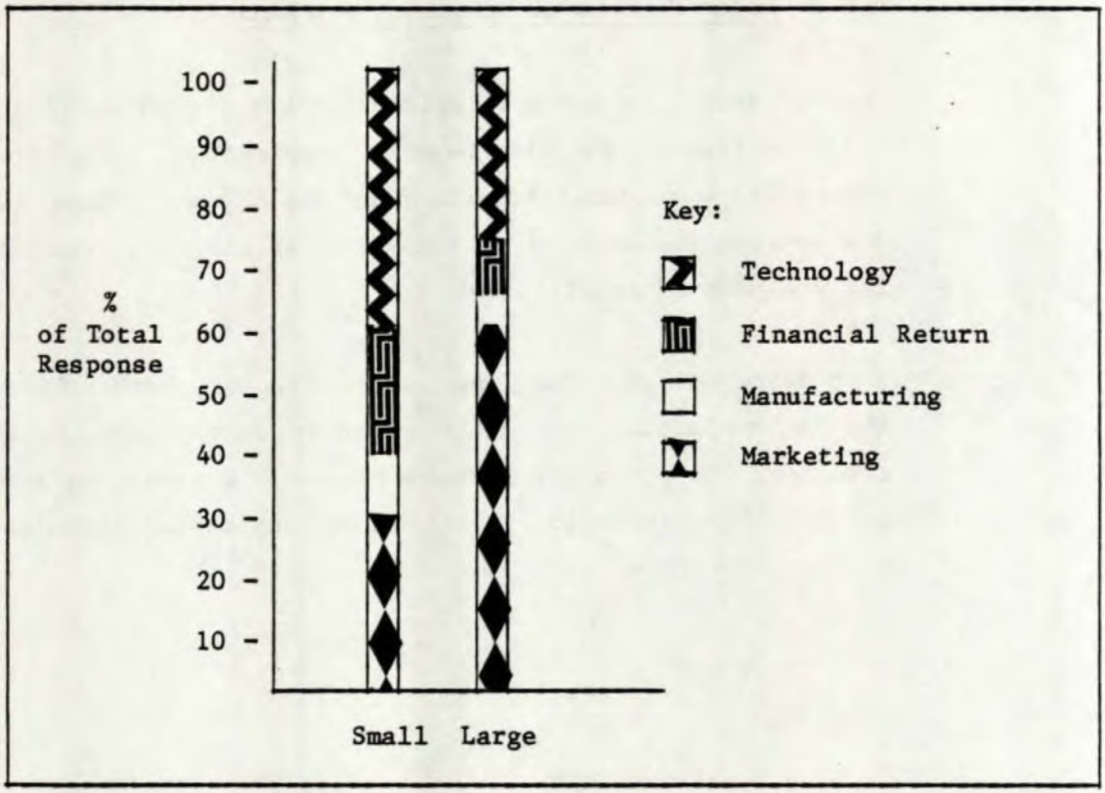
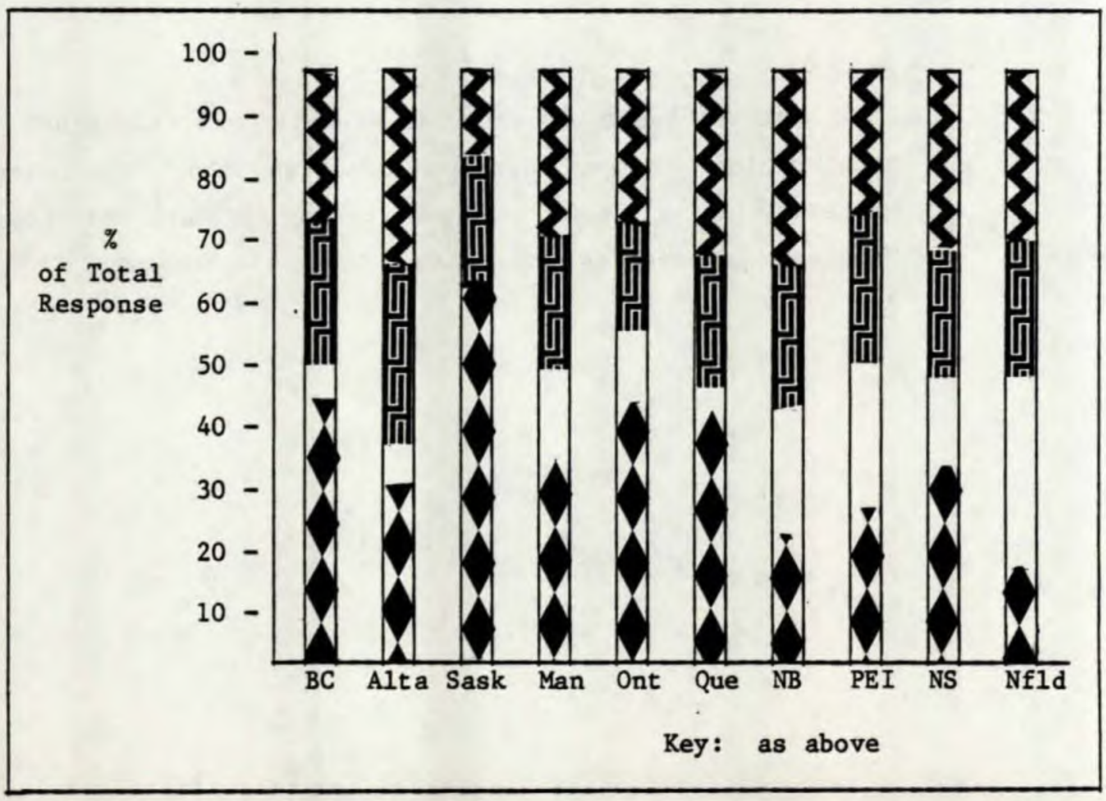


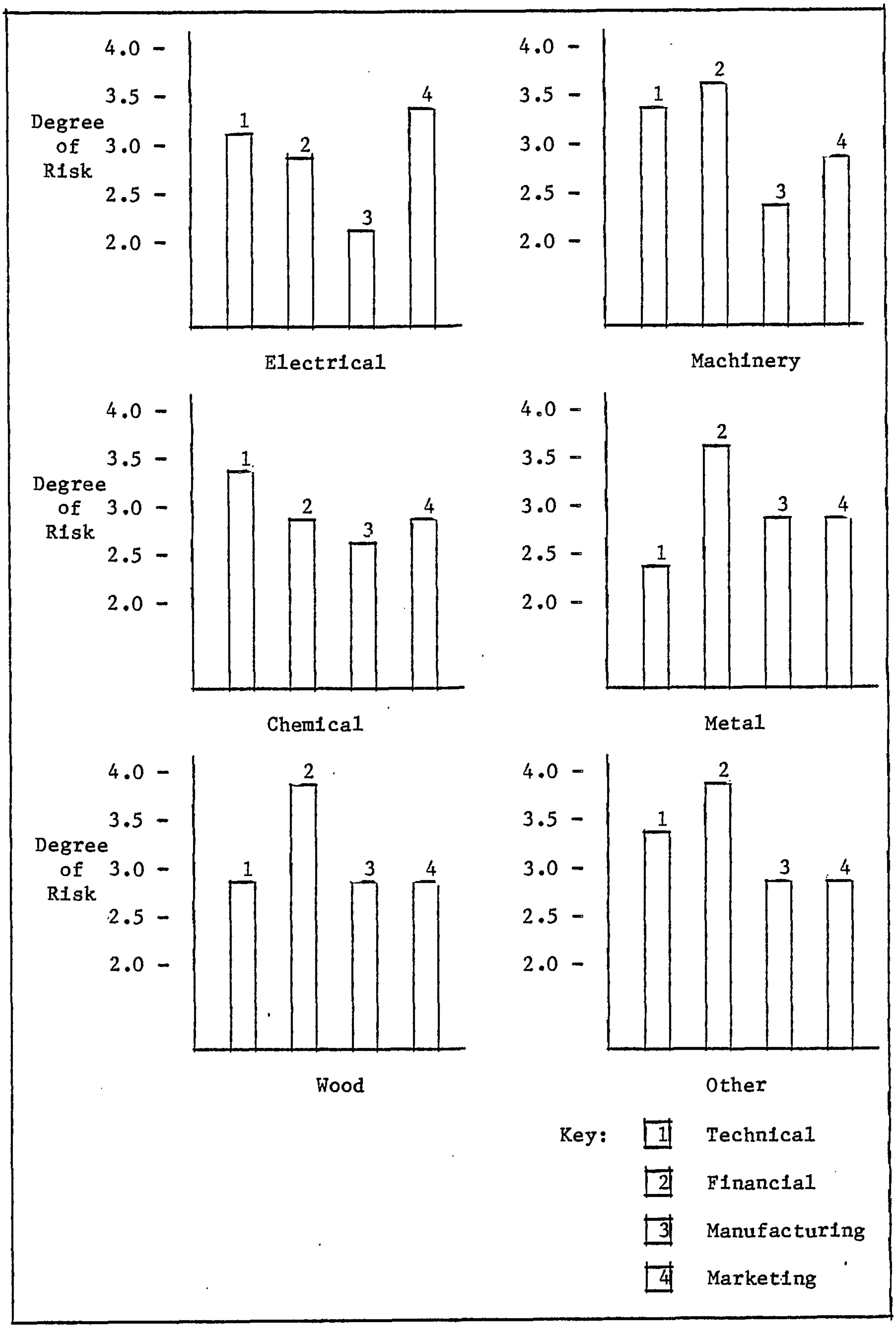
Exhibit 4-23
Innovation Decision Factors By Province



On a size basis, large firms appear more concerned with markets than technology capability. Small companies, as shown in Exhibit 4-22, tend to be more conscious of technological implications, but do consider markets an important factor.

Regionally, as shown in Exhibit 4-23, the Maritime provinces appear to be more concerned with manufacturing capabilities relative to other provinces across Canada.

Exhibit 4-24
Innovation Risk By Sector

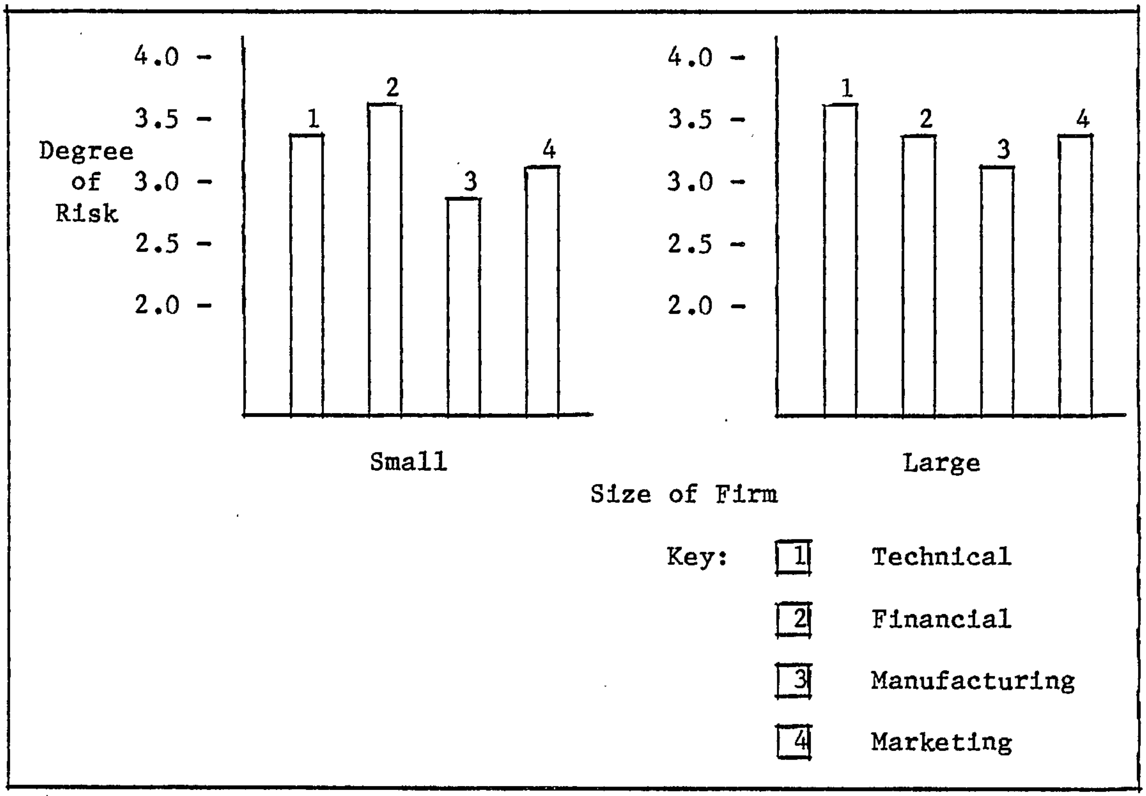


4.5.3 Risk

Traditionally, government innovation funding support has been designed to assist firms financially in those activities deemed risky to the extent that the overall risk would be lowered to the point that projects would commence under normal commercial risk-taking criteria.

EDP users were asked to consider which areas of the innovation process they considered to be most risky. As shown in Exhibit 4-24, electronics companies drew marketing as the highest risk area. Chemical firms considered that technical concerns posed the greatest risk factor whereas most other sectors perceived that product development was primarily a financial risk.

Exhibit 4-25
Innovation Risk By Firm Size



4.5.3 (continued)

On a firm size basis, as shown in 4-25, small companies indicated financial risk as the greatest risk factor while large companies indicated that technical risk was most significant.

Exhibit 4-26
Source of Technology
By Region (EDP Firms)

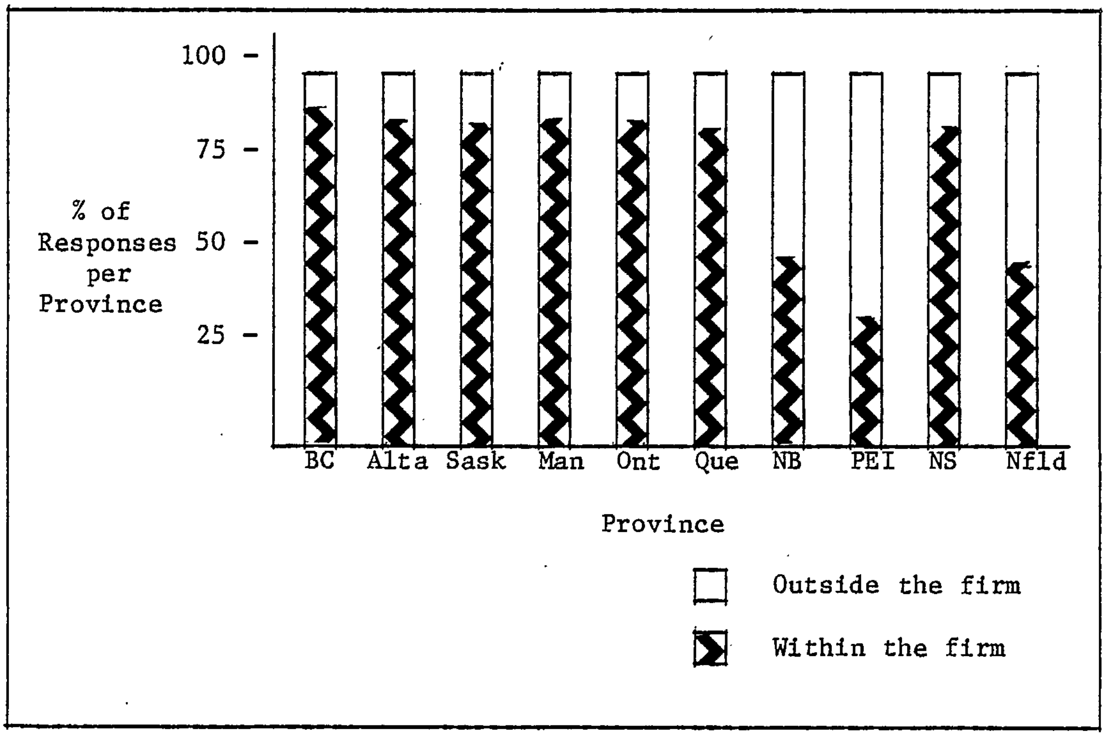
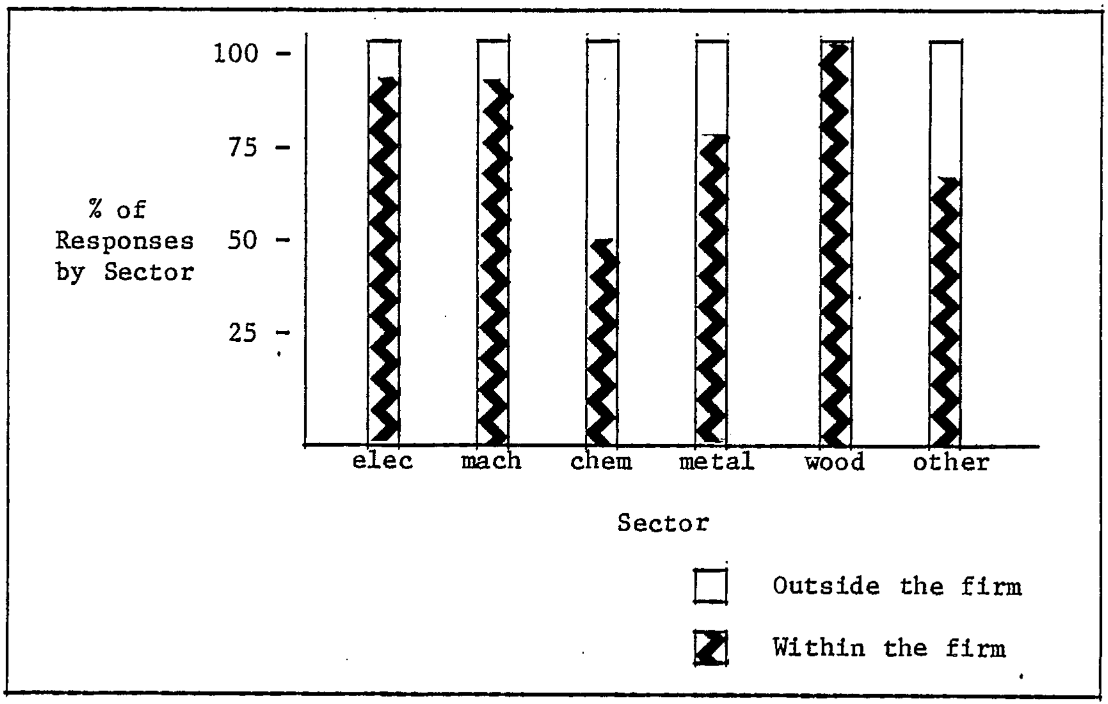


Exhibit 4-27
Source of Technology
By Sector



4.5.4 Technology Source

The source of technology leading to innovation can vary on the basis of spatial location and sector with each source being economically justifiable dependent upon the circumstances facing individual firms.

As shown in Exhibit 4-26, firms in the provinces of New Brunswick, Prince Edward Island and Newfoundland relied heavily on technology obtained outside the firm.

On a sector basis, Exhibit 4-27 shows that the chemical firms tended to utilize a higher degree of outside technology.

Exhibit 4-28
Source of Technology
By Firm Size

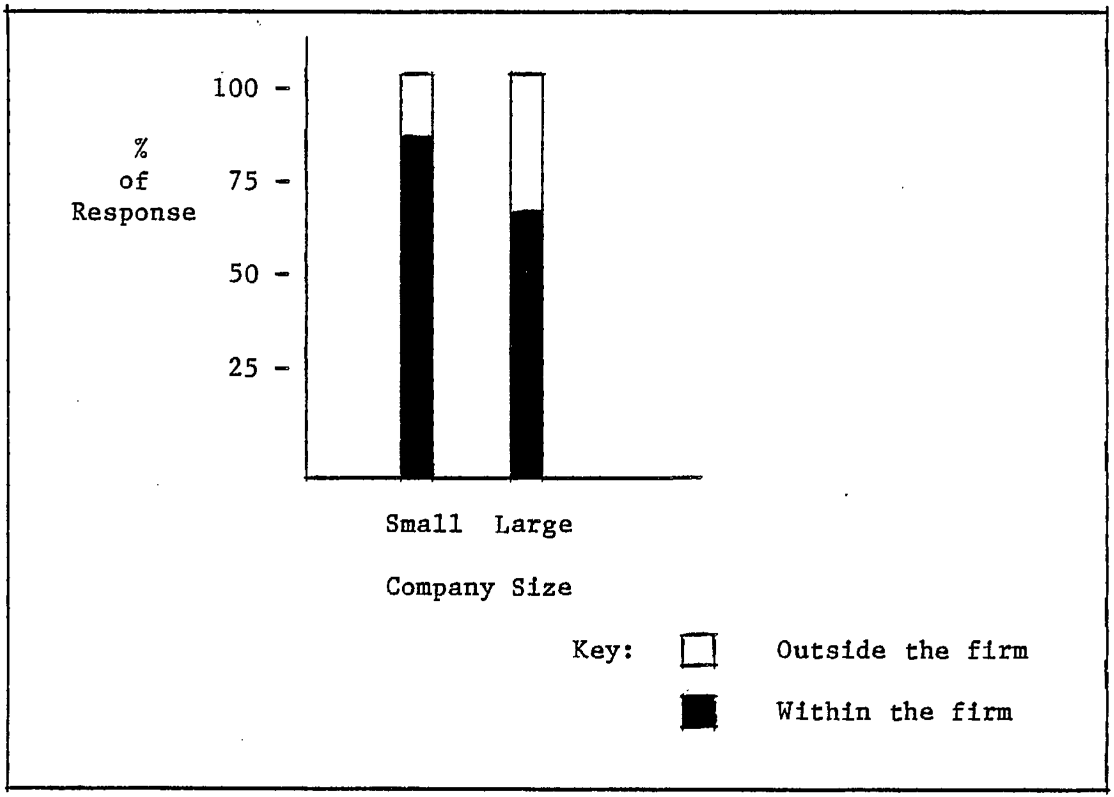


Exhibit 4-29
Overall Average Product Development
Expenditures (EDP Firms)

Research	16%
Market Evaluation	6%
Engineering Development	42%
Marketing Start-up	9%
Manufacturing Start-up	27%
	100%

4.5.4 (continued)

In terms of firm size, Exhibit 4-28 shows that larger firms are more likely to utilize outside sources of technology than small firms.

In conclusion, it would appear that a majority of firms utilise in-house technology and that outside support services are not fully realising their potential for technology transfer. Secondly, there is only limited integration and/or support between EDP program users and other government technology resources.

4.5.5 Product Development Cycle Costs

Innovation in the firm is defined as the process by which an idea is developed into a product which is introduced into the market place. Models describing this process generally include the following steps: research; market evaluation; engineering development; marketing start-up; and manufacturing start-up. The magnitude and relative portion of these costs differ amongst companies with the result that government programs aimed at one or more of the costs will provide differing levels of motivation to the firm to use the program.

The relative spread of these costs has been measured previously by Statistics Canada and the Economic Council of Canada from slightly differing perspectives and types of firms.

In this study, EDP users were asked to categorize their innovation/product development expenditures as shown in Exhibit 4-29. It can be seen that engineering development and manufacturing start-up consume the greatest portion of product development funds.

Exhibit 4-30
Product Development Expenditures
By Company Size (EDP Firms)

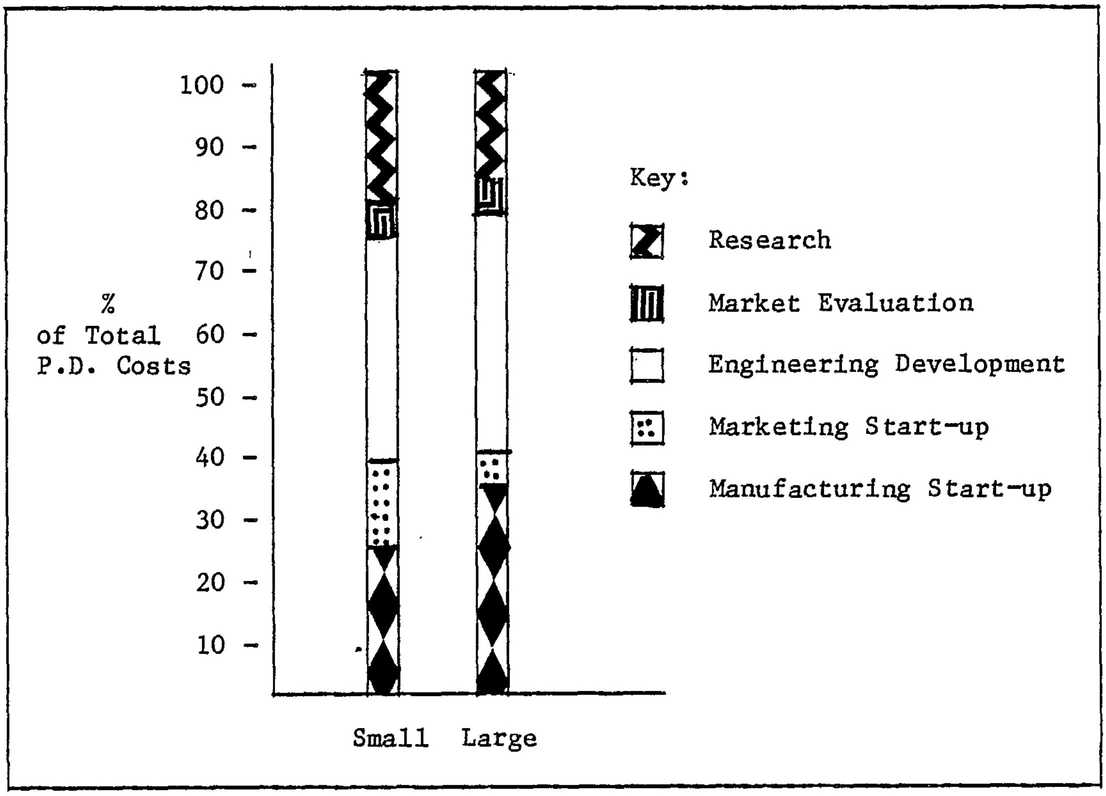
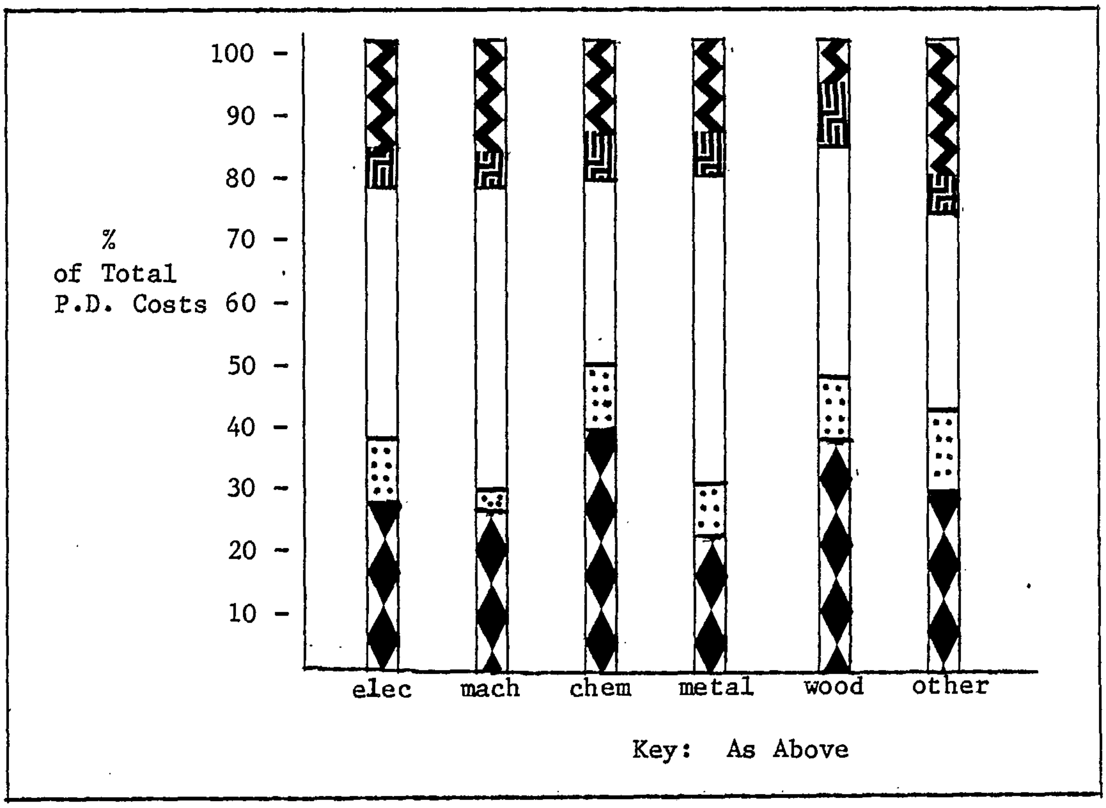


Exhibit 4-31
Product Development Expenditure
By Sector (EDP Firms)



4.5.5 (continued)

When the product development costs of respondents was categorized by firm size, as shown in Exhibit 4-30, it is apparent that the major difference is that large firms tend to spend a greater percentage of their innovation costs on manufacturing start-up.

On a sector basis, the EDP user innovation cost make up shows significant differences as illustrated in Exhibit 4-31. It is apparent that the process-oriented industries such as chemical and wood have higher manufacturing start-up costs.

Exhibit 4-32
Product Development Expenditure
By Region (EDP Firms)

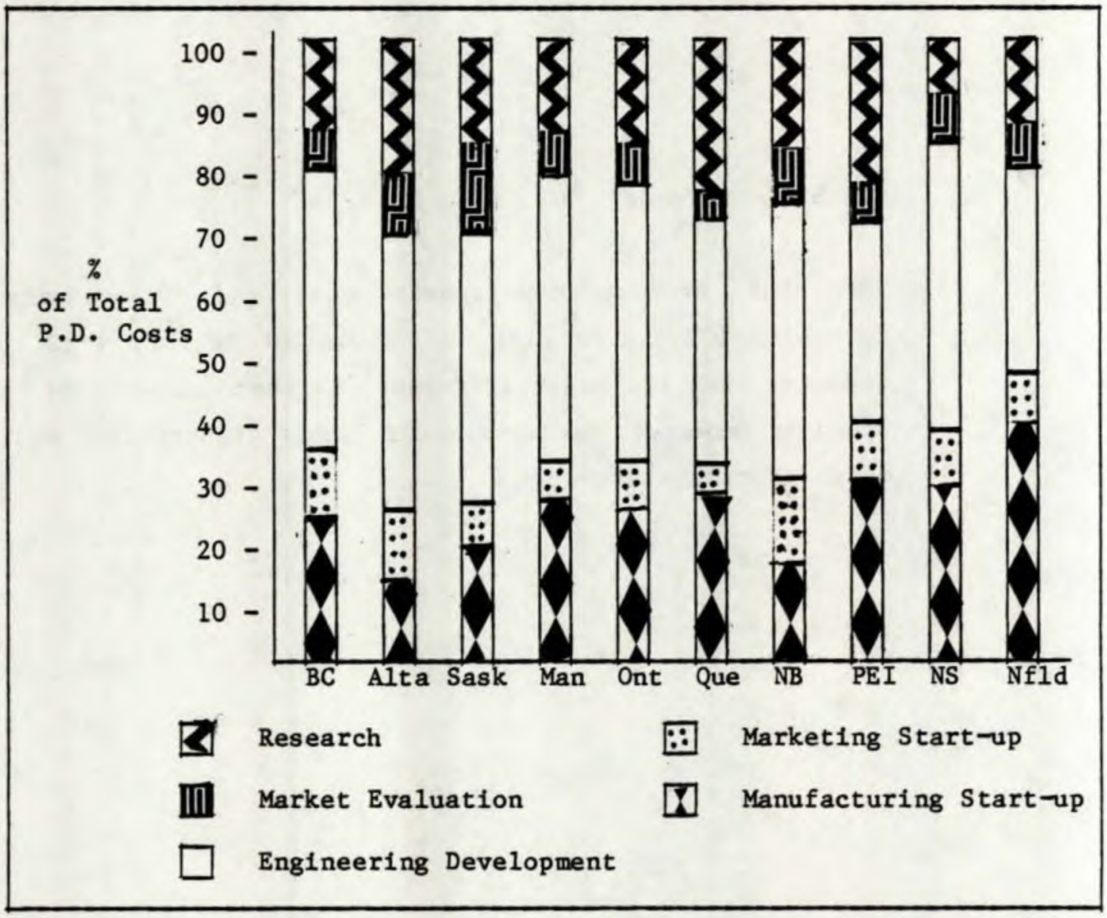
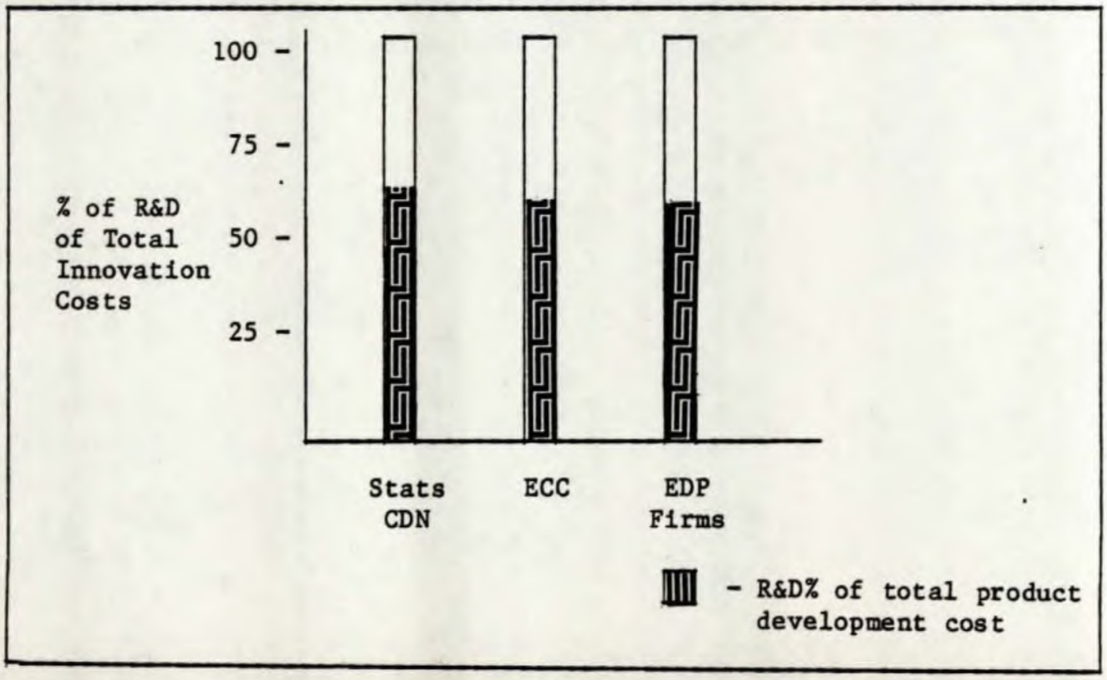


Exhibit 4-33
Comparative Findings of R & D as Percent of Total
Innovation Cost



4.5.5 (continued)

Regionally, the spread of innovation costs, as shown in Exhibit 4-32, is different between provinces and is perhaps coincident with the sectors predominant in these regions. For example, manufacturing start-up costs generally appear to be higher in the Maritimes which to date have a relatively high proportion of processing companies in their industrial base.

In a 1973 survey, Statistics Canada, using a slightly different classification of innovation costs, found the relative expenditures on each innovation activity to be:

R&D	46%
Product marketing	2%
Product and design engineering	13%
Tooling and industrial engineering	11%
Manufacturing start-up	6%
Other current costs	2%
Capital	20%
	100%

R & D as a proportion of total product development costs averages close to 60% for the EDP firm population. This porportion is very similar to the proportion found by Statistics Canada (1973) and the Economic Council of Canada (1980) as shown in Exhibit 4-33.

Exhibit 4-34
Basis for Annual
Product Development Expenditure By Sector

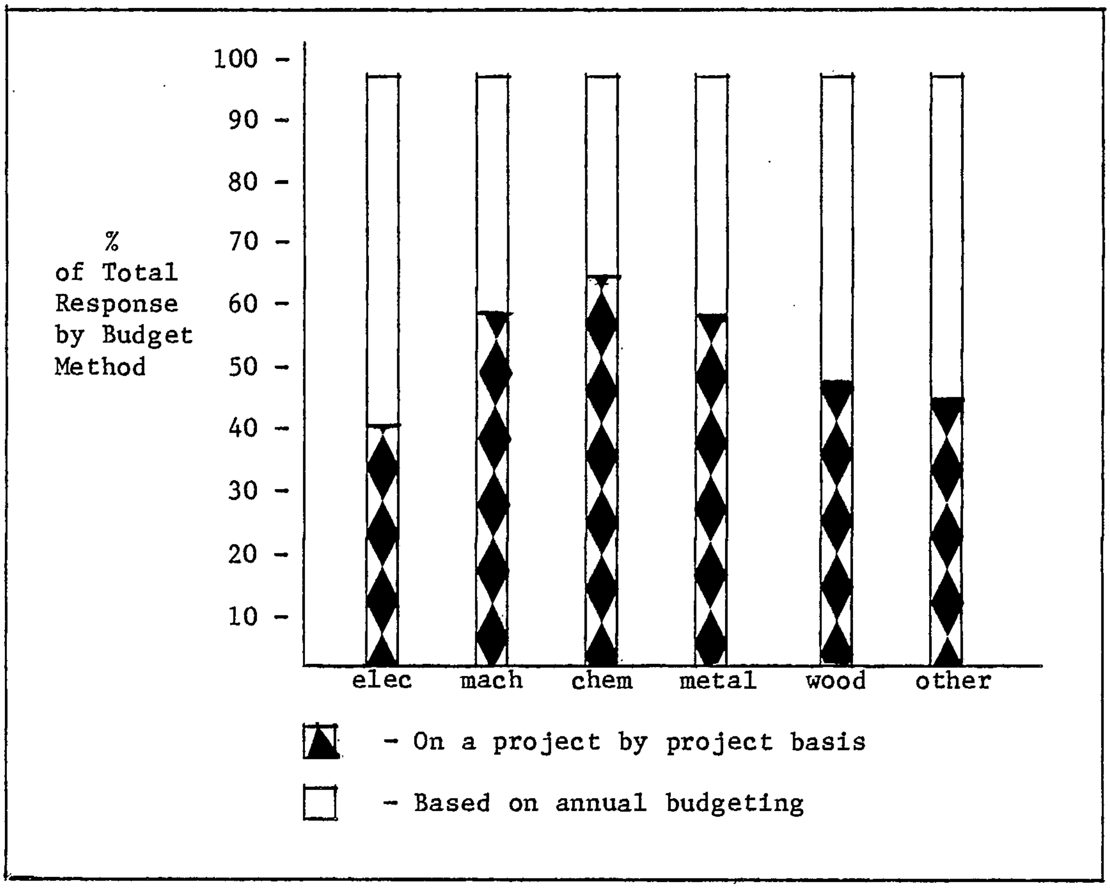
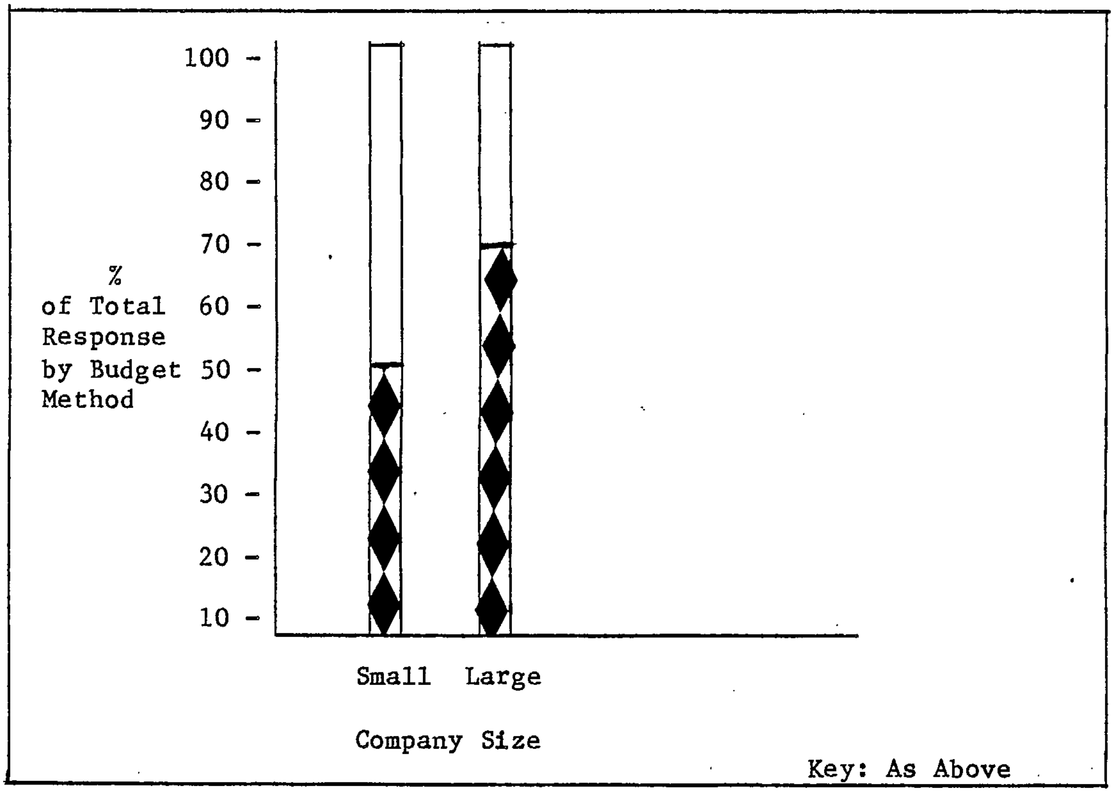


Exhibit 4-35
Basis for Annual
Product Development Expenditure By Firm Size



4.5.6 Basis for Annual Product Development Expenditure

The internal method by which firms budget for innovation is an aspect of innovation funding availability relevent to understanding the impact of government funding. Two methods were investigated, firstly on a project by project basis and secondly, on an annual budget basis. As shown in Exhibits 4-34 and 4-35, the prevalent method of budgetting varies by sector and firm size.

Electrical firms generally depend on annual research budgets; chemical companies tend to budget on a project to project basis.

Large companies reported a tendency to budget on a project by project basis. This likely reflects the fact that the large companies' projects are proportionately larger in magnitude and are considered individually because of the financial implications.

Exhibit 4-36
Source of Product Development Funds By Sector

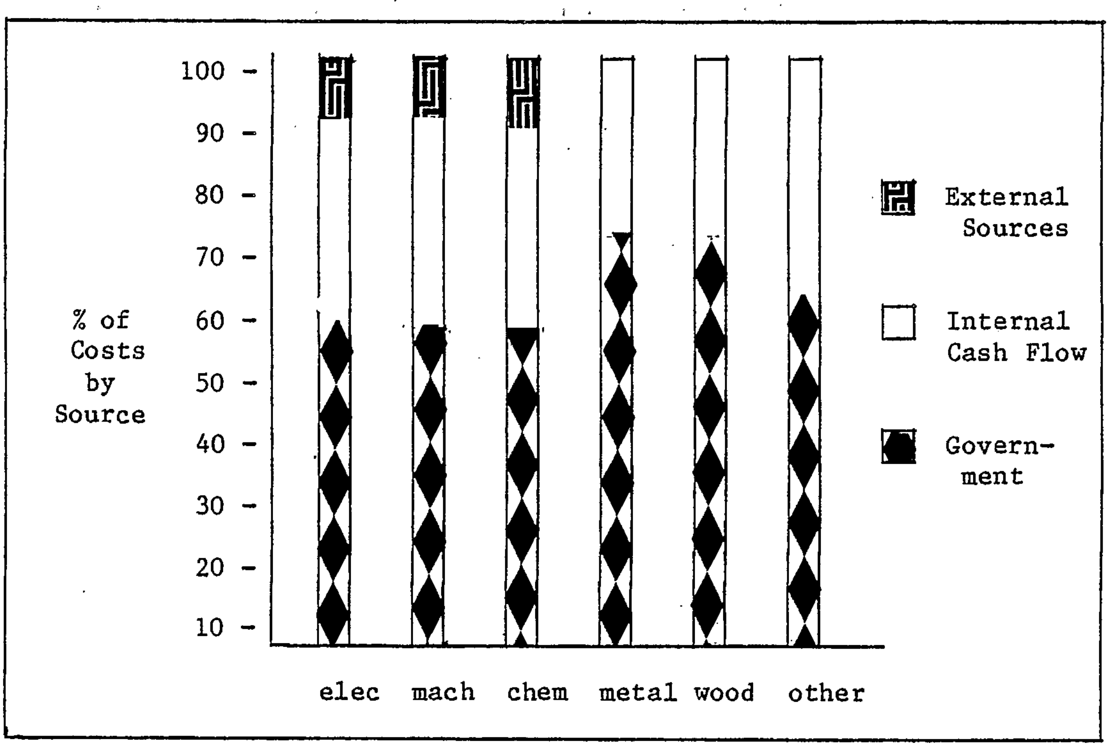
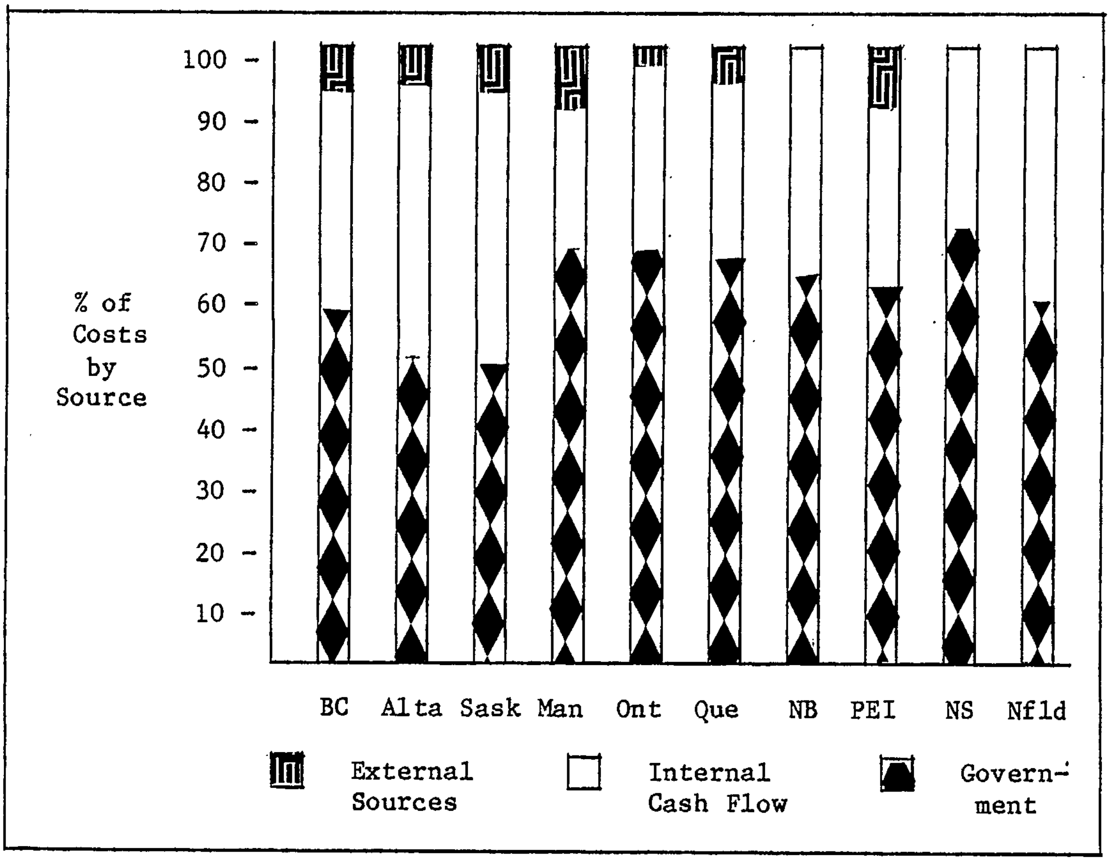


Exhibit 4-37
Source of Product Development Funds by Province



4.5.7 Funding Availability

The source of funds for project development can generally include external sources such as debt or equity, internal cash flow and government programs. As show in Exhibit 4-36, EDP firms rely heavily on government funds to finance product development.

This chart reflects the funding based primarily on the EDP project costs, not necessarily the entire product development cost.

There is very little outside cash resources used other than government.

On a sector basis, as shown in Exhibit 4-36, it is noted that electrical, machinery and chemical firms rely more heavily on internal and external sources of funds than do the metal and wood sectors.

On a regional basis, as shown in Exhibit 4-37, it may be seen that the Maritime provinces have used virtually no external financing sources.

Exhibit 4-38
Source of Product Development Funds by Firm Size

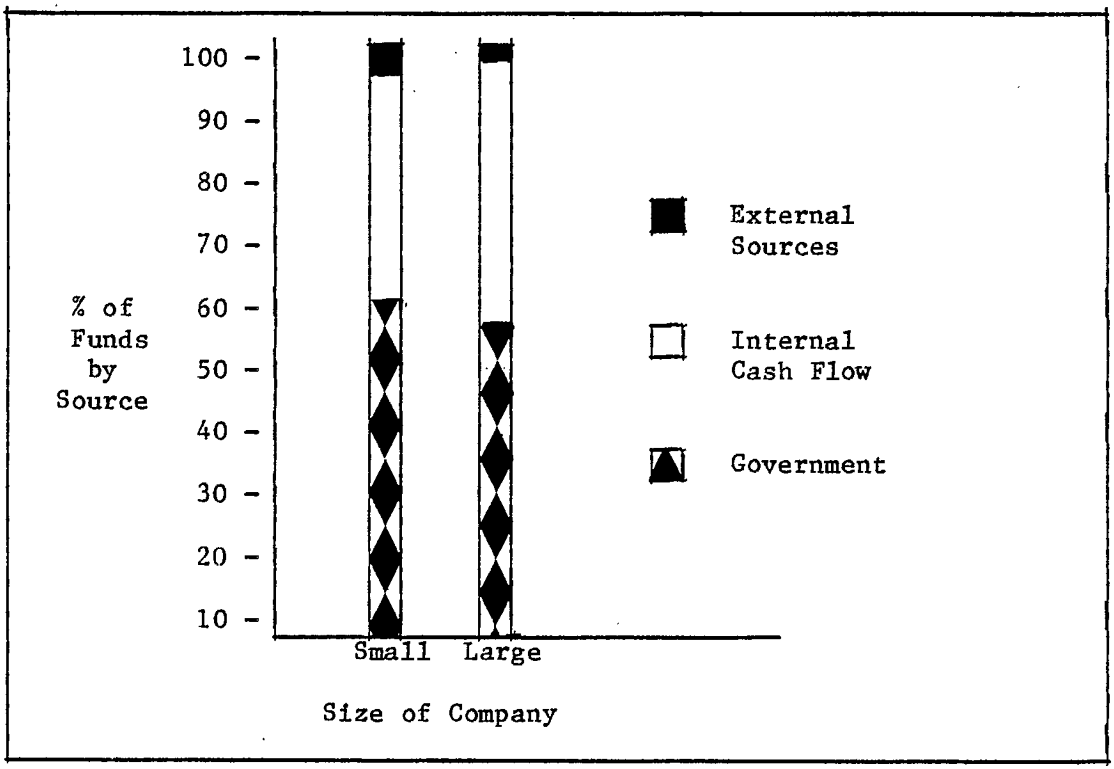
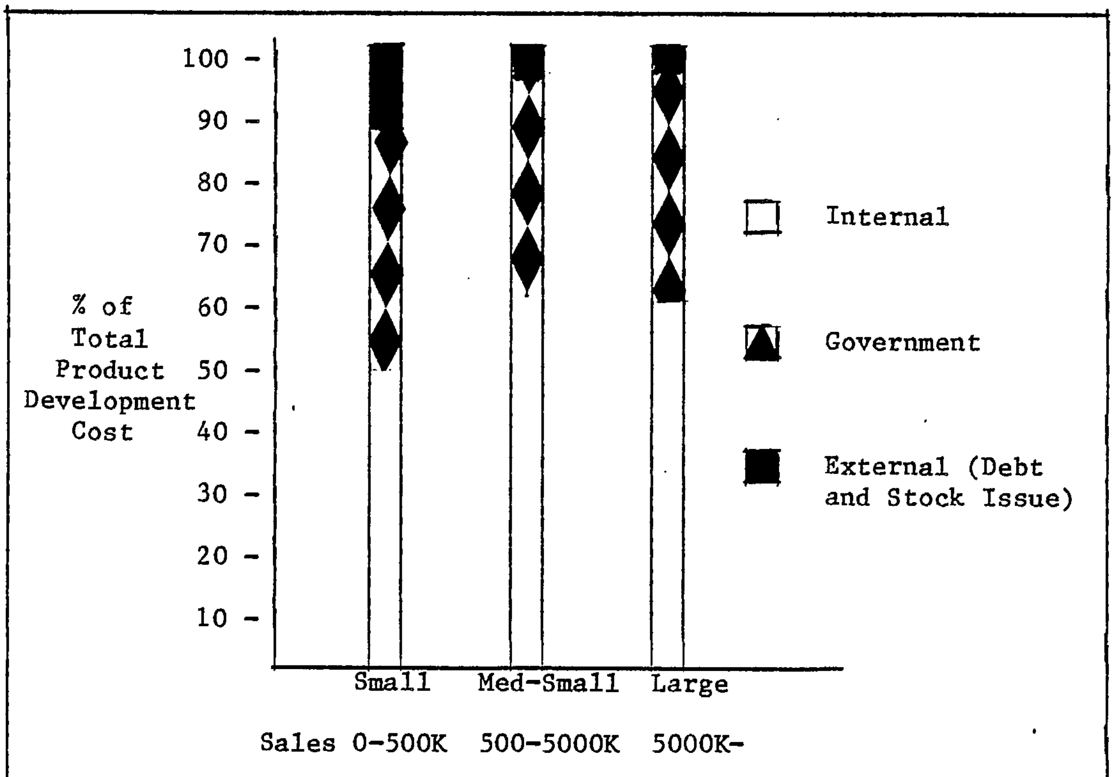


Exhibit 4-39
Sources of Finance for Innovation Supported by Government (ECC Sample)



Source: ECC Database - Government assisted projects

According to the survey, small firms are more apt to seek external funding sources than are large firms (Exhibit 4-38).

The Economic Council of Canada study in 1980 also considered the sources of product development finance. For those companies surveyed which had government assistance, it was found that government funding averaged less than 40% in most cases. (Note that this is of total product development costs.)

The government funding was most significant for small firms, and as shown in Exhibit 4-39, a similar percentage for large firms and medium-sized firms. External financing in the private market is a factor for small firms, but only very small factor for medium and large firms when government funding is used.

Exhibit 4-40
EDP Contribution/Actual Total Product Development Costs

Chemical Based (Includes food processing)	.30
Machinery	.43
Electrical	.41
Other Industries	.31
Overall Average	.38
Standard Dev.	.19
n = 62	

4.5.8 EDP Assistance as a Proportion of Total Development Costs

Against this backdrop of the nature of innovation costs in the firms which have utilized EDP, it is interesting to note the impact of EDP eligible cost criteria on the proportion of total innovation costs which were funded.

Analysis of the EDP files (project submissions to the Approval Board) for EDP funding and actual total innovation costs (as stated by the interviewed company) for the project show that the proportion of EDP assistance to <u>total product development cost</u> varies considerably amongst firms. There is a significant difference in percent EDP funding amongst sectors, <u>irrespective</u> of project cost sharing ratios stated in project approvals. The 'actual' cost sharing ratio of EDP funding averages less than 40%.

In four sectors for which adequate numbers of cases existed, the proportion of EDP assistance to total product development cost (includes all costs associated with commercializing an innovation including research, market evaluation, development, marketing start-up and manufacturing start-up) provided the results in Exhibit 4-40.

A simple R calculation of correlation between EDP/Project costs (as written in the project approval) and the EDP/Actual total product development costs (total cost of commercialization) showed that there was not a significant relationship. ($R = .11290$, $n = 63$, $F = .7875$). In other words, the % of actual EDP assistance to total product development would seem to be more closely linked to things like sector and firm characteristics than to project approved cost sharing (50% - 75% funding).

Exhibit 4-41
Average Percent of Government Funding to Total Product Development Cost
(ECC Sample)

	Gov't/Total Product Development Cost
Telecommunications	.369
Electrical Industrial	.301
Plastics Compounds + Synthetic Resins	.376
Smelting + Refining	.08
Crude Petroleum Production	.272
Average Total	.345*

* While the average percentage funded in the ECC survey is lower than that found for EDP firms, the difference may be attributed to the inclusion of different programs in the ECC study and the larger size of the ECC survey firms. (See Appendix I).

The Economic Council of Canada showed that the average percent of Government/total funding for product development varied tremendously amongst the five sectors which they surveyed. The Council's findings are strikingly similar to those found in the EDP study in terms of % of Government to total actual product development (Exhibit 4-41).

It may thus be concluded from this analysis that funding assistance level differences as a percentage of total product development costs would seem to be heavily dependant on firm characteristics such as sector and size as well as individual project characteristics such as labour vs. capital intensity, product vs. process related innovation, level of technology, and the nature of a firms' markets. For this reason assistance based on specific direct cost factors tends to favour some firms over others, regardless of the percentage of assistance (50-75%) for approved projects.

Exhibit 4-42

Distribution of Product Development Elements Found in EDP Work Statements

	%
MARKET EVALUATION	27*
RESEARCH	38
DEVELOPMENT	100
MARKETING START-UP	13
MANUFACTURING START-UP	30

* 27% of the EDP work statements reviewed contained Keywords relating to market evaluation.

4.5.9 EDP Funded Activities

Innovation assistance has been targetted in the past at specific segments of the innovation process. Generally, EDP funding was targetted at research and development activities, although other activities are included in the innovation or product development process. For simplicity these other activities may be classified as market evaluation (market assessment, feasibility, etc.) marketing start-up (distribution activities, advertising, etc.) and manufacturing start-up (tooling, adjustment of plant layout, expansion of facilities, etc.).

EDP project work statements (110 in number) were reviewed in order to determine whether key words and statements pertaining to the separate elements of research, market evaluation (assessment), development, marketing start-up, and manufacturing start-up were contained. (See Appendix G for an explanation of the content analysis methodology.)

Exhibit 4-42 shows the distributions of product development elements that were found in EDP project work statements.

It may thus be concluded that while EDP funding has focussed on development activities, other activities (most remarkably market evaluation and manufacturing start-up) have frequently been included in EDP product development projects. Such a finding indicates the importance of these activities and their inextricability from the product development process even when they are formally excluded. (Market evaluation, marketing start-up and manufacturing start-up were all 'officially' excluded from eligible EDP product development activities and were to be funded under separate assistance programs.)

Exhibit 4-43
Type of Innovation Costs by Firm Size

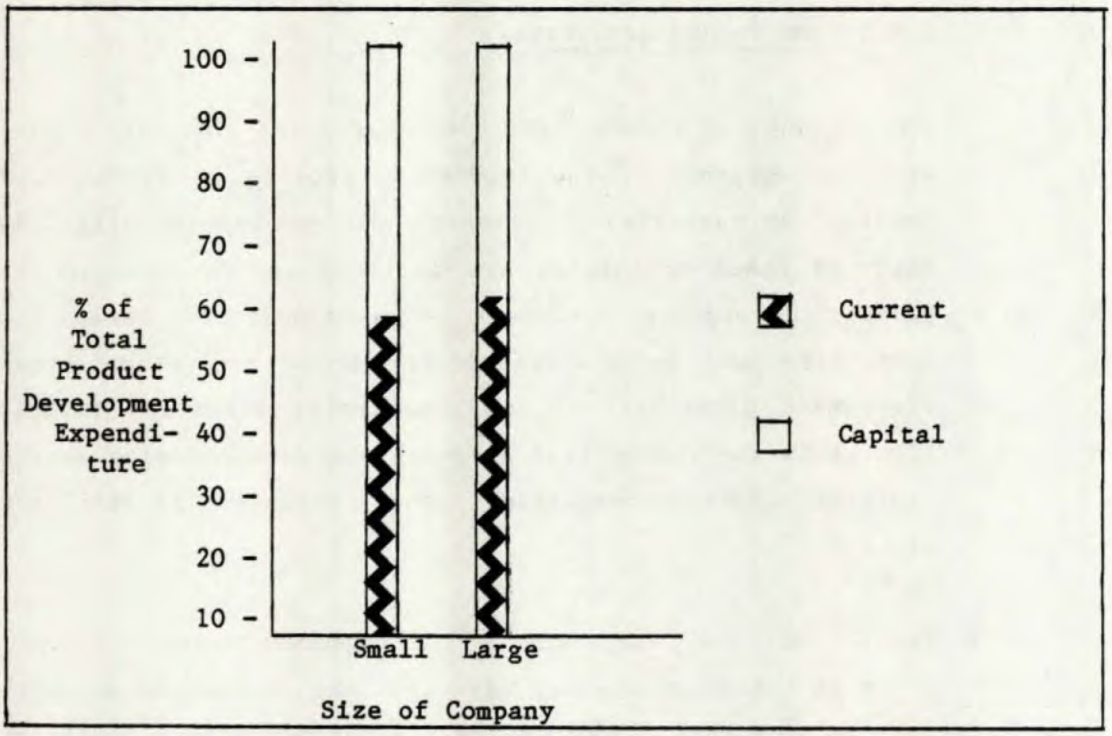
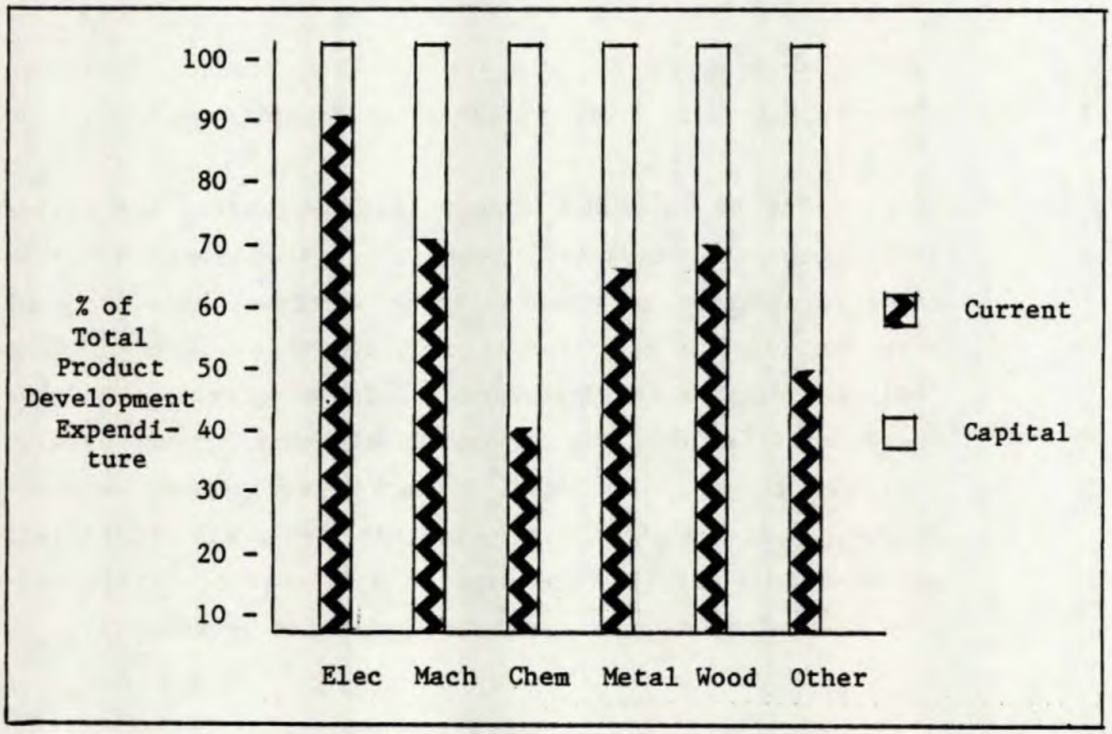


Exhibit 4-44
Type of Innovation Costs by Sector



4.5.10 Funded Costs Relative to Normal Product Development Costs

The type of funded costs allowable, whether it be current or capital, labour or materials, has a bearing on the suitability of innovation programming.

EDP users were asked to describe their innovation costs in terms of current and capital costs, and breakdowns therein. As shown in Exhibit 4-43 current/operational costs are the most important costs in development projects; labour accounts for about 90% of the current costs.

On a sector basis, as shown in Exhibit 4-44, electronic companies have the lowest capital requirements while chemical companies have the highest.

When EDP firms were asked if the EDP project costs by type differed from their normal product development costs, the firms stated that their EDP projects tended to use slightly lower proportions of the budget for capital costs as follows:

PRODUCT DEVELOPMENT COSTS
(% of total costs)

	Normal Projects	EDP Projects
Current costs	75%	79%
Capital costs	25%	21%

4.5.11 Product Development Cost Trends

Firms were asked if the relative cost of their future product development would change with respect to the categories provided in the innovation model.

A significant portion of companies (52%) expected that their allocation of funds for product development would be altered in the near future. Over 75% of those companies that indicated change stated that more emphasis would be placed on basic research and marketing in the future. This was a result of the ever increasing complexity and competitiveness of product development.

Companies appear to be recognizing that they have to become more active in all areas of product development and in particular, in the front-end opportunity identification and marketing.

4.5.12 Product Development Financial Burden

Total product development costs did not vary significantly with firm size in the firms sampled. This indicates that product development is a relatively bigger burden for small companies than for large companies.

In fact, total product development costs averaged 100% of firm assets at the start of an EDP project for the small EDP companies sampled. (Sales less than two million per year) For large companies, the ratio was just over 50%.

From these observations it can be concluded that firm financial risk in product development is generally higher in small firms than in large firms.

4.6 Previous Program Implementation

The purpose of this section is to review the perceptions of previous EDP innovation assistance held by government program delivery officials and non-government people familiar with private sector innovation.

The source of information is personal interviews with people located in the regions. The information contained in this section is of a perceptive nature only.

However, the information provides some insight as to the previous usefulness of innovation programming and the future applicability of IRDP.

Topics covered include:

4.6.1 Usage Rates
4.6.2 Enquiry Success Rates
4.6.3 Interpretation of Criteria
4.6.4 Contribution Level
4.6.5 Program Impact
4.6.6 Coordination with other Innovation Programs

In summary, indications are that:

- the EDP program has not been utilised to its fullest possible extent as a result of lack of promotion and also regional industrialization factors.

- a majority of projects that reach the proposal stage eventually are funded.

- flexibility is used in the interpretation of program criteria.

- the maximum level of contribution is made in a majority of cases.

- government incentives do not likely play a significant role in furthering long term product development.

- information sharing among federal and provincial programs, departments and institutions is a critical consideration for the implementation of the IRDP.

4.6.1 Usage Rates

For the most part, DRIE officials consider usage rates in their province have not been influenced by pro-active activities undertaken by the department. Projects tended to be put forward by companies rather than actively sought by regional staff.

The absence of proactive promotion of the program contributed to an impression among most DRIE officers that the program had not been utilized by companies to its fullest extent and that many firms were unaware of the assistance available. However, in provinces such as Ontario and Quebec, concern was expressed that active promotion of the program would place severe workload demands on delivery personnel. A dramatic increase in the number of applications for assistance is expected in the Central and Western provinces when the new program is more actively promoted.

Firm attitudes towards product development risks combined with the lack of industrial base in Maritime and Western provinces have further limited usage of the program. Equally as important is the cost eligibility rules of the program; acting as an inhibiting factor in eight provinces.

Maritime provinces cite the lack of technology as curtailing product development in their region.

4.6.2 Enquiry Success Rates

Estimates by DRIE officials of the ratio of enquiries to accepted projects varied widely from province to province but centered in the range of 3:1. Most provinces reported about 75% or more of the applications proposed resulted in funded projects.

4.6.3 Interpretation of Criteria

Regional officers stated that program criteria were broadly interpreted in order to take advantage of the widest variety of innovation opportunities in their province. Most looked first to the capability and viability of the firm to ensure technical competence and sufficient financial resources to carry out the project. Nearly all provinces were generous in interpreting significant burden so long as the potential benefits of the project were apparent. Ontario, Quebec and Alberta stressed the degree to which the product was innovative.

Regional officers generally felt that flexibility was needed in setting up the terms and conditions of product development projects and that EDP overall provided such flexibility.

4.6.4 Contribution Level

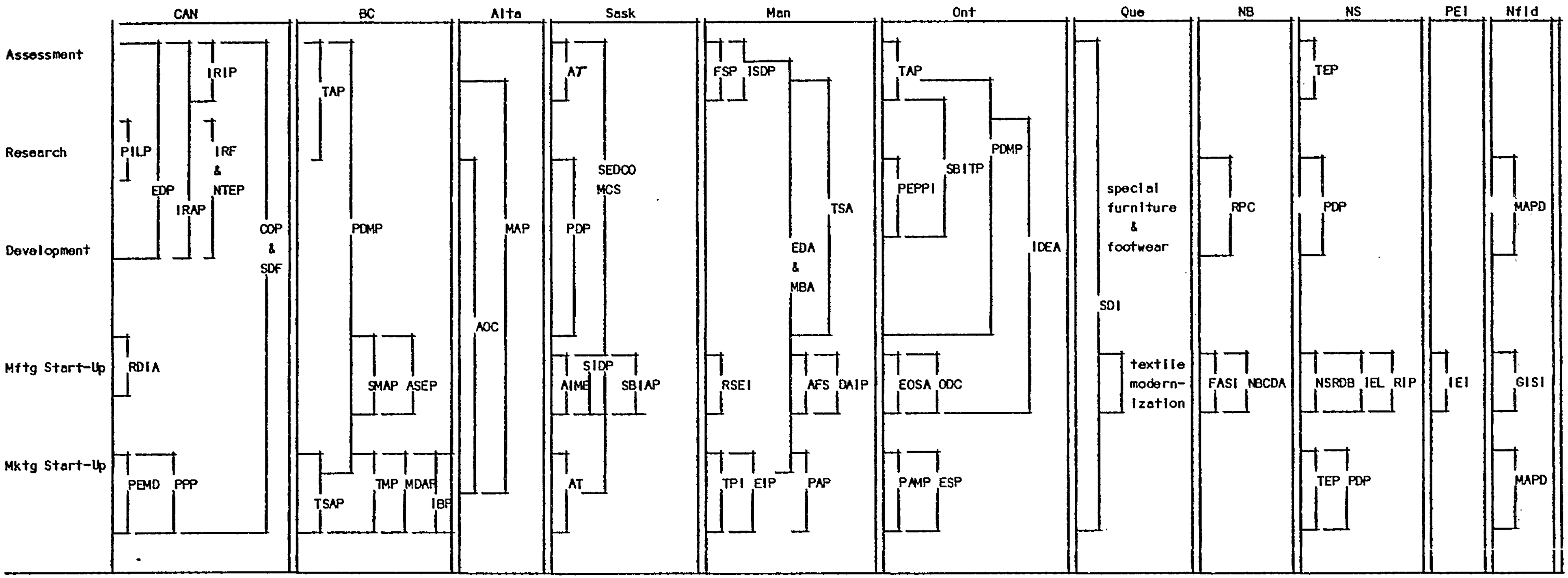
DRIE officials in every province indicated the maximum level of contribution (75% for small and 50% for large business) towards eligible costs was made in 90% of the cases.

4.6.5 Program Impact

Despite the existence of complementary provincial programs providing incentives to innovation, experts are generally unconvinced that government incentives have played a significant role in furthering product development. An exception though is Ontario, Manitoba and Quebec where most experts agreed that incentives have had an impact on increasing product development. At the least, many felt the programs were better than doing nothing to support and encourage companies.

Exhibit 4-45

Government Direct Assistance Programs Related to the Product Development Cycle



4.6.6 Coordination with PDMP and Other Product Development Programs in the Provinces

The Product Development Management Program (PDMP) has been used in some provinces to provide general management assistance to small companies engaged in product development. A few of these projects have eventually been linked with EDP assistance in the past, however for the most part the client base for PDMP has been different from EDP in that firms tend to be smaller and less sophisticated in terms of R&D capability.

While usage levels of this federal-provincial program were not available, interviewees who delivered the program in different provinces described the assistance as general, flexibile, (incorporating marketing, general management and development activities into assistance), and small (less the $25,000 total project costs).

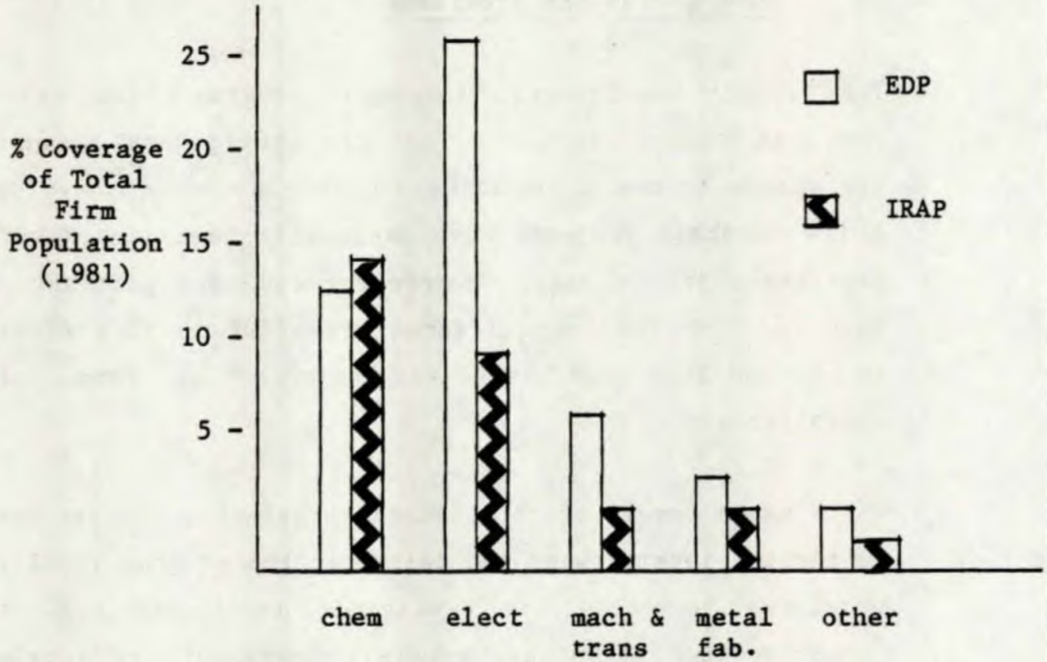
In addition to PDMP there are many other provincial programs which are related to product development activities, some directly (SBIT in Ontario, PDP in Saskatchewan, Nova Scotia, etc.) and many indirectly.

In terms of direct assistance programs alone (not counting tax programs, R&D and innovation centre indirect services, etc.) there were more than 50 federal and provincial programs assisting one or more elements of the product development cycle. (See Exhibit 4-45.)

As a general rule, most provincial assistance programs tend to assist projects costing less than $20,000 in medium to low technology applications.

Many of the direct monetary assistance programs are delivered by provincial research foundations, councils and innovation centers. Those institutions also provide technical services and management consulting directly. Most of these services

Exhibit 4-46
Coverage of EDP vs IRAP by Sector



Source: EDP Product Developments 77-82

IRAP Companies as of 81 Government Assistance Programs in Canada

J.P. Johnson, Price Waterhouse, 1982

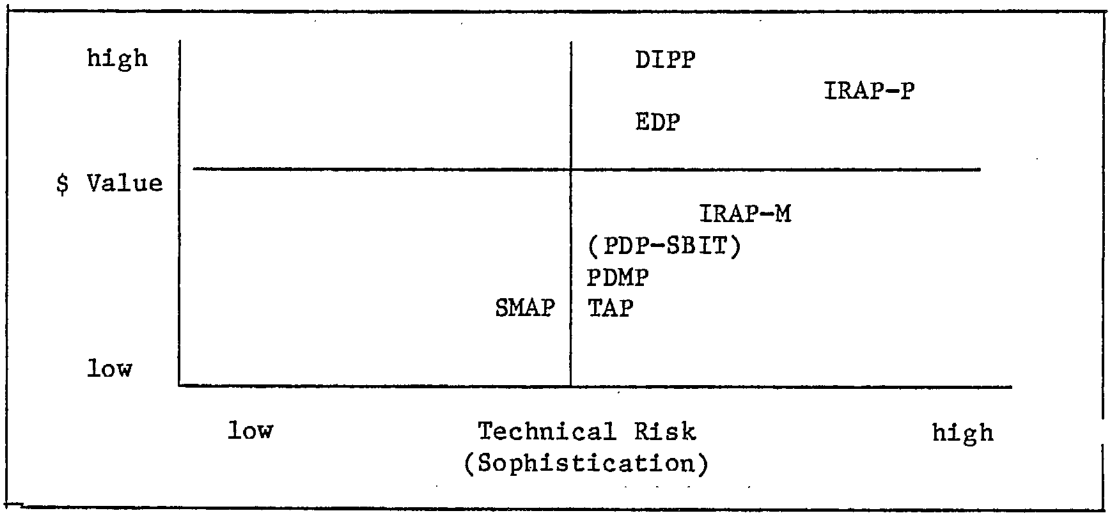
constitute short-term, low dollar value assistance. For example, one provincial research organization provided services to 661 firms during 1981/82, over 50% of which were for less than $1,000.

The Industrial Research Assistance Program (IRAP) is administered by the National Research Council with objectives to i) increase the calibre and scope of industrial research in Canada in situations where it leads to high business effectiveness with economic and/or social benefit to Canada and ii) provide exposure to the value of research and development to encourage its further use. The program consists of a Technical Information Service (TIS) and a direct contributions segment. In 1981-82, contributions totalled almost 25 million dollars. The two major sub-programs within the contributions element of IRAP are i) IRAP-P, the original IRAP, which assists medium-long term projects (greater than one year) in firms which usually have well-established R&D facilities, and ii) IRAP-M (mini-IRAP) which assists short term projects (less than one year) in companies without established R&D facilities via contributions up to $30,000. Both programs fund salaries of professional staff assigned to projects on a discretionary-grant cost share basis.

The delivery of the IRAP contributions, especially IRAP-M, has been streamlined so that the waiting time for grant recipients is generally perceived to be less than that for EDP. (While the comprehensive audit of EDP found the total delivery time to average almost 9 months for EDP product development contributions, IRAP staff claim that delivery of IRAP assistance takes less than 3 months.)

While IRAP has stronger coverage in more applied research oriented industries (chemical sector), EDP coverage would seem to be stronger in sectors more oriented to development (electrical sector) and in more capital intensive product development (machinery and metal fabrication) (Exhibit 4-46).

Exhibit 4-47
Risk and Value Characteristics of EDP Relative to Other Programs



Amongst the EDP firms surveyed 70% had used some other form of government assistance and almost 20% had used at least two other assistance programs. 12% of firms had more than one involvement in EDP (or its forerunner PAIT). Of the other programs used, PEMD was the most used (12% of firms) followed by IRAP (11%). 20% of firms had used some form of provincial assistance.

In conclusion, EDP assistance is one program among many discretionary grant programs run by Federal departments and Provincial governments to assist the innovation - product development process in firms.

Forming a profile of EDP vis-a-vis other related discretionary grant programs in Canada, EDP could be viewed as a medium-high dollar, variable risk-oriented program with more financial screening criteria, medium flexibility, and slower delivery than most other programs. One portfolio description of EDP vis-a-vis other product development - discretionary grant programs is presented in Exhibit 4-47.

EDP has many potential complementary programs. For the purposes of enhancing the focus of programs, the effectiveness of delivery, and to avoid duplication of efforts, information sharing amongst federal and provincial programs, departments and institutions is a critical consideration for the implementation of IRDP.

4.7 User Perception of Programs

The purpose of this section is to consider the reaction of EDP users to the program's design and delivery and to thus draw implications for the implementation of the IRDP.

Main source of data is the firm questionnaire which asked several open-end questions relating to how the program could better meet the firm's innovation needs and if the firm would consider using the program again.

The major topics that are discussed are:

4.7.1 Overall Program Suitability
4.7.2 Future Interest in the Program

In summary:

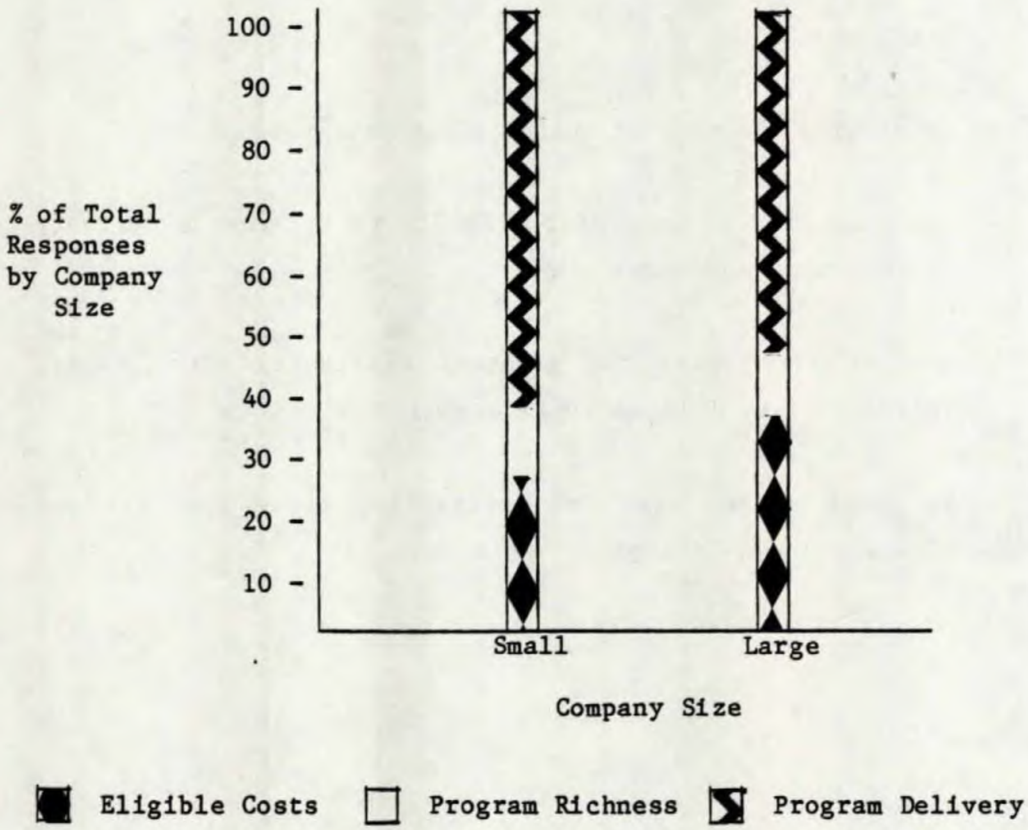
- users find the program suitable to their needs
- the main area of complaint with EDP is in program delivery ... too slow and uncertain
- smaller firms have the greatest difficulty with program delivery (i.e. initial application)
- it would appear that the application procedures are not clearly enough defined or explained

Exhibit 4-48
Overall Suitability of EDP

(frequency of responses suggesting changes in specific areas)

	% of Respondents
Eligible Costs	28
Program Richness	12%
Program Delivery	60%
	100%

Exhibit 4-49
EDP Program Suitability by Company Size



4.7.1 Overall Suitability

Generally speaking, EDP users found the program very suitable to their requirements.

The main areas of complaint were with program delivery, as shown in Exhibit 4-48 which indicates the response frequency of suggested changes in the categories of eligible costs, program richness and program delivery.

Of the 28% of firms that stated dissatisfaction with eligible costs, the vast majority stated that detailed market study and opportunity identification costs should be covered. A common statement received was that the certainty of financing was more important than negotiation of the contribution.

On a company size basis, as shown in Exhibit 4-49, smaller firms have the greatest difficulty with program delivery (i.e. primarily the initial application procedures and paperwork). Large companies emphasized that the concept of eligible costs should be broadened at the same time as improving delivery.

Exhibit 4-50
EDP Program Suitability by Sector (EDP Firms)

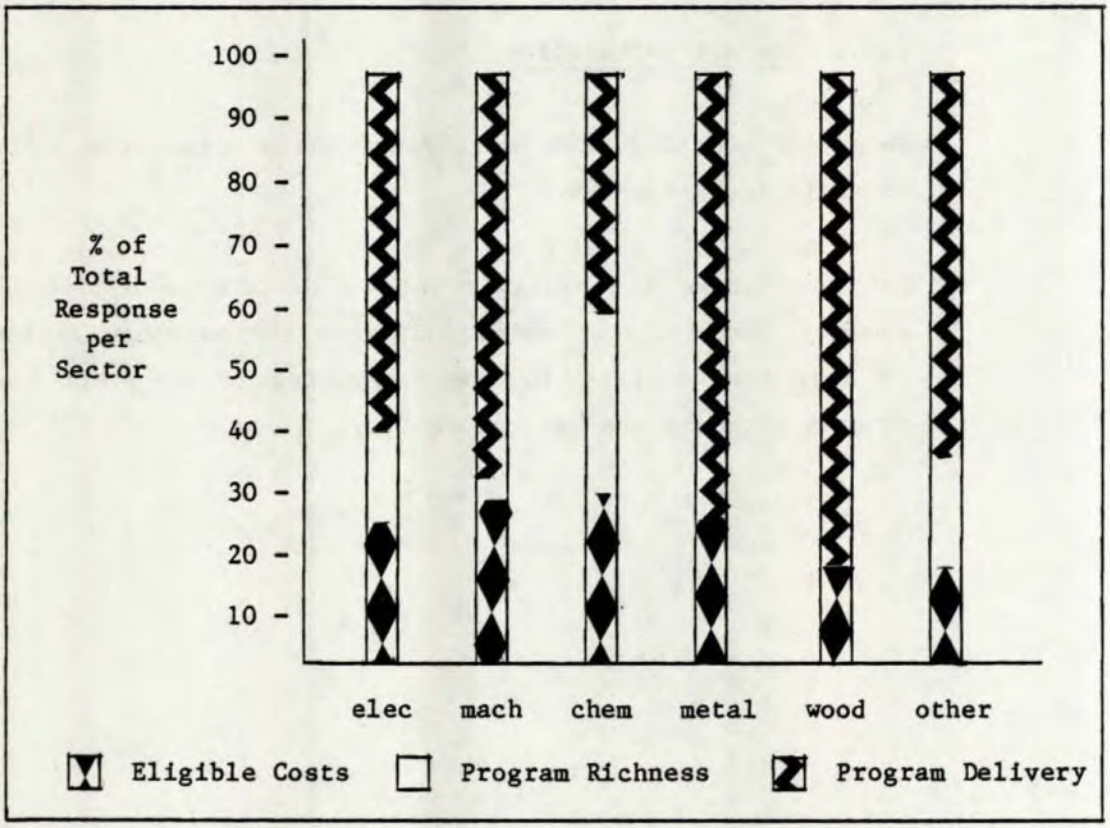
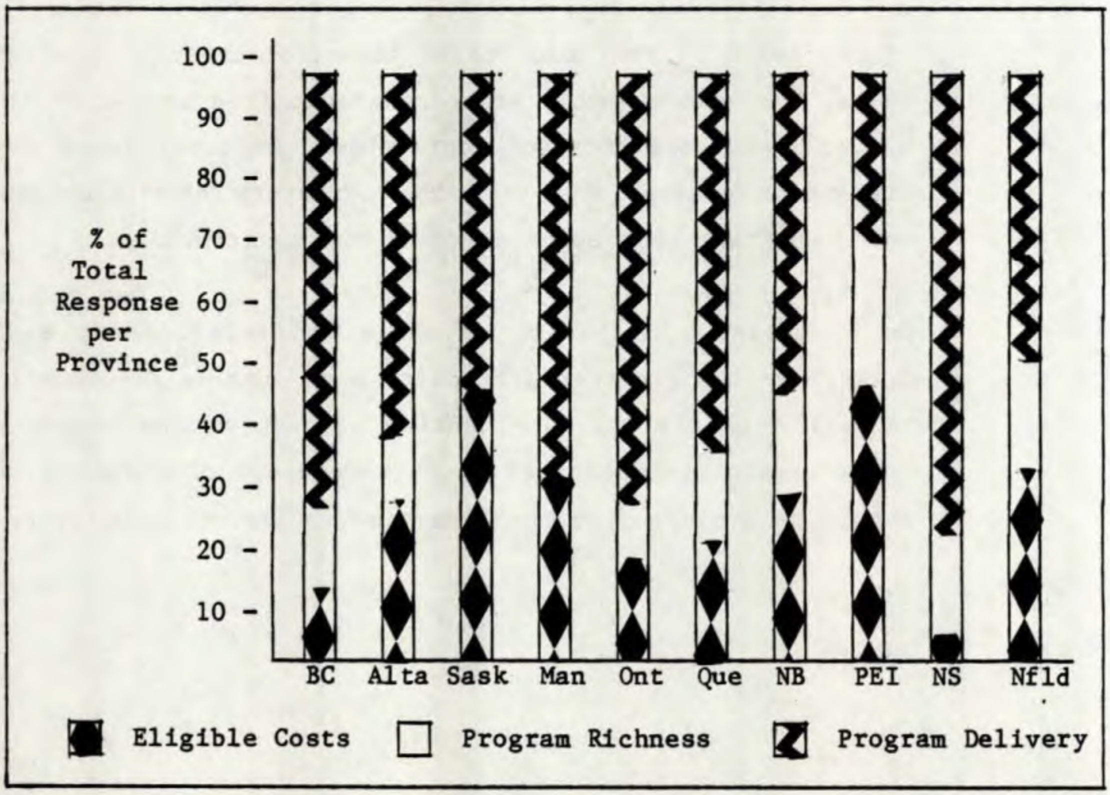


Exhibit 4-51
EDP Program Suitability by Province



Sectoral differences, as shown in Exhibit 4-50, indicate that program richness is a more significant concern to chemical companies relative to other sectors. This is largely the result of the magnitude of many chemical process developments.

Regionally, Nova Scotia and British Columbia firms demonstrated the highest level of problems with program delivery relative to other provinces. P.E.I. and Saskatchewan, of all the provinces, as shown in Exhibit 4-51, demonstrated the least delivery concern and were generally more interested in program richness.

Exhibit 4-52
Retrospective Opinion on Benefit/Cost of Program Application
(Would you have originally applied given current knowledge)

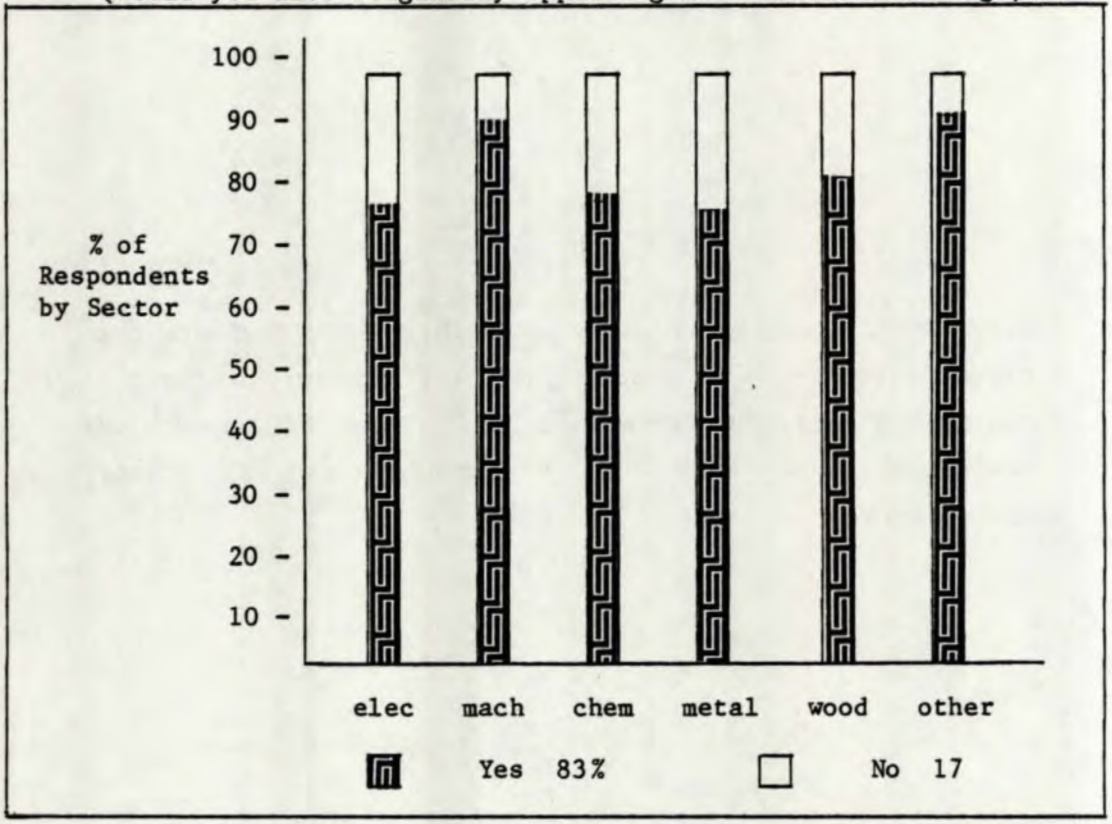
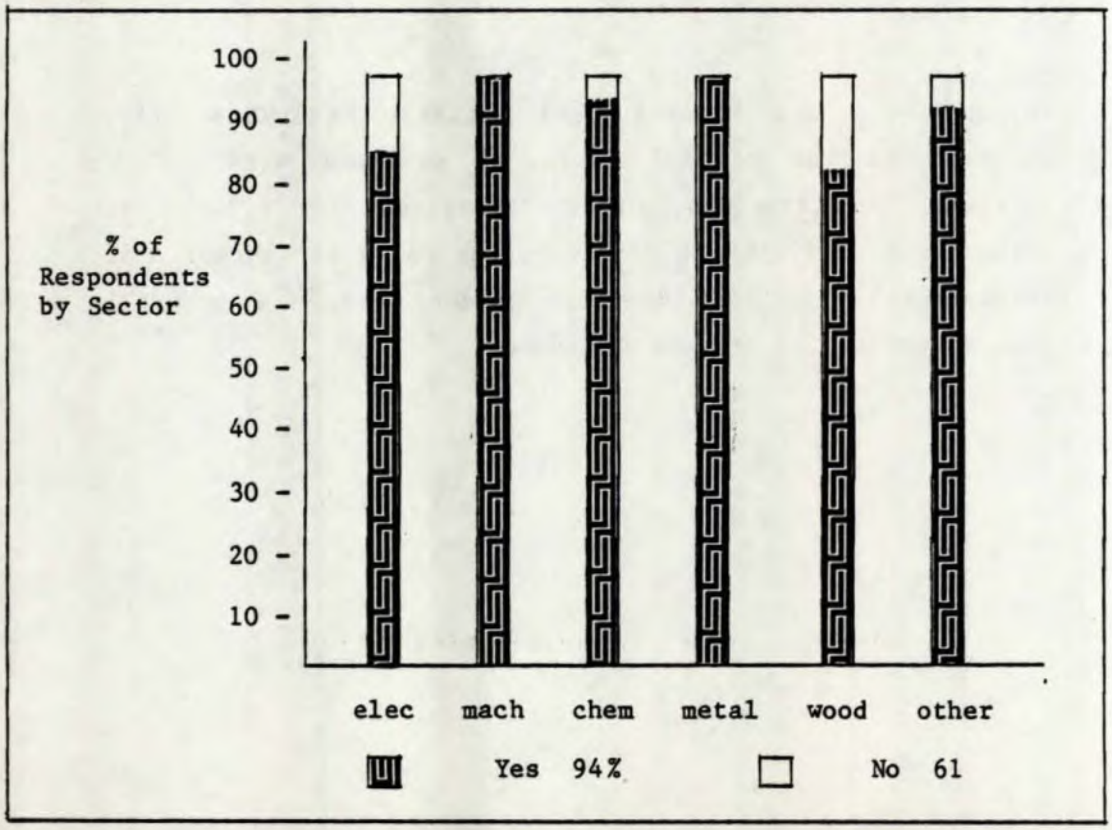


Exhibit 4-53
Willingness to Utilise EDP Program Again



4.7.2 Future Interest in Program

When the EDP users were asked if they would have applied originally had they known the time and effort required to obtain funding assistance, as shown in Exhibit 4-52, 17% said in retrospect that they would not have applied.

However, as shown in Exhibit 4-53, now that the firms have learned the process, and done some of the preparation, 94% of the firms would apply again.

Exhibit 4-54
EDP Satisfaction by Firm Size
(In retrospect would you apply for the EDP program again?)

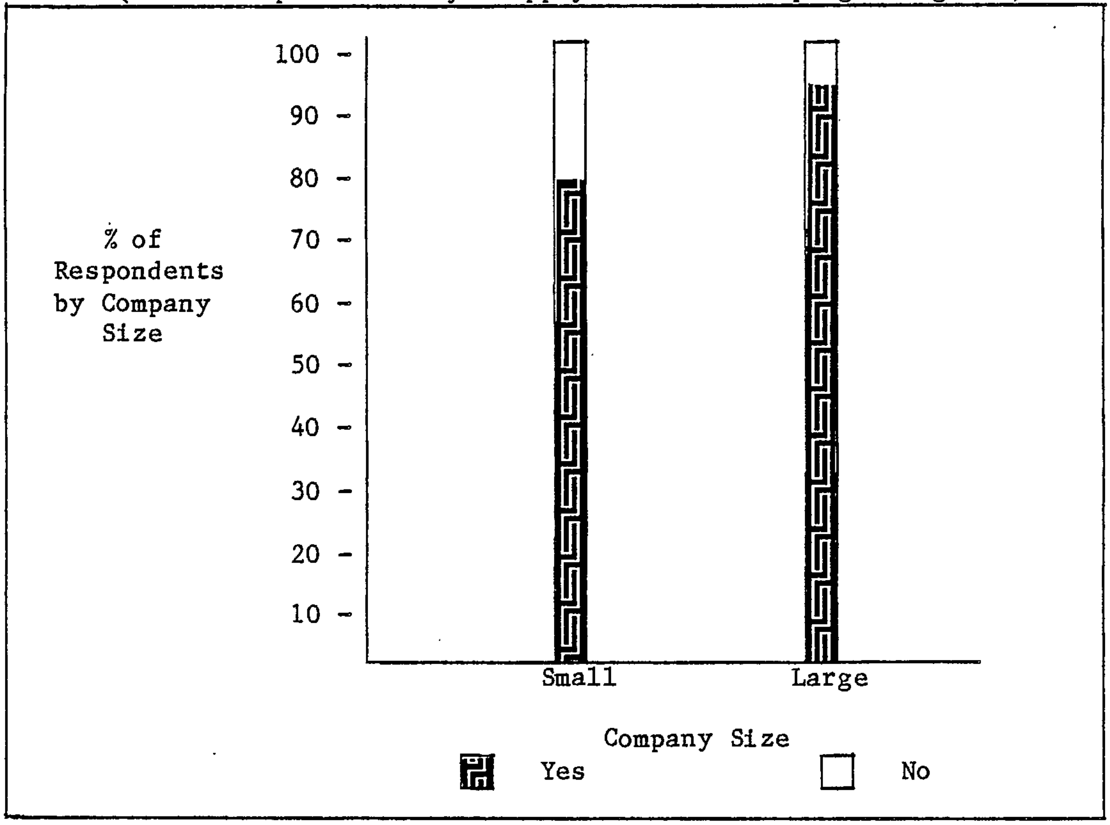
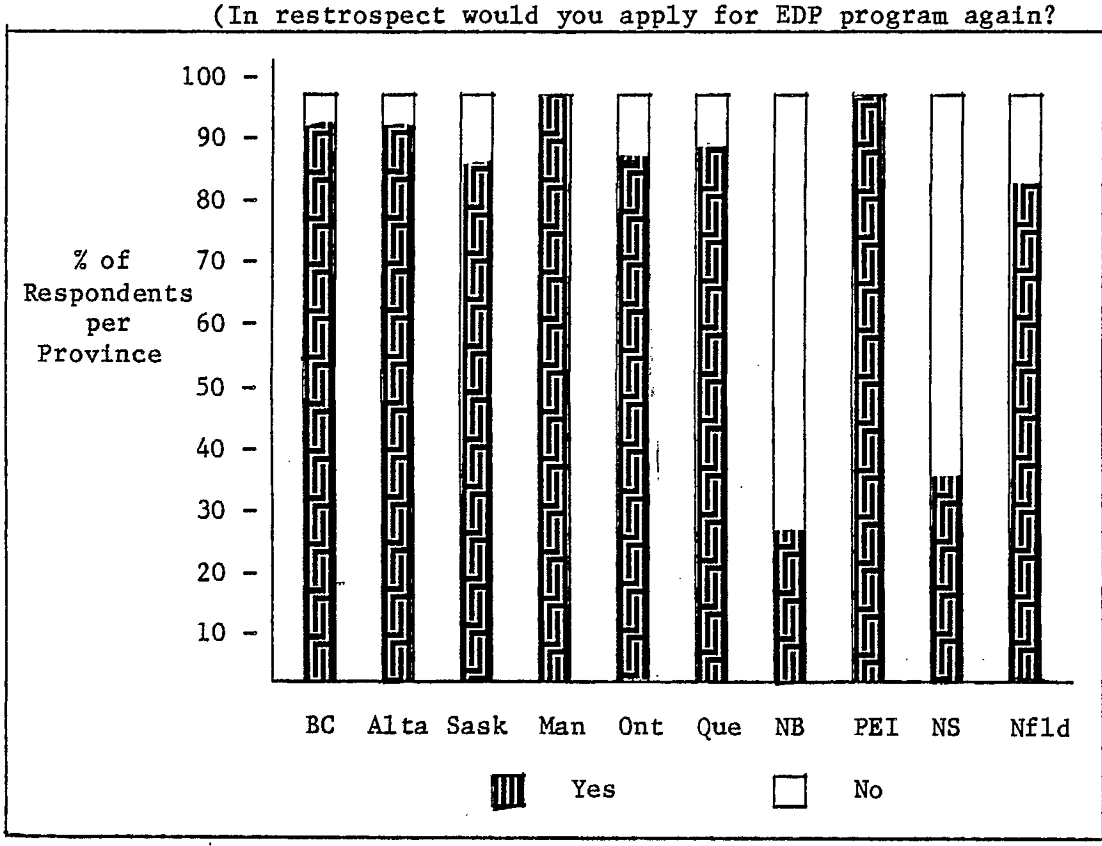


Exhibit 4-55
EDP Satisfaction by Province
(In restrospect would you apply for EDP program again?



On a company size basis, Exhibit 4-54 shows that the smaller firms are more burdened with the delivery process than are large firms and would not be as likely to enter into the application process again.

Regionally, as shown in Exhibit 4-55, Nova Scotia and New Brunswick had the largest portion of "disenchanted" EDP users.

In summary, generally the program is useful to product development participants; however, users have difficulty understanding the implications of applying for the contribution. Secondly, the range and level of eligible costs is generally reasonable with the exception that a broader coverage of marketing costs is required.

4.8 DRIE Innovation Objectives and Applicability of IRDP

The purpose of this section is to review past achievement of regional industrial development objectives via EDP and to consider the extent to which the IRDP will be successful in meeting future regional innovation objectives.

Principal information sources are personal interviews with DRIE regional officials and experts familiar with government programming in the regions. This is augmented by a review of the Regional Industrial Development Frameworks prepared in 1983 and the 1983 Regional Operational Plans.

This section covers the following topics:

4.8.1 Perceptions of Achievement of Past Objectives
4.8.2 Expert Opinion on Future Program Direction
4.8.3 Ability of IRDP to Meet Regional Innovation Objectives

In summary, the experts and government officials generally agree that:

- the EDP program has contributed to the economic viability of regional industry but the program has not been utilised to its fullest extent

- many product development opportunities are missed because of lack of internal company funds

- specific industrial development needs that are not currently met tend to center around the needs of small businesses, i.e.
  - management skills
  - financial resources
  - R&D infrastructure

- government programs should be directed or focussed towards companies ("winners") and sectors.

- the overall attitude of experts is to build on regional strengths while at the same time encouraging traditionally smaller sectors

- the most effective form of government R&D assistance is grants and contributions

- broadening the scope of eligible product development costs would increase the utility of the program

- the program delivery process should be streamlined

- more effective promotion is required to make users aware of the programs

- experts are optimistic about the IRDP in terms of achieving their regional objectives because:
  - IRDP applies to all phases of the corporate life cycle
  - flexible program instruments can be tailored to the users needs
  - decentralized program delivery should assist in more efficient delivery

- expert concerns about the IRDP center around:
  - EDP maximum contribution limits are appropriate and changes may cause problems
  - paperburden for applications and approvals must be reduced
  - regional offices may not be able to meet the expected increase in assistance demand

4.8.1 Previous Achievement of Industrial Development/ Innovation Objectives

In the past all regional officers looked to EDP innovation as a means to improve the manufacturing industrial base of their province. Sub-objectives included improving local resource utilization, accelerating the transfer of technology from institutes to private enterprise and developing export markets.

While, in general, the feeling is that EDP has been useful, DRIE officials in the Atlantic, Central and Western regions hold the view that the program has not been employed to its fullest extent. Several reasons have been advanced for this under utilization of the EDP, the more prominent being:

- Program usage has been largely determined by applicants

- Firm attitudes toward product development/innovation have not been encouraging

- To some extent, the ineligibility of certain costs has discouraged product development

- High labour costs and lack of skilled manpower in the Western Region

- Language perceived as a barrier in attracting skilled labour in Quebec

- Lack of an industrial base, and the reluctance to break with tradition in the Atlantic Region

- Lack of proactivity on the part of program.

Experts interviewed believed that innovation assistance has contributed to the economic viability of sectors important to their respective regions. However, they considered that many product development opportunities have not been met within their region generally as a result of the lack of financing. No expert considered the lack of government support as a factor in missed opportunities. Indeed, government assistance was viewed as critical to enable companies to capitalize on product development opportunities by reducing financial risk or, in some cases, ensuring the survival of some companies.

Specific industrial development needs not being met tended to be centered around the needs of small business, specifically in the areas of management skills and attitude towards product development, insufficient financial resources, lack of skilled labour and lack of a technology base/infrastructure in the region. These needs have tended to inhibit product development to a greater or lesser degree in each region.

Exhibit 4-56
Perceived Technological Leadership in Economically Important Sectors

	BC	ALB	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD
Electrical		-	.AY	AN	AY	.AN		.A-		
Mach/Trans		-		.AN	.AY	.AY		.AN		.AN
Chem./Food Proc.	.	-		AN	A-	AN	.AY	AN	.AN	.AN
Metals		-			AY					
.Wood	A-	-					.AY			
Other (Mines, Oils)	.	-	.AY			.				
Related Service	A-	-						AN		

KEY

A = important sector

Y = leaders in technology

N = not leaders in technology

- = no response

. = major opportunities for produce development

4.8.2 Expert Opinion on Future Program Direction

Without exception experts agreed that product development/ innovation was an extremely important activity to Canada. Many went on to say that without emphasis on this activity, industrial development would eventually stagnate for lack of marketable products.

Unaware to what extent the program had been focussed to sectors, regions or companies in the past, experts generally agreed that government programs should be "directed" rather than delivered using a "shot-gun" approach. Those in the Ontario, Quebec and the Atlantic provinces prefer that programs be focussed on companies, the "winners", while experts in the West are divided in opinion whether focussing should be applied at the region or sector level, if at all. Western experts tend to the view that market demand for program assistance has operated by itself as an effective means of providing direction to support.

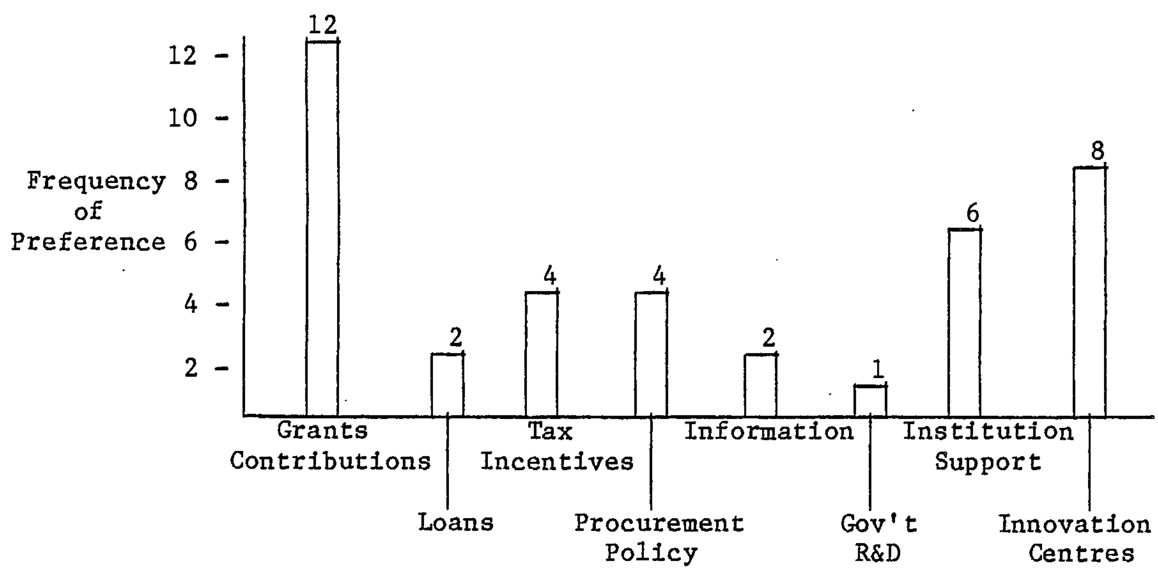
Regionally, experts tended to identify as first those sectors which were considered the most important to the regions economy followed by sectors where growth potential existed. The overall attitude seemed to be to build on regional strengths while at the same time encouraging traditionally smaller sectors.

Exhibit 4-56 represents the sectors considered the most important to the experts to their region and their assessment of sector technology leadership.

Exhibit 4-57
Important Indicators of Success
(as Delivery Criteria)

	BC	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD
Employment Benefits	X	X	-	X	-	-	-	X	X
Sales Growth	-	X	-	X	-	X	-	-	-
Other	-	-	X	-	X	-	X	-	-

Exhibit 4-58
Ranking of Incentive Instruments



Sales growth and employment were the two most commonly cited indicators of project success and hence program effectiveness as shown in Exhibit 4-57. To a lesser extent, the department should be assessing the impact of the project on the firm's labour/management skill level and competitiveness in international markets as measured in exports. The indicator most appropriate to the regional requirements, as seen by the experts, was employment followed by impact on company sales growth.

<u>Experts</u> perceive that businesses require grants and contributions over all other possible instruments to most effectively carry out product development. A ranking of possible incentive instruments appears in Exhibit 4-58.

<u>Experts</u> consider that the broadening of the scope of eligible product development costs by introducing more flexibility into the program would increase the utility of the program to their region's industry. At the same time, the program delivery process should be streamlined in order to flow funding to companies when it's needed. Other suggestions by experts included the provision of back-up management and technical assistance programs for small companies and emphasizing, through more effective advertising, the existence of the department's innovation programs and the benefits to be derived by the firm from successful product development.

4.8.3 Achievement of RIDF Objectives

In their Regional Industrial Development Frameworks (RIDF), each of DRIE's regional offices have described their operating objectives for the medium term (1983-88) over the six planning elements of the IRDP including that for R&D/innovation. Preliminary distributions of the medium term budgets, as well as committed, proposed and new initiatives are described for each element.

The R&D/innovation element of IRDP more closely resembles EDP than any of the other programs. Therefore the comments on, and observations of EDP can help in assessing the reactions of the regions to the IRDP.

To set the scene, R&D/innovation in the RIDF was the largest expenditure for the DRIE regions of B.C., Alberta, Saskatchewan, Ontario and Quebec. While Ontario and Quebec earmarked over 34 per cent of budgetary expenditures for R&D/innovation over the next two years, B.C., Alberta, Saskatchewan allotted almost 30 per cent. The Atlantic region of Newfoundland, PEI, Nova Scotia and New Brunswick have devoted less than 10 per cent for R&D/innovation over the next two years. Figures for Manitoba are between 10 and 14 per cent.

The Central region (Ontario and Quebec) with its large manufacturing base, places greater emphasis on R&D/innovation than the mostly resource-based Atlantic region. The Western region, with a mixture of manufacturing and resource industries, have decided to concentrate on manufacturing rather than the abundant resource-based industries.

In the three fiscal years to March 1980, the Western region had 22 per cent of the number of all EDP authorizations, but only 14 per cent of the disbursements; the Central region - 71 and 83 per cent; and the Atlantic 7 and 3 per cent respectively. During the same time frame, the number and value of EDP product development for the three regions were: Western - 36 per cent of the number, and 33 per cent of disbursements; Central - 51 and 56 per cent; Atlantic - 13 and 11 per cent.

Against the backdrop of the perceived shortcomings of EDP mentioned in the previous section, the considerable variance of program funding among regions, and the early indications of the design for the IRDP, there is a good deal of cautious optimisim among regional officials towards the ability of IRDP to meet regional innovation needs.

The broad-based characteristics of IRDP have addressed most of the usage obstacles of EDP, with the possible exception of the ones that emanate from company attitudes. The fact that IRDP applies to all phases of the corporate and product life cycle holds tremendous potential for the low manufacturing-based Western and Atlantic regions.

While all the operating features are not yet in place, early indications are that the flexible program instruments give the IRDP the capacity to be tailored to the needs of its users.

Armed with the overall details of IRDP, DRIE regional officials see the new program as a vast improvement over EDP. Regional officials can now conceptualize program delivery based on the premise that an innovation development begins with an idea which must be taken through the development stage to implementation and finally to commercial exploitation.

Regional officials are pleased that such activities as applied research and in-house studies, development and engineering projects, and large-sized projects not covered under EDP will be eligible for IRDP support. Where previously resource-based regions had to contemplate a shift to manufacturing-based industries to fully utilize innovation programs, they can now, with IRDP, concentrate on improving their resource-based industries.

The Western region, rich in wood, oil and gas, coal, agriculture and fisheries, sulphur, mining, etc., can look forward to R&D/innovation derived from market research, technology transfer and energy saving technology.

The Atlantic region, with its primary resource industries of agriculture and fisheries, forestry, offshore oil and gas, minerals, etc. can look to R&D/innovation for more efficient production processs and new products.

As has been mentioned before, most of the research and development/innovation performers are located in the Central region - Ontario and Quebec. However, if Canadian manufacturing industries are to compete effectively in international markets, new technology to reduce costs and to improve productivity must be introduced.

In summary, where EDP has been found lacking, IRDP, it is believed, will fill some gaps. In areas where EDP has performed creditably, IRDP has the potential to perform even better.

Against this background of perceived positive features of the IRDP, regional officers have expressed some concerns relating to implementation of the program which may or may not become a problem. Officers feel that a degree of flexibility should be allowed to suit regional circumstances. In addition, officers view current maximum limits of support under EDP as appropriate and appear concerned at the ramifications of the new Tier System which will reduce maximum contributions in some regions. Whether or not the paperburden associated with applications and approvals will be reduced is also a question in their minds. Finally, there is some concern that regional offices may not be able to meet the expected increase in demand for assistance.

Overall, however, officers feel the objectives set in the RIDF for delivery of the innovation element of IRDP are achievable with few exceptions.

4.9 Recommendations

- innovation policy and program design should reflect the requirements of the size of the firm and have the flexibility to meet the unique requirements of individual sectors important to regions

- the market research instrument made available within the new IRDP innovation element should be vigorously utilized prior to or in conjunction with product development funding

- product development activities should be coordinated with other product development programs and resources available provincially and nationally

- more attention should be paid to the front-end education of the innovator with respect to eligible projects and application requirements for IRDP

- the EDP instrument is a useful instrument for funding and promoting product development projects. The basic design should be maintained

- efforts should continue to streamline the application/approval process

- maximum contribution levels need not be increased

- an analysis should be undertaken to ensure adequate program staff are available to handle increased program interest and application activity from industry

5.0 ISSUE II — REGIONAL SKEWING

5.1 BACKGROUND

5.2 MAJOR FINDINGS AND CONCLUSIONS
- 5.2.1 Program Richness
- 5.2.2 Locational Factors
- 5.2.3 Sensitivity of Business to Program Richness
- 5.2.4 Impact on IRDP Innovation
- 5.2.5 Regional Skewing Summary

5.3 THE IMPACT OF PROGRAM RICHNESS ON CONTRIBUTION TO TOTAL INNOVATION COSTS

5.4 LOCATIONAL FACTORS IN INNOVATION

5.5 SENSITIVITY OF BUSINESS TO PROGRAM RICHNESS

5.7 RECOMMENDATIONS

5.0 ISSUE II REGIONAL SKEWING

5.1 Background

Issue II was formally posed in the following terms "What is likely to be the effect of regional skewing on the usage and effectiveness of the innovation element.

Regional skewing can take place in three ways: varying eligible costs; targetting a larger budget for innovation support in particular areas; or enhancing the program richness or contribution in particular areas. In this study emphasis is given to this latter aspect in that in the IRDP, it is proposed to vary the maximum level of contribution from 50% to 75% dependent upon economic disparity of regions, and secondly, to provide a contribution level of up to the maximum to the extent that only sufficient funds are provided in order to allow the project to proceed.

The key data sources for the analysis of this issue were the firm survey augmented by the government official and expert surveys.

Regional skewing is considered from several viewpoints:

5.3 Impact of Program Richness on Contribution to Total Innovation Costs
5.4 Locational Factors in Innovation
5.5 Sensitivity of Business to Program Richness

5.2 Major Findings and Conclusions

This section summarizes the major findings of the study with respect to regional skewing.

5.2.1 Program Richness

- The impact of increased contribution level richness for large and/or small firms in disparate regions is not likely to promote significant additional innovation.

- The majority of small firms in the disparate regions already receive the maximum allowable contribution.

5.2.2 Locational Factors

- Location is not a significant factor in undertaking product development.

- 80% of the costs of innovation are current costs. Therefore, regional cost advantages for product development are related to the cost of labour.

- Most factors that would induce companies to locate in disparate regions are not sensitive to program financial support: i.e. market proximity, availability of skilled labour, and proximity to research centers.

- Location first affects manufacturing which then impacts upon product development.

5.2.3 Sensitivity of Business to Program Richness

- Research programs and budgets are often established by firms on a project by project basis.

- The nature, scope, and cost of a given product development project is relatively fixed, regardless of firm size.

- Any significant decrease in funds availability may inhibit or delay product development.

- The availability of increased funding will not change projects 50% of the time.

- Increased funding reflects only on individual projects and not on an overall continuing R&D level.

5.2.4 Impact on IRDP Innovation

- Regional skewing potentially will:

  - decrease the product development activity in regions where maximum funding will no longer be available.

  - increase a small portion of individual development projects in designated areas.

- The overall net effect of skewing may be negative.

5.2.5 Regional Skewing Summary

The effect of regionally skewing financial assistance to innovation-product developments in disparate regions will very likely be negligible and could show negative overall impacts on program effectiveness.

There is no evidence from the study's survey of firms and experts that increased product dvelopment funding up to 25% will induce companies to perform more R&D in disparate regions. R&D is apparently tied to the location of manufacturing facilities in most cases and manufacturing is tied to on-going concerns such as suppliers, labour, markets and the like.

Under the new IRDP the winners from regional skewing in terms of raised assistance levels will be large firms in disparate regions since small firms in these regions are already eligible for maximum contribution levels. The 'losers' will be small firms in non-disparate regions since their funding levels will be cut back.

If the new IRDP maintained the EDP status quo of financial skewing in favour of small firms, the effect would be similar to regional skewing since the vast majority of firms in disparate regions are small.

5.3 Impact of Program Richness on Contribution to Total Innovation Costs

Under IRDP, disparate regions will be provided with enriched program funding on the hypothesis that it will offset perceived natural disadvantages of the region and thus foster economic development.

In the instance of small firms of less than $10 million sales, funding at 75% in disparate regions will not provide additional support as those firms had received 75% funding previously under EDP. For the less than 15% of firms who had sales greater than $10 million and had received 50% EDP funding, the new higher level of 75% funding of eligible costs will of course provide the opportunity for additional funding and thus perhaps increased motivation for innovation.

In the "have" or Tier I regions, the previous funding status of large firms at 50% contribution level for EDP will not change under IRDP. However, for small firms in Tier I, maximum funding levels will drop from 75% to 50%.

The impact of a 25% increase in program richness for large firms in disparate regions or a 25% decrease for small firms in Tier I regions can be shown as a percentage of total innovation costs such as in the following hypothetical example:

	75% funding	50% funding
Total project	$100,000	
Research and engineering development (60% of innovation cost)	$60,000	
Govt. contribution	$45,000	$30,000
% Govt. to total innovation	45%	30%

The increased program richness for large firms in disparate regions is not likely to promote significant additional innovation since the impact on the total project is relatively minor. The impact on small firms will be negligible, since, the majority already receive the maximum allowable contribution.

5.4 Locational Factors in Innovation

One possible approach to increasing the industrial base in disparate regions is to encourage innovation either through support of resident firms or by attracting the establishment of new firms or facilities. The question might be asked if enriched IRDP innovation support can be utilized to attract the relocation of firms into disparate regions.

Almost all companies in the survey, 95%, indicated that location was not a major factor in their decision to undertake product development. Most contacts were small companies and would not consider doing research anywhere other than where they manufacture. Contacts indicated that location does impact upon innovation; however, vitually none of the contacts would consider taking any action to counter the disadvantage, because of the tie-in to the manufacturing plant.

Some of the locational factors that affected research were noted by the firms as:

- proximity to markets
- availability of skilled labour
- proximity to research centres
- availability of testing facilities

From an analysis of the types of costs funded previously under EDP projects, 80% of the cost of innovation are current costs. Of these current costs, 90% are labour related. Any other costs are relatively insignificant. If wages are tied at all to the perceived lower standard of living in disparate regions, then labour costs/innovation costs would not at first glance appear in need of special subsidy in disparate regions.

Though many officers could not identify any locational factors which, if subsidized, would induce firms to locate in disparate regions, those factors cited were not sensitive to program financial support. Examples of such factors centred around the availability of skilled workers in the region and proximity of the firm's manufacturing facilities and market.

Outside of B.C., Ontario and Quebec regions, where experts consider locational factors to have little if any impact on firm's motivation to perform product development, opinion is divided. In the Maritime provinces, market isolation and unavailability of skilled labour were thought to limit the amount of product development taking place. Prairie provinces cited the lack of infrastructure and associated technology transfer as significant factors.

In conclusion, it would appear that location first affects manufacturing which then impacts upon product development.

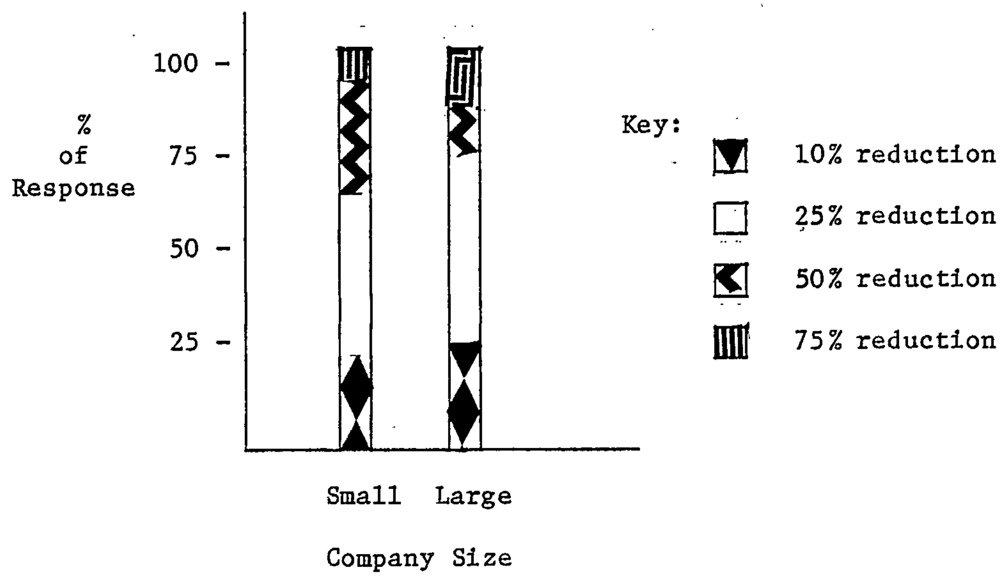
Exhibit 5-1
Sensitivity of Projects to Government Funding Level

% Reduction in Govt. Funds	% of Total Responses Indicating They Would Terminate
10%	23
25%	43%
50%	27
75%	7

Exhibit 5-2
Impact on Project if Govt. Assistance not Available

Level of Effect	% of Total Responses
No effect	6%
Modify Project	40%
Terminate Project	54%

Exhibit 5-3
Sensitivity to Contribution Reduction by Company Size
(Project Termination)



5.5 Sensitivity of Business to Program Richness

The purpose of this section is to determine the sensitivity of business to various levels of funding assistance and the level of funding at which the firms would either not undertake the projects or not seek government involvement. Firms were asked several questions pertaining to the effect of more or less funding.

When the firms were asked at what point would the project be terminated if government funds were reduced, 66% of companies which were sensitive to program richness indicated, as shown in Exhibit 5-1, that their projects would be dropped if funding were reduced 25%.

As shown in Exhibit 5-2, 54% of the companies nationally indicated that they would terminate the project if government assistance had not been available.

On a firm size basis, as shown in Exhibit 5-3, larger companies appear more sensitive to decreases in project funding up to the 25% level decrease. At 50% decrease in funds, small companies become more sensitive.

Exhibit 5-4
Sensitivity to Contribution Reduction by Province

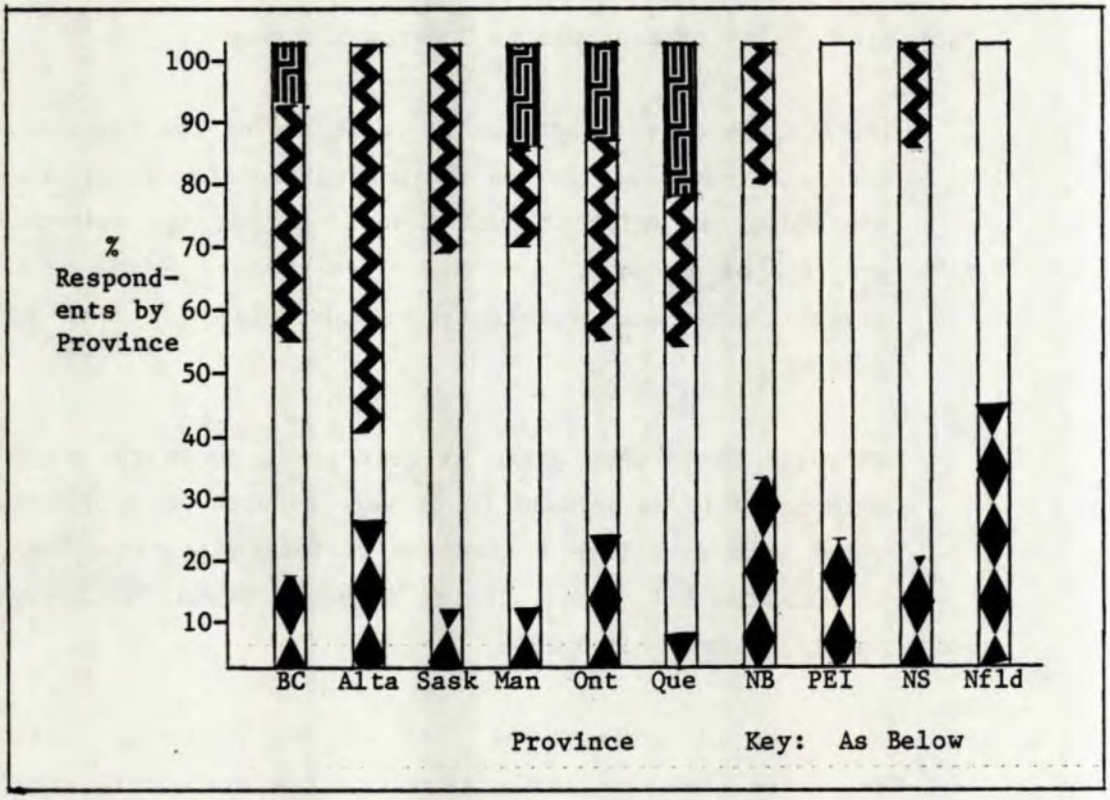
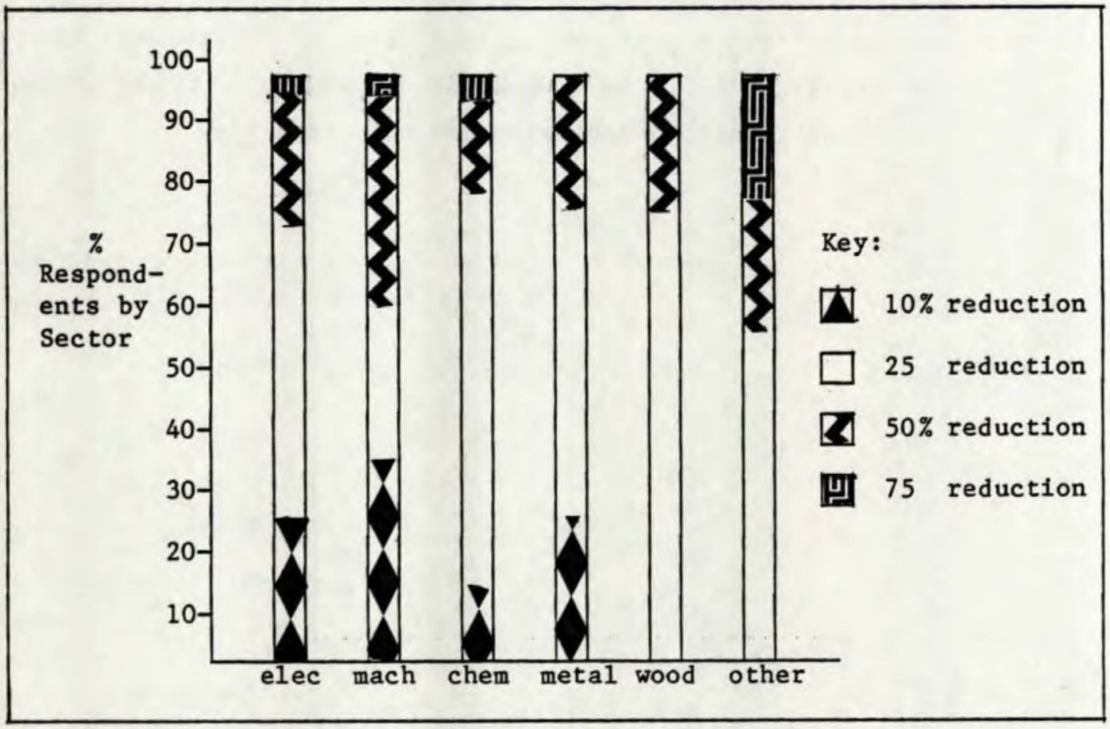


Exhibit 5-5
Sensitivity to Contribution Reduction by Sector



On a regional basis, the Maritime provinces appear to be the most sensitive to decreasing program richness as indicated in Exhibit 5-4.

Sensitivity to decreasing program richness fluctuates according to sector as shown in Exhibit 5-5, and region at a contribution decrease of 10% and 25%. However, at a level of 50% contribution decrease the regional and sectoral differences disappear and virtually 90% of richness sensitive contacts indicate project termination.

Exhibit 5-6
Sensitivity to Increased Contribution by Sector

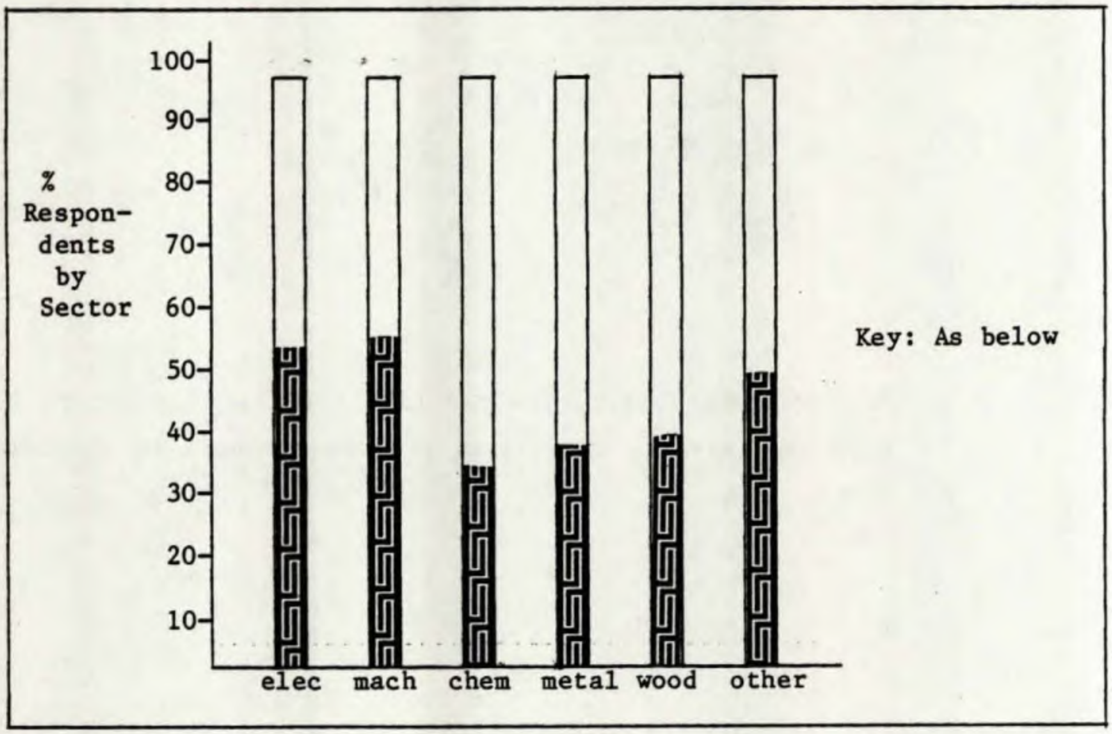
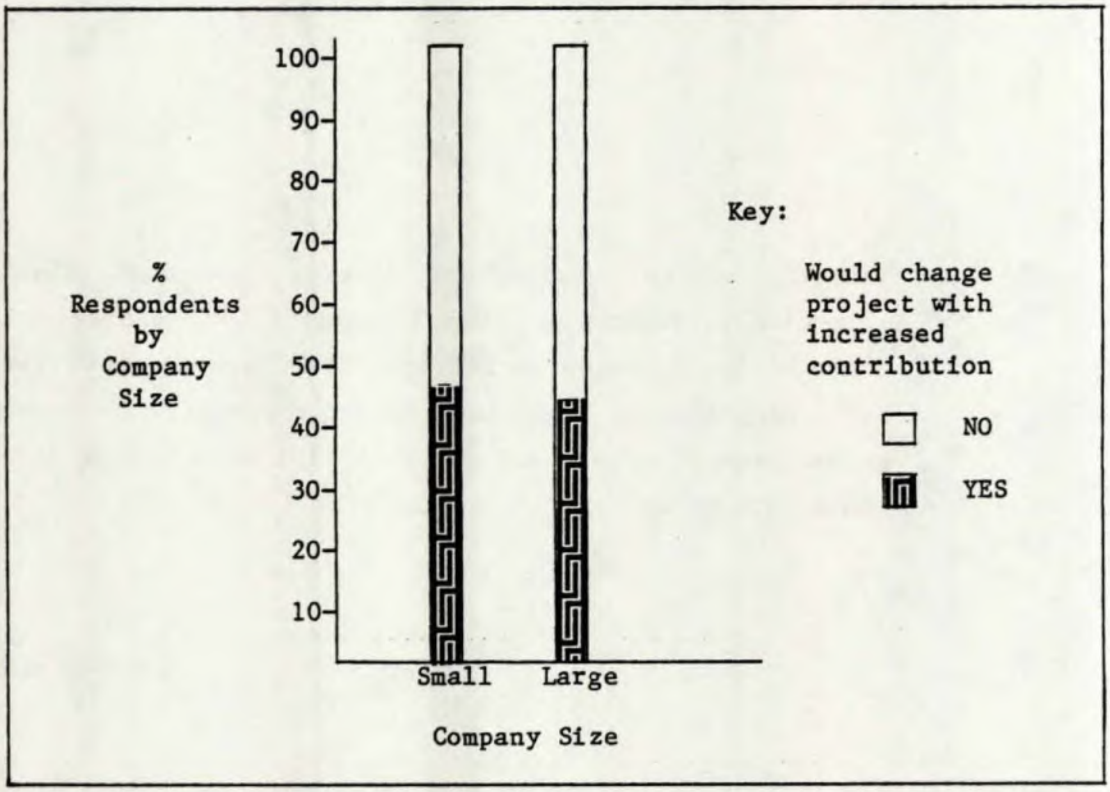


Exhibit 5-7
Sensitivity to Increased Contribution by Company Size



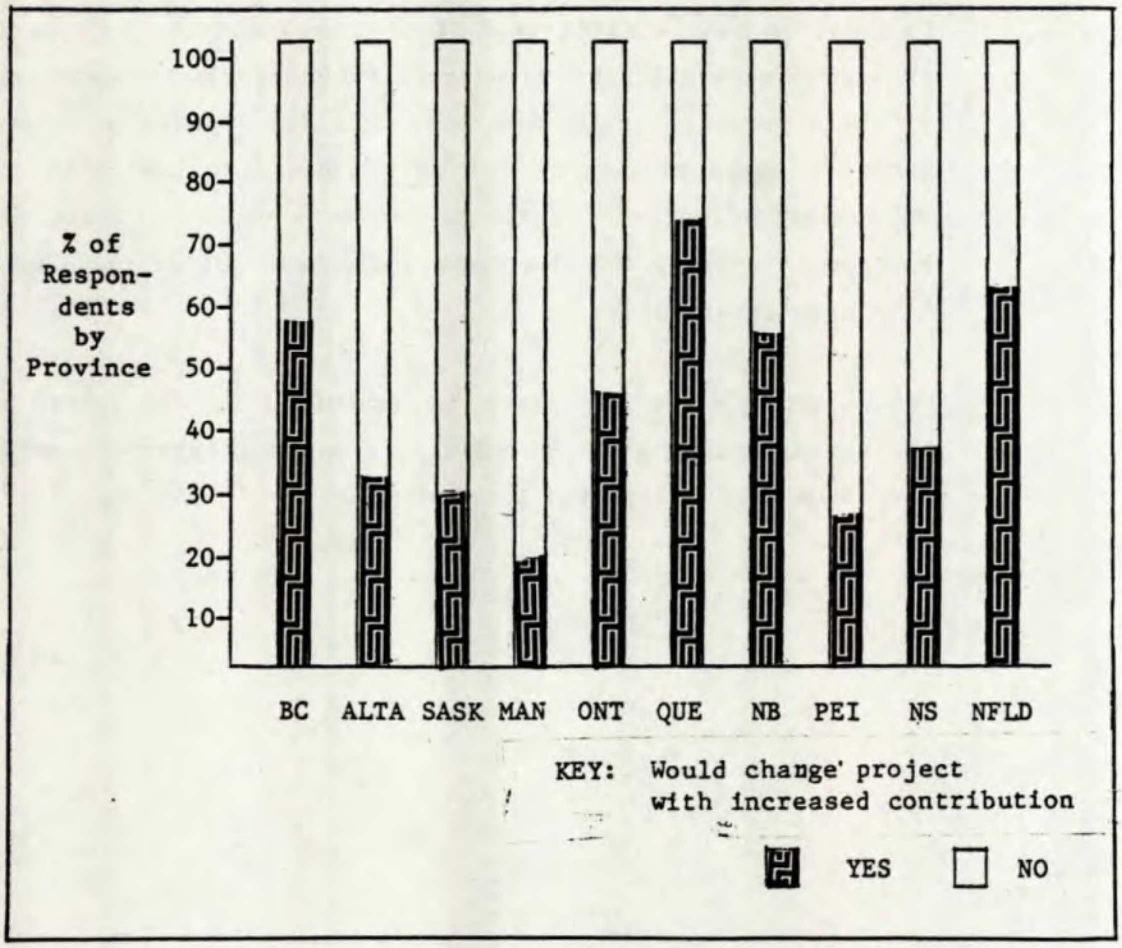
In order to take a slightly different approach to the question of business sensitivity to program richness, firms were asked if their projects would have been modified if more government funds had been available. If more funds were available, 54% of companies indicated that the projects would not have been altered in any way and the firms would have put in the same or less amounts of funds.

On a sector basis, as shown in Exhibit 5-6, electrical and machinery sectors are more likely to adapt the project to fit the level of funding from government.

On a firm size basis, as shown in Exhibit 5-7, both large and small companies seem equally likely to adapt the project with increased funding from government.

Exhibit 5-8

Sensitivity to Increased Contribution by Province



Regionally, as indicated in Exhibit 5-8, the Prairie provinces appear to be the least flexible in terms of altering their projects with increased funding.

In conclusion, research programs and budgets are generally established on a project by project basis. The costs associated with a given product development are relatively fixed. Any significant decrease in funds availability may mean the termination of the project. The availability of increased funding will not change the project at all 50% of the time. Generally speaking, the increased funding reflects only on individual projects and not on an overall or continuing R&D level.

5.6 Recommendations

- the concept of regional skewing should be re-evaluated for the IRDP innovation element

- skewing in favour of small firms should be considered as an alternative

- in order to assist disparate regions, additional support should be provided in market assistance, skills training and innovation resources availability

- additional funds will not significantly increase product development in disparate regions

- maximum funding levels should be maintained as in EDP in all regions provided there is flexibility in their application

- government programming relating to market/opportunity information, skills training and provision of innovation infrastructure should be promoted in lieu of enriched product development support in order to further establish innovation in disparate regions

6.0 ISSUE III — INVESTMENT GENERATED AND BENEFITS

6.1 BACKGROUND

6.2 MAJOR FINDINGS AND CONCLUSIONS
- 6.2.1 Program Incrementality
- 6.2.2 Investment
- 6.2.3 Benefits
- 6.2.4 Innovation Investment and Incrementality Summary

6.3 PROJECT INCREMENTALITY
- 6.3.1 Full Incrementality
- 6.3.2 Partial Incrementality
- 6.3.3 Incrementality and Significant Burden
- 6.3.4 Incrementality Summary

6.4 INVESTMENT GENERATED
- 6.4.1 R&D Investment Levered
- 6.4.2 New Facilities and Expansion

6.5 BENEFITS TO THE FIRM
- 6.5.1 Indirect Benefits
- 6.5.2 New Product Lines
- 6.5.3 Sales
- 6.5.4 Cash Flow Benefits to Firms
- 6.5.5 Product Development "Winners and Losers" by Sector
- 6.5.6 Exports

6.6 IMPACTS PER EDP $
- 6.6.1 Product Sales
- 6.6.2 Exports
- 6.6.3 Investment
- 6.6.4 Employment

6.7 RECOMMENDATIONS

6.0 ISSUE III INVESTMENT GENERATED AND BENEFITS

6.1 Background

Issue III was formally posed in the following terms: "Have companies increased their overall investments in innovation? Has the investment been incremental?"

The issue was subsequently expanded to include an overview of additional benefits to the firm and Canada resulting from government supported private sector R&D.

Key data sources for the analysis of this issue were the firm survey and the EDP file review.

Benefits arising from previous EDP programming are contexted by:

6.3 Project Incrementality
6.4 Investment Generated
6.5 Benefits to Firm
6.6 Impacts per EDP$

6.2 Major Findings and Conclusions

This section summarizes the major findings with respect to the investment generated and benefits accrueing as a result of the innovation programming.

6.2.1 Project Incrementality

° The EDP program is incremental in allowing companies to undertake specific product development projects

° Without the government contribution fewer development projects would be undertaken and the overall quality of research would be lower

- The significance of the government funds varies depending on sector and region

6.2.2 Investment

- EDP contribution has only minimal impact upon long term product development investment in the company

- Funds tend to stimulate project by project development, not an ongoing self-sustaining product development effort

- In many cases new facilities and/or expansion is undertaken as a result of the new EDP product development.

6.2.3 Benefits

- EDP projects appear to have the largest indirect impact on firm growth potential

- The projects generally improve the technological capability of the firms

- The EDP contribution allows for the expansion or diversification of a company's product line

- EDP product sales increase over time to represent almost 25% of the typical company's total sales.

- Expert sales increase over time to represent almost 40% of the typical company's EDP project total sales.

- EDP projects are typical of all product development in terms of success rates.

- The EDP program has produced net direct benefit to the firms assisted.

6.2.4 Innovation Investment and Incrementality Summary

EDP assisted companies have generally increased their investment in product development activities as a result of funding, however, this has not included an increase in long term investment in R&D.

While EDP funding was found to have incrementally levered firms investment in product development, the investment has been tied to the product life cycle and tended to include investment in on-going production capability rather than investment in on-going research and development staff and facilities. In terms of the short term R&D which was levered by EDP, the quality of product develpment activity was often improved both with respect to technical work and project management.

In summary, the study found that the EDP contribution instrument was appropriate for assisting new product development projects, however, it was not as useful as a tool to induce long term R&D investment.

6.3 Project Incrementality

The purpose of this section is to demonstrate the extent to which government funding has induced firms to undertake additional product development or altered their allocation of resources towards innovation.

An understanding of this degree of incrementality is important in associating the appropriate level of observed benefits to the introduction of government funding via the program.

Incrementality in this study is considered from the viewpoint of the firm as opposed to the market or country as a whole. As further discussed in Appendix C, incrementality may be defined in terms of full incrementality, ie. would the project not have been undertaken at all without government funding, and partial incrementality, ie. is the timing, magnitude or scope of the project favourably altered.

Project incrementality was addressed in the firm survey by asking the firms about i) the likelihood of project commencement without financial support, ii) where funds would have been spent in the absence of project assistance, and iii) how the program impacted on the project.

Exhibit 6-1
Likelihood that Project Would be Undertaken Without Program Funding

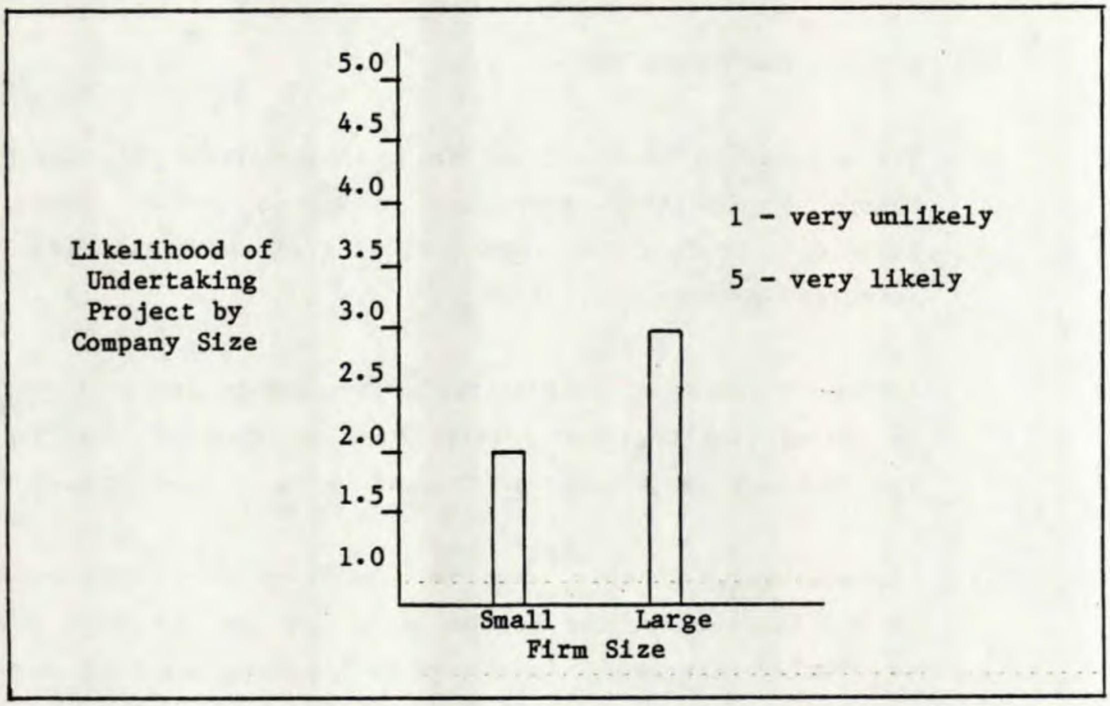
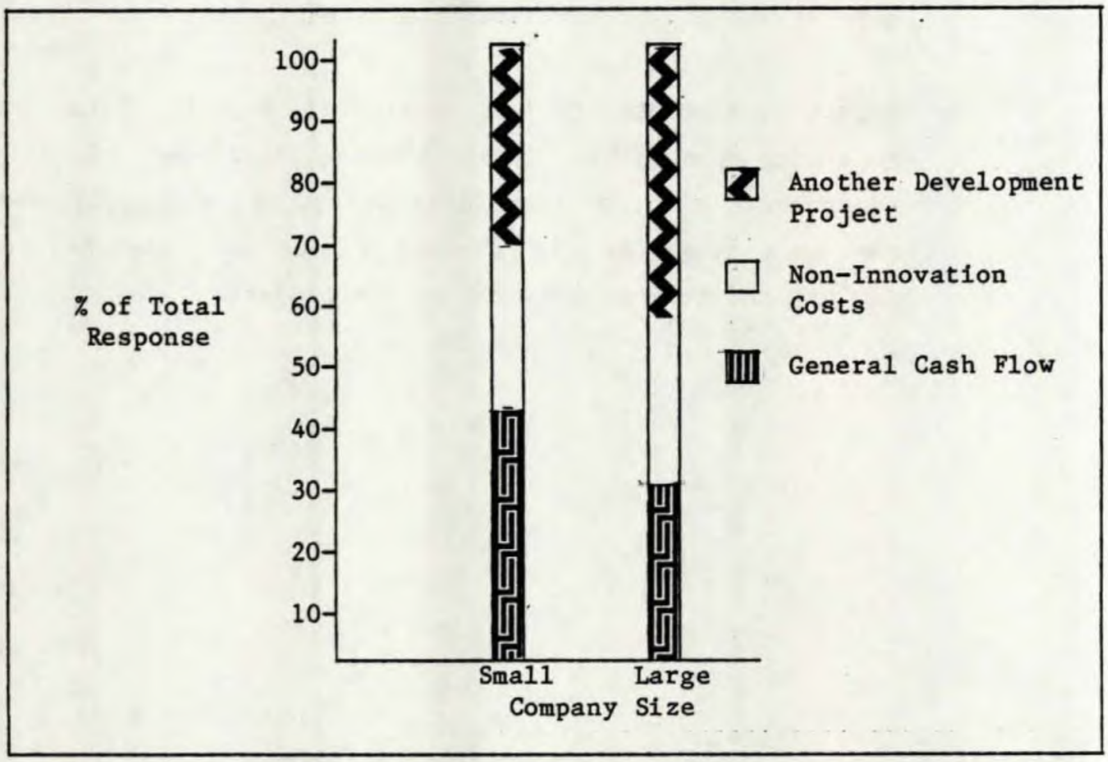


Exhibit 6-2
Alternate Use of Funds if not Spent on EDP Project



6.3.1 Full Incrementality

The first approach to ascertaining if the projects would have gone ahead without government funding was to ask the firms directly to put the likelihood of this on a scale of 1 to 5. As shown in Exhibit 6-1, this likelihood that the typical EDP project would have been undertaken without government funding is small, especially in the case of small firms (sales less than $2 million).

On the same basis as above, there appears to be only minimal differences in incrementality levels between provinces and sectors.

Further evidence on the incrementality of the EDP projects can be derived from the response of fifty-five percent of companies which reported that their project would have been terminated if the funding were not available. Additionally, forty-five percent of the firms responded that the one major way that this funding enhanced their product development was that it allowed their project to go ahead.

Another indication of project incrementality is what the firms would do with their share of the project costs if the project were not undertaken. If the alternate use were for another product development project, one may suspect a low level of incrementality. In this survey of firms, 65% of companies (nationally) would have used the funds for non-innovation cash flow or other purposes rather than product development. As shown in Exbibit 6-2, small firms were the most likely to use available funds for non-innovation purposes.

Exhibit 6-3
Alternate Use of Funds if not Spent on EDP Project by Sector

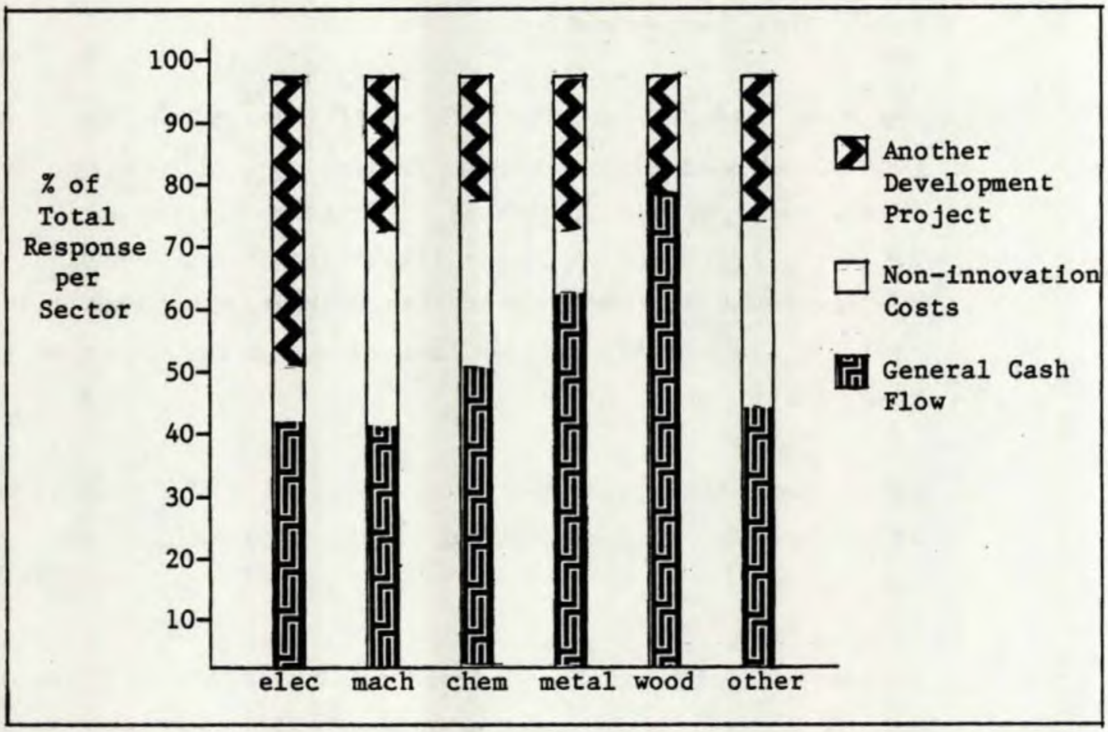
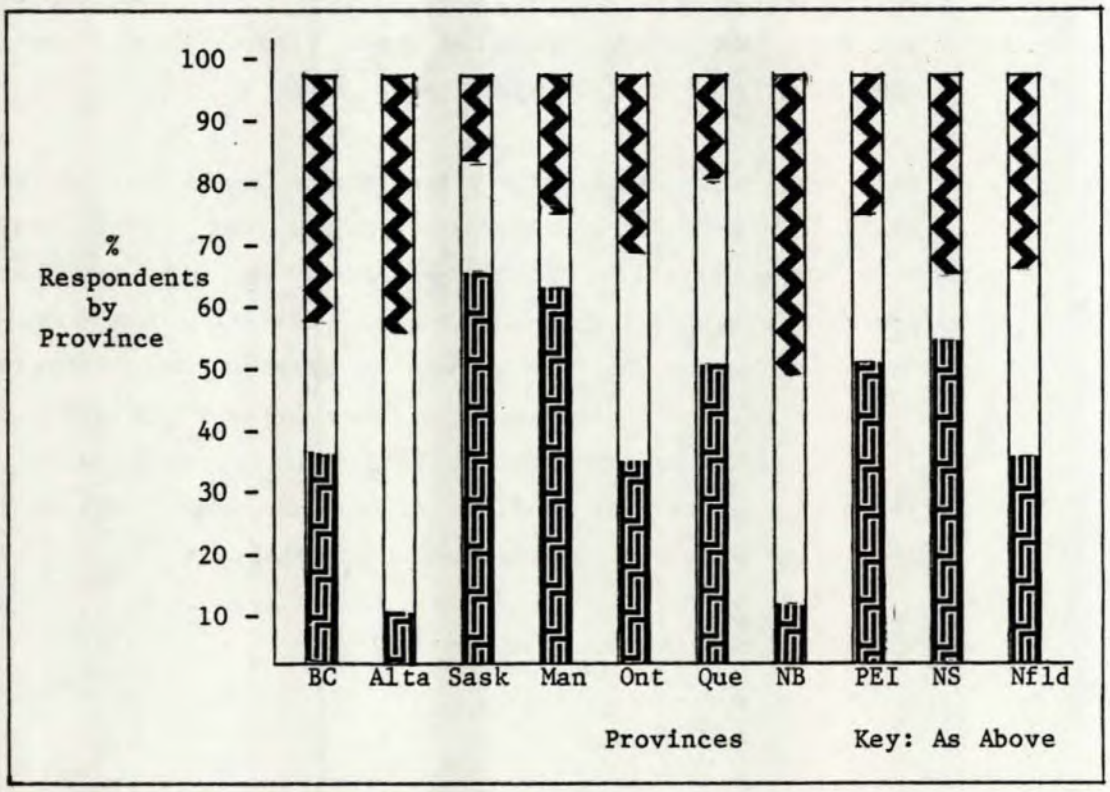


Exhibit 6-4
Alternate Use of Funds if not Spent on EDP Project by Region



As shown in figure Exhibit 6-3, electronics firms are the most likely to dedicate funds for product development.

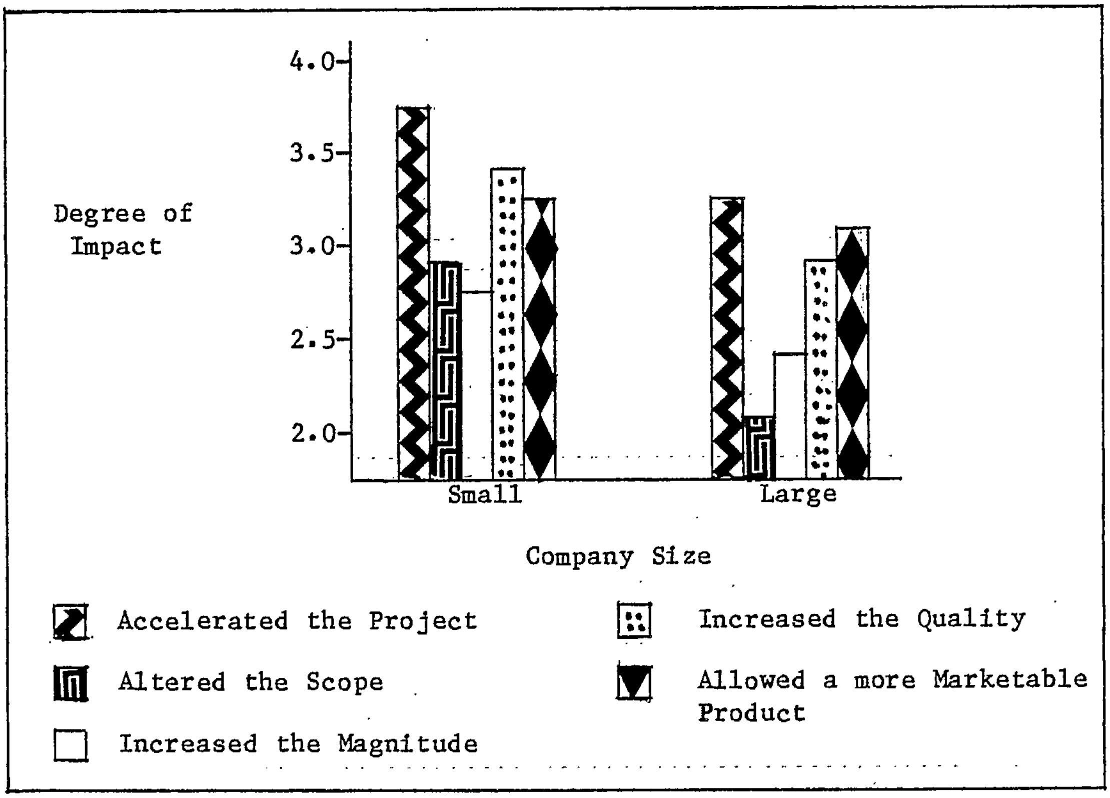
If government assistance had not been available 94% of companies responded that they would terminate or modify the project. Small companies were just as likely as large companies to terminate or modify the project if no government funds were available.

DRIE officers consistently assessed project incrementality as being very high. Some observed that incrementality is affected by the size of company with small firm projects tending to be more incremental than those of larger companies.

Experts believed that product development projects assisted under the program would not likely proceed without support or at least would be modified in scope. The greatest incrementality can be expected in the small companies where the greatest need for financing product development exists.

Experts in B.C., Ontario and Newfoundland estimated project incrementality in the range of 75% to 90%.

Exhibit 6-5
EDP Impact on the Development Project



6.3.2 Partial Incrementality

Projects which may have failed to achieve full incrementality, (ie. would have proceeded without funding) were accelerated as a result of the program to a moderate extent. To a lesser degree government funding improved the quality of the development allowing for a more marketable product. Small companies demonstrate this partial incrementality more so than large companies as shown in Exhibit 6-5.

6.3.3 Incrementality and Significant Burden

One feature of EDP was a significant burden criterion which, via 3 ratios, measured the degree of financial burden imposed upon the company by the product development project. The intent, in part, was to direct EDP funding towards those companies undertaking projects which taxed their financial capabilities (incremental projects) rather than to larger companies undertaking small projects which would not tax their financial capabilities (non-incremental projects).

In comparing the incrementality response received from firms with the one measure of significant burden applied at the time of application, the two were not found to be significantly related.

The survey response question was a 1 to 5 rating of project incrementality stated as "what is the likelihood that this project would have been undertaken without program funding?" (1 = small chance, 5 = large chance).

The measure of significant burden was one of the measures used by project officers to assess significant burden ex-ante to a project approval decision. The measure was based on some financial variables as in the following formula:

significant burden = (Cp + Ci)/TGNWTH

where Cp = total cost of approved project

Ci = implementation cost beyond project

TGNWTH = tanglible net worth (at time of submission)

The results of simple R correlation showed a weak relationship to exist between the survey response to incrementality and the ex ante measure of significant burden for all firms. When firm size was controlled, a significant relationship <u>was</u> found between financial burden and incrementality for small firms. (R = .18, n = 77)

In addition to the total product cost/tangible net worth test, two other measures were also generated and correlations run with the incrementality survey response. These measures were total product cost/assets and total product cost/working capital. These two additional measures were found to be more significantly related to incrementality in small firms than total product cost/tangible net worth. (R = .30, .20 and .18 respectively).

Conclusions which may be drawn from the above consideration of project incrementality include the following:

- The EDP program is instrumental in allowing companies to undertake specific product development projects. Without the government contribution, fewer development projects would be undertaken and the overall quality of research would be lower.

- Government assistance is relevant to both small and large firms.

- Indications are that the funds are more incremental in the Maritimes.

- Electronics firms are likely the most independent of government funding relative to all other sectors. (least incremental)

- The use of significant burden calculations are appropriate in determining project incrementality in small firms, however, they only explain a small portion of incrementality.

6.4 Investment Generated

The purpose of this section is to indicate the magnitude of investment in product development levered by government funding at the time of the project and on a continuing basis. Additionally, capital investment in the establishment of new manufacturing facilities or the expansion of existing manufacturing facilities associated with the funded project is shown.

6.4.1 R&D Investment Levered

R&D leverage may be analysed through consideration of an investment multiplier, and secondly through consideration of time series of absolute R&D dollars or R&D/sales.

Investment Multiplier

The amount of private product development investment levered by EDP assistance is dependent on the following factors:

i) the incrementality of assisted projects
ii) product development cost factors
iii) the level and timing of EDP assistance.

In order to determine a rough estimate of the amount levered for 104 EDP cases the following procedures/assumptions were followed:

i) incrementality was judged by response (1 to 5) to the question of "what is the likelihood that you would have gone ahead with the project without funding?". Only an answer of 1 (very small) was taken to represent an incremental project.

ii) product development costs were determined as the total project and implementation costs incurred by firms (for incremental projects only) to commercialize a product development.

iii) EDP assistance levels were taken from project audit statements. The timing of assistance was assumed to take place over the same period as company costs making discounting factors negligible.

The incremental investment levered by EDP can be roughly calculated as follows:

$$\text{incremental investment levered} = EDP\ (\Sigma\ IP_{xy} / \Sigma\ IG_{xy})$$
$$= EDP_{(im)}$$

EDP = All EDP grants (n = 104)

ΣIP_{xy} = Sum of private incremental investment out of a sample of x firms over y projects

ΣIG_{xy} = Sum of public total investment out of a sample of x firms over y projects

im = the investment multiplier for EDP (IP_{xy}/ IG_{xy})

Out of 104 cases:

(Σ IP_{xy})	Firm incremental investment	= $10,619K
(Σ IG_{xy})	EDP contribution	= $ 8,580K
(im)	Investment multiplier	= 1.238

Based on the rough multiplier calculated here, the total amount of product development levered by EDP can be calculated as 1.238 x $160M = $198M.

Exhibit 6-6
Average Research Budgets Over Time

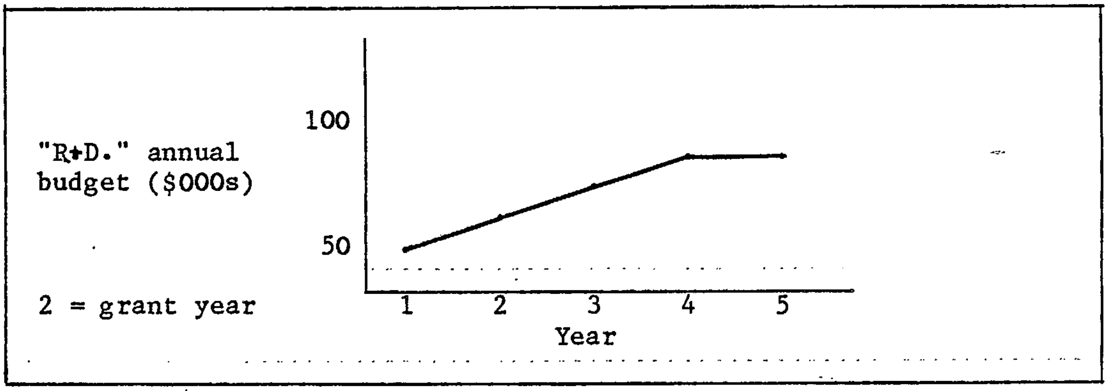


Exhibit 6-7
Research Budget as Percent of Sales Over Time

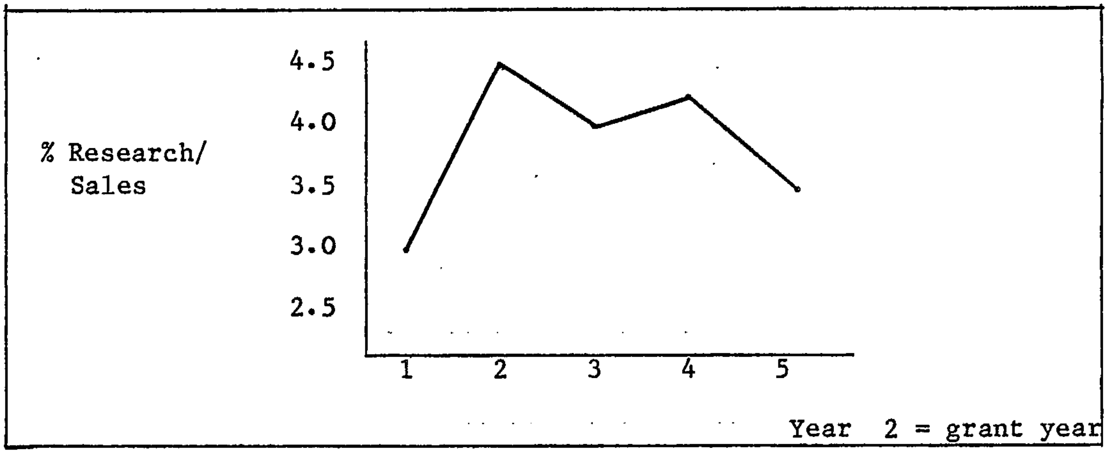
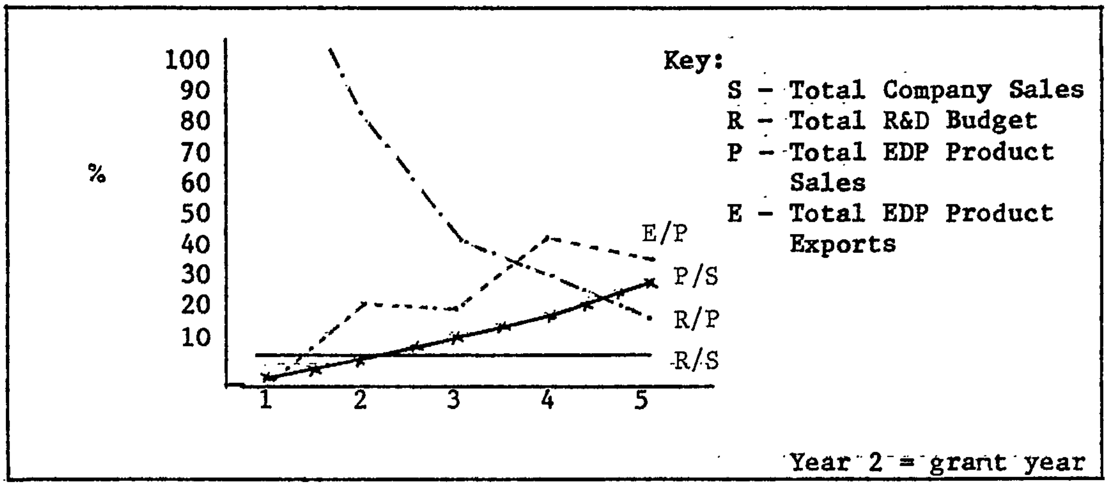


Exhibit 6-8
Investment Generation Overlaps with Sales



Time Series

Turning to the second approach of time series, it is noted that on an absolute dollar basis a short term increase in product development spending is noticed upon receipt of the EDP grant and this absolute level is maintained or slightly increased after the grant (as shown in Exhibit 6-6). A limitation on this observation of absolute measurement is that the investment is not normalized by firm growth over the period.

A comparison of total product development research budget and total company sales over time, indicates that there is negligible long-term investment generation resulting from the EDP funds. A short term increase in investment spending is realised as shown in Exhibit 6-7.

Investment generation overlaps, as shown in exhibit 6-8, show that the research budget relative to the EDP product sales plummets after the initial product development expenditures.

By way of contexting the above R&D/sales ratios, it is useful to compare the EDP firm ratios with the information gathered by Statistics Canada. Recognizing that for reasons of R&D definition that the Statistics Canada ratios may be under-represented, it can be seen from Exhibit 6-9 that the EDP firms are relatively more R&D intensive than the average of all Canadian industries.

Exhibit 6-9

Current Intramural R&D Expenditures as a Percent of Company Sales by Industry Group, 1975 to 1981

Industry Group	1975	1977	1979	1981
	(per cent of company sales)			
Chemical based	0.5	0.5	0.6	0.7
Wood based	0.3	0.3	0.3	0.4
Metals	0.6	0.6	0.6	0.5
Machinery and transportation equipment	0.9	1.3	1.7	1.5
Electrical	3.5	3.2	3.8	4.1
Other Industries*	0.4	0.6	0.6	0.9
TOTAL (all industries)	0.8	0.8	0.8	1.0

*Includes: Mines and wells
Other manufacturing
Other industries

Source: Statistics Canada

Also with reference to the Statistics Canada Exhibit 6-9, it is worthy to note that on the basis of research intensities, chemical-based, machinery and transportation, and electrical industry groups have been defined as high technology industries. Paper and allied products, and primary metals are regarded as medium technology sectors. In the industrial groupings used, electrical is the most research intensive followed by machinery and transportation, and chemicals. Between 1975 and 1981 the trend in the research intensities of all three high technology sectors was one of increase.

When Exhibit 6-7 (EDP firms R&D/Sales) and Exhibit 6-9 (StatsCan survey R&D/Sales) are compared, one can conclude that EDP assisted firms did nothing more than follow a general trend in increasing R&D intensity.

Exhibit 6-10
New Facilities Resulting from EDP Project by Company Size

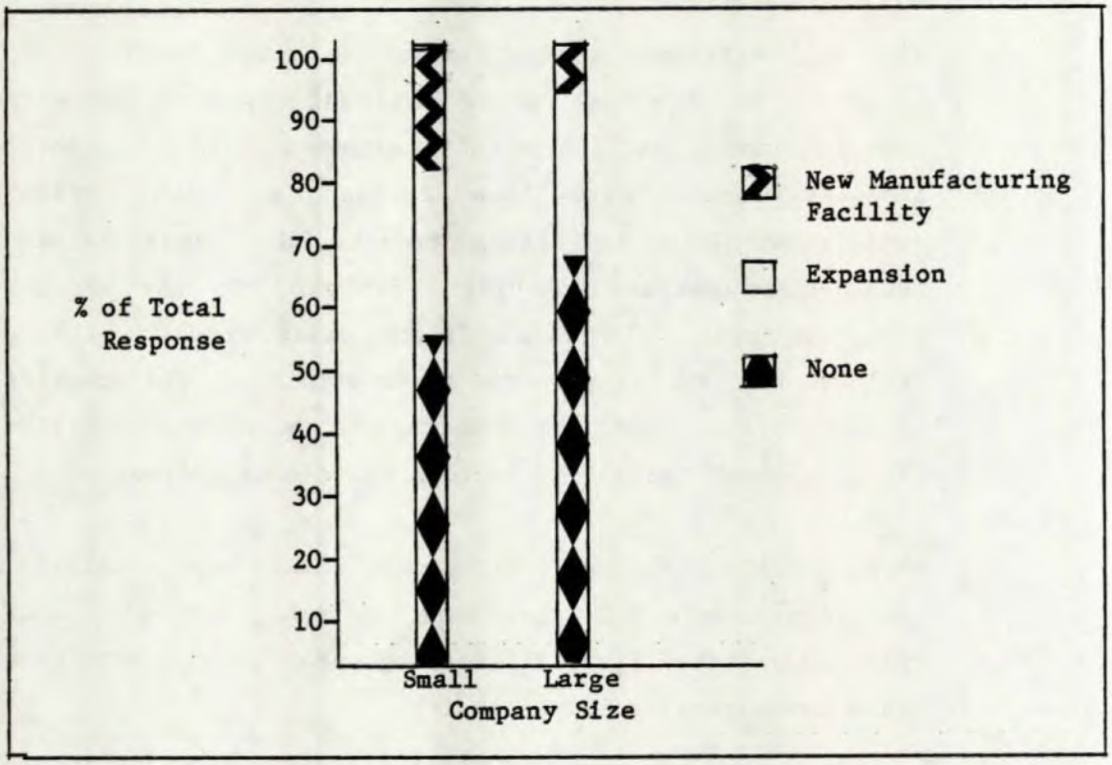
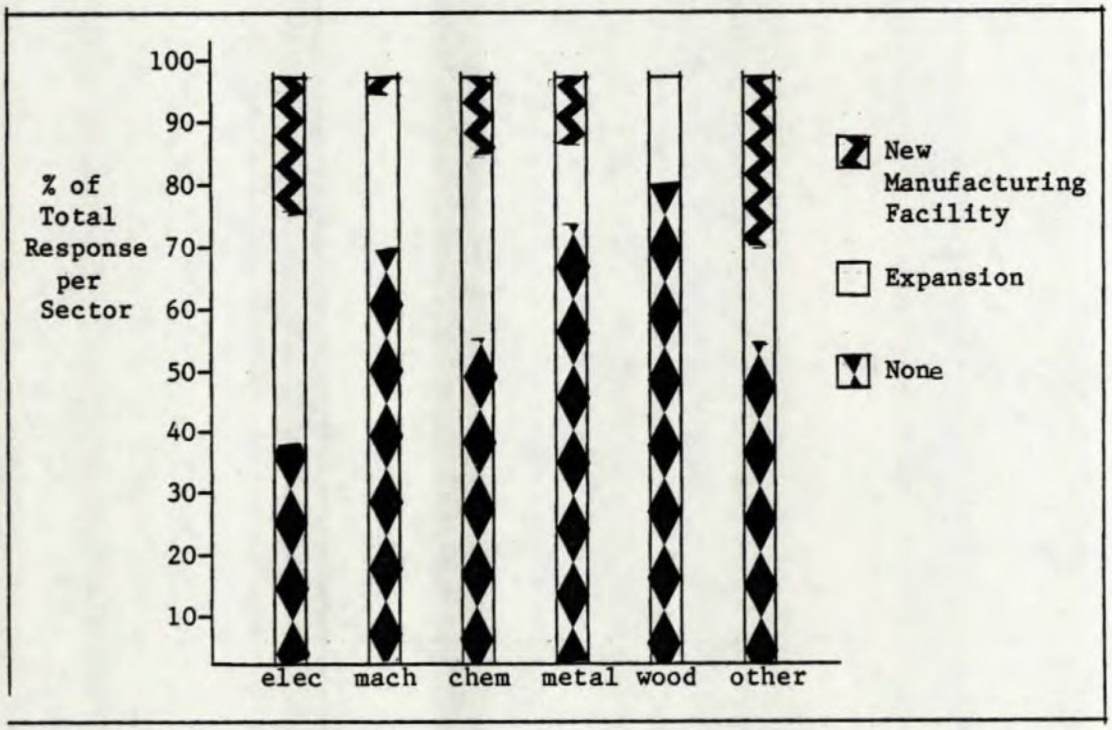


Exhibit 6-11
New Facilities Resulting from EDP Project by Sector



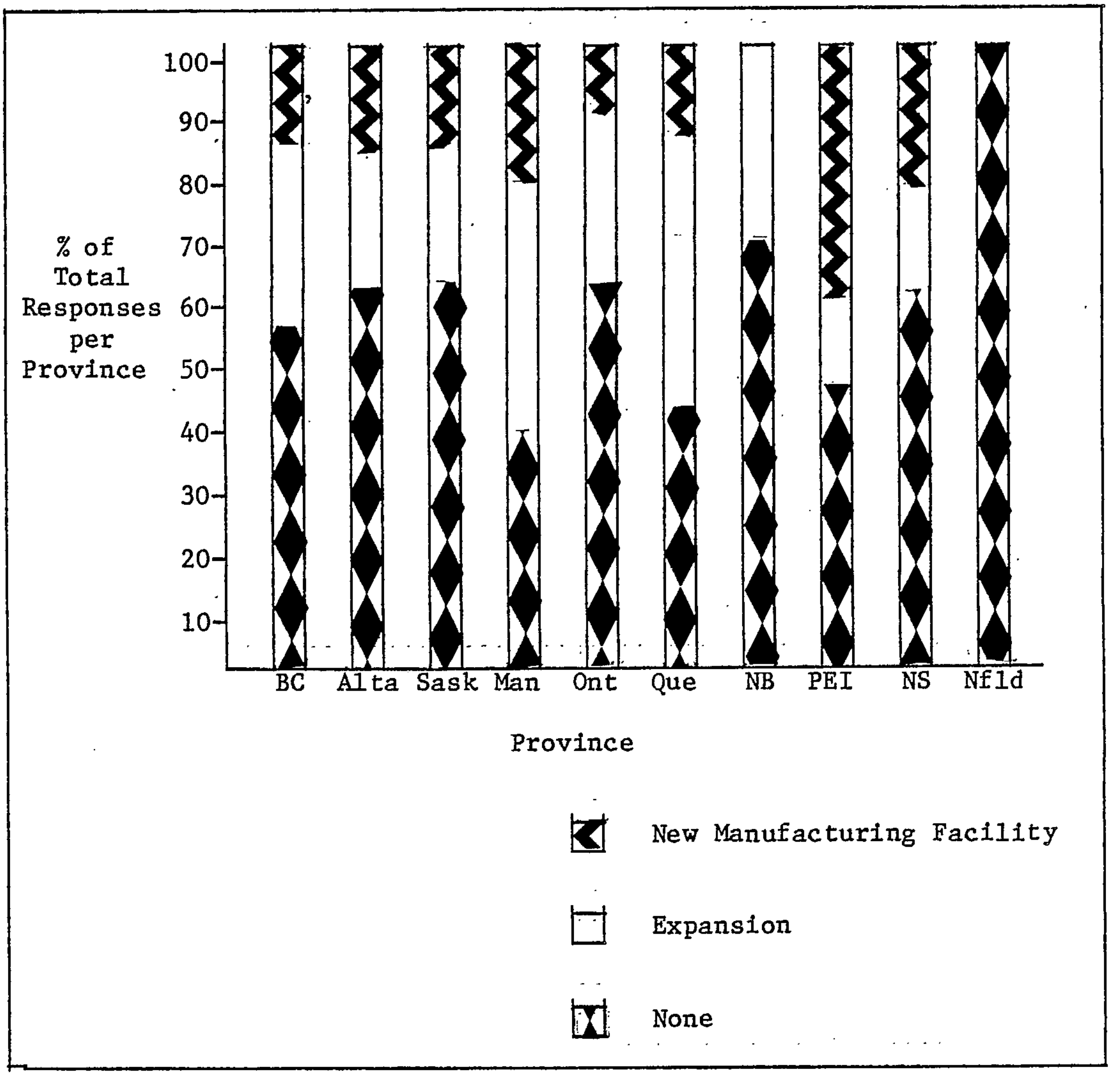
6.4.2 New Facilities and Expansion

Nationally, 16% of the companies reported that the project influenced the establishment of new manufacturing facilities and 30% reported that the project influenced the expansion of existing facilities.

Small companies demonstrated a much more significant impact upon new facilities and expansion than did the larger companies. Large companies were more apt to expand existing facilities as shown in Exhibit 6-10.

The electronics sector demonstrates the highest rate of addition of new facilities or expansion. The older, more established sectors such as food processing, chemical and metal fabrication tend to expand existing facilities rather than establish new manufacturing as shown in Exhibit 6-11.

Exhibit 6-12
New Facilities Resulting from EDP Project by Region



On a regional basis, Newfoundland, New Brunswick and Nova Scotia demonstrate the lowest addition of new facilities relative to all other provinces as shown in Exhibit 6-12.

In conclusion, it would appear that the EDP contribution has only minimal impact upon long term product development investment in the company. This is consistent with the facts presented that many companies budget for product development on a project by project basis.

In many cases new facilities and/or expansion is undertaken as a result of the new EDP product.

6.5 Benefits to the Firm

The purpose of this section is to highlight the degree to which the EDP users realized the benefits which might be expected from innovation activity.

These benefits include indirect benefits such as growth potential and more technologically advanced products and more tangible benefits such as new product lines, sales and financial returns.

Benefits are discussed in terms of:

6.5.1 Indirect Benefits
6.5.2 New Product Lines
6.5.3 Sales
6.5.4 Cash Flow Benefits to Firms
6.5.5 Product Development "Winners and Losers"
6.5.6 Exports

Exhibit 6-13
Extent to Which Companies Have Benefitted from EDP Funding Indirectly

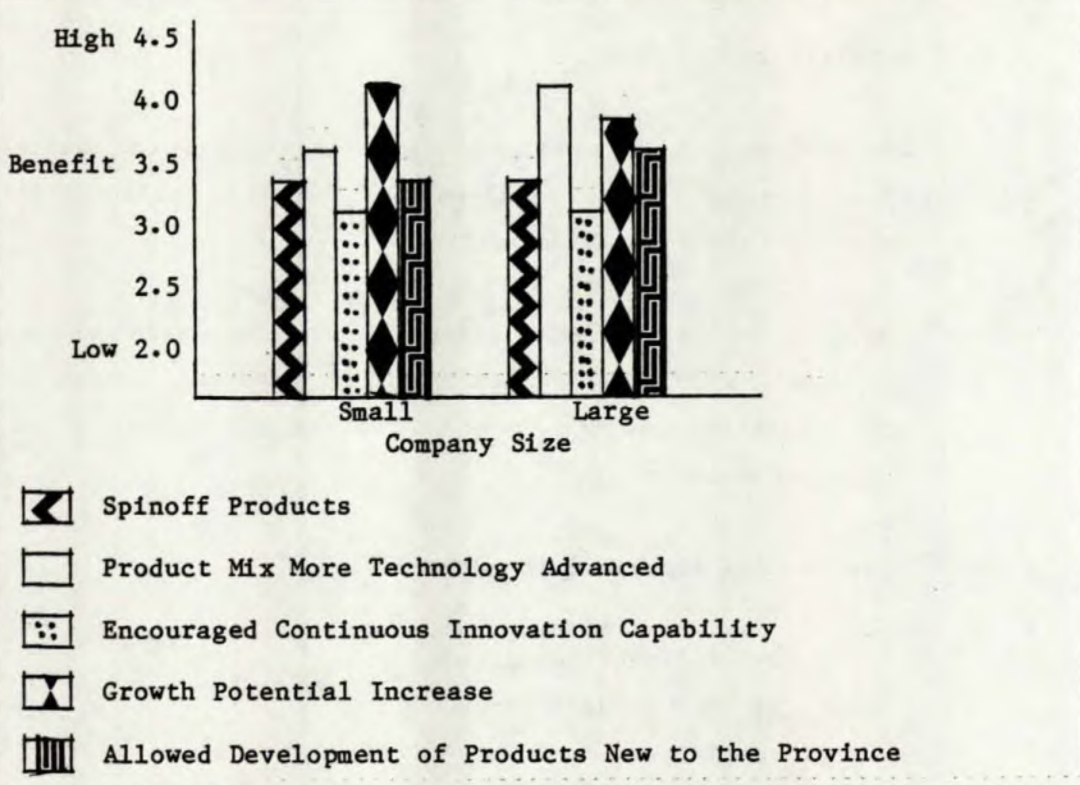


Exhibit 6-14
DRIE Perception of Innovation Funding Benefits to Firm

	BC	ALB	SASK	MAN	ONT	QUE	NB	NS	PEI	NFLD
1. Spin-off products	3.0	3.0	1.5	2.0	3.0	3.0	-	1.5	-	3.0
2. More technologically advanced	4.5	4.0	4.0	4.5	2.5	4.5	-	2.5	-	3.0
3. Continuous innovation capability	4.0	3.0	2.5	2.5	2.0	2.5	-	1.5	-	2.0
4. Growth potential	4.5	4.0	3.5	4.5	2.0	-	-	-	-	-
5. New products	4.5	4.5	4.0	4.5	3.0	1.0	-	3.0	-	3.0

Key: 1 - Low
5 - High

6.5.1 Indirect Benefits

The EDP projects appear to have had the largest indirect impact on growth potential of firms and technological advancement of their product mix. Large companies point towards the technological advancement aspect while the smaller companies note the growth potential impacts as shown in Exhibit 6-13.

Electronics firms tend to emphasize the development of spinoff products as the primary indirect spinoff. Spinoff products, when they occur, have had a significant impact on the company.

Complementary to the firms which have used EDP, Exhibit 6-14 shows the perception of DRIE Officials concerning benefits of the program beyond that of the assistance provided.

Outside of the product developed as a result of the program, experts believed firms also acquired a foundation for the development of follow on products particularly in Ontario and Quebec. In Maritime and Western Canada the benefit in this respect were seen to be lower.

Further, but to a lesser degree, experts felt projects generally improved the technological capability of firms rather than merely maintaining an established R&D capability.

Exhibit 6-15
Establishment of New Product Lines
By Sector

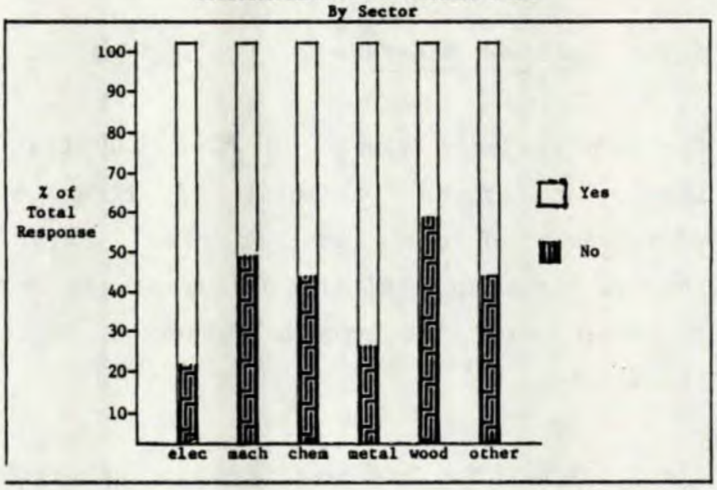


Exhibit 6-16
Establishment of New Product Lines
by Region

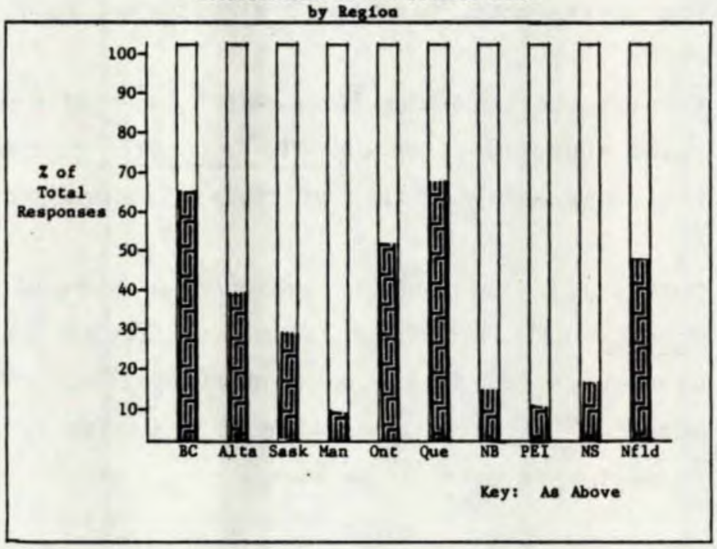
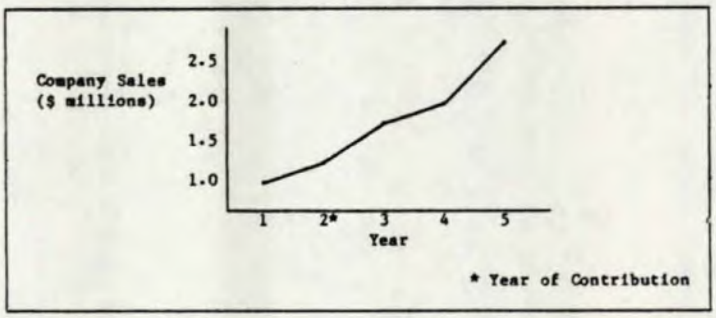


Exhibit 6-17
Typical EDP Companies Average Total Annual Sales



6.5.2 New Product Lines

Fifty nine percent of companies indicted that new product lines resulted from the product development project. On a sector basis, as shown in Exhibit 6-15, the electronics and metalworking sectors demonstrated the highest addition of new product lines.

Generally speaking, with the exception of Quebec and Newfoundland, the DREE designated regions demonstrated the highest addition of new product lines. The non-designated regions (i.e. B.C., Ontario, Alberta) showed the lowest rate of new product line formation as seen in Exhibit 6-16.

By company size, it would appear that large companies are not more successful at adding new lines than small companies. In conclusion, the EDP contribution allows for the expansion or diversification of a company's product line and in turn increases the growth potential.

This contribution, of course, reflects the overall impact of product development and emphasizes the importance of product development in the total product cycle and economy.

6.5.3 Sales

Typical companies supported by EDP have had sales at the time of project application of less than $1.5 million and have experienced significant sales growth rates as shown in Exhibit 6-17.

EDP product sales increase over time to represent almost 25% of the typical companies total sales. (see Exhibit 6-8)

6.5.4 Cashflow Benefits to Firms

It was observed that cash flow benefits, as estimated by net present value (NPV) and by benefit-cost ratios (benefits/costs) vary significantly amongst projects. Mean and median projects were found to have benefit-cost ratios greater than one when using a 10% discount rate for cash flows. The mean NPV was positive however the median was negative. Supporting data includes:

Benefit-cost ratio: (Discounted total product sales/ Total Product Cost)

	MEAN -	3.8
	MEDIAN -	1.29
	STD DEV -	12.6
Confidence Interval -		99% confident mean is between 0 - 6

NPV: (Discounted product sales - Total Product Cost)

	MEAN -	506,789
	MEDIAN -	-7,500
	ST DEV -	1,351,437
Confidence Interval -		99% confident mean is between \$42,000 - \$972,000

Thus EDP projects have generally produced net benefits to firms, although these benefits vary significantly among projects (projects would seem to be either "big winners" or "big losers" with very few projects on the margin).

Secondly, it was observed that:

- While firm size may have some influence on net present value, the benefit-cost of projects was not found to be related to firm size;
- The percent of EDP funding was found to be unrelated to benefit-cost;
- Benefit-cost ratio is positively related to jobs created by a project.

Supporting data includes the following R statistics of factors related to the benefit/cost ratio:

Percent of EDP funding	0.13	(Not significant)
Current Ratio at application	-0.07	(Not significant)
Sales over employees	0.05	(Not significant)
Sales over assets	-0.07	(Not significant)
Sales at application (Firm Size)	-0.10	(Not significant)
Total Jobs created by project	0.63	(99% certainty level)

n = 54

Thus it may be concluded that big firms are not necessarily the most likely to have a winner. Also, "Winners" in terms of NPV or benefit/cost tend to also be positively related to job creation.

Finally, it was observed that <u>project incrementality considerations</u> influence the NPV and benefit-cost calculations. (Incremental projects show lower NPVs and benefit cost ratios)

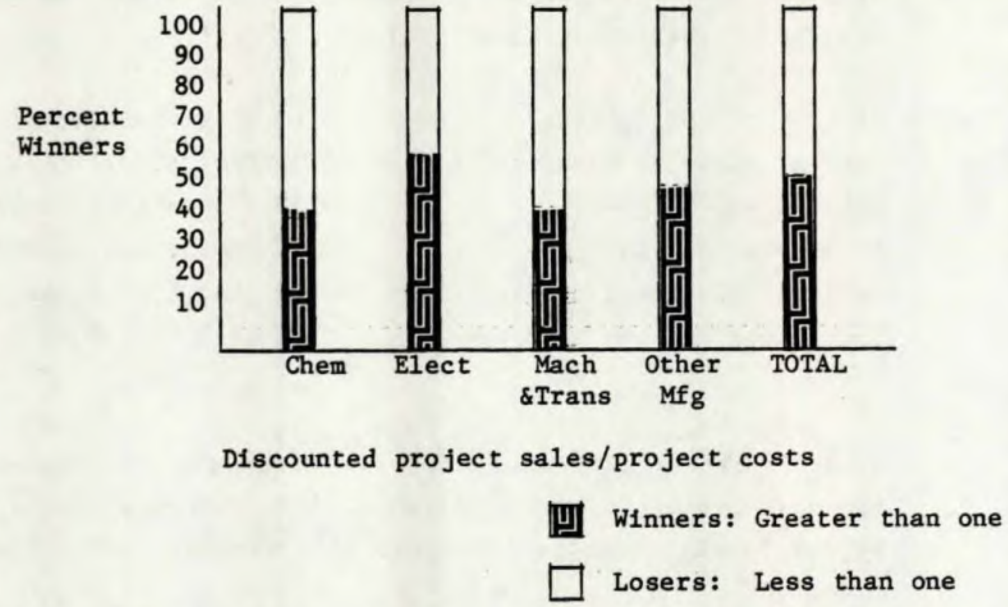
Supporting data when only fully incremental projects are included as benefits. (10% discount rate) are as follows:

Benefit-cost ratio	MEAN :	1.49	
	MEDIAN:	0.001	
	STD DEV:	11.8	
			n = 63
NPV	MEAN :	64,760	
	MEDIAN:	- 310	
	STD DEV:	626,000	

Thus, when a conservative estimate of incrementality is imposed, the average NPV, and BC ratios remain positive, (The median NPV ratio, however, turns negative).

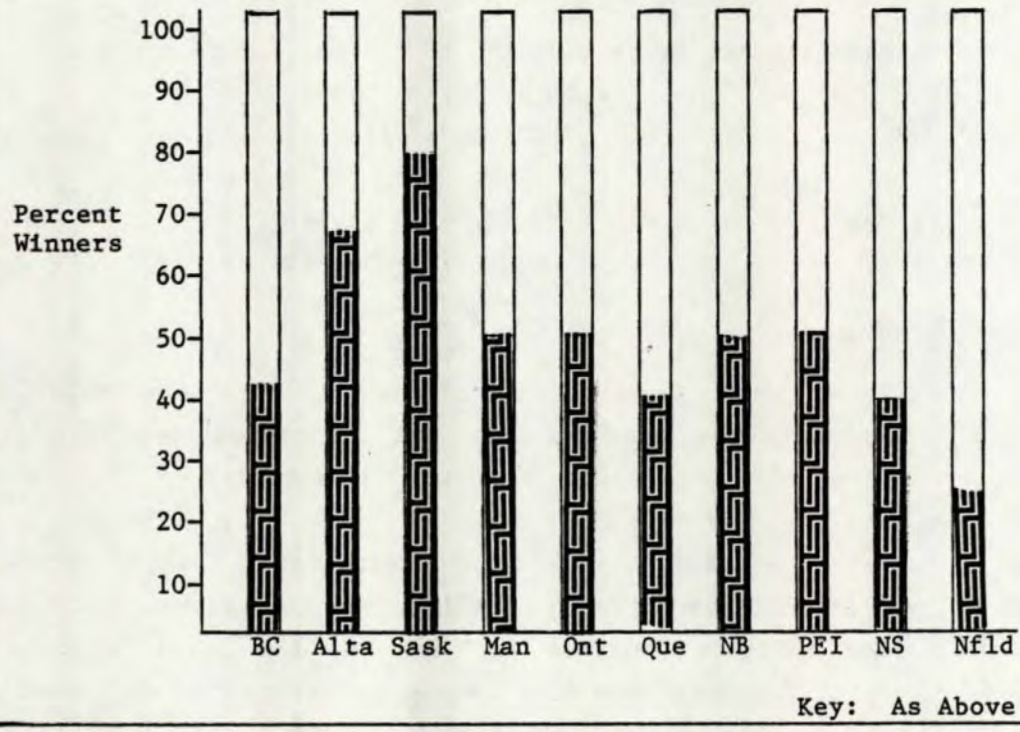
From these estimates we can conclude that the EDP program has produced net direct benefits to the firms assisted and net indirect benefits in terms of the projects undertaken (i.e. projects were done sooner, quicker or of different scope and quality as shown in s6.5.1).

Exhibit 6-18
Product Development Winners by Sector



* Metal Fab and Wood products were excluded due to lack of valid cases. (Note estimates of future product sales were not included in the calculation. Only realized sales were taken and discounted at 10%.)

Exhibit 6-19
Product Development Winners by Province



6.5.5 Product Development Winners and Losers By Sector

Project "winners" and "losers" average about 50-50 when a simple discounted product sales/product costs calculation is made.

As shown in Exhibit 6-18, there are no appreciable differences among sectors with regard to winners vs losers except that electrical industry firms may have slightly more winners.

In conclusion, it would appear that EDP firm development projects neither tend to be winners or losers. This seems to indicate that EDP users are neither "windfall gainers" (get money for low risk, high return ventures) nor are they "bail outs" (get money for high risk low gain ventures).

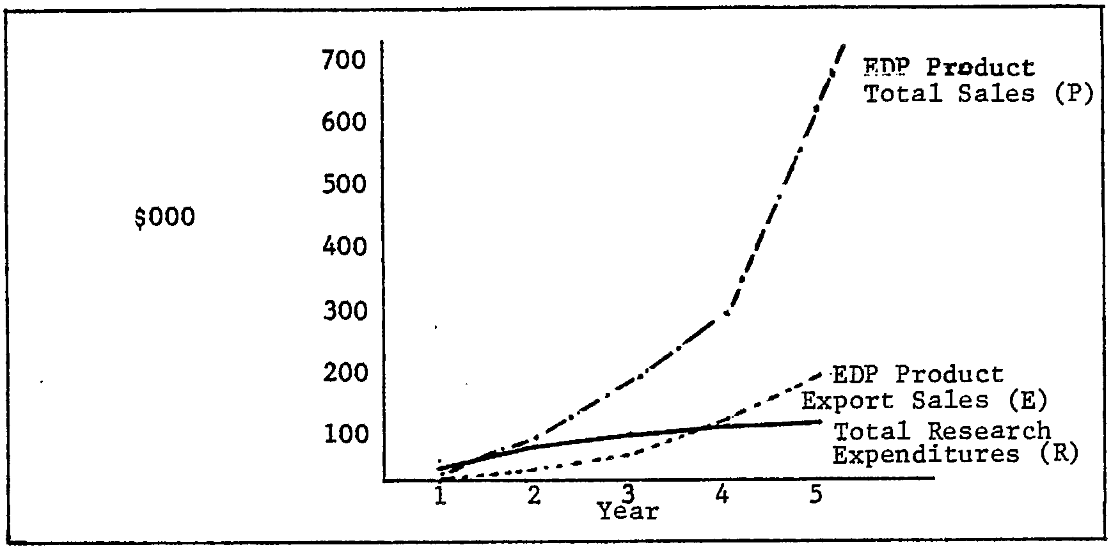
A finding of 50% success suggests that EDP projects are more or less typical of all product developments in terms of success rates. (Reference Cooper, Appendix I)

6.5.6 Exports

The purpose of this section is to quantify, to the degree possible, the exports generated by government assistance to innovation. Exports are important both to the firm in terms of expanding markets and to the government in terms of maintaining appropriate trade balances.

As shown in Exhibit 6-20, exports began to become significant two to three years after receipt of the contribution and rise to 30% of the EDP product sales after five years in operation.

Exhibit 6-20
EDP Product Exports



The impact of the program on a firm's ability to export is positive according to DRIE officials. This has been particularly true in cases where markets were thoroughly analyzed and the firm had the resources to exploit the export potential of their new product.

Many officers examined carefully the export potential of a project prior to granting assistance and in some cases considered this factor as a project selection criteria.

Officers observed that many companies lack the marketing skills and corporate infrastructure to fully exploit the new product in international markets.

6.6 Impacts Per EDP $

In order to get some feel for the impacts per dollar of EDP, averages were calculated along with the confidence intervals (range within which we can be relatively certain the population average lies) for each measure. While these impact estimates and confidence intervals cannot be treated as strictly valid in a statistical sense, they nevertheless give an indication of the likely impacts which EDP contributions had on firm sales, exports, investment, and jobs before consideration of incrementality.

6.6.1 Product Sales per EDP $ (discounted @ 10%)

Mean	12.251	
Median	3.365	
Standard Dev.	28.367	n = 78

99.74% confident that the mean lies between $2.60 per EDP$ and $21.80 per EDP$. (3 x standard error ± mean)
68.26% confident that the mean lies between $9.00 per EDP$ and $15.50 per EDP$. (1 x standard error ± mean)

6.6.2 Exports per EDP$ (discounted @ 10%)

Mean	3.021	
Median	0	
Standard Dev.	13.798	n = 78

99.74% confident that the mean lies between 0 and $7.70.
68.26% confident that the mean lies between $1.40 and $4.60.

6.6.3 Investment per EDP$

Mean	3.931	
Median	2.25	
Standard Dev.	5.471	n = 87

99.74% confident that the mean lies between $2.10 and $5.70.
68.26% confident that the mean lies between $3.30 and $4.50.

6.6.4 EDP$ per Job

Mean	17,893	
Median	7,832	
Standard Dev.	25,491	n = 82

99.74% confident that the mean lies between $9,448 and $26,339.
68.26% confident that the mean lies between $15,078 and $20,708.

As shown by the above confidence intervals, impacts per EDP$ were highly variable amongst projects.

6.7 Recommendations

- Incrementality should be considered in all future estimates of program impacts and effects. As a minimum, periodic detailed estimates of incrementality based on in-depth analysis should be performed in addition to on-going assessments.

- support for marketing assistance should be emphasized in order to realize the full potential of successful product developments;

- short term product development should continue to be assisted by programs similar to the EDP design;

- The IRDP innovation element should not be relied upon to increase innovation capability without consideration of other forms of assistance. The promotion of long term self sustaining technological capability in industry will require special consideration as to the most appropriate government assistance instrument(s). It is likely that a development program is required that instigates and initiates follow-on activity after the completion of successful EDP-styled projects. Greater support for basic research will be required to maintain an ongoing capability;

- Funding levels are adequate and should be maintained. Additional funding (unless the levels are very significantly increased) will not likely generate additional investment. Reductions on funding levels run a significant risk of demonstrating a net decrease in overall product development activity and should not be implemented at this time.

7.0 ISSUE IV — EMPLOYMENT CREATION

7.1 BACKGROUND

7.2 MAJOR FINDINGS AND CONCLUSIONS
- 7.2.1 Magnitude
- 7.2.2 Timing
- 7.2.3 Regional
- 7.2.4 Cost Per Job
- 7.2.5 Employment Opportunities Conclusions

7.3 MAGNITUDE OF EMPLOYMENT CREATED
- 7.3.1 Consideration of Jobs Created During Product Development
- 7.3.2 Consideration of Jobs Created After Product Development
- 7.3.3 Incremental Jobs

7.4 TIMING OF EMPLOYMENT CREATED

7.5 REGIONAL

7.6 COST PER JOB CREATED

7.7 RECOMMENDATIONS

7.0 ISSUE IV EMPLOYMENT CREATION

7.1 Background

Issue IV was formally posed in the following terms: "What type and number of employment opportunities have been created through the use of constituent programs."

This formal issue definition was refined during the study to consideration of employment related to EDP as the sample for the other programs was very limited. Employment was defined as job maintenance and job creation.

Key data sources are the firm survey and the EDP files.

Employment is considered from the viewpoints of:

7.3 Magnitude
7.4 Timing
7.5 Regional
7.6 Cost per Job

7.2 Major Findings and Conclusions

This section summarises the major findings with respect to employment creation and maintenance resulting from innovation programming.

7.2.1 Magnitude

- EDP program funding has had an overall positive effect on jobs

- effects have been highly variable and are significantly lower when incrementality is considered

- the most strongly related factor to job creation is project financial success expressed in terms of the ratio of discounted product sales/product costs

7.2.2 Timing

- most jobs are initiated within one year of project startup and become permanent positions

7.2.3 Regional

- the difference in employment in Central and Western Canada versus the Maritimes is about 2/1 per project (excluding resource projects)

7.2.4 Cost per Job

- the average cost per "incremental" job is estimated at $22,000

7.2.5 Employment Opportunities Conclusions

Employment impacts varied significantly among projects and were generally related to project commerical success. An average of one technical employee, one management employee, and four or five production employees were employed as a result of EDP projects. This number is reduced if incrementality assumptions are made.

The duration of employment gains has been long term for all employees in successful projects. It has generally been permanent for the technical staff and related to commercial success for other staff.

Exhibit 7-1

Average # of Workers per Successful Project in Sample

	Year	Research	Production	Management Administration	Total
grant year =	1	1.9	4.1	.8	6.8
	2	1.2	3.5	.8	5.5
	3	1.3	6.6	1.5	9.4
	4	.9	9.1	1.2	11.2
	5	2.2	9.4	N/A	11.6
					44.5

44.5 ÷ 5 years = annual average of 9 person years of employment as a result of the project.

The incremental cost per job was found to be \$22,000, or significantly higher than the average cost per job when incrementality is not considered. The incremental average jobs per project is between one and two workers when a conservative estimate of incrementality is made.

Employment impacts were most significant in electronics firms which also showed the largest number of commercial successes. Employment impacts were greatest in Central and Western Canada when estimated on a per project basis.

7.3 Magnitude of Employment Created

7.3.1 Profile of Jobs Created

On average each project results in the employment of which 15% is engineering, 70% is production and 15% is management.

Employment patterns do not differ significantly between large and small firms, with the exception of the grant year where 4/1 research workers are employed by large firms versus small firms.

There are no consistent sectoral employment patterns that developed from the survey.

7.3.2 Magnitude of Jobs Created

The mean number of jobs created by EDP funding was 9 per project. The variance amongst projects was significant (standard deviation = 21.9).

Total Jobs Created (No Consideration of Incrementality)

Mean = 9
Std Dev = 21.9
n = 95

7.3.3 Incremental Jobs

When a conservative estimate of incrementality is considered, the mean jobs per project drops to just over three.

Total Jobs Created (Consideration of Incrementality)

Mean (Most conservative) = 3.6 (1 on incrementality scale)
Mean (Least conservative) = 8.2 (1-3 on incrementality scale)
n = 95

Job creation is positively correlated with net financial benefits.

The simple R statistic measuring correlation between benefits/costs (product sales/product costs) and total jobs created was strongly positive. (R = .6324, n = 54, significance .01 level).

In conclusion, EDP program funding has had an overall positive effect on jobs. Effects have been highly variable, and are significantly lower when incrementality is considered.

The most strongly related factor to job creation is project financial success in terms of product sales/product costs.

7.4 Timing of Employment Created

Technical jobs start immediately upon commencement of the project and apparently continue on if the project is successful.

Management jobs appear during the first couple of years and continue if the project is commercially a success.

Production workers commence within one year of the grant and the relative number increases with sales.

7.5 Regional

Regionally, more jobs are created per dollar of EDP in Central and Western Canada with the exception of the resource industries, ie. fish processing.

7.6 Cost per Job Created

Cost per job estimates were made considering the cost per permanent job at the end of project assistance. This would include both new jobs and jobs saved as a result of the project, <u>but</u> does not include temporary jobs terminating at the end of a project.

The mean cost per job was $17,893

$/JOB	Mean	= 17,893
	Median	= 7,832
	St Dev	= 25,491

The standard error is $2,815 which means that we can be 99% confident that the mean cost per job is between $9,400 and $26,300. (estimates are made before consideration of incrementality)

The cost per job under conservative incrementality estimates (response 1 on incrementality scale, see section 6.3.1) is $22,000.

Sum of EDP$/Sum of Incremental Jobs

= 7,980,000/360

$/JOB = $22,167

Jobs created are from projects where the respondent claimed that the firms would not have undertaken the project without assistance. This is very likely the most conservative (i.e. highest cost per job) estimate that could be calculated within a reasonable range since it does not include any partially incremental jobs (jobs due to projects being done faster, sooner or with greater scope than without funding) nor does it consider temporary jobs terminated after the project.

7.7 Recommendations

- Innovation assistance in the form of contributions should be maintained as a viable job creation program.

- Where maximum employment effects are desired, assistance should be focussed on projects which have the possibility for high financial return (commercial success).

- The most significant employment impact is in Central Canada, hence, funding levels in non-disparate regions should be maintained if employment creation is a major objective.

APPENDICES

A. Rationale for Study Issues
B. Innovation Model
C. Incrementality
D. Glossary of Terms
E. Firm and Government Questionnaires
F. Summary of Firm Questionnaire Responses by Province/Sector
G. Content Analysis Methodology and Coding for EDP File Review
H. Validity of Study Findings
I. Pertinent Studies Referenced
J. Information Sources and Data Collection

APPENDIX A

RATIONALE FOR STUDY ISSUES

Section:

1.0 Issue I - Regional Suitability

2.0 Issue II - Regional Skewing

3.0 Issue III - Investment Generated and Benefits

4.0 Issue IV - Employment Creation

APPENDIX A

RATIONALE FOR STUDY ISSUES

This appendix provides some of the background relating to the choice of study issues.

1.0 ISSUE 1: REGIONAL SUITABILITY

Rationale:

- The innovation element of the new IRDP program will utilize terms and conditions similar to constituent programs.

- The innovation element will replace, to a large degree, former regionally developed programs (subsidiary agreements) and there is some question as to whether the national terms and conditions will be appropriate to the needs of all regions.

- The effective regional delivery of the innovation element may require modifications to the proposed terms and conditions or an understanding as to how the terms and conditions can be interpreted in individual regions.

- The Department is at a stage of finalizing the terms and conditions for the new program. One means of conducting "market research" on the appropriateness of these terms and conditions is to interview on the basis of past experience with the constituent programs. In this way, the new program can be compared to that of the past in order to estimate its relative attractiveness.

2.0 ISSUE 2: REGIONAL SKEWING

Rationale:

- The IRDP program proposes to have the maximum level of support available nationally to be 50% of costs with a higher level of up to 75% proposed for disparate regions.
- There is some question as to whether this enriched support will be sufficient to overcome the perceived disadvantages of conducting innovation in disparate regions. (Poorer access to information, less effective financial intermediation, higher operating costs, necessary inputs such as skilled labour may not be readily available.)
- In addition the IRDP proposes to allow capital costs for innovation projects in disparate regions. The impact of such a change is considered by this study.

3.0 ISSUE 3: INVESTMENT GENERATED AND BENEFITS

Rationale:

- In order for the Canadian economy to derive benefits from the innovation element of the IRDP, the program must induce firms to alter their allocations of resources. The potential achievement of the IRDP proposals is therefore related to the past success of the constituent programs to bring about private sector investment in innovation.
- There is some question as to the extent to which constituent programs have been able to induce private firms to engage in innovation projects which they would not otherwise have undertaken.

4.0 ISSUE 4: EMPLOYMENT CREATION

Rationale:

- The creation of employment opportunities is an important effect of the constituent programs for both the short and the long term.

- The relative employment effects of program policy will be a major consideration in future resource allocation decisions.

- The employment benefits of innovation element program assistance are more tangible than many of the other types of benefits.

- The employment benefits of the innovation element are less certain in terms of impact on long term employment (production) than the other IRDP elements.

APPENDIX B

INNOVATION

Section:

1.0 Broad Definition

2.0 Specific Definition and Terminology

3.0 Program Coverage by Innovation Sub-component

4.0 Independent Variables in the Innovation Model

5.0 Causal Model of Innovation

6.0 Overview of Current Views on Innovation

APPENDIX B

INNOVATION

1.0 BROAD DEFINITION

An innovation may be defined in the broad sense as the total process by which a new or improved product, process, or procedure is introduced into the market to satisfy an identified need.

2.0 SPECIFIC DEFINITION AND TERMINOLOGY

Innovation can be viewed as being made up of many sub-components. While it is helpful conceptually to order these components in a linear fashion, one must be cognizant of the fact that the innovation process is not linear. In practice, the sub-components listed here would often occur in differing sequences:

- Problem definition/screening, including identification of market opportunity
- Idea
- Market evaluation or business analysis, including feasibility/marketing studies
- Research, including basic and applied research, and patent search
- Development, including: engineering, prototype construction, layout, pilot plant construction, design, testing, and market evaluation
- Manufacturing start-up, including: tooling, plant arrangement(IE), construction of additional plant.
- Acquisition of equipment
- Marketing start-up
- Diffusion, including spin-offs and other technical effects.

3.0 BREAKDOWN OF PROGRAM COVERAGE BY INNOVATION SUB-COMPONENT (NOTE 1)

INNOVATION SUB-COMPONENTS	IRDP	EDP (*)	DIPP	STEP	MSA	IERD
(1) Problem Definition						
(2) Idea						
(3) Market Evaluation (Business Analysis)	(X)			X		
(4) Research	X		X	X		X
(5) Development						
- Engineering	X	X	X	X	X	X
- Layout	X	X	X	X	X	X
- Design	X	X	X	X	X	X
- Prototype Cónstruction	X	X	X	X	X	X
- Pilot Plant Construction	X	X	X	X	X	X
- Testing	X	X	X	X	X	X
(6) Mftg Start-Up						
- Tooling	(X)		X	X		
- Plant arrangement	(X)		X	X	X	
- Construction of add.plant	(X)		X	X	X	
- Aquisition of equipment	(X)		X	X		
(7) Marketing Start-Up	(X)					
(8) Diffusion						

See Section 5 for a further definition of IRDP eligible activities.

X funded activity

(X) to be funded in addition as part of core program.

* The above table shows the theoretical coverage of product development elements by existing departmental programs and for the IRDP. Note that EDP and DIPP coverage refers only to the "Innovation" and "R&D" elements of those programs.

4.0 INDEPENDENT VARIABLES IN THE INNOVATION MODEL

4.1 Return on Investment

Firms are generally considered to be in business to make profits. Any innovation decision must compete with other investment opportunities available to the firm. This makes ROI an important component of the innovation process.

4.2 Firm Characteristics

Variables which can be distinguished at the firm level are important determinants of innovation activity. These firm characteristics include the following:

i) firm size
ii) foreign affiliation
iii) management attitudes & practices (re: risk, marketing, product device etc.)
iv) access to financial capital
v) administrative structure
vi) access to skilled labour
vii) production state of the art.

4.3 Market Structure

Variables which can be distinguished at the market level may also play an important role in determining innovation activity. These market characteristics are closely related to firm characteristics and include the following:

i) number of firms in market (concentration)
ii) prevalence of large or small firms
iii) degree of differentiation of product
iv) competitiveness (monopolistic, oligopolist, polypolistic)
v) market area (domestic, international).

4.4 Geographic Area

Cities and regions may vary markedly with respect to the generation and exploitation of successful innovations. Some geographic variables will include the following:

i) Sector make-up
ii) Labour market
iii) Epidemicity (e.g., physical distance from influencial/ market centers)
iv) Urban hierarchy.

4.5 Sector

The industrial sector has empirically been found to be closely related to all four of the above mentioned general independant variables. The hypothesized relationship which exists between sector and innovation activity is that product characteristics, including cost of production, life cycle duration, marketing factors and other variables influencing innovation determine the characteristics of many of the other variables including innovation activity.

4.6 Exogenous Socio-Economic Variables

Variables related to socio-economic environment are hypothesized to affect all of the general areas of variables mentioned above. These socio-economic variables include:

i) Cultural activities, beliefs and norms
ii) Fiscal and monetary structural variables
iii) Fiscal and monetary policies
iv) Other government interventions including specific contribution programs.

5.0 CAUSAL MODEL OF INNOVATION

The causal model in Figure 1 implies a natural ordering for the Innovation Study approach and reporting.

The approach should firstly take into consideration geographic factors since they largely determine the other activities and are the least likely to change.

The second 'must factor' when considering an evaluation approach is to consider the industrial sectors (products) since this factor, along with geographic areas and exogenous socio-economic factors largely drive the other variables.

Geographic area and sector variables largely come into play in the sampling phase of the study. This is a reflection of their importance. Information on these variables (product life cycle, innovation costs, etc.) were collected through the data collection instruments.

Market structure variables (competitiveness, large-small firms, market area etc.), firm characteristics (size, management attitudes, access to financing etc.) and return on investment will be determined on a case by case basis through the data collection instruments.

The relationship of exogenous socio-economic variables with innovation activity will be examined with specific reference to one critical variable, IT&C/DREE program support in the form of innovation assistance.

The relationship of government innovation assistance and company innovation activity will be examined within the

FIGURE 1

MODEL OF INNOVATION ACTIVITY IN AN ECONOMY

Exogenous
Socio-Economic
Variables

Geographic Area
Sector
Market Structure
Firm Characteristics
Profitability
of Investment
Innovation Activity

Problem Definition
Idea
Business Analysis
Research
Development
Mftg Start-Up
Marketing Start-Up
Diffusion

INNOVATION

PROCESS

context of geographic and sector sampling parameters and in terms of all five general independent variable categories.

Regional suitability issues can be framed in this way by considering each factor. For example, one observation might find that in geographic area X, that the major sector Y, showed high product development costs leading to a highly concentrated industrial market structure, which tended to be composed of firms with the characteristics of high risk aversion requiring extremely high ROIs for project initiation. For this reason, the number of innovation assistance projects considered suitable tended to be small for this region but were for large amounts of money and of long duration. The incremental impact on investment and employment might tend to be low for these projects.

6.0 AN OVERVIEW OF CURRENT VIEWS ON INNOVATION

6.1 Definitions of Innovation

Definitions of innovation vary more in interpretation than in semantic definition. Most definitions define innovation as some sort of improved product or process which is introduced into a market to fulfill a need. For example,

(1) Auditor General/OCG: "...the total process by which a new or improved product, process, or procedure is introduced into the market to satisfy an identified need".

(2) PAIT - Innovation Project: "...projects concerned with improvements to existing products or processes, or the adaptation of a product or process to a new and usually related use".

The Marshall report's definition of R&D, and Development, Design and Engineering Projects sounds very similar; that is,

(3a) R&D Projects: "...the development of products and processes with identifiable prospects for commercial exploitation...This would include projects where financial support is required to develop an idea into a commercially exploitable activity".

(3b) Development, Design and Engineering Projects: "...the development of products and processes where significant scientific or technical risk does not exist (as compared with R&D projects)".

The Marshall report acknowledges a funding 'gap' between allowable development costs and further stages in the product development life cycle (innovation cycle).

6.2 Success in Innovation

While the definitions of innovation do not vary very much, interpretation of success or failure may vary. For example, the Auditor General defines success as contributing to economic and/or social benefit, while PAIT defined it as the achievement of a worthwhile market share. The DeMelto study (co-sponsored by IT&C and the Economic Council) defined successful innovations as those leading to increased firm profits.

6.3 Stages of Innovation

The Departmental innovation assistance program elements cover the following stages:

- Feasibility Studies*
- Developing Technological Capability*
- Developing Products or Processes*
- Development, Design + Engineering*
- Plant Establishment, Expansion, Modernization, Productivity Improvement
- Marketing.

Note that the asterisked stages are known as "Innovation Element Projects".

The DeMelto study defines innovation as being made up of the following (technological change) stages:

• Basic Research	Invention
• Applied Research	
• Development	Innovation
• Mftg Start-Up	
• Mktg Start-Up	Diffusion
• Spread of Innovation	

Rutherford and Goss in their Review of the Literature on the Management of Innovation view the process as follows: (from their section 1.4)

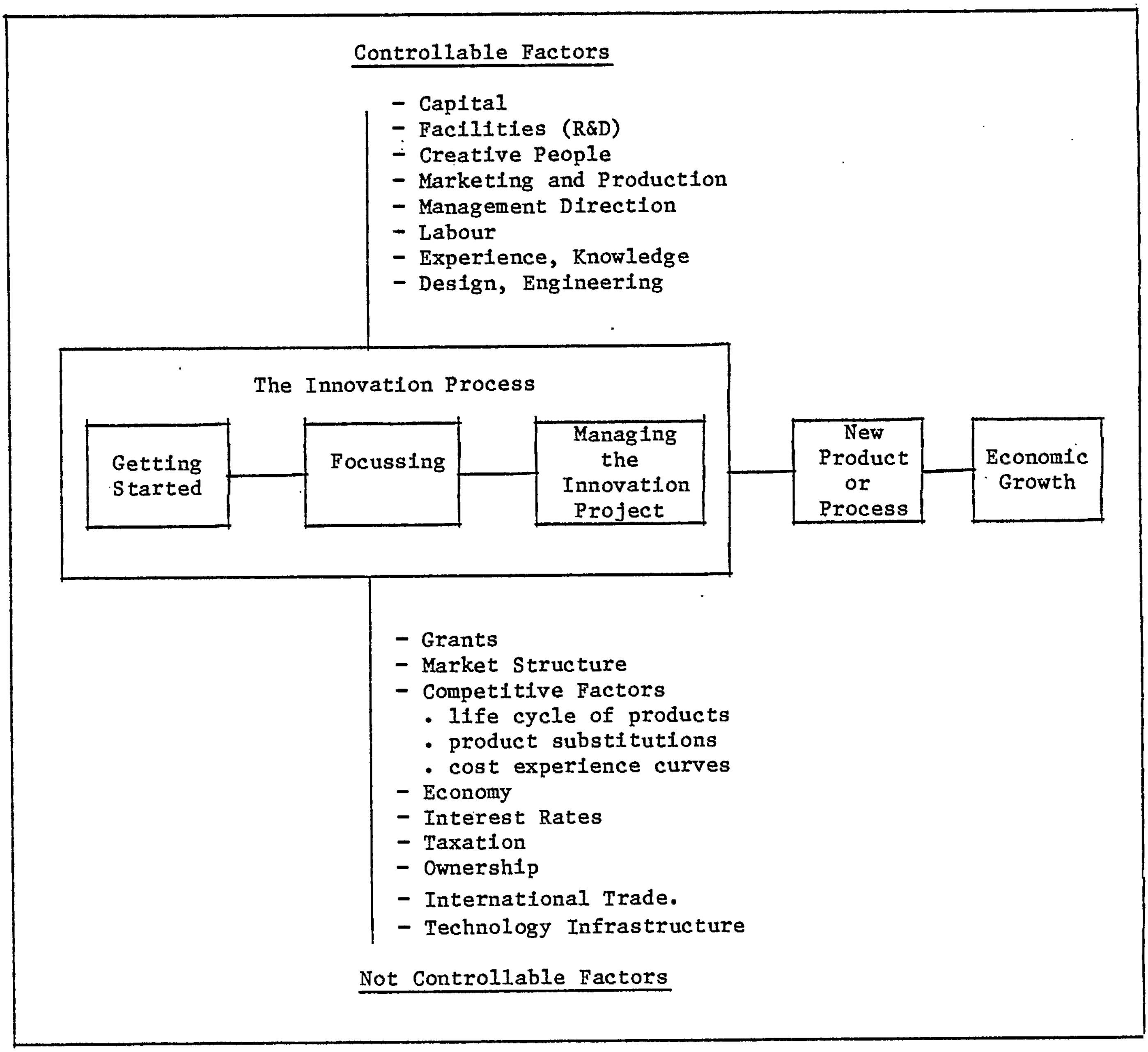
1.4 A Three-Phase Managerial Model

"In Figure 1.4 we present a three-phase managerial model of the innovation process that is implicit in the reviewed literature. The first phase is labelled "getting started" and represents a heterogeneous collection of activities that is highly variable from one innovation sequence to another. At the other end, the procedure for "managing the innovation project" is often very similar from one organization to another. These two phases are linked by a "focussing" phase where the "getting started" activities are transformed into specific innovation projects that are to be "managed" in the classical sense. The output of this process is a new product or process. The controllable and uncontrollable factors of Figure 1.3 are displayed in Figure 1.4."

FIGURE 2

THREE - PHASE MANAGERIAL MODEL OF THE
INNOVATION PROCESS FOR A NEW PRODUCT OR PROCESS

(Rutherford and Goss Figure 1.4)



6.4 Recommended Definition(s)

Innovation: – The process by which a new or improved product or process is introduced into the market to satisfy an identified need.

Innovation Projects: products/processes (Gov't Assisted) – Projects concerned with new or with improvement to existing products or processes, or the adaptation of a product or process to a new and usually related use. Innovation projects need not encompass all stages but must relate to some segment of the innovation process of identifying market needs and feasibility, conducting applied research, performing development work (including engineering, layout, design, prototype construction, pilot plant construction, and testing), manufacturing start-up (including tooling, plant arrangement, construction of additional plant, acquisition of equipment) and/or marketing start-up.

Innovation Project: (Success/Failure) – Project success occurs when, in the view of the firm bringing the innovation to market, the project provided an adequate return on investment (NPV, payback, benefit-cost).

– Project failure is defined when, in the view of the firm bringing the innovation to market, the project provided a less than adequate return on investment (NPV, payback, benefit-cost).

6.5 Scope of Activities Related to Innovation in the IRDP Program.

Research and Development/Innovation

a) Developing New Products or Processes

Projects to develop new or improved products or processes, which are scientifically feasible, entail significant technical risk and represent attractive prospects for commercial exploitation, may be provided contributions. Eligible costs are current, incremental project-related costs to bring a product or process to commercial production, including demonstration of prototypes. The cost of project-related capital costs such as buildings and machinery and equipment will be eligible as well in disparate areas. The maximum sharing ratio is 50% nationally, 75% in disparate areas.

b) Developing Technological Capability

Projects which are scientifically feasible and entail significant technical risk but which do not lead directly to identifiable sales may be supported if the development of the technological capability is of strategic importance to the firm and the regional industrial development priorities of the Department. Eligible costs and maximum sharing ratios would be the same as for new product development. Support of this nature will only be provided if other sources such as NRC are unable to support the project.

c) <u>Development, Design, Demonstration and Engineering</u>

Projects to develop or demonstrate new or improved products or processes but which do not entail significant technical risk may be eligible on a basis similar to new product development. Normally, this support would be restricted to small and medium-sized firms and the contributions would be repayable upon successful exploitation of the project.

APPENDIX C

INCREMENTALITY

Section:

1.0 Definition

2.0 Scope

3.0 Methods

4.0 General Analysis

5.0 Working Definition

6.0 Further Discussion

APPENDIX C

INCREMENTALITY

1.0 DEFINITION

For the purposes of the Innovation Study incrementality was defined as a change in a firm's allocation of resources which was induced by program assistance. More specifically, it was defined as the conduct of a project by a firm which would not have been conducted otherwise, or which was performed sooner, faster or with a broader focus as a result of assistance. (See Section 5 for a working definition of incrementality.)

2.0 SCOPE

Incrementality was analyzed at the firm level only, technological incrementality, market incrementality, and macro economic incrementality was not considered.

There are two reasons for this focus:

1) Estimates of incrementality at the technological, market, or macroeconomic level would require a detailed analysis not possible given current study constraints.

2) Firm level incrementality is prerequisite for the other types, therefore it was the logical first priority for incrementality analysis.

The complexities and trade offs involved in the measurement (i.e. operationalization) of incrementality are referred in Section 6.0 of this Appendix.

3.0 METHODS

3.1 Measure Change in Firm R&D Expenditures (t-(t-1)

Data: Data was collected from project case files including:

i) Project expenditures

ii) Government contribution

iii) Firm R&D budgets over time

iv) Other firm characteristics (sales, assets, employment etc.)

Analysis: A two year average of R&D expenditure before project assistance was contrasted to an average of R&D expenditures after assistance in order to assess change. Expenditures could also have been "normalized" by sales or employees in order to facilitate inter-firm comparisons.

Usefulness: The approach provided insight into whether assisted firms had taken project assistance as a windfall and reduced their total R&D spending by an amount proportionate to assistance, or whether they increased their investment by a proportionate amount to the assistance level. The approach was not definitive about incrementality but did provide information on potential 'abuses' of the system.

3.2 Measure Change in Firm R&D Expenditures (t-(t-1) Against Industry Sector Averages

Data: In addition to the data collected for method 1 above, statistics on privately financed R&D were gathered from Statistics Canada and rates of change were estimated from year to year.

Analysis: Change over time in R&D expenditures for assisted firms were compared to sector averages. (Data was normalized by using ratios such as R&D/Sales R&D/Assets etc.)

Usefulness: Assisted firms were compared to an expected norm which provided rough estimates of change attributable to differences in the assisted company population. (Not to be confused with predictive modelling).

3.3 Ex Poste Project Evaluation in Terms of Benefit-Cost

Data: Information was collected on the net benefit-costs to firms in undertaking EDP projects.

Analysis: A conceptual model of assisted projects as intra-marginal (non-incremental) and of firms getting assistance as windfall profit takers would predict a high success/failure ratio for EDP projects. If EDP projects showed success ratios greater than the norm, it could be said that some evidence for the non-incremental-project-model was found. If EDP projects were found to have average or below average success ratios, then one could at least say that the case for EDP firms as "windfall gainers" was not substantiated.

Usefulness: Ex poste information provides an incrementality analysis from a results-oriented approach. The method would not, however, lend itself to impact measurement.

3.4 Qualitative Techniques

Data: Information was collected from telephone and personal interviews on:

i) Self assessments of full and/or partial incrementality

ii) Changes in resource allocation, product mix, employment or other spin-offs resulting from project assistance. (i.e. Did they do something they otherwise would not have done?)

Analysis: Firm interpretations of project incrementality in magnitude and type.

Usefulness: Firm assessments provided depth to incremental estimates based on numerical interpretations. The method was the only source of information on changes in innovation focus, strategy or other intangible aspects of assistance induced resource allocation.

4.0 GENERAL ANALYSIS

While objective data analysis can reveal extremes in project incrementality (abuses or resounding successes) the sample size and complexity of the subject makes numerical interpretations relatively unreliable for precise measures of incrementality.

Properly phrased interview questions, cross validated with other questions, serve as the main source of information on project incrementality for this study.

5.0 WORKING DEFINITION OF INCREMENTALITY

Types of incrementality

The Canadian economy cannot derive benefits from program assistance unless it alters the allocation of resources. Program assistance will not change the allocation of resources unless it induces subsidy recipients to engage in projects which they would not otherwise have undertaken.

We can define a project which would not otherwise have been undertaken as a fully incremental project. Assistance may also induce a recipient to change the manner in which he conducts his project. A project which is conducted differently as a consequence of support can be defined as a partially incremental project. Partially incremental projects also change the pattern of resource allocation in the economy and are thus potentially beneficial.

There are several types of partial incrementality:

- A project may be conducted sooner than would otherwise have been the case.

- A project may be conducted faster than would otherwise have been the case.

- A project may be more broadly focused than it would have been without assistance.

6.0 FURTHER DISCUSSION

For a further discussion of project, market and technical incrementality see D. Usher The Benefits and Costs of Firm Specific Investment Grants: A Study of Five Federal Programs, mimeo, August 1982.

APPENDIX D

GLOSSARY OF TERMS

Section:

1.0 Purpose

2.0 Definitions

APPENDIX D

GLOSSARY OF TERMS

1.0 PURPOSE

The purpose of this glossary of terms is to describe the meaning and usage of words found in the issues addressed by the study and the questionnaires utilized in data collection.

2.0 DEFINITIONS

Capital Cost - A cost of acquiring a good, such as a machine or building, that is used to produce or goods.

Commercial Launch - The point in the innovation process when the firm is able to commence delivery of the product.

Commercial Success - Achievement of expected sales or profit levels or a return on investment commensurate with the level of risk taken.

Core Program - The interim title given to the department's new major funded program. Subsequently the program has been officially named the Industrial Regional Development Program.

DIPP - The ITC Defence Industries Productivity Program (DIPP funded in part product development related to defence-oriented export markets.

Direct Costs - A cost that is related directly to the conduct of the project, e.g. labour and materials. These costs would normally be expensed in the year in which they were incurred.

Disparate	- An economically disadvantaged region designated based upon a development index which includes employment rates, average and disposable incomes per capita, and transfer payments as a ratio of total regional income. Disparate regions will account, in varying levels, for approximately 35% of Canada's population.
EDP	- The Enterprise Development Program (EDP) was the principle ITC funded program targetted at product development and industrial adjustment.
Employment	- In this study, employment resulting from innovation will be considered from the point of view of job creation vs maintenance, duration, skill level and timing.
Engineering	- The work required to take a new product from the applied research stage to the demonstration of feasibility. This would include engineering, design, prototype construction and testing.
IERD	- The ITC Industrial Energy Research and Development (IERD) Program funded the development of products and processes which would reduce utilization of oil in Canadian industry.
Industrial Development	- The creation and expansion of private sector economic activity primarily in the manufacturing and processing sectors.
Industrial Grouping	- The grouping of companies/sectors utilized by Statistics Canada R&D expenditure surveys including: mines and wells; chemical based; wood based; metals; machinery and transportation equipment; electrical; and other.

Incremental - A change in a firm's allocation of resources which was induced by program assistance, i.e. the conduct of an innovation project which would not have been conducted otherwise, or which was performed sooner, faster, or with a broader focus as a result of assistance. Incrementality is considered at the firm level but not at the level of technology, market or marco-economic incrementality.

Innovation - The total process by which a new or improved product, process or procedure is introduced into the market to satisfy an identified need. It is thus the use of a new idea, material or technology by an industry to change either the goods or services produced or the way in which goods and services are produced or distributed, e.g. improved managerial systems, new production techniques, new technology, industrial results of R&D.

Innovation Capability - The corporate strategy, personnel, facilities, and finances which will support the ongoing development of new products.

Innovation Element - One of six sections of DRIE's new funded program called the Industrial Regional Development Program which provides funds to firms for product development, industrial design, applied research and pollution control development.

Invention - The creation of new technology or process, as opposed to its application.

Investment - The expenditure of corporate resources on innovation including facilities, materials and personnel but primarily reflected in dollar terms.

Location - Pertains to geographical location in Canada.

Magnitude - (As in magnitude of product development project). The number of different analytical and test activities undertaken in the development process. Typically, a term used to describe the size of a project relative to the amount of resources (i.e. people, material, facilities) expended.

Management Workers - All corporate personnel not primarily involved in product development or manufacture, i.e. management, administration sales, finance, distribution.

Manufacturing Industry - An industry that takes raw materials, semi-finished products, or finished parts and components, and uses them to produce final goods or goods used in the production of final goods.

Manufacturing Start-up - The preparatory activities required for full scale production including manufacturing planning, tool design and acquisition, plant arrangement, and acquisition of plant or production equipment.

Market Evaluation - A preliminary study made of the profit potential involved in developing a specific product derived from consideration of customer requirements and characteristics, competitive factors, market size and share, and feasibility/profitibility assessment.

Marketing Start-up - The trial of a new product in the market place prior to full scale manufacturing and other marketing activities conducted near the end of a product development project such as development of marketing approaches and plans, preparation of promotion and advertising.

MSA	- The DREE Montreal Special Area (MSA) program provided in part funded assistance for acquisition of buildings, equipment and technology in order to establish innovation capabilities in firms.
Production Workers	- Personnel primarily involved in the manufacture of product.
Product Development	- The process by which a new product is advanced from an idea to the stage at which it is introduced into the market to satisfy an identified need. (Used in this study as being synonymous with innovation.)
Program Richness	- The percentage of eligible costs which are funded by the government.
Quality	- (as in product development) the excellence of resources and approaches utilised in the process. Also used in a technical sense to denote the level of relevant, useful or reliable information or data, as in the quality of rsearch results.
Regions	- Provincial boundaries.
Research	- Basic research refers to original investigation undertaken in order to acquire a new knowledge. Applied research involves the consideration of the available knowledge and its extension in order to solve particular problems. Such work would normally be conducted in a laboratory by highly specialized staff.
Research Workers	- Scientific, engineering and technical support personnel primarily involved in product development.

ROI - The after-tax profits earned on an investment, expressed as a percentage of the original cost of investment or purchase price. Can be extended to consider the time value of money through the use of discontinued cash flow or internal rate of return techniques.

Risk - Technical - the degree of probability that the product development would fail due to inability to meet technical specifications.

- Financial - the degree of probability that the product development would fail due to inability to raise development funds or to inability to produce an adequate return on investment through sales.

- Manufacturing - the degree of probability that the product development would fail due to inability to manufacture the product or manufacture it at a competitive cost.

- Marketing - the degree of probability that the product development would fail due to changing market needs, competitive environment or inadequate marketing capabilities.

Scope - (as in scope of product development project) the characteristics of the entire development process, from the initial stages of product development to the end product.

Skewing - Increasing the maximum formal program richness, i.e. the percentage of eligible costs funded by the government, dependent upon the level of economic disparity of a region. In this study, consideration is not particularly given to the variance of eligible cost between regions nor the targetting or program resources between regions.

STEP	- The ITC Support for Technology Enhanced Productivity (STEP) Program funded the development of micro-electronic production capabilities and consultant studies on how micro-electronics could be applied in products and production processes.
Technology	- The adaptation of scientific discoveries by industry, resulting in new products, production processes, and distribution systems.
Technology Development	- Advances in technology and knowledge that increase society's output of goods and services.
Technology Transfer	- The transfer of knowledge from where it is developed to where it is used. (Means by which access to technology is spread and the terms and its costs of use by others) e.g. sale of patents, blueprints and industrial processes; or spread through direct investment of MNE's scientific papers, movement of people and technical aid.
Terms and Conditions	- Program features relating to eligibility criteria, type and level of fundings, assessment criteria, program delivery aspects and conditions placed on the firm.

APPENDIX E

FIRM AND GOVERNMENT QUESTIONNAIRES

Section:

1.0 General Approach

2.0 Firm Questionnaire

3.0 Government Questionnaire

APPENDIX E

FIRM AND GOVERNMENT QUESTIONNAIRES

1.0 GENERAL APPROACH

Firm and government questionnaires were designed to facilitate the structuring and standardization of personal and telephone interviews and the subsequent data collection.

Specific questions were designed to address the study issues and to augment or complement data obtained from other study data sources.

While the questions were posed in a free response mode, potential responses were pre-determined and placed on the firm questionnaire to facilitate data collection and to ensure a uniform approach to prompting when it was required.

The questionnaire approach and design was reviewed with Statistics Canada. The Bank of Information number assigned to the study database is T.B./C.T. - Reg. B2053.

2.0 FIRM QUESTIONNAIRE

INNOVATION ELEMENT EVALUATION

TELEPHONE AND PERSONAL INTERVIEW GUIDELINE & DATA ANALYSIS TOOL

Company Name ____________________

Address: ____________________

# of Years in Business __________

# of Employees at Time of Grant __________

Contact ____________________ Position ____________________

1. Type of Operation

☐ Main Plant ☐ Foreign Subsidiary
☐ Branch Plant ☐ Other (specify)

2. In which major industrial grouping does your firm belong?

☐ electrical ☐ metals
☐ machinery transportation equipment ☐ wood
☐ chemical ☐ other (mines, wells etc.)

3. Please indicate the three most important factors which motivated/stimulated this product development product.

☐ to develop export markets
☐ to meet governmental regulatory requirements
☐ response to domestic competition
☐ perception of a new market gap in existing markets
☐ response to foreign competitors
☐ as a result of pressures from deteriorating profit margin
☐ response to domestic competitors employing similar innovations
☐ to improve quality of the products covered by this innovation
☐ to take advantage of new technological advances
☐ interactions with your customers
☐ to reduce labour requirements
☐ interactions with your suppliers
☐ to reduce energy requirements
☐ to gain a larger market share
☐ to reduce capital requirements
☐ other (please describe) __________

4. What was the source of technology/idea for this product?

☐ primarily outside the firm ☐ primarily within the firm

5. If the technology came from outside the firm, specify the source.

☐ research/technical centre ☐ government laboratory
☐ university ☐ other (specify __________
☐ private company

6. Did you license the original technology?

☐ Yes ☐ No
obtained at no charge ☐
purchased technology ☐

7. Please indicate the source of funding for this product development through to the first commercial launch:

☐ internal
☐ bank financing: - conventional bank loan,
☐ parent or affiliated firm
☐ - income debenture &/or floating rate preferred
☐ private investors (as opposed to financial institutions)
☐ venture capital firm
☐ stock/bond issue
☐ government
☐ other (please specify)

8. If you cited government, please list the name of the program(s) under which you received funding.

____

____

9. If this project had been undertaken, where else would the funds have been spent?

☐ on a different development project
☐ on a production costs
☐ capital investment
☐ put into year end profits
☐ used for cash flow
☐ other (specify) __________

2.0 FIRM QUESTIONNAIRE

10. What were the total costs involved in this project through to manufacturing startup?

current	- wages & salaries	$ ______
	- other current costs	$ ______
capital	- land	$ ______
	- building	$ ______
	- equipment	$ ______
	Total	$ ______

11. Is this typical of normal annual product development costs?

☐ Yes ☐ No - go to 12

12. Within your total annual product development expenditure, what is the typical breakdown of costs?

wages & salaries	____ %
other current costs	____ %
equipment	____ %
other	____ %
	100%

13. How do you decide the annual expenditure for product development?

☐ annual budget is established at beginning of year based on:

- ☐ anticipated requirements
- ☐ previous years' profits
- ☐ industry standards
- ☐ availability of government funding
- ☐ other (specify) ______

☐ on a project-by-project basis

..../4.

14. What factors are used by your firm to decide to undertake product development projects? Name the primary 3-4 characteristics ... rank? (1 is most important).

(a) Technology
- likelihood of technical success ____
- development cost ____
- development time ____
- in house capability - skills ____
  - facilities ____
- availability of outside skills ____
- availability of outside facilities ____
- patent status ____
- compatibility with other products ____

(b) Financial Return
- profitability ____
- capital investment required ____
- annual (or unit) cost ____
- rate of return on investment ____
- payback period ____
- cash flow requirement ____
- availability of financing ____

(c) Manufacturing
- capability of manufacturing product ____
- facility & equipment requirements ____
- availability of raw material ____

(d) Marketing
- size of potential market ____
- capability to market product ____
- relationship with existing markets ____
- pricing and its effects on existing products ____
- product line & quality improvement ____
- pressure from competition ____
- product compatibility ____

15. What impact does location have in terms of the major factors identified in question #14?

______

______

16. Please indicate the <u>one</u> major way in which this product development program has

enhanced product development: ______

______

______

hindered product development: ______

______

______

17. Have any new product lines resulted from this particular development project?

☐ Yes ☐ No

18. Have any new manufacturing establishments or expansion of existing facilities resulted from the sales of the new product?

(a) ☐ new manufacturing establishment

☐ expansion

capital cost ____________

location ____________

employment ____________

(b) ☐ No. Is this likely to occur in the future?

☐ Yes ☐ No

19. Generally speaking, the program had the following impact on the product development project:

	Small Impact		Moderate		Large Impact
- accelerated the project	1	2	3	4	5
- altered the scope	1	2	3	4	5
- increased the magnitude	1	2	3	4	5
- increased the quality of the product development	1	2	3	4	5
- allowed for a more marketable product	1	2	3	4	5
- other ____________________	1	2	3	4	5

20. If the project did not achieve the expected commercial success, what were the principal reasons?

☐ too early to judge results

Financial

☐ higher unit manufacturing costs than expected

☐ cost overruns in development

☐ investment requirements too high

☐ selling price too low for adequate ROI

☐ volume too low for adequate ROI

☐ inadequate financial resources

☐ other (specify)____________________________

Marketing

☐ new product was not a significant improvement

☐ customer needs changed since inception of project

☐ inadequate sales/distribution effort

☐ no explicit product launch strategy

☐ inadequate market research

☐ intervening competitive products

Technical

☐ technology became obsolete

☐ production facilities inadequate

☐ technical product weaknesses

☐ production planning inadequate

☐ unexpected technical difficulties

Management Resources

☐ R&D resources inadequate

☐ engineering resources inadequate

☐ marketing resources inadequate

☐ financial resources inadequate

21. NOTE: The following annual information will be collected from file reviews and spaces will be completed from the interview. Approximations will be sufficient.

*Year of Project (Specify) Submission

Total Company Sales ($)							
Total Product Development/ Research Budget							
Total Sales Resulting from Project							
% of Project Sales that are Exports							

2.0 FIRM QUESTIONNAIRE

22. Product development may be categorised as follows. What is the relative total expenditure by your company in each stage of product development?

Stage	% of Total Product Development Expenditure
Research	______
Market Evaluation	______
Engineering Development (eg design, prototype construction, pilot plant construction, testing)	______
Marketing Start-up	______
Manufacturing startup (manufacturing planning, tooling, plant arrangement, acquisition of equipment and plant)	______
	100%

23. Do you expect any changes in the above ranking in the future? Explain.

☐ Yes ☐ No

____
____
____
____

24. What impact has this project had on the employment within the company?

	Person Years during project year____	Person Years After Project year ____	year ____	year ____	year ____
Research Workers					
Production Workers					
Management Workers					

25. What percentage of the product sales is subcontract work? ______

____

..../8.

26. Over and above the actual development of the particular product in this project, to what extent has your company benefitted from the funding in other ways?

	None		Moderate		Large
- development spinoff products	1	2	3	4	5
- product mix is now more technologically advanced	1	2	3	4	5
- encouraged the establishment of a continuous innovation capability	1	2	3	4	5
- growth potential is increased	1	2	3	4	5
- has allowed development of products new to the province	1	2	3	4	5
- other (specify)______	1	2	3	4	5

27. What would be the consequences if this project was unsuccessful or incomplete?

____
____
____

28. In retrospect, if you put a dollar value to your time and effort in actually getting the funding for this project:

(a) would you have still gone through with the project application?

☐ Yes ☐ No - why not?______

____
____

29. Now that you are familiar with the application procedures and timing will/would you apply for the project in future?

☐ Yes ☐ No

30. What is the likelihood that this project would have been undertaken without program funding?

Small		Moderate		Large
1	2	3	4	5

31. If government assistance had not been available for this project, what effect would there have been on the project?

No effect	Modified Project (go to Question 32)	Terminate
☐	☐	☐

..../9.

2.0 FIRM QUESTIONNAIRE

32. How would you have modified the project?

____

33. If you could have had more government funds on this project:

(a) would the project have been altered in any way? ____________

(b) would your financial input have been:

- [ ] the same
- [ ] less
- [ ] more

34. If the government funding had been reduced, at what point would the project have been terminated?

% Reduction in Funding

[ ] 10%   [ ] 25%   [ ] 50%   [ ] 75%

35. How would you rate the risk of your project?

	Very Low		Moderate		Very High
Technical risk	1	2	3	4	5
Financial risk	1	2	3	4	5
Manufacturing risk	1	2	3	4	5
Marketing risk	1	2	3	4	5

36. What type of government programs do you feel most effectively contribute to your firm's innovation efforts? (Rank the top three - "1" is most important).

- [ ] direct contributions for specific projects
- [ ] loans &/or guarantees for specific projects
- [ ] tax incentives
- [ ] government procurement policies
- [ ] direct government R&D
- [ ] funding of institutional/basic research
- [ ] innovation centers
- [ ] other (specify) ____________

37. What other government funded product development programs have you been involved in?

Federal ____________

Provincial ____________

38. In your opinion, how could this program better suit your needs?

Eligible costs ____________

Program richness ____________

Program delivery ____________

39. Interviewer Impressions (Confidential)

(Comment generally on validity of respondent, nature of the business operation, extent of facilities and any other comments that will provide a useful "backdrop".)

____

3.0 GOVERNMENT QUESTIONNAIRE

GOVERNMENT INTERVIEW GUIDE

NAME:
LOCATION:
DEPARTMENT: POSITION:
PHONE:

1. What is your background with respect to product development/ innovation?

2. What were the objectives of your regional office in utilizing the various product development programs?

3. In light of the industrial development circumstances in your region, how did you have to interpret the program criteria in order to facilitate program delivery?

4. What are the major criteria in approving a project? (Note: private sector information + check for emphasis).

5. How much flexibility (regional discretion) is needed in setting up the terms and conditions for a project? (eligibility of costs, risk assessment, eligible groups etc.)

6. Is there any deliberate focussing of the product development programs? (i.e. to sectors, subregions, particular companies, big/small).

..../2.

7. Which industry sectors in this province are considered to be most important to the economy? Are they also the leaders in technology innovation in the province?

8. How important is the product development/innovation process in terms of the other core program elements relative to industrial development in your province? Discuss.

9. What are the major factors which motivate/stimulate a company to undertake a product development project?

10. Have the government product development programs been of use in the furthering of innovation/development in private industry? What has been their major impact?

11. Generally speaking what impact does the program have on a typical product development project?

	Small Impact		Moderate	Large Impact	
. accelerates the project	1	2	3	4	5
. alters the scope	1	2	3	4	5
. increases the magnitude	1	2	3	4	5
. increases the quality of the product development	1	2	3	4	5
. allows for a more marketable product	1	2	3	4	5

...../3.

3.0 GOVERNMENT QUESTIONNAIRE

12. Over and above the actual development of particular products in the projects, to what extent do companies benefit from the funding in other ways?

	None		Moderate		Large
. development of spinoff products	1	2	3	4	5
. product mix becomes more technologically advanced	1	2	3	4	5
. encourages the establishment of a continuous innovation capability	1	2	3	4	5
. growth potential is increased	1	2	3	4	5
. allows development of products new to the province	1	2	3	4	5
. other (specify)____________	1	2	3	4	5

13. Do the programs have any impact upon the companies ability to export? In what way is this impact realised?

____

____

____

14. What is the likelihood that most projects would be undertaken without program funding?

Small		Moderate		Large
1	2	3	4	5

15. How would you rate the risk of most projects?

	Very Low		Moderate		Very High
Technical risk	1	2	3	4	5
Financial risk	1	2	3	4	5
Manufacturing risk	1	2	3	4	5
Marketing risk	1	2	3	4	5

16. What is the frequency of giving the maximum allowable portion of cost? (i.e. 50% of the time?)

____

____

____

..../4.

17. When projects do not achieve commercial success, what are the principal reasons?

Financial

- [ ] higher unit manufacturing costs then expected
- [ ] cost overruns in development
- [ ] investment requirements too high
- [ ] selling price too low for adequate ROI
- [ ] volume too low for adequate ROI
- [ ] inadequate financial resources
- [ ] other (specify)

Marketing

- [ ] new product was not a significant improvement
- [ ] customer needs changed since the inception of the project
- [ ] inadequate sales/distribution effort
- [ ] no explicit product launch strategy
- [ ] inadequate market research
- [ ] intervening competitive products

Technical

- [ ] technology became obsolete
- [ ] production facilities inadequate
- [ ] technical product weaknesses
- [ ] production planning inadequate
- [ ] unexpected technical difficulties

Management Resources

- [ ] R&D resources inadequate
- [ ] engineering resources inadequate
- [ ] marketing resources inadequate
- [ ] financial resources inadequate

18. Which costs, if allowable in the innovation incentives, would induce a company to locate in a disparate region?

____

____

____

19. What impact does location have in terms of the major product development motivational factors? Are companies in this region placed at a disadvantage due to their location? Explain.

____

____

____

..../5.

3.0 GOVERNMENT QUESTIONNAIRE

20. What would be the net effect on product development in this region if government incentives were not available?

21. What would be the net effect on the provinces industrial base if government innovation assistance were to be eliminated?

22. Which stages of product development do you feel require the greatest concentration of government assistance in order to accelerate the entire process? Why?

- research (basic and applied)
- market evaluation
- engineering development
- marketing start-up
- manufacturing startup

23. What type of government programs do you feel most effectively contribute to a firm's innovation efforts? Explain.

24. What provincial or municipal government programs exist or are planned which assist firms in innovation in your region? Describe.

25. What is the ratio of accepted projects to enquiries?

26. What are the major reasons why some companies who enquire about the program do not follow through to the project stage?

27. What factors inhibit product development in your area?

28. Is the usefulness of the product development programs inhibited by the fact that innovation in some sectors requires heavy investment in costs not covered by the programs? (i.e. capital expenditures).

29. Do you feel EDP is used to its fullest potential extent in this province? If no, why not?

30. Based on your past experience with EDP and your knowledge of the CORE program & what it is going to offer, will there be any difficulty in meeting the targets established in the RIDF & regional operating plan?

31. What are the product/industrial development needs in your province that have been met or may not be met with the CORE program?

7. In your opinion how could the programs better suit regional industries needs? (i.e. eligible costs, delivery, richness).

General Comments:

Interviewer Assessment (confidential)
(Comment on interviewee interest, level of expertise, + other factors that will provide a backdrop of the interviewees).

APPENDIX F

SUMMARY OF FIRM QUESTIONNAIRE RESPONSES BY PROVINCE AND SECTOR

Section:

1.0 Introduction

2.0 Responses by Question

APPENDIX F

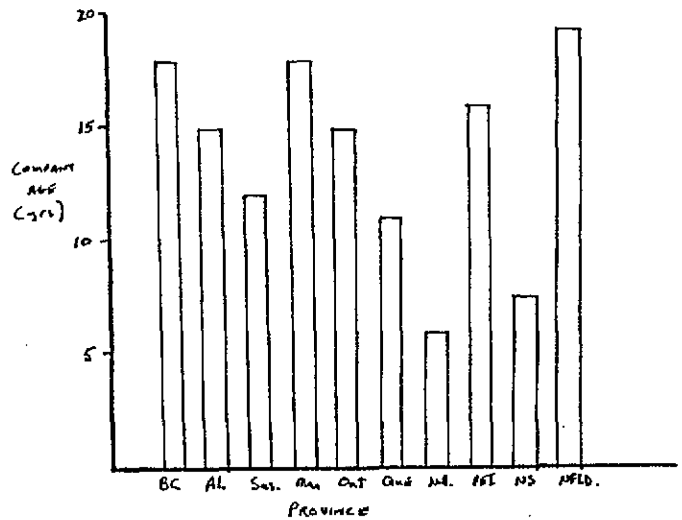
SUMMARY OF FIRM QUESTIONNAIRE RESPONSES BY PROVINCE AND SECTOR

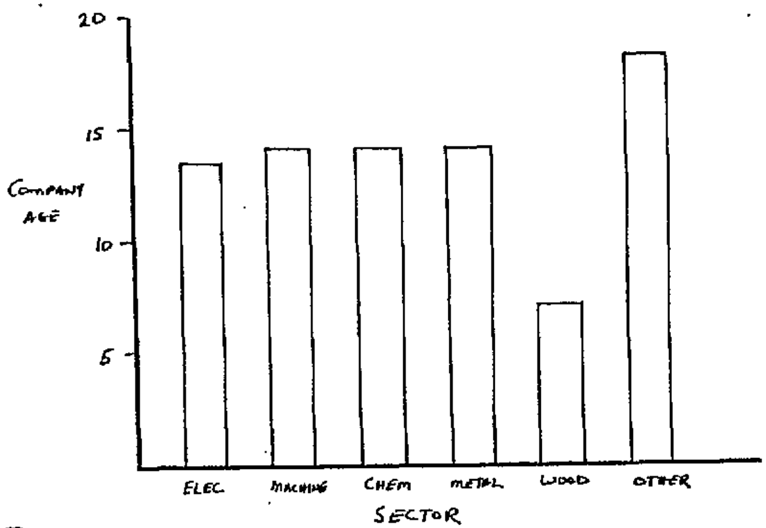
1.0 INTRODUCTION

The following provides a summary of the responses obtained from each question posed to the firms which is ammenable to quantification via a bar chart.

For each question, the responses are broken-out by province, sector and size of firm as appropriate.

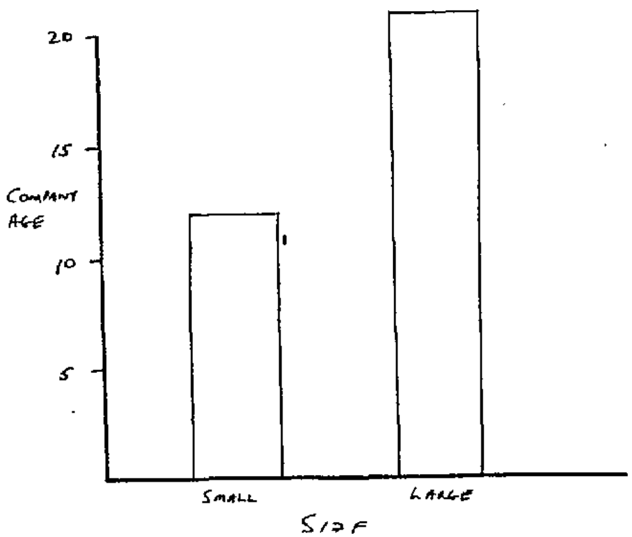
Each page indicates the relevant questionnaire number and the substance of the question. The reader interested in the detailed question is referred to Appendix E.

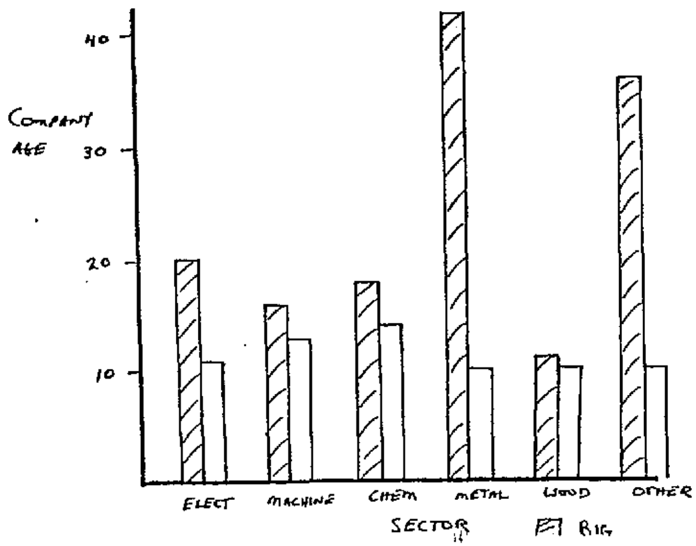


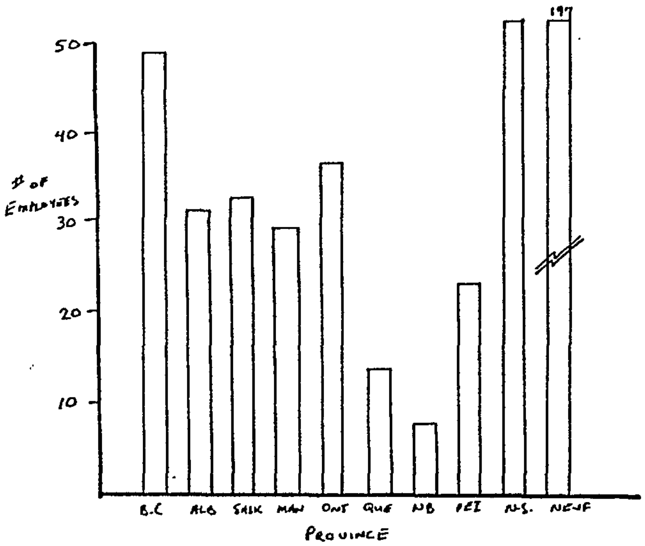


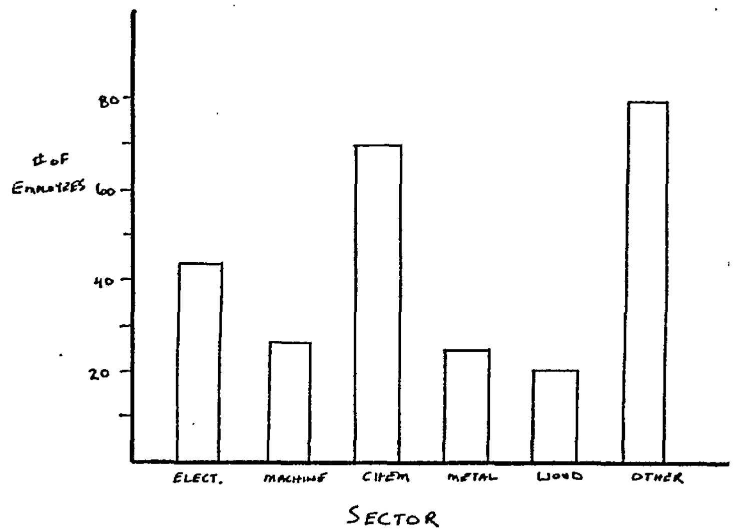
COMPANY AGE

#1

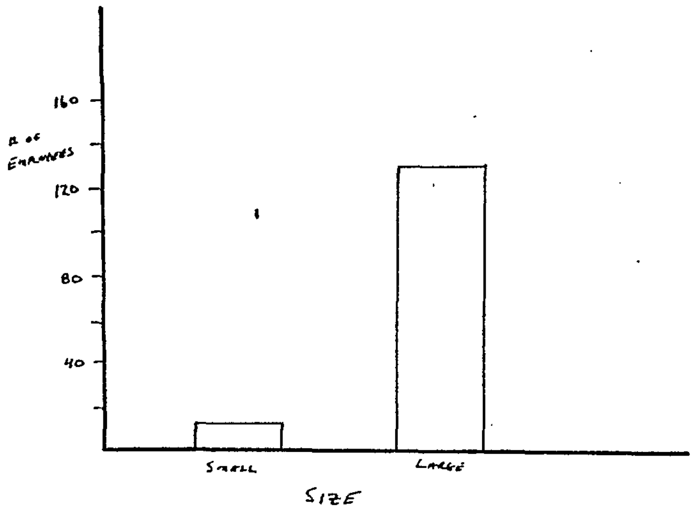


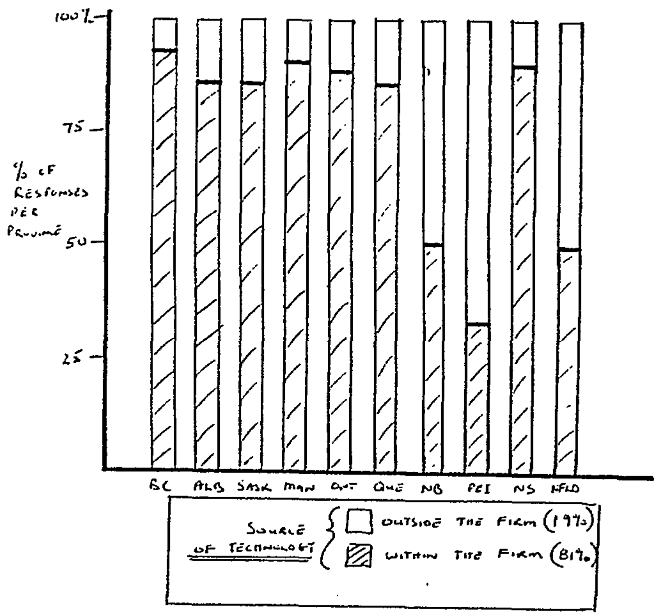




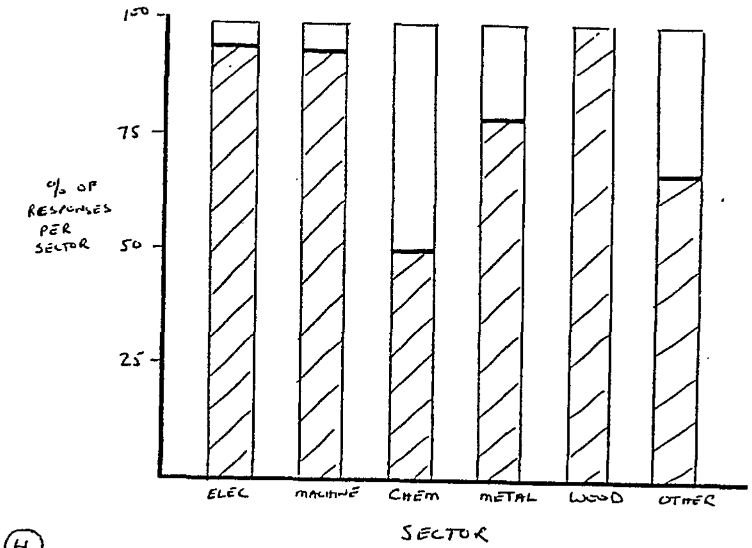


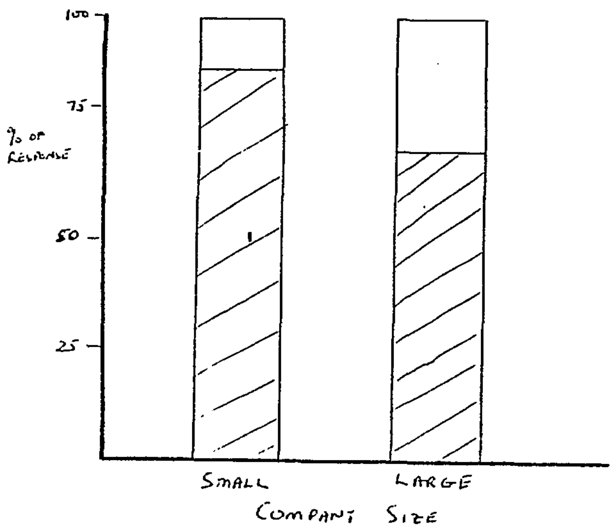
COMPANY SIZE (1*)

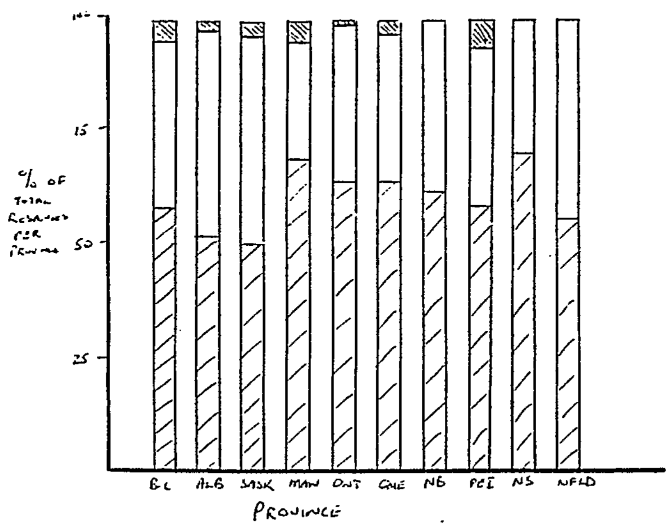


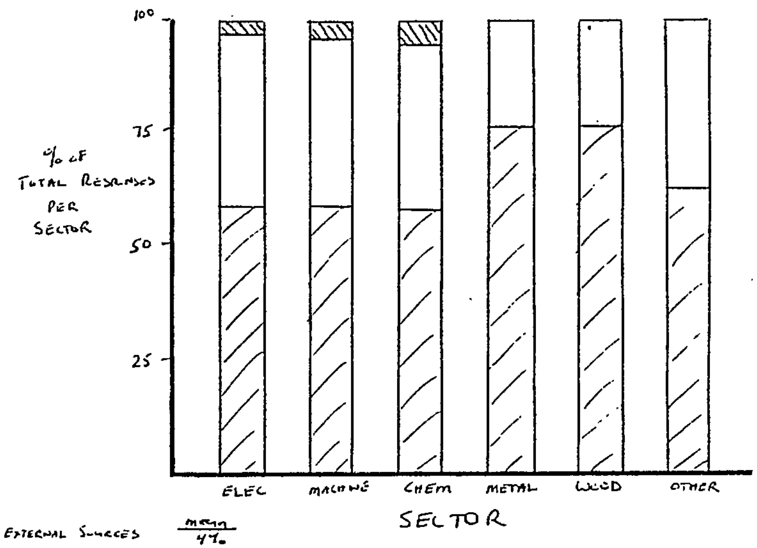

100%
75
% of Responses per Province
50
25
BC
ALB
SASK
MAN
ONT
QUE
NB
PEI
NS
NFLD
Source of Technology
Outside the Firm (19%)
Within the Firm (81%)

(4)


100
75
% of Responses per Sector
50
25
ELEC
MACHINE
CHEM
METAL
WOOD
OTHER
SECTOR

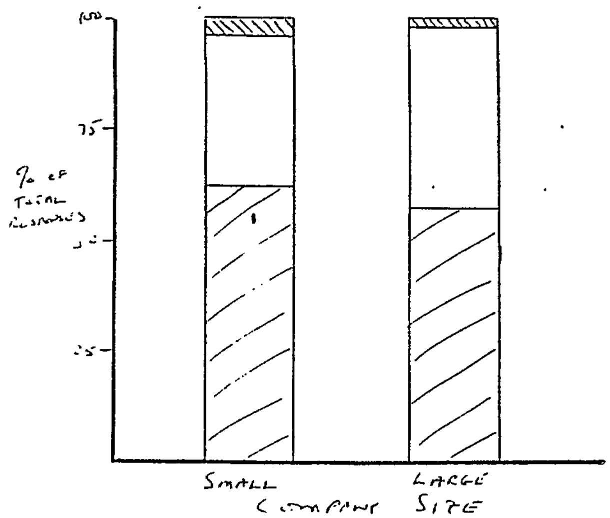

100
75
% of Response
50
25
SMALL
LARGE
Company Size

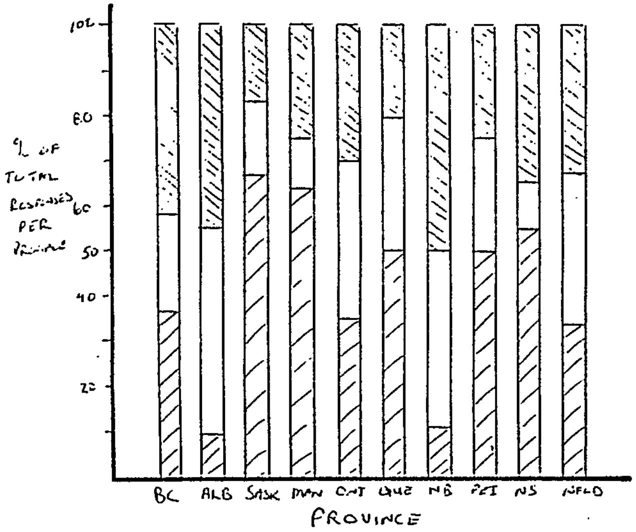


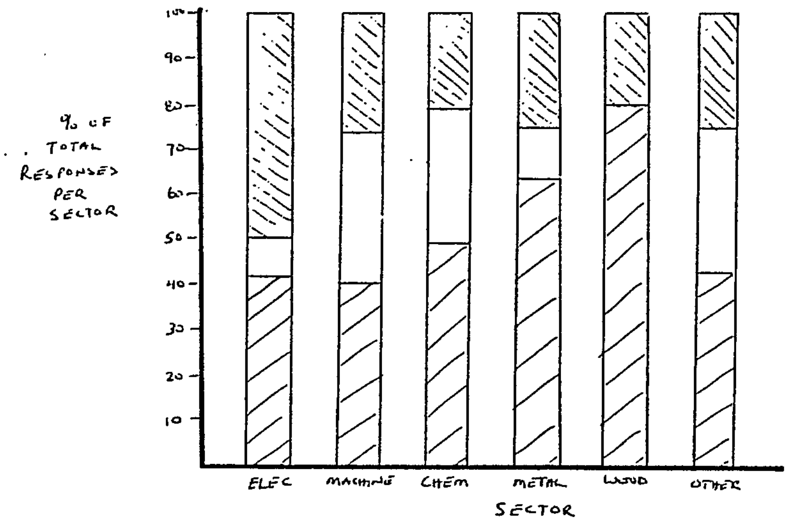


(7) SOURCE OF PRODUCT DEVELOPMENT FUNDING

		mean
▧	External Sources	4%
☐	Internal Cash Flow	35%
◪	Government	61%

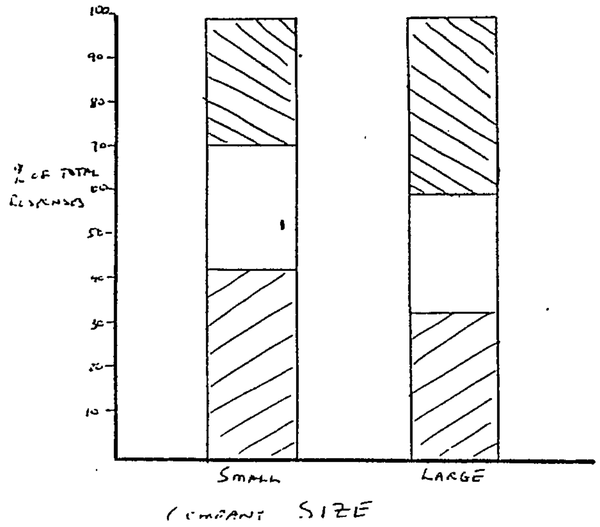


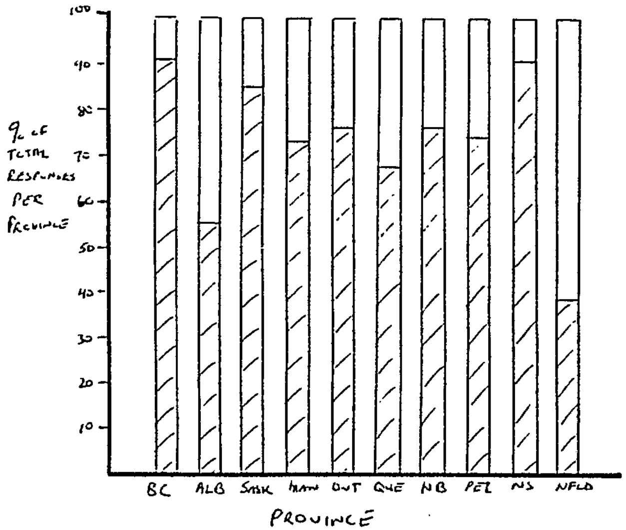


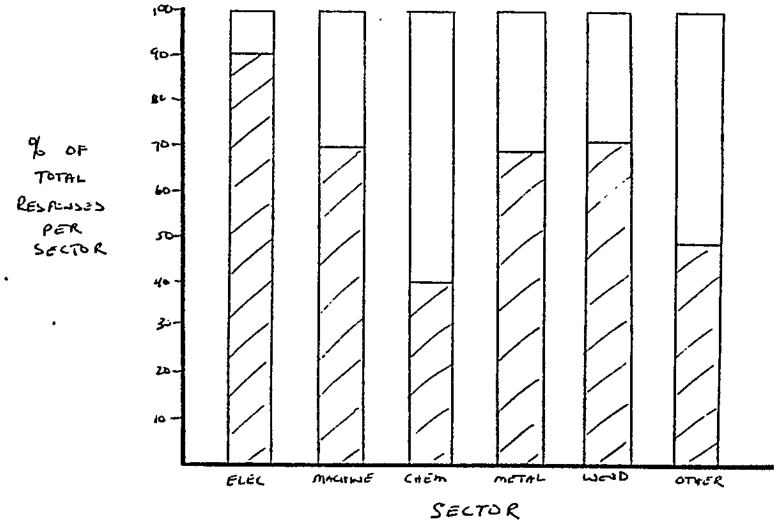


(9) WHERE FUNDS WOULD HAVE BEEN SPENT IF NOT ON EDP PROJECT

		mean
▧	ANOTHER DEVELOPMENT PROJECT	35%
☐	NON INNOVATION COSTS	30%
▨	GENERAL CASH FLOW	35%

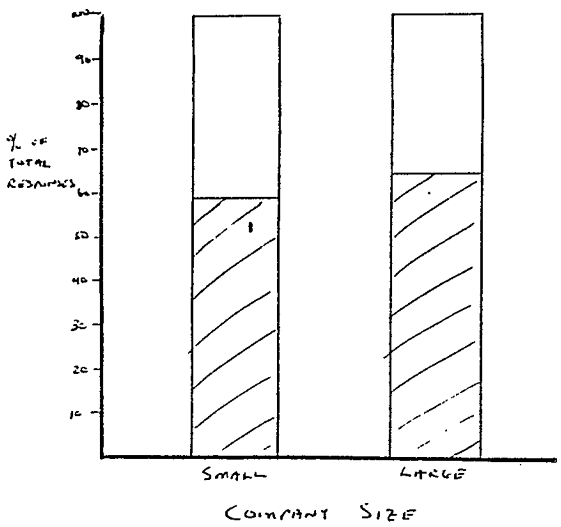


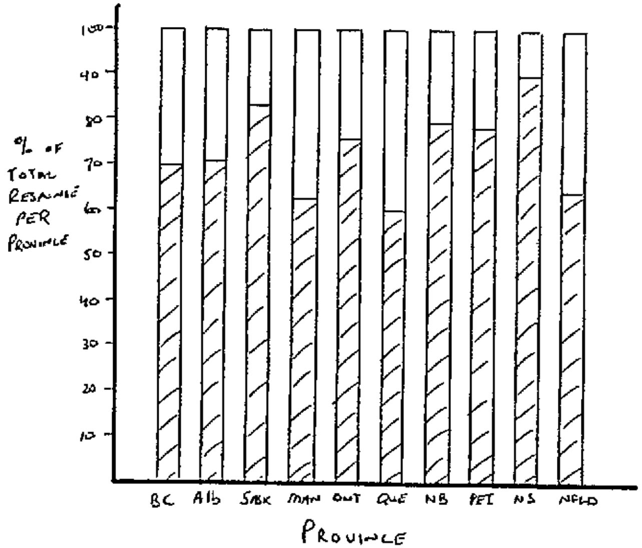


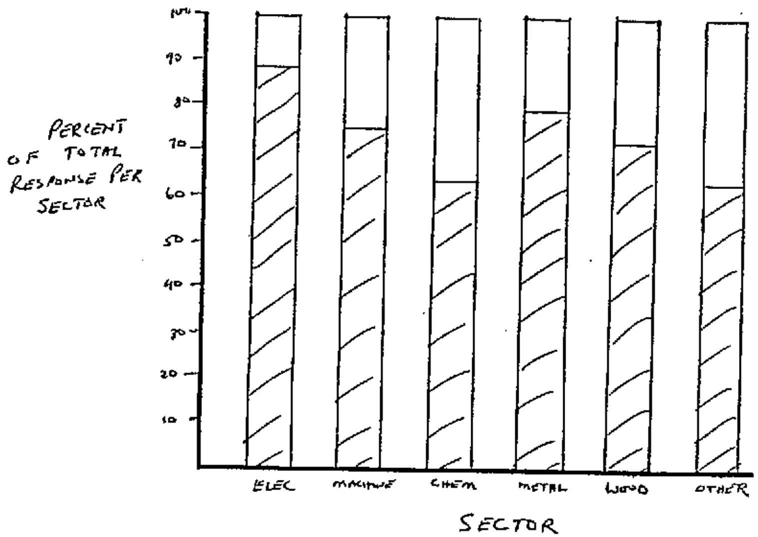


(10) TOTAL EDP PROJECT COSTS THROUGH TO MANUFACTURING STARTUP

	mean
▨ CURRENT	79%
☐ CAPITAL	21%

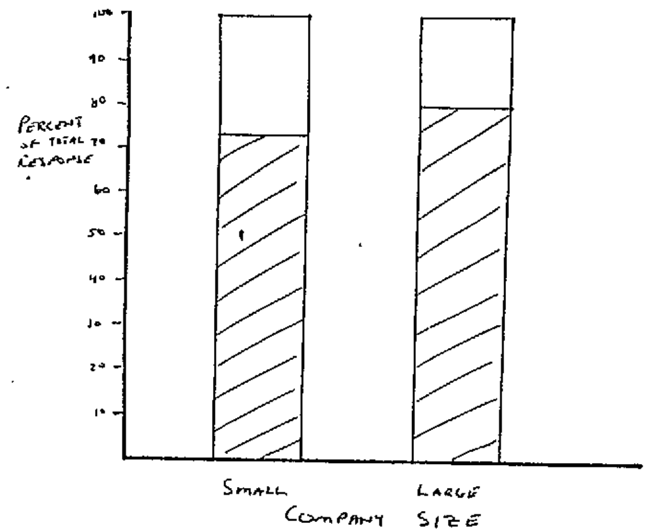


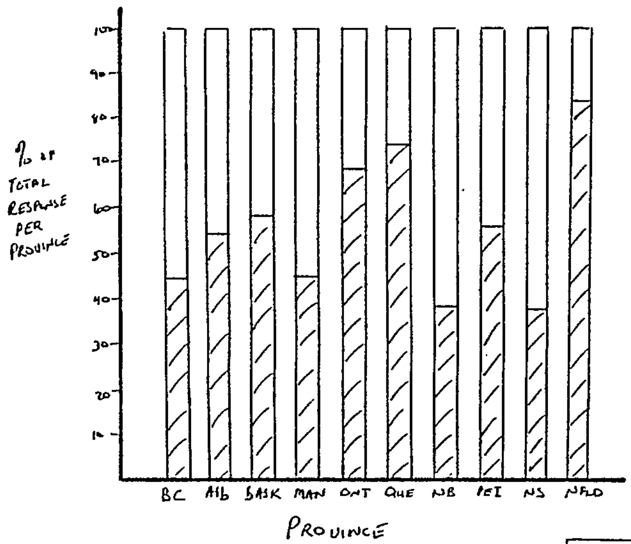


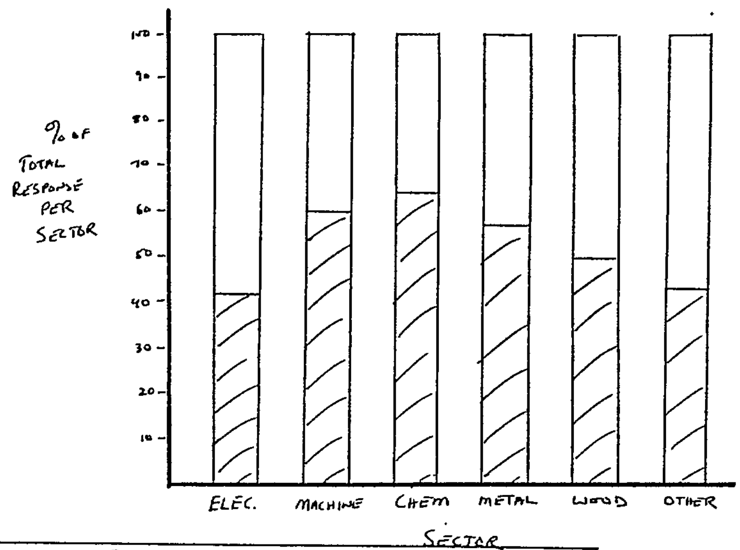


(12) TYPICAL BREAKDOWN OF ANNUAL PRODUCT DEVELOPMENT EXPENDITURES

	mean
CURRENT	75%
CAPITAL	25%

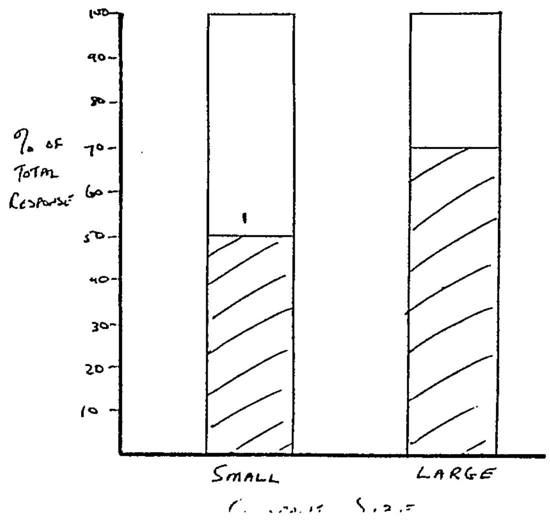


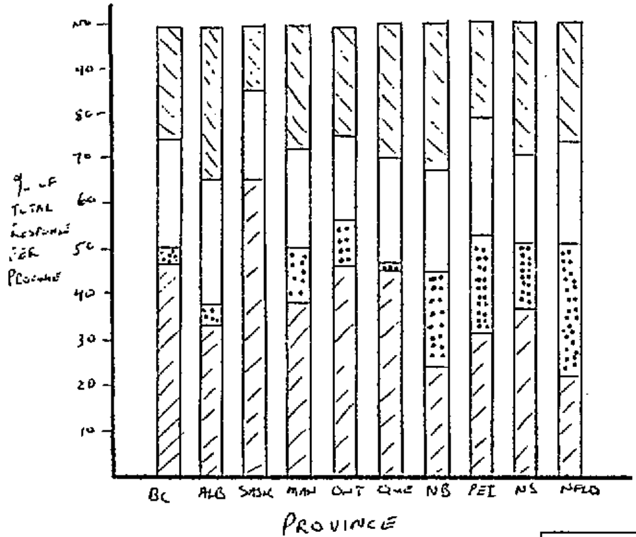


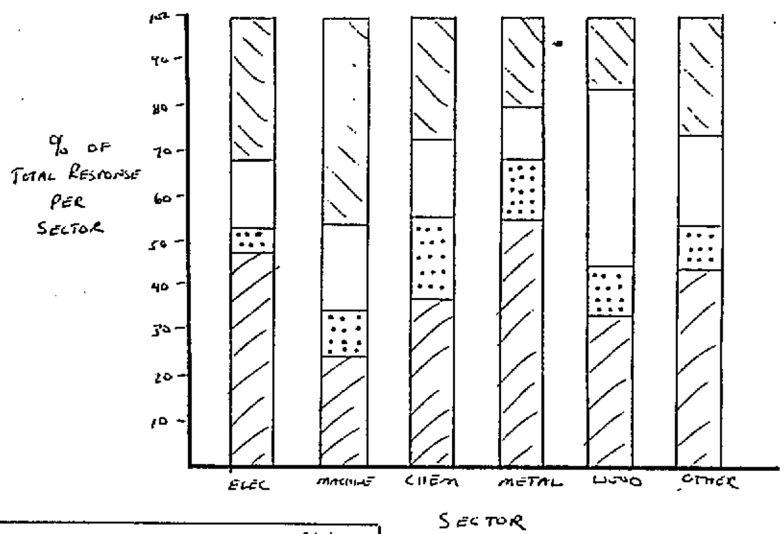


(13) How is the Annual Product Development Expenditure decided upon

▨	On a project by project basis	56%
□	Based on annual budgeting	44%



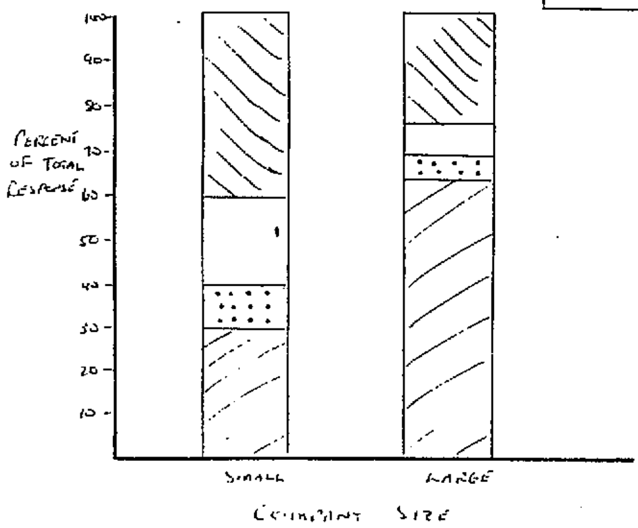


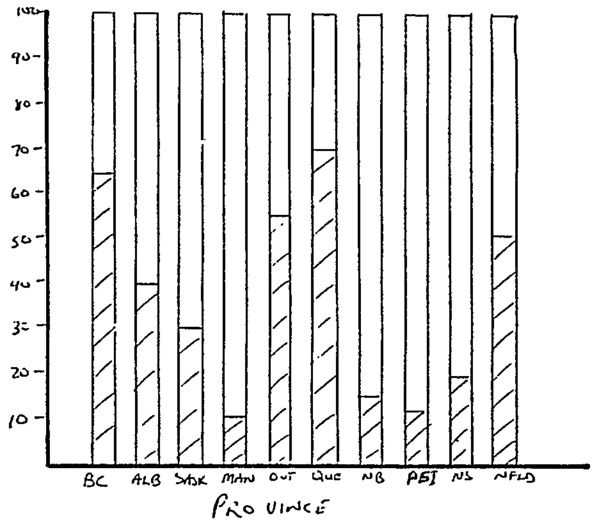


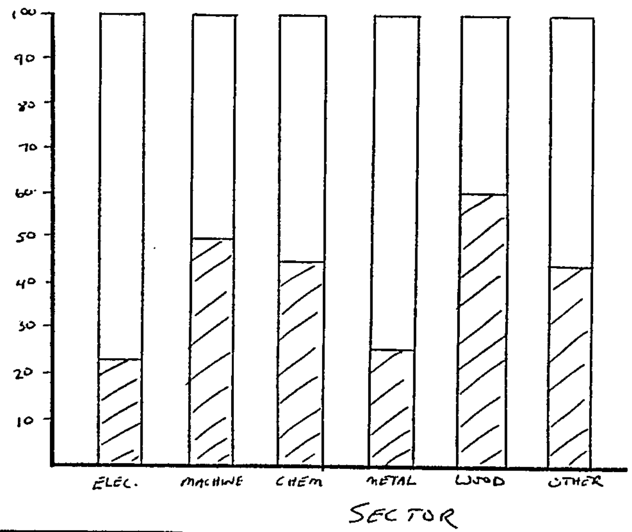
(14)

MAJOR FACTORS IN THE DECISION TO UNDERTAKE PRODUCT DEVELOPMENT PROJECTS

	MEAN
TECHNOLOGY	27%
FINANCIAL RETURN	20%
MANUFACTURING	13%
MARKETING	40%



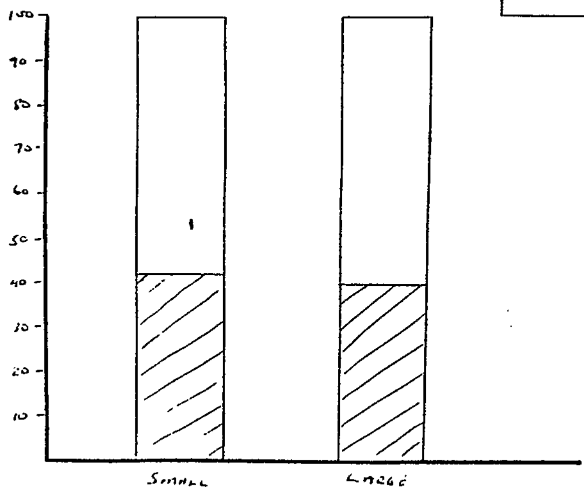


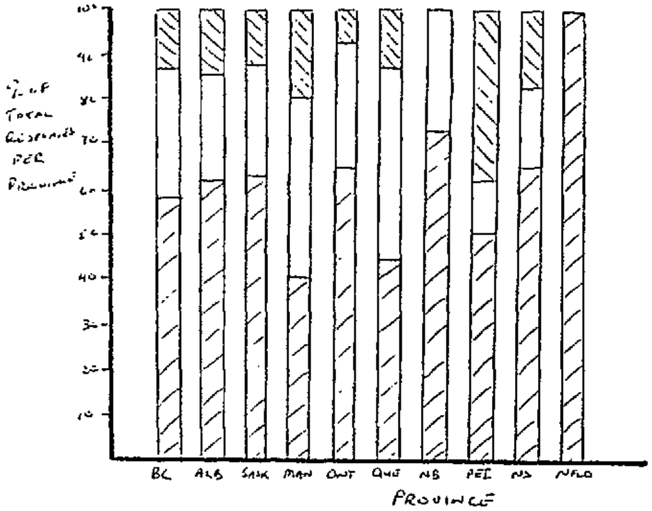


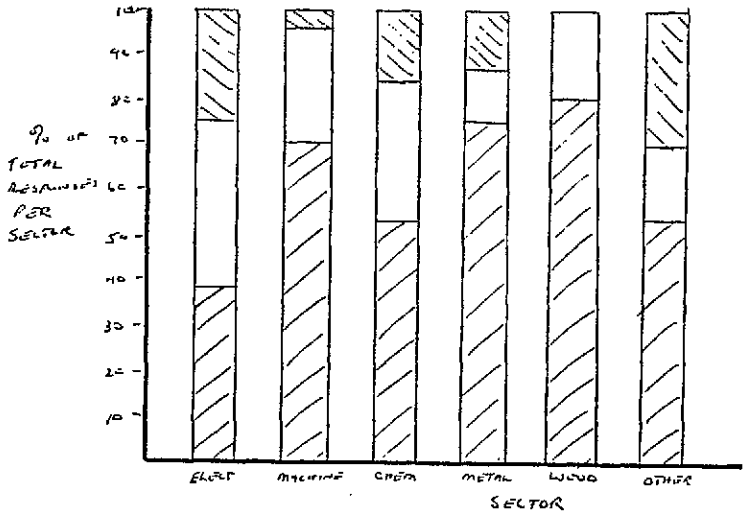
(17) HAVE NEW PRODUCT LINES RESULTED FROM THIS PRODUCT DEVELOPMENT PROJECT?

YES 59%

NO 41%

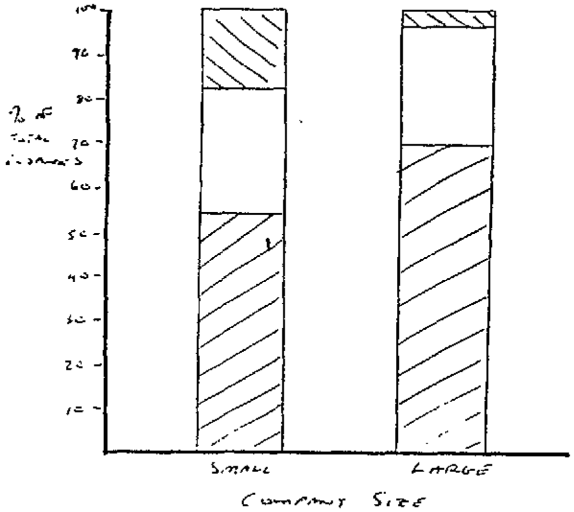


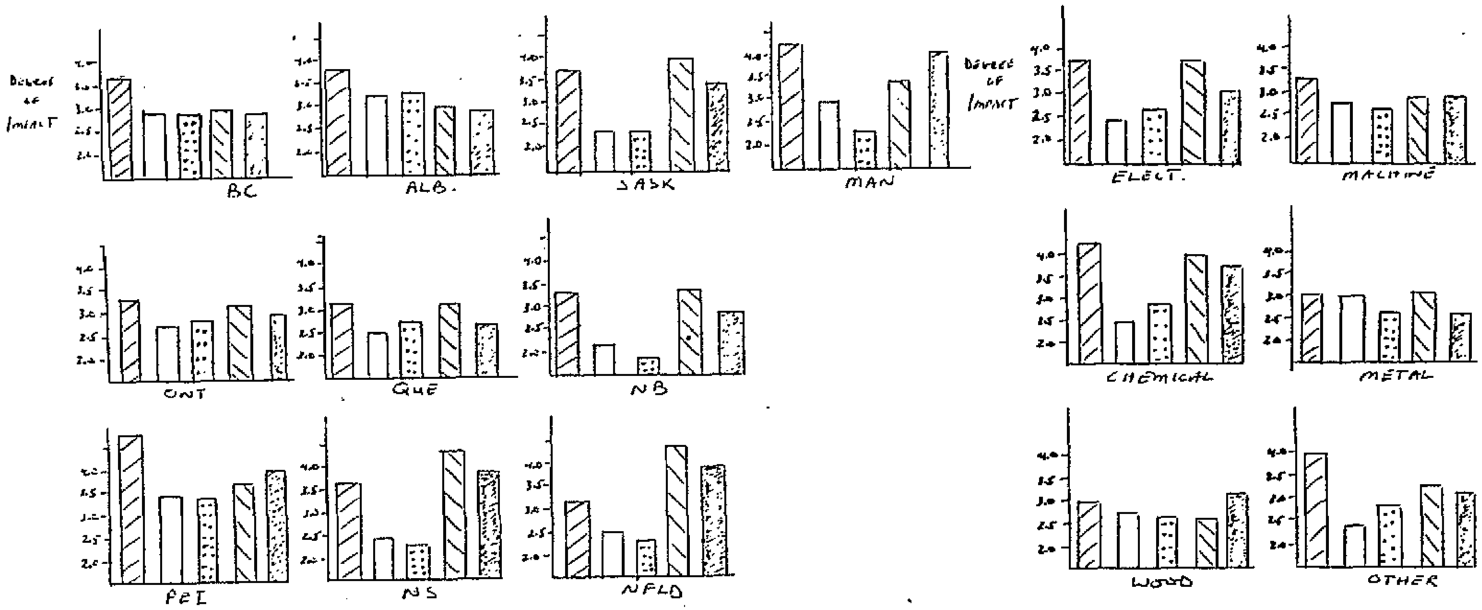




(18) HAVE ANY NEW FACILITIES RESULTED FROM THE SALES OF THE NEW PRODUCT DEVELOPED UNDER THE EDP PROJECT?

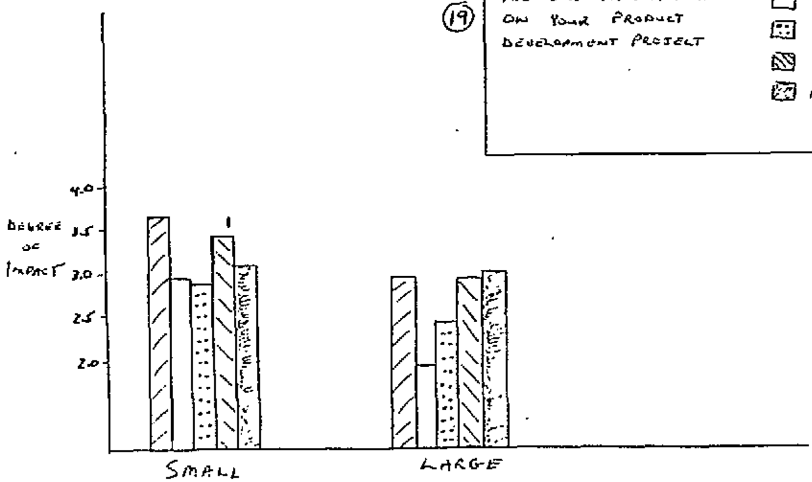
	MEAN
NEW MANUFACTURING FACILITY	16%
EXPANSION	30%
NONE	54%

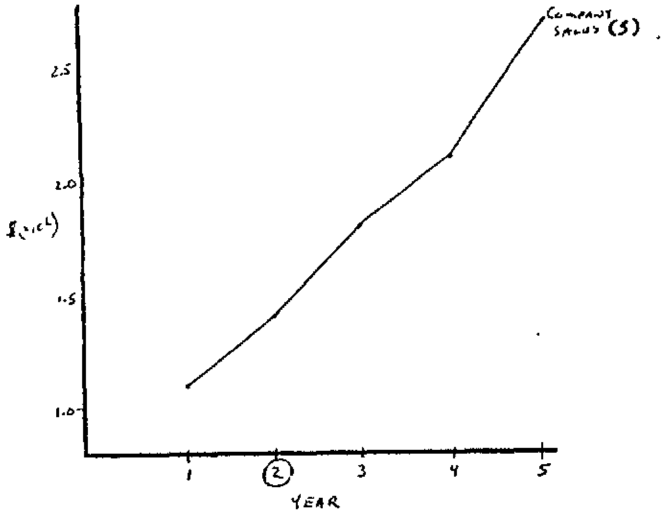


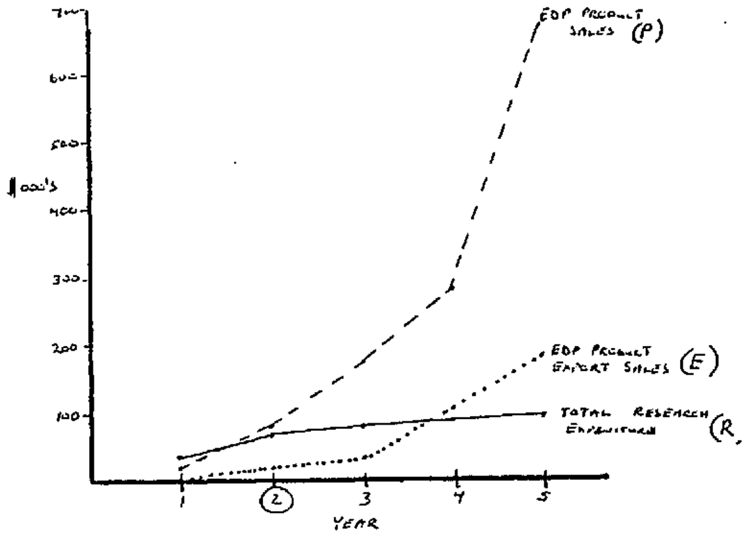


(19) How much "Impact" did the EDP program have on your product development project

	Mean
Accelerated the project	3.6
Altered the scope	2.7
Increased the magnitude	2.7
Increased the quality	3.0
Allowed a more marketable product	3.1



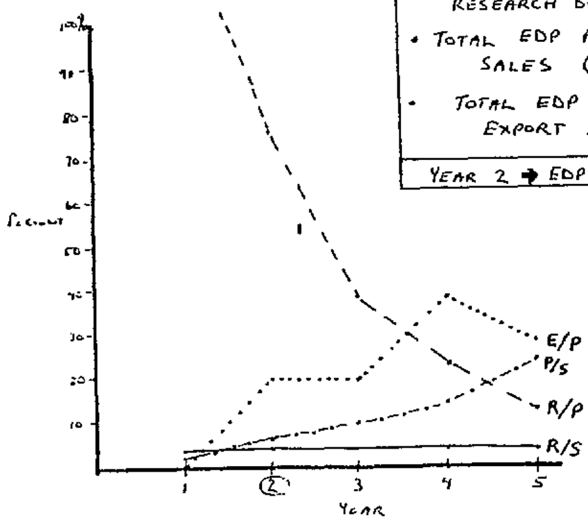


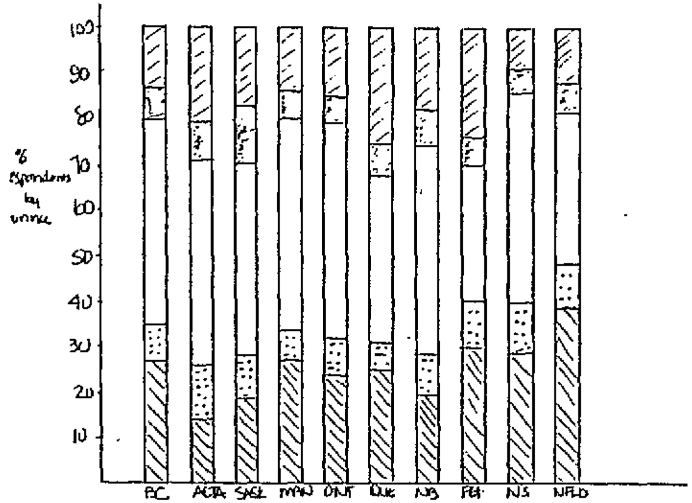


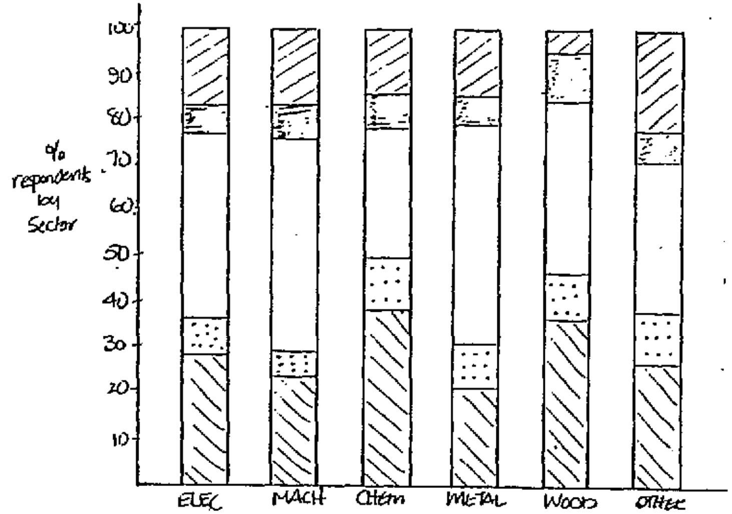
(21)

- TOTAL COMPANY SALES (S)
- TOTAL PRODUCT DEVELOPMENT/ RESEARCH BUDGET (R)
- TOTAL EDP PRODUCT SALES (P)
- TOTAL EDP PRODUCT EXPORT SALES (E)

YEAR 2 → EDP GRANT YEAR



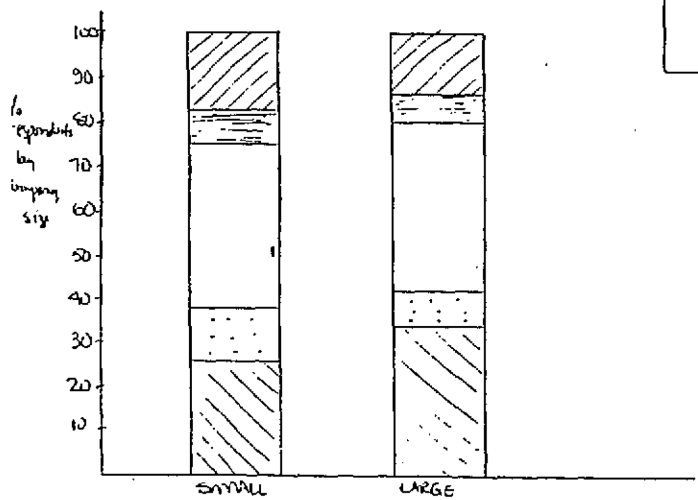


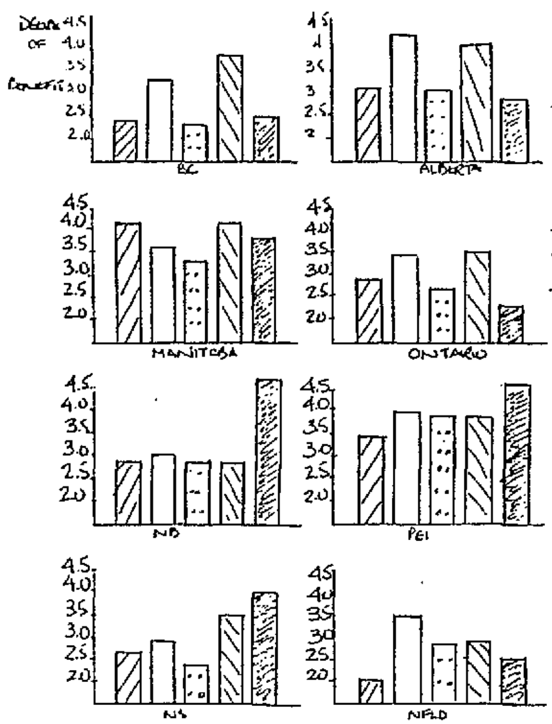


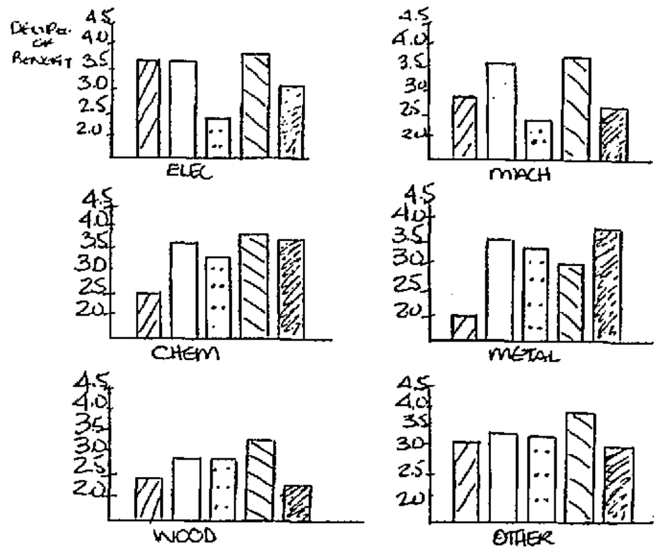
(22)

RELATIVE TOTAL EXPENDITURE IN EACH STAGE OF PRODUCT DEVELOPMENT

	MEAN
RESEARCH	16%
MARKET EVALUATION	6%
ENGINEERING DEVELOPMENT	42%
MARKETING STARTUP	9%
MANUFACTURING STARTUP	27%

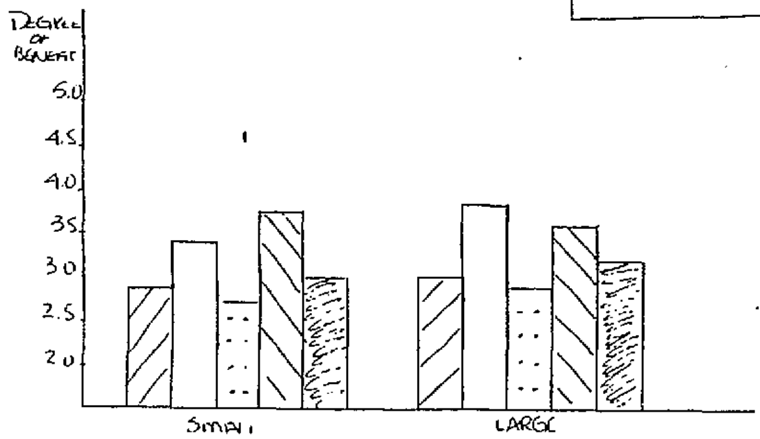


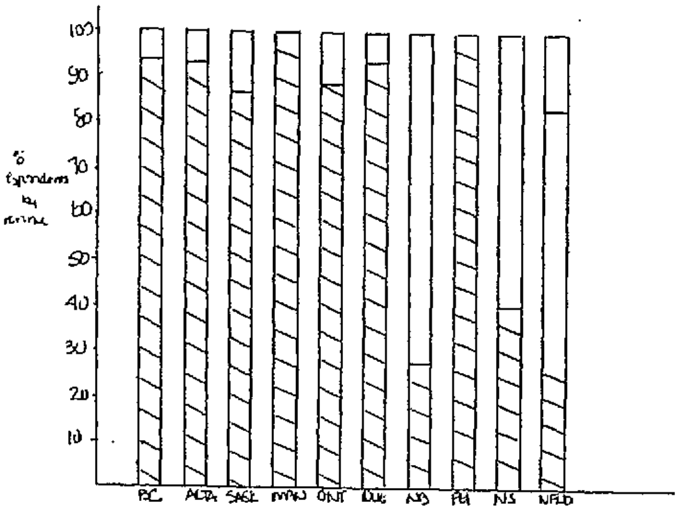


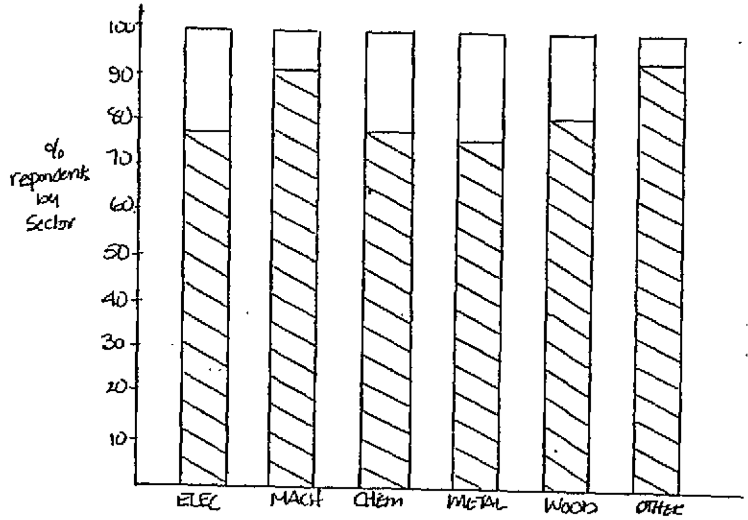


(26) EXTENT TO WHICH COMPANIES HAVE BENEFITTED FROM FUNDING INDIRECTLY

	mean
SPINOFF PRODUCTS	2.9
PRODUCT MIX MORE TECHNOLOGICALLY ADVANCED	3.5
ENCOURAGED CONTINUOUS INNOVATION CAPABILITY	2.8
GROWTH POTENTIAL INCREASED	3.7
ALLOWED DEVELOPMENT OF PRODUCTS NEW TO THE PROVINCE.	3.1

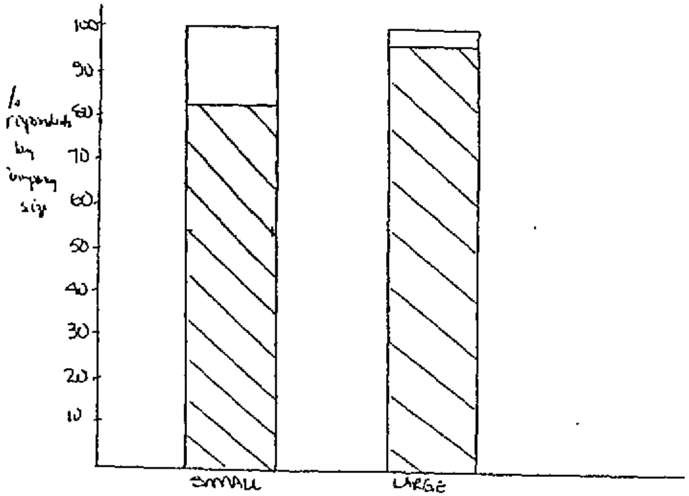


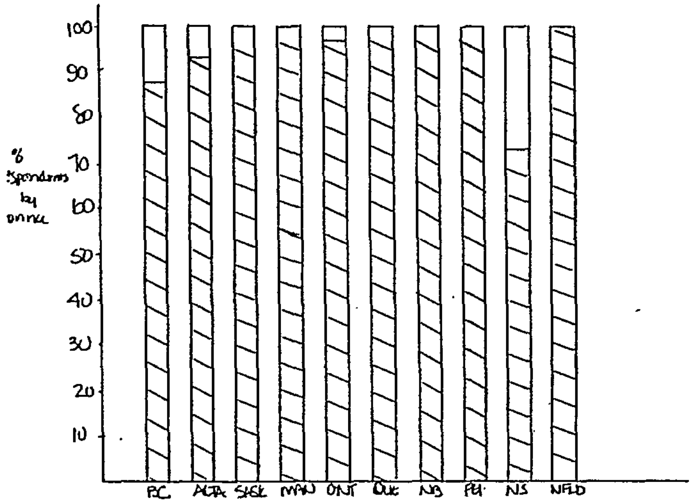


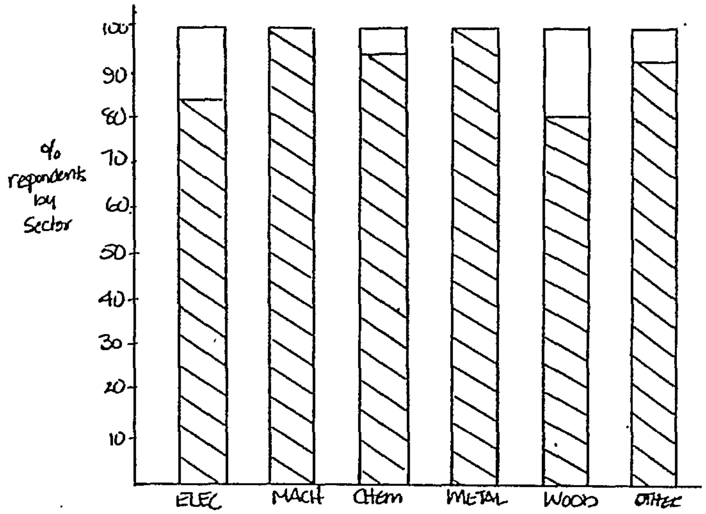


(28) IN RETROSPECT, STILL HAVE GONE THRU WITH PROJECT APPLICATION

		MEAN
	☒ YES	83 %
	☐ NO	17 %

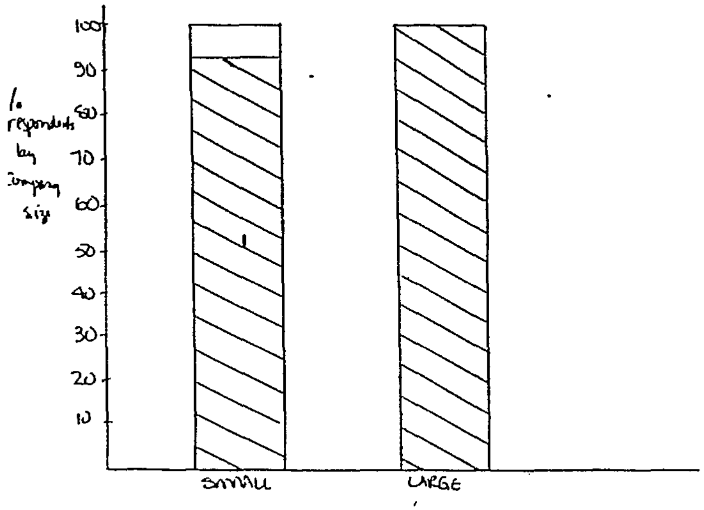


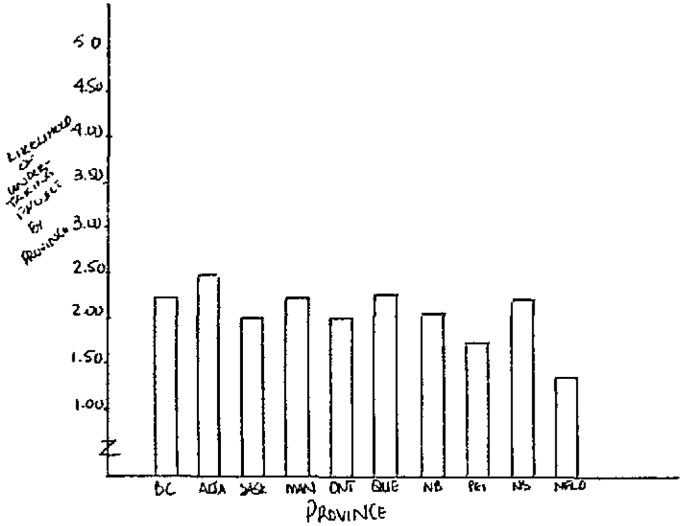


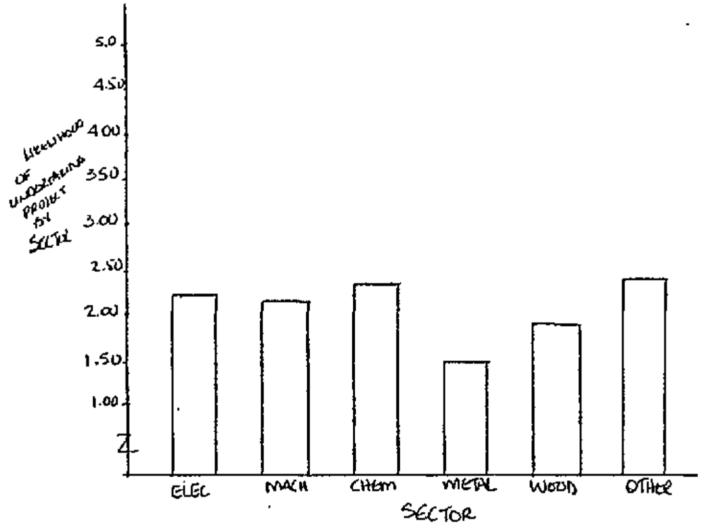


(29) APPLY FOR PROJECT IN THE FUTURE

		mean
	▨ YES	94%
	☐ NO	6%

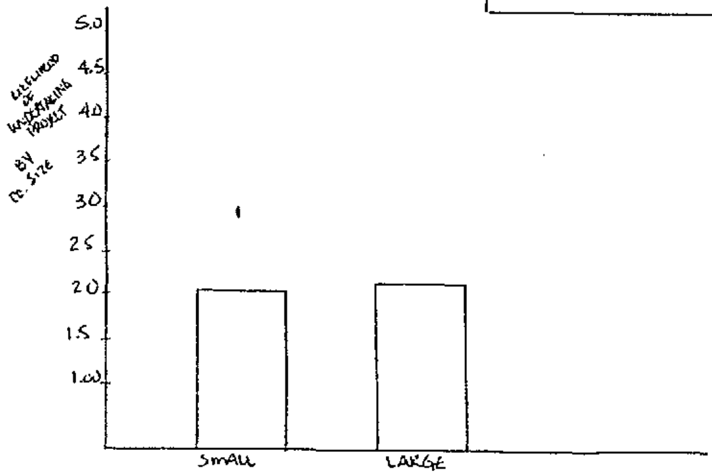


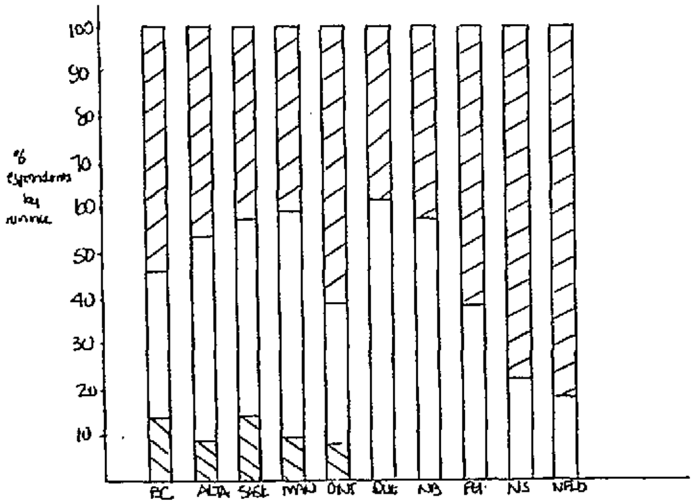


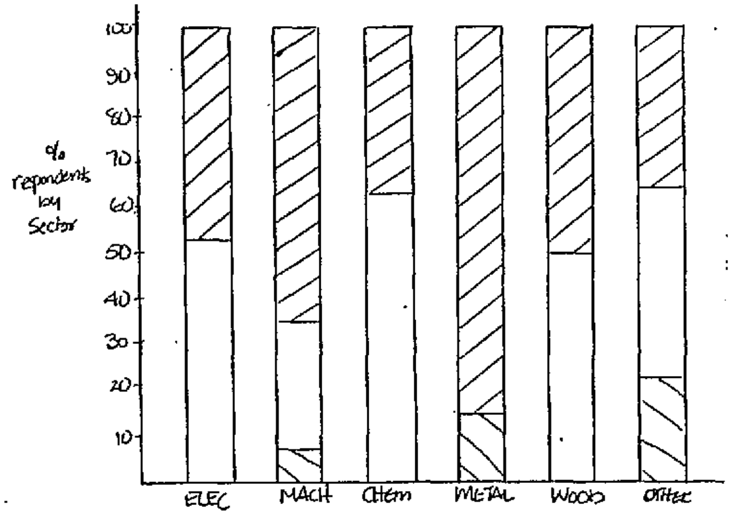


(30) LIKELIHOOD THAT PROJECT WOULD HAVE BEEN UNDERTAKEN WITHOUT PROGRAM FUNDING

		MEAN
1	SMALL	2.1
2		
3	MODERATE	
4		
5	LARGE	

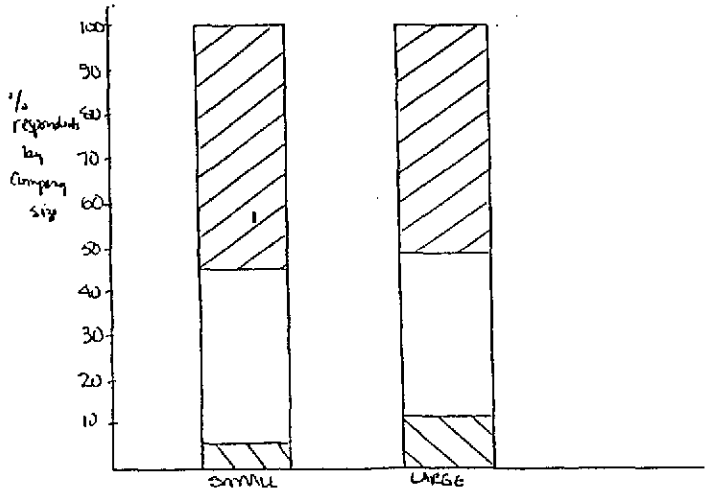


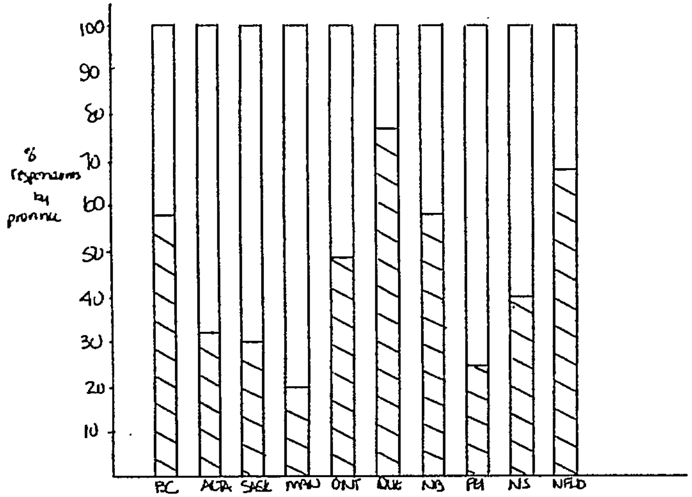


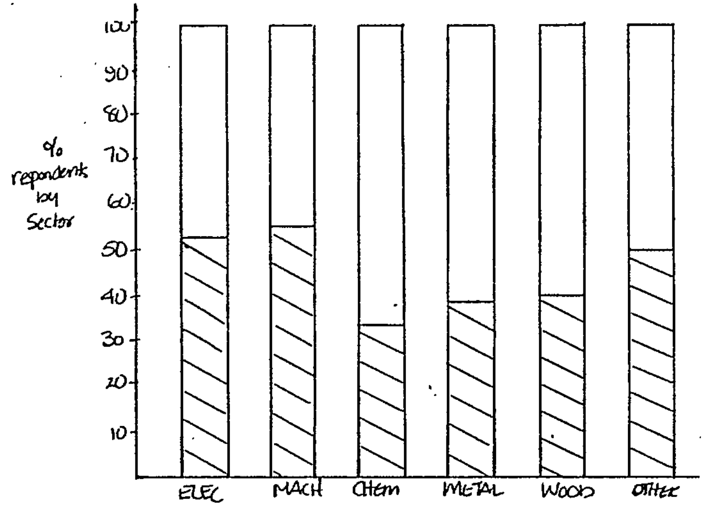


(31) IF GOV'T ASSISTANCE NOT AVAILABLE, WOULD THERE BE ANY EFFECT ON THE PROJECT

		MEAN
⧅	NO EFFECT	6%
☐	MODIFIED PROJECT	40%
▨	TERMINATE	54%

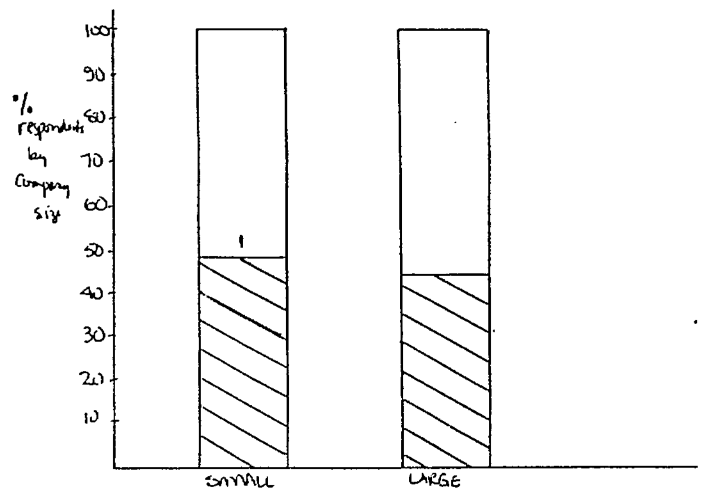


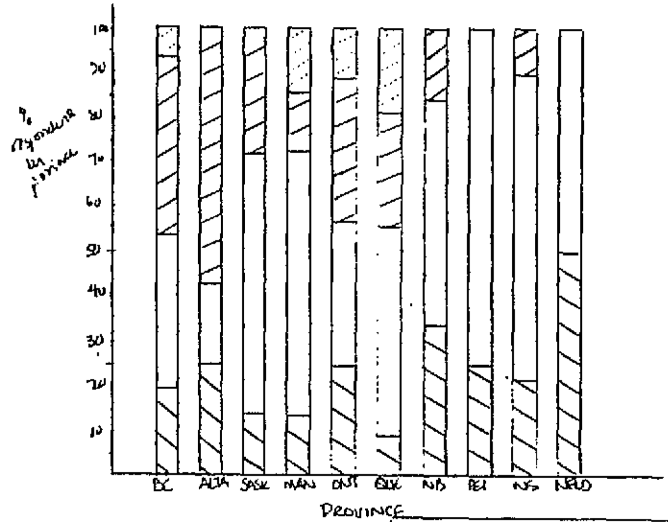


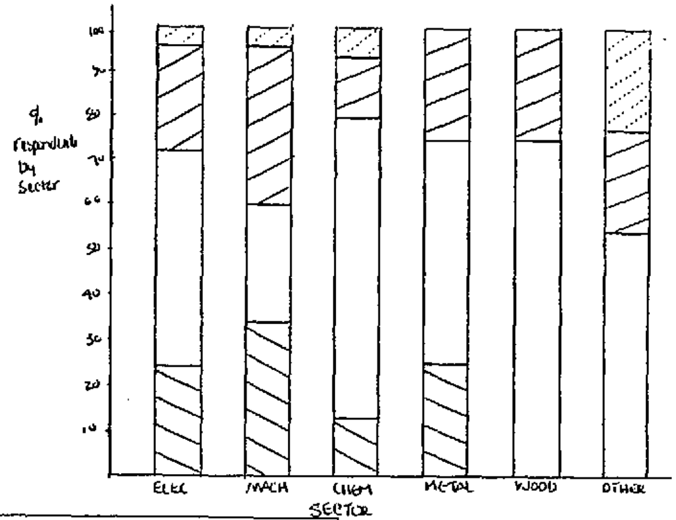


(33) WOULD CHANGE PROJECT IF GOV'T INCREASED FUNDING

		mean
▨	YES	46.5 %
☐	NO	53.5 %

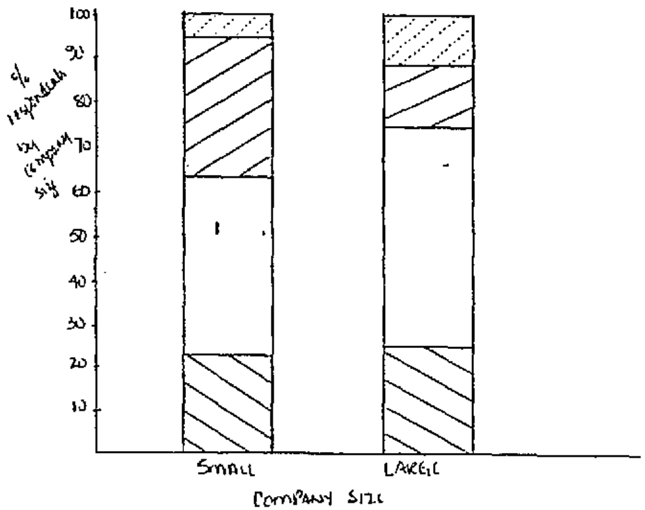


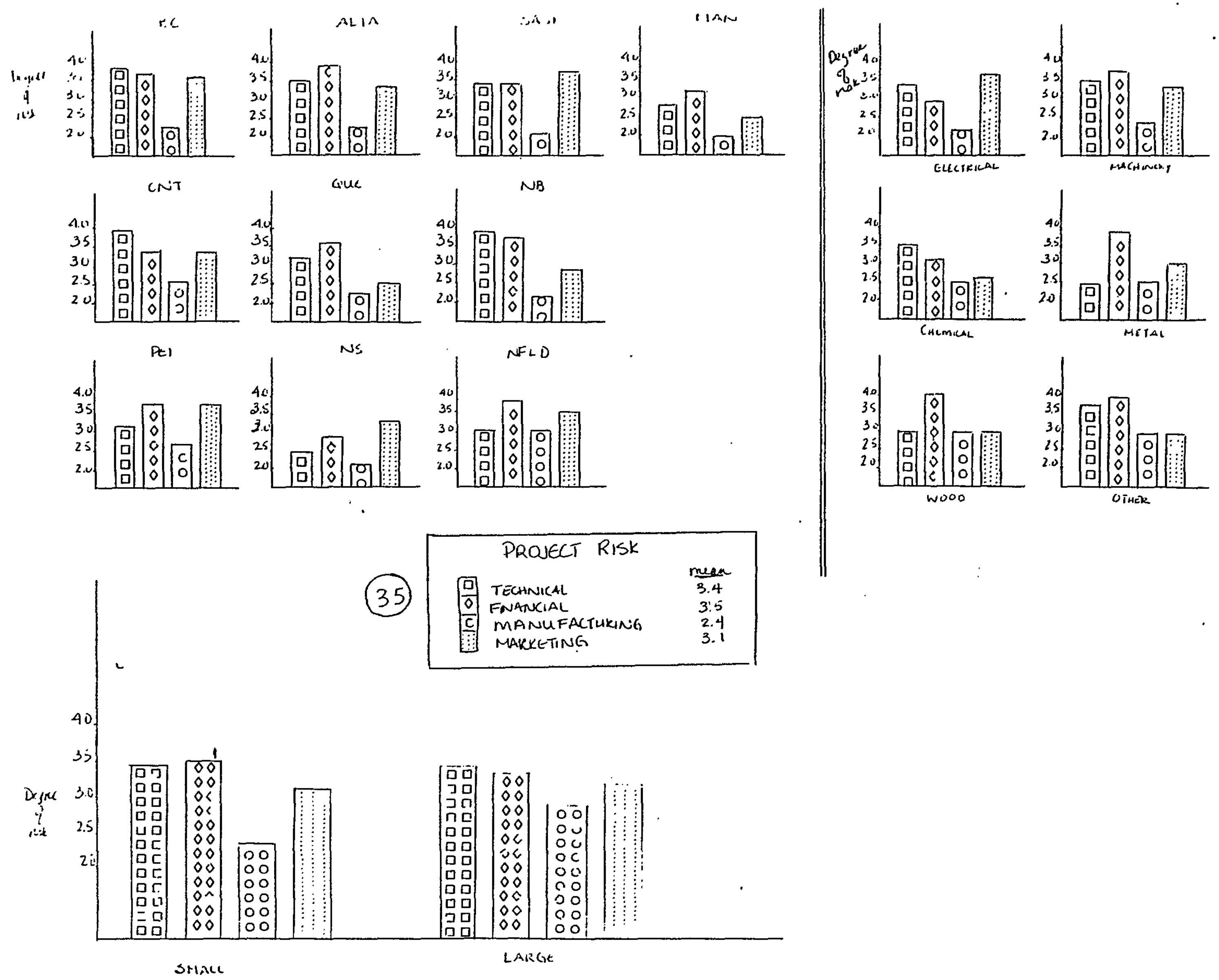




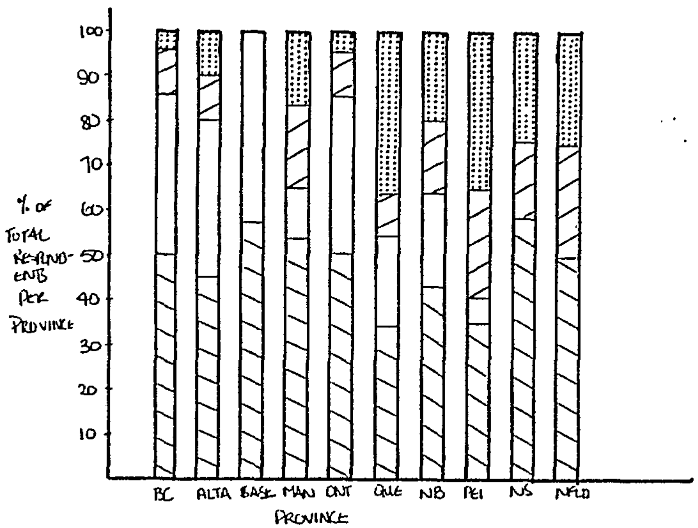
(34) IF GOV'T FUNDING REDUCED AT WHAT POINT WOULD PROJECT HAVE BEEN TERMINATED

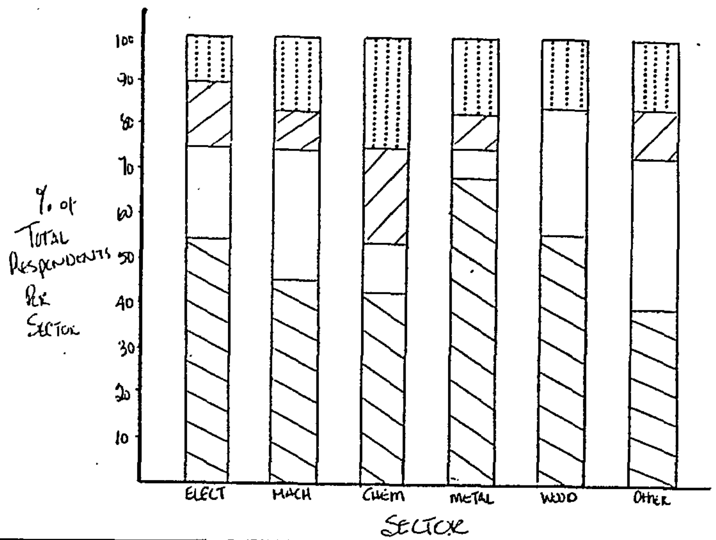
		mean
⧅	10%	23%
☐	25%	43%
▨	50%	27%
⬚	75%	7%





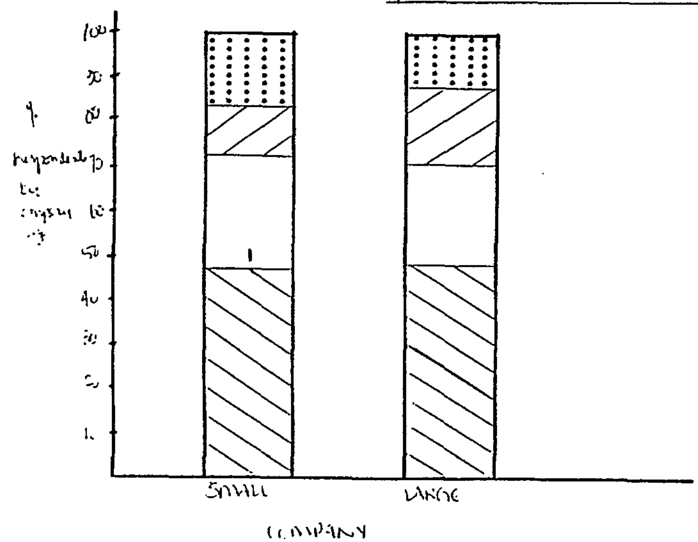
ALTA
MAN
ONT
QUE
NB
PEI
NS
NFLD
ELECTRICAL
MACHINERY
CHEMICAL
METAL
WOOD
OTHER
35
PROJECT RISK
mean
TECHNICAL 3.4
FINANCIAL 3.5
MANUFACTURING 2.4
MARKETING 3.1
Degree of risk
SMALL
LARGE

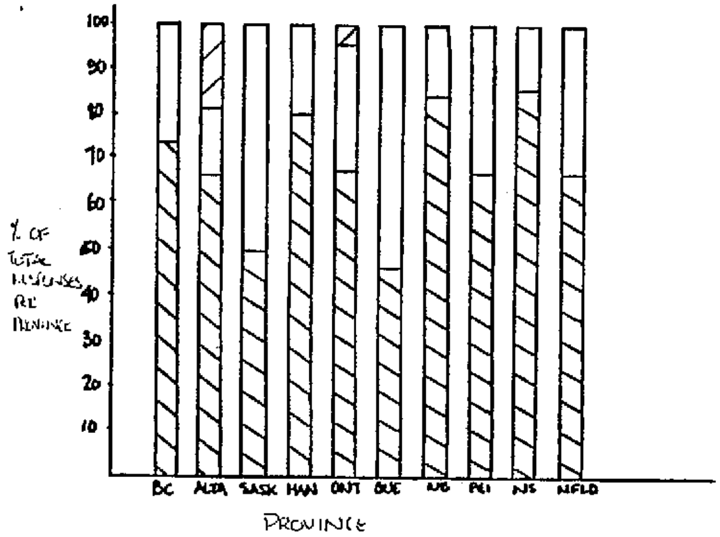


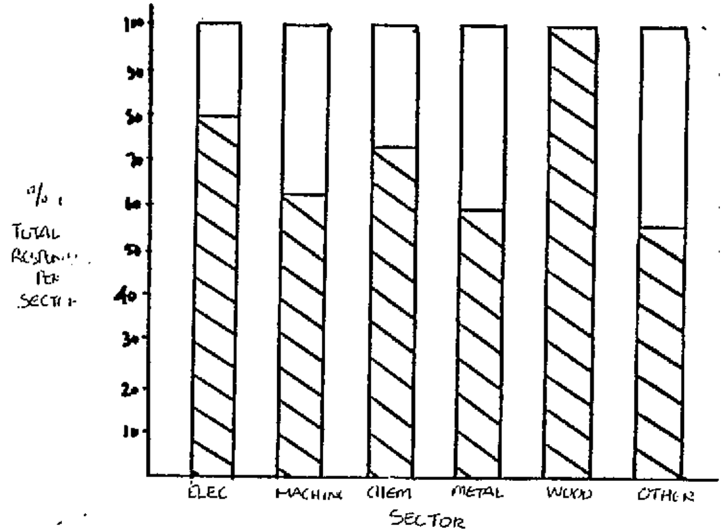


(36) GOVERNMENT PROGRAMS CONTRIBUTING TO INNOVATION EFFORTS

DIRECT CONTRIBUTIONS	47%
LOANS &/OR GUARANTEES	24%
TAX INCENTIVES	12%
OTHER	17%

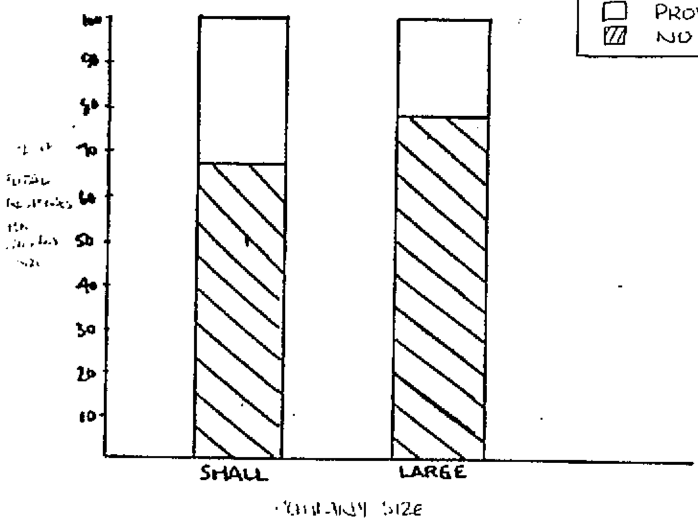


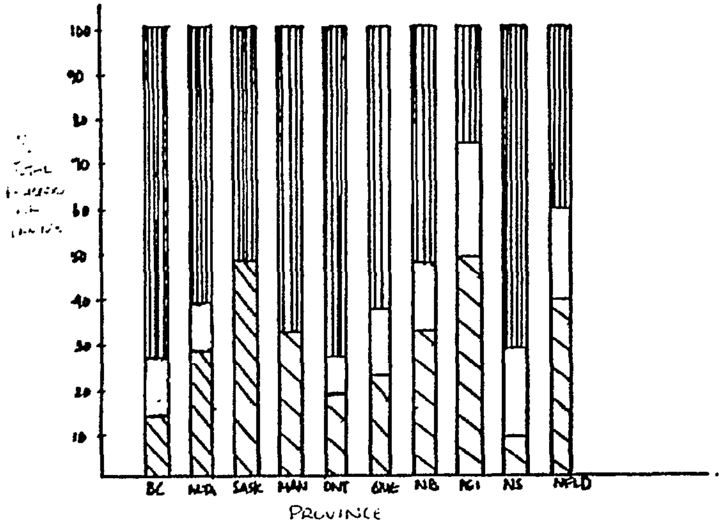


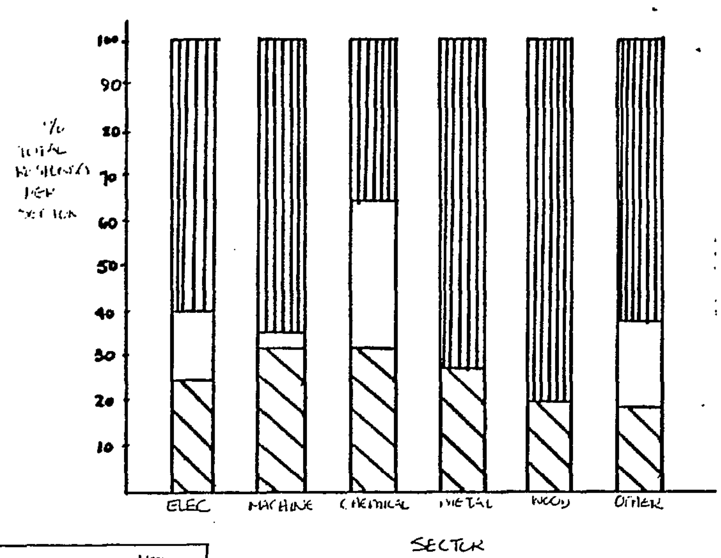


(31) OTHER GOVERNMENT FUNDED PRODUCT DEVELOPMENT PROGRAMS

		TOTAL
FEDERAL	–	67%
PROVINCIAL	-	31%
NO PREVIOUS FUNDING	-	2%

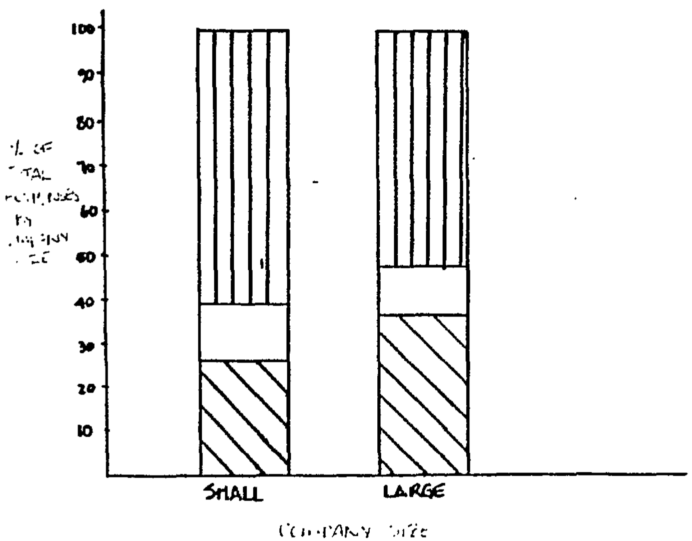






(38) CHANGES REQUIRED IN PROGRAM TO BETTER SUIT COMPANY NEEDS

	Mean
ELIGIBLE COSTS	28%
PROGRAM RICHNESS	12%
PROGRAM DELIVERY	60%



APPENDIX G

CONTENT ANALYSIS METHODOLOGY AND CODING
FOR E.D.P. FILE REVIEW

Section:

1.0 Information from EDP File Review

2.0 Notes to File Review Guide and Content Analysis Methodology

3.0 File Review Guide

APPENDIX G

CONTENT ANALYSIS METHODOLOGY AND CODING FOR E.D.P. FILE REVIEW

The EDP file review involved the interpretation, coding, collection and analysis of information in project files. Section 1 of this appendix summarizes the information collected from the project files. Section 2 outlines the content analysis methodologies used for the critical interpretation of project risk and innovation (product development) phase. Section 3 indicates the coding scheme for the content analysis.

1.0 INFORMATION FROM EDP FILE REVIEW

As a result of a logical data requirement analysis and a file review pre-test the following elements of information were collected from EDP file reviews:

1.1 **Project Specific Information**

- Project Name – Project Number
- Project Description – Process Product
  - Project Sector
- Province
- EDP contribution
- Company project expenditure
- Total project cost
- Implementation cost (estimate)
- Timing – Estimated project time
  - Actual

• Risk	- Project (Technical), human resources, market, financial, overall
	- Element of highest risk
• Markets	- Domestic, export
• Product Sales	- Projected
	- Actual
• Innovation Phase(s)	- Market assessment, research, development, market testing, manufacturing start-up, marketing start-up
• Employment Considerations	- Technical, production, marketing
	- Total

1.2 Firm Specific Information

• Firm sector	
• Firm size	- sales, exports, domestic
	- employees
• Firm age	
• Past government assistance	
• Past R&D investment	

1.3 Firm Specific Financial Information

• Sales	- exports
• Assets	
• Working capital	
• Liquidity	
• Tangible net worth	

2.0 NOTES TO FILE REVIEW GUIDE AND CONTENT ANALYSIS METHODOLOGY

2.1 Variable Name: Risk, Field Numbers 13-18

Objective and Rationale:

Innovation assistance is intended to assist projects which are extra-marginal or which would not be performed otherwise, or, in the same way, by the company developing the product/process. For this reason, some element of funded projects must have a risk of failure which makes the project not feasible without government assistance. (Assuming that the project was extra-marginal or incremental - see discussion on incrementality.)

In the model project submission, various elements of risk are considered ex ante the project including project (or technical) risk, human resources (or management) risk, financial risk, and market risk. In addition, an overall assessment of risk is made.

Analysis of the various ex ante risk assessments made by project officers for innovation projects can be used in several ways to assist analysis:

i. Risk can be analyzed as to its magnitude by sector, by region, and by other firm characteristics;

ii. The element(s) (project, human resources, financial, marketing) of highest risk can be analyzed by sector, region and firm characteristics;

iii. Significant trends between ex ante risks identified by project officers and project performance can be identified.

For coding the element of highest risk, statements indicating that one element is highest are taken as well as charts, tables, short statements, etc. which clearly show one element to have a higher risk rating than the others. In the case of a tie between risk weightings, (e.g. project and financial are both ranked high) then the highest element of risk is ambiguous and a 9 is coded.

2.2 Variable Name: Innovation Phase (IP) - Field Numbers 22-27

Objective and Rationale

Innovation assistance has been targetted in the past at specific segments of the innovation process (see Working Paper on Innovation). The future core program will change this coverage to include activities related to developing a research capability (applied research) and will shift feasibility studies into a separate form of assistance.

In order to assess the appropriateness of such changes, it will be useful to understand what types of activities were funded in the past. Part of this information will be picked up in firm personal interviews, but in order to enlarge the scope of companies for which funded activities are analyzed, it will be useful to perform a content analysis on the work statement of company project submissions.

For example, firms in certain sectors/regions may tend to engage in more applied research activities than firms in other sectors/regions. This kind of information would be useful in helping to plan program design and resource allocation.

Analysis of magnitudes and relative magnitudes of risk (i, ii) can profile innovation projects receiving assistance. Firstly, trends associated with other variables (sector, region, firm size, etc.) can be identified in order to show first order indications of adequacy, and project incrementality (e.g. market risk may predominate for projects in certain sectors/regions. This could show the low technology of the innovation and/or might indicate a need for linked marketing assistance in this area. Further analysis using interviews and expert opinion could pursue preliminary observations made by the content analysis). Secondly, a content analysis of ex ante risk determination could be compared to subsequent project performance to identify trends in risk assessment and project outcome, i.e. there is a general hypothesis among several departmental officers that inadequate marketing is responsible for many project failures - see Analysis of PAIT Failures - 1974 mimeo; if high market risk is associated with low commercial success (low product sales estimates) then such a hypothesis may be confirmed by ex ante risk analysis. Thirdly, content analysis of ex ante risk can be used to cross-check the validity of ex poste statements made by the companies about risk (i.e. hindsight is always 20-20, therefore comparisons of perceived risk before and after could highlight needs for improved analysis and project selection criteria etc.).

Concept Definition

Risk is defined as risk of failure.

Operationalization (Content Analysis Decision Rules)

The operationalization of the content analysis of project submissions regarding risk includes the analysis of the section Summary of Risk in the model submission, and any other reference(s) of risk as they (it) appear(s) throughout the submission text.

Operational definitions are based on both words and themes. Where the key words high, medium or low are stated with reference to particular elements project (technical), human resources (management), marketing, finance) then this statement is taken as the definition of risk for that element. Synonyms for these key words include the following:

Concept - Variable	Key Words Associated with Element
Concept of High Risk: Value = High = 3	high, severe, big, heavy, extreme, inordinate, dangerous
Concept of Medium Risk: Value = Medium = 2	medium, moderate, normal
Concept of Low Risk: Value = Low = 1	low, light, inconsequential

In cases of ambiguity or contradiction, the more direct statement of risk is taken such as would be shown in a chart, graph or table or in a short statement (i.e. "Financial risk is considered low" takes precedence over "Financial risk could be extreme if project delays are encountered").

Concept Definition

Innovation Phase Activities

For the purpose of content analysis the innovation phases were broken down into the following elements:

1. market assessment
2. research
3. development
4. market testing
5. manufacturing start-up
6. marketing start-up

This breakdown was based on several factors:

- The division of activities generally correlates with the breakdown used by Stats Canada, Economic Council, and U.S. researcher Ed. Mansfield.

- The separation of marketing activities (especially market testing) from others reflects a realization that marketing activities take place in various forms and at various stages of the product development cycle. (Market testing, for example, is included in Development under the ECC definition but is separated here because official program regulation would not support such activity.)

- A cursory analysis of EDP program files over the period 1977-82 indicated that the above segments appeared to be generally divisible in most cases.

Operationalization

The content analysis is performed on the Statement of Work section of a model submission including both the general description of tasks and activities and any time charts (GANT, PERT, CPM etc.) which list one word descriptions of project tasks.

The operational definitions of the innovation phases include both key words and general themes. These themes, and their associated key words, are listed below:

1. Market Assessment - Refers to a stage in the product development cycle where a preliminary study is made of the profit potential involved in developing a specific product.

   Key Words - business assessment, assessment of competitors, feasibility study, profitability assessment.

2. Research - Refers to original investigation undertaken in order to acquire a new knowledge. This could include basic or applied research (found to be indistinguishable for most companies). It involves the consideration of the available knowledge and its extension in order to solve particular problems. Such work would normally be conducted in a laboratory by highly specialized staff.

Key Words - analysis of...(name phenomena such as tensile strength, corrosion, etc.), laboratory testing, basic, applied research, scientific data collection, testing performed prior to construction of a prototype, experiments prior to prototype construction)

3. Development - The concept development encompasses the work required to take a new product, process, or procedure from the applied research stage to the demonstration of feasibility.

Key Words - engineering, layout, design, prototype construction, pilot plant construction, prototype testing.

4. Market Testing - The concept involves the trial of a new product or prototype in the marketplace. This step would usually occur before true manufacturing or production start-up since alterations to the product could be made as a result of the test.

Key Words - trial marketing, test marketing, consumer trials of prototype.

5. Manufacturing Start-Up - The manufacturing start-up stage would include the preparatory activities required for full-scale production.

Key Words - tooling, plant arrangement, industrial engineering, tooling (acquisition of equipment & tools for production, production start-up, construction of additional plant and/or production equipment)

6. Marketing Start-Up - The marketing start-up stage includes all activities, conducted near the end of the project which would be required in selling the product.

Key Words - promotion, advertising, marketing, preparation of marketing plan, development of market approach.

3.0 File Review Guide

3.1 PROJECT SPECIFIC INFORMATION	Variable Name	Field	Length
Project Name - Year + Project No. from Submission	-	1	6
Project Description -			
- Product, Process	-	2	1
1 - Product 9-N/A*			
2 - Process			
3 - Both			
- Project Sector -		3	2
- Chemical Based -			
Food & Beverages 01			
Rubber & Plastics 02			
Textiles 03			
Petroleum Prod. 04			
Drugs & Medicines 05			
Other Chem.Prod. 06			
- Wood Based -			
Wood 07			
Furniture 08			
Paper 09			
- Metals -			
Primary Metals(F) 10			
Primary Metals(NF) 11			
Metal Fab. 12			
- Machinery & Transp.			
Machinery 13			
Aircraft + Parts 14			
OtherTransp.Equip. 15			
- Electrical -			
Elec. Products 16			
Scientific Instr. 17			

*9 is the designation for unkown or not available in all cases except where specified.

	Variable Name	Field	Length
- Other Industries -			
Mineral Prod. 18			
Other Mfg. 19			
Utilities 20			
Non-Mfg. 21			
Clothing 22			
Footwear 23			
Province - Province No.	Prov.	4	2
Nfld 01			
N.S. 02			
N.B. 03			
P.E.I. 04			
Qué 05			
Ont. 06			
Man. 07			
Sask. 08			
Alta. 09			
B.C. 10			
N.W.T. 11			
EDP contribution - Amt.($000s)		5	6
Company Project Expenditure - Amt.($000s)		6	6
Total Project Cost - Amt.($000s)		7	7
Implementation Cost - Amt.($000s)		8	6
Timing - Est.Project Time(months)		9	3
- Actual Proj. Time(months)		10	3
. Risk - Project (technical) H=3,M=2,L=1		11	1
- Human Resources (mgt) H=3,M=2,L=1		12	1
- Financial H=3,M=2,L=1		13	1
- Market H=3,M=2,L=1		14	1
- Overall H=3,M=2,L=1		15	1

Variable Name	Field	Length
- Element of Highest Risk	16	1
Project 1		
Human Resources 2		
Financial 3		
Market 4		
. Markets		
(for product) - Domestic = 1	17	1
Export = 2		
Both = 3		
Doesn't Say = 0.9 (N/A)		
. Product Sales - $Estimated (999999=N/A)	18	6
- $Actual (999999=N/A)	19	6
. Innovation Phase - Market Assessment	20	1
1=yes		
0=No		
Business Assessment Evaluation		
- Research 1=Y,0=N		
- Development 1=Y,0=N		
(engineering layout design prototype pilot plant testing)		
- Market Testing 1=Y,0=N	23	1
- Mftg Start-up 1=Y,0=N	24	1
tooling		
plant arrangement		
plant expansion/new plant acquisition of equipment		
Marketing Start-up 1=Y, 0=N	25	1
design market strategy/approach		
distribution		
advertising		

	Variable Name	Field	Length
• Employment	Number of Jobs to be created by project		
	– technical	26	3
	– production	27	3
	– marketing	28	3
	– total	29	3

3.2 Firm Specific Information

• Firm Sector			
	– Sector Number (see field #3)	30	3
• Firm Size	– Annual Sales (000s) (latest Actual in submission)	31	7
	– % Domestic (999=?)	32	3
	– Annual Sales (000s) (1 before latest in submission)	33	7
• Firm Age	Years since commencement of operations	34	3
• Past Gov't Assistance	0=No, 1=yes contribution ITC/DREE	35	1
• Past R&D Investment			
	– Before latest Actual	36	5
	– Latest Actual	37	5
	– First Year Projected	38	5
	– 2nd Year Projected	39	5

3.3 Firm Specific Financial Information

• Assets	– latest Actual prior to submission	40	7
• Working Capital	– latest Actual prior to submission	41	6
• Liquidity	– current assets	42	6
	– current liabilities	43	6

	Variable Name	Field	Length
• Tangible net worth		44	7
• Latest Firm Financial Statistics	– Year	45	2
	– Sales	46	7
	– Assets	47	7
	– W.C.	48	6
			177

APPENDIX H

VALIDITY OF STUDY FINDINGS

SECTION

1.0 Introduction

2.0 Validity Framework

3.0 Explanitory Validity

4.0 Internal Validity

5.0 OCG Guidelines

6.0 Conclusion

APPENDIX H

VALIDITY OF STUDY FINDINGS

1.0 INTRODUCTION

The methodological literature of the evaluation field abounds with terms used to assess the "validity" of measurements/relationships (e.g. construct validity; convergent validity; predictive validity; face validity; internal validity; external validity; statistical conclusion validity). Each is a useful concept when applied to its particular aspect of the general problem of the validity of research information. In addition, the terms "reliability" and "generalizability" are part of a family concepts although they do not include the word "validity".

Since results from an evaluative study (e.g. the Innovation Element Evaluation) always require interpretation, and different clients, reviewers or users of the study findings are likely to make different interpretations, a framework for assessing the "validity" of the results -- where "validity" is appropriately defined and related to the particular aspect of interest is highly desirable.

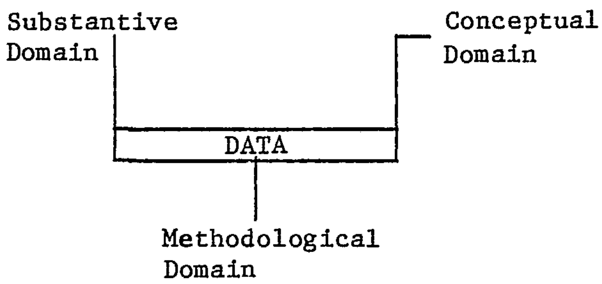
Such a conceptual framework, that relates all the above validity concepts to the research process, it presented in the paper: "A Network of Validity Concepts Within the Research Process" (authored by D. Brinberg and J.E. McGrath; in the 1982 Jossey-Bass Inc. monograph entitled Forms of Validity in Research). For our innovation element evaluation, the study was first contexted within this validity framework described below) in order to identify and minimize during all stages of development - "the threats to the study conclusions "derived from the sample data (and inherent evaluation design). For example, the OCG has documented eight "threats to internal validity" and three "threats to external validity" that each evaluation study should appropriately address through a rigorous design. Further comment on how these potential threats were addressed will be given later in the Appendix.

2.0 VALIDITY FRAMEWORK

In order to properly context the validity framework of an evaluative research study, a characterization of the research process (inherent in the study) is first required. The figure below grapically highlights the main domains of study during the research process underlying the Innovation Element Evaluation:

Figure 1

Main Domains of Study Research Process



Theme of Validity Framework:
- explanatory validity
- explaining a data set by construing it in terms of a set of concepts

The Substantive Domain involved the detailed examination (and hypotheses-setting exercises) of the key issues deemed most important for further study (i.e. regional suitability of terms and conditions; regional skewing; innovation assistance impacts on investment and employment). Section 3.1 and Appendix A contain further (selected) details from internal working papers on the background work for this domain of study. The Conceptual Domain involved the detailed investigation (i.e. background/literature review; definitional work-ups; cause-and-effect modelling; hypotheses-setting exercises) of the key concepts underlying the study itself; namely, the innovation process and incrementality, (project-level). Appendixes B, C and G highlight the study definitions and treatment of these concepts in the study definitions and treatment of these concepts in the study setting. The Methodological Domain involved the development of: survey instruments; a sample design; the associated data collection and analysis techniques; tabular presentations of data summaries; and, an approach to assessing the validity/reliability of the study findings (i.e. by a methodology(ies) that interfaced all major stages of the development process of the study). Sections 3.2, 3.3, 3.4 and Appendices E and G contain further (selected) details from internal working papers on the background work underlying the Methodological Domain of Study.

From Figure 1, we illustrate the research structure or style of the Innovation Element Evaluation study itself; that is, by combining the Substantive and Methodological Domains (i.e. operationalizing the study issues into survey questionnaires) a survey database was built up. The study data were then interpreted or explained in terms of the (predetermined) study concepts (e.g. by aggregating, segregating, contrasting, co-relating sets or subsets of the data), the final output being "an interpretable body of data". Essentially, the study team's approach (to achieving its original objectives) was to build and interpret a body of data.

3.0 EXPLANATORY VALIDITY

Given the above structure of the evaluative study, the theme or focus of the Validity Framework was then defined in relation to this structure (i.e. chosen style of development). That is, "explanatory validity" (EV) was chosen as the critical concept or measure to address, where EV centers on addressing the key questions:

- to what degree do the chosen concepts account for the study findings?

- are there alternative, equally plausible, conceptual explanations for the findings?

- to what extent do the (sample) findings generalize over the areas (Substantive, Methodological or Conceptual elements and relations not yet studied? or, how robust are the findings?

The use of complementary surveys (i.e. government program officers and outside experts), in conjunction with external database comparisons (e.g. Statistics Canada; B&D; ECC) and an extended EDP file analysis, constituted the primary methods for assessing the "explanatory validity" of the study findings. Appendix J contains further details on the use of these sources.

4.0 INTERNAL VALIDITY

In addition to the above focus on "explanatory validity", which can also be thought of as a forum of "external validity", the project team addressed the "internal validities" associated with the ongoing development and implementation of the study itself.

Specifically, at the basic element/data item - level of the study, concern with the "reliability" of response (i.e. the internal consistency of stability of respondents' answers) centered mainly on measurement error associated with the survey instruments. For example, unreliable responses (data) would likely result from: inconsistent application of the questionnaires by the interviewers; inconsistent coding of the questionnaires; fatique on the part of the respondent and/or the interviewer; and so on.

At the inter-data element/relations - level, concern with the "statistical conclusion validity" of the response (i.e. the statistical distribution, summary, or profile of the respondents' answers) centered mainly on the potential misuse (or violated assumptions) of the underlying key concepts models addressed in the study (e.g. innovation process; incrementality). For example, unreliable or invalid responses (data) would likely result from: inapproriate or incorrect application of the measures for project incrementality; misunderstanding of the innovation process as contexted by the survey questions leading to inappropriate responses; and so on.

5.0 OCG GUIDELINES

As a final note, a brief discussion with respect to the OCG's evaluation guidelines on "threats to the validity of conclusions" is warranted. Although their guidelines represent a different research structure or style from ours (i.e. their validity framework is more akin to "building, implementing and validating a research design", that emphasizes different validity concepts than our design), it is still worthwhile to context our validity framework within their classification scheme. A wide set of factors may potentially confound the interpretation of findings resulting from a particular evaluative design/study. These factors (as given by the OCG) are presented as:

5.1 Types of Threats to Internal Validity

i) History - events external to the program which affect the responses of those involved in the program

ii) Maturation - changes in the program outcomes that are a consequency of time rather than the program (e.g. participant aging)

iii) Mortality - respondents dropping out of the program (this might undermine the comparability of the experimental and comparison groups)

iv) Selection bias - the experimental and comparison groups involved in the program are initially unequal with respect to their propensity to respond to the program

v) Regression artifacts - pseudo-changes in outcomes occuring when persons or treatments units have been selected for the program upon the basis of their extreme scores

vi) Diffusion or Imitation of Treatment - respondents in one group learn the information intended for others

vii) Instrumentation - the measuring instrument may change from one measurement to the other (e.g. when different interviewers are used)

viii) Testing - changes observed may be due to familiarity with the measuring instrument; and,

ix) Selection and Program Interaction - unrepresentative responsiveness of the program participants due to being aware of being in the program or to the measurement method.

x) Setting and Program Interaction - unrepresentativeness of the setting of the experimental or pilot program.

xi) History and Program Interaction - conditions under which program took place are not representative of future conditions.

5.2 Study Counter-Actions to Threats

Briefly addressing each (potential) threat noted above, the following remedies or counter-actions were employed in the design of the Innovation Element Evaluation:

for (i):	the use of government and expert surveys
for (ii)	the design and implementation of a longitudinal sample from 1978 to 1982
for (iii):	the scoping-out/elimination of bankrupt or non-active firms
for (iv):	the use of a highly stratified (i.e. regional; sector; size of firm) sample of firms was developed in order to "best represent" the target populations
for (v):	no formal data analysis/modelling (e.g. regression analysis) was necessary (or intended) for the chosen design
for (vi):	selected firms were independent of one another (multiple/repeat grant firms were reduced to one application/grant situation); also, more than one interview was used in the implementation of the design
for (vii):	instruments were developed in the light of previous knowledge and experiences from similar studies (first and second-hand); internal question-by-question rating methodology was employed to rank question variability/stability/ consistency of response across team interviewers
for (viii):	standardized coding and training procedures; pilot testing for all instruments
for (ix), (x) & (xi):	application of a highly stratified sample design and rigorous survey implementation methodology (e.g. complex concepts and substanctive issues

were supported by detailed team working papers) for firms were used in parallel with the government and expert surveys, and independent, external database comparisons; also, the study was primarily intended to provide relevant, indicative and timely results (i.e. major findings, conclusions, implications and recommendations) related to four predetermined study issues for a number of senior/regional managers and clients of the IRDP

6.0 CONCLUSION

The main qualifications pertaining to the study design and findings are imbedded in the text of the report as "cautionary notes", but only when the related findings warrant such treatment; otherwise, the underlying "data quality" that support the statements in the text is deemed satisfactory in a non-statistical, judgemental sense. In other words, strong indicative evidence can be inferred to exist in support of these statements in the text where no cautionary notes are given.

APPENDIX I

PERTINENT STUDIES REFERENCED

SECTION	
1.0	Innovation and Technological Change in Five Canadian Industries (ECC)
2.0	A Strategic Approach to Promoting Industrial Innovation and Productivity (ITC/DREE)
3.0	Technological Innovation Studies Program (ITC)
4.0	The Costs of Technological Innovation (Statistics Canada)
5.0	Approaches to an International Comparison of Canada's R&D Expenditures
6.0	Comprehensive Audit of EDP (ITC)

PERTINENT STUDIES REFERENCED

During the research phase of this study a number of sources were referenced with regard to their contribution to knowledge about the innovation process in Canadian firms and DRIE program assistance.

Some of the most important studies referenced included the following:

1.0 INNOVATION AND TECHNOLOGICAL CHANGE IN FIVE CANADIAN INDUSTRIES

D. DeMelto, K. McMullen, R. Wills
Economic Council of Canada and
Industry Trade and Commerce
October 1980

The study collected information on 284 inovations in 174 firms in 5 sectors.

Our study adopted the basic product development - innovation model used by the study. We also performed our own analysis on the data base generated by the study with regard to project funding and, government assistance. The study is generally referred in the text as the 'ECC study'.

It should be noted here that while the ECC study dealt with innovation in Canadian industry, there are several significant differences from our study. Firstly, in the ECC Study, only 'winners' were examined in terms of innovation. Secondly, both gov't assisted and non government assisted projects were studied. Thirdly, because the survey was a mail-out questionnaire, the respondent sample has a much greater proportion of large firms than our study and the actual population. (Only 35% of the ECC study firms had less than two million in sales v.s. 80% in our study and over 85% in the general Canadian population.)

2.0 A STRATEGIC APPROACH TO PROMOTING INDUSTRIAL INNOVATION AND PRODUCTIVITY

Internal department document April 3, 1983

The policy paper outlines a strategic policy approach to guide the innovation and productivity policies and programs of the Department of Regional Industrial Expansion.

Our study tested some of the hypotheses stated in this document with reference to the innovation model adopted from the ECC study.

Our findings generally support the hypotheses generated by the study regarding product development cycle coverage "gaps" and provides some information regarding incrementality, expansion of innovation capabilities, and firm financial burdens.

3.0 TECHNOLOGICAL INNOVATION STUDIES (TIS) PROGRAM

Several TIS studies were referenced with regard to their findings, study methodologies and questionnaire design. Some of the more important studies referrenced were:

A Study of Some Variables Relating to Technological Innovation in Canada — J. Watson, June 1975

Assessment of R&D Project Evalution and Selection Procedures

I. Vertinsky, S.L. Schwartz, Dec. 1977

Project New Prod: What Makes a New Product a Winner?

R. Cooper, July 1980

4.0 THE COSTS OF TECHNOLOGICAL INNOVATION

H. Stead, Statistics Canada
Research Policy, 1976

The study breaks down R&D costs as a percentage of total product development costs. The study is based on a sample of 57 firms in similar sectoral categories as our study. The conclusion of the study is that R&D costs make up the majority of new product development costs.

Our findings corrborate the findings of this study. (R&D and design-development makes up 59% of total product development costs in the Statistics Canada Study; R&D and design-development averages 58% of total product development costs for the 120 firms surveyed in our study.)

5.0 APPROACHES TO AN INTERNATIONAL COMPARISON OF CANADA'S R&D EXPENDITURES

K. Palda, B. Pazderka

The study develops a predictive model of R&D intensity based on OECD R&D data for seven industrial sectors.

Our study reviewed some of the independant variables used as determinants of R&D intensity on a macro level.

Our findings generally corroborate findings that government contributions are not important determinants of R&D intensity.

6.0 COMPREHENSIVE AUDIT OF THE ENTERPRISE DEVELOPMENT PROGRAM

- Internal Audit Branch 1980

The study performed a comprehensive (internal) audit of the EDP during 1979-1980. The study reviewed the systems procedures and controls in place for program delivery.

Two findings were of particular importance to the study. Firstly, it was observed that delivery was slow (A survey of over 200 projects produced an estimate of about 9 months between application and receipt of funds for product development grants.) Secondly, recommendations were made for better monitoring and information collection on impacts. Our study findings support the need for improvements in these areas.

APPENDIX J

INFORMATION SOURCES AND DATA COLLECTION

SECTION

1.0 Literature Review

2.0 EDP Files

3.0 Firm Survey

4.0 Government Survey

5.0 Expert Survey

6.0 External Databases

7.0 Data Quality

APPENDIX J

INFORMATION SOURCES AND DATA COLLECTION

1.0 LITERATURE REVIEW

An extensive literature review of a number of important information sources was conducted at the onset of the study. Generally, the review included:

- data sources and documents pertinent to the IT&C/DREE innovation and innovation-related programs;
- previous program studies, such as EDP evaluation assessment and DIPP evaluation;
- innovation literature
- incrementality measurement methodologies.

Of particular note, the review of the innovation and incrementality concepts led to separate internal project team working papers on these topics. In the innovation paper (see Appendix B) a definitional work-up of the term innovation and the underlying innovation process is outlined, followed by an analysis of the IRDP with respect to its innovation coverage and treatment. A causal model for innovation, applied to the context of the study objectives, was developed in conjunction with a general data analysis stratagem for subsequent analyses.

In the incrementality paper (see Appendix C) a number of current and traditional approaches to the analysis of incremental effects is discussed. A working definition of project-level incrementality was chosen for the purposes of addressing the study issues. Company-level, sector/market-level incrementality was deemed out-of-scope for this study. This exclusion was mainly due to the many confounded (and unknown) factors that influence these incrementality-type analyses. A glossary of terms related to the study is contained in Appendix D.

2.0 EDP FILES

Detailed EDP/STEP program information is available from the ITC/DREE file review database. Project file reviews of approximately 160 project files were used to provide information on program element assistance. The general areas of information gathering included:

- project specific data
- firm specific data
- firm specific financial data
- some updated data from survey results.

The information gathered on the project includes:

- project name and brief description
- categorization of supported activities
- project cost
- government contribution
- project risk assessment:
  - human resource
  - financial
  - technical
  - marketing
- timing and duration of project
- projected cash flows
- employment effects
- actual cash flows
- product or process
- work statement product development activities.

The information gathered on the firm includes:

- location of project activity
- company age
- company size (sales, assets, tangible net worth, persons employed)

- sector
- company risk (human resources, financial resources)
- participation in past government projects.

The firm specific financial data includes:

- R&D investment over time
- sales over time
- statistics from financial statements at time of submission
  - working capital
  - current assets and liabilities
  - total assets
  - tangible net worth
  - sales
- Dun and Bradstreet and survey updates on the above data for the latest year available.

See Appendix G for a further discussion of the file review methodologies.

3.0 FIRM SURVEY

A 39-item questionnaire used for both the telephone and personal firm interviews, was developed and pilot-tested by the project team, as part of the operationalization of the study plan. A model of the innovation process and for measuring project incrementality were implemented through various questions, which lent support from similar applications (e.g. 1980 Economic Council of Canada innovation study; 1981 IT&C consulting project re: incrementality measurements; 1973 joint Arthur D. Little/Industrial Research Institute study sponsored by National Science Foundation on "Barriers to Innovation in Industry").

The developent of the questionnaire was also scrutinized and approved by Statistics Canada. Appendix E contains a copy of the final firm survey questionnaire.

The questionnaire stressed an open-ended approach where the onus was on the interviewers to reliably code the respondent answers. From previous experiences of target populations and issues similar to this study, it was judged that the "best quality" data could be obtained by allowing a free-flowing, contentual question-and-answer dialogue between the interviewer and the interviewee. The survey "questionnaires" themselves were, therefore, used as much as an ongoing, data recording and analysis tool as a straightforward sequence of questions to pose to the respondent.

This method of data collection demanded a high degree of coding standardization, cross-checking and collaboration among team interviewers, which was accomplished through a series of project team meetings spaced throughout the data gathering process.

The personal interview questionnaire took between one and two hours to complete, while the telephone interview averaged one to one-and-one-half hours. Most questions from both surveys were answered in an adequate manner. Problem areas were discussed at length by team members, whereupon data analysis implications for such area were carefully defined and documented. For example, for those areas in the issue analysis where problem areas related to the data collection phase surfaced (e.g. poor response/coding or inconsistency of response with independent/expert souce data), appropriate cautionary notes were included in the study findings. Appendix F contains a summary of the firm responses by region and sector.

Specific innovation outputs of the study for each major issue (at the national level, and regional level of disaggregation where appropriate) included:

- baseline information on program usage (both past and future);
- company-level data (both financial and opinions of senior manager) related to the supportive program, e.g. such data included economic impact data on measures on incrementality, investment in R&D, and employment;

- Specific company senior management perceptions of acceptance or usefulness of the innovation support program, including indicators and insights on program constraints or limitations to company usage both past and future, e.g. this aspect of the study included a discussion between the interviewer and respondent of the potential impacts of the new program design and future use of all innovation element programs;
- Profiled regional perspectives in terms of:
  - perceived innovation needs of senior company managers;
  - sectoral strengths and weaknesses;
  - marketing intelligence related to innovation support programs.

4.0 GOVERNMENT SURVEY

A 32-item questionnaire, used for interviewing government innovation program policy and delivery officers, was developed and pilot-tested by the project team, as part of the study design-scheme to augment any information gaps from the firm survey. In addition, the government survey provided a regional overview and perspective of the study issues, in particular, and gave insight to the perceived usefulness of the government programs to promote innovation capability in the regions, in general.

Appendix E contains a copy of the final government survey questionnaire.

The questionnaire stressed an open-ended approach to the questions, with an underlying rationale similar to the firm survey questionnaire. Length of interview ranged from thirty minutes to two hours.

Each issue was carefully analyzed (especially from the answer sets given in the firm survey questionnaire) and assessed, both individually and as a group by the study team interviewers, for overall completion and consistency of response. Thus complementary government official survey data was used to calibrate, test, verify and critique the main survey data (i.e. the firm data).

5.0 EXPERT SURVEY

A 26-item questionnaire, used for interviewing selected innovation program experts, was developed and pilot-tested by the project team, as part of an independent backdrop or impression (i.e. in contrast to the firm interview data) sought on the innovation needs specific to each region.

The questionnaire stressed an open-ended appraoch to the questions, with an underlying rationale similar to the firm survey questionnaire. The interview took between forty minutes and three hours to complete. Each issue was carefully analysed (especially relative to the firm data sets) and assessed, both individually and as a group by the study team interviewers for overall completion and consistency of response.

6.0 EXTERNAL DATABASES

A "database survey" task was carried out in parallel to the preceding study activities. The main purpose of the database task was to provide a set of reasonably objective (e.g. independent, quantitative) data that can be compared, contrasted and assessed in relation to the firm interview data collected by the study team. Consultations were made, for example, with representatives of the Economic Council of Canada, Small Business Secretariat and Statistics Canada to identify complementary databases and studies which may be of use as background information for the study.

Five main sources of data were analyzed in detail in the above context: EDP file reviews; a 1980 ECC/IT&C innovation study, the Dun and Bradstreet financial profiles of Canadian firms; Small Business Secretariat data on business size, financial and sector profile distributions; and Statistics Canada baseline R&D

expenditure data. Only the ECC, D&B and SC databases were actively pursued for the purposes noted. Each database is briefly described below.

6.1 ECC/IT&C Innovation Study

During 1979-80, the ECC conducted a joint innovation study of Canadian firms with IT&C. In total, 174 firms were surveyed, with detailed interview information (e.g. 3 hour interviews) collected from 54 firms.

Data on 284 innovations were reported, which covered five industrial sectors; namely,

(a) Electrical Industrial Equipment
(b) Smelting and Refining (non-ferrous)
(c) Plastics, Compounds and Synthetic Resins
(d) Crude Petroleum Exploration + Production
(e) Telecommunications Equipment + Components

Detailed insight on both government-assisted and non-governmental assisted innovative firms was gained from a systematic analysis of their computerized database. ECC followed a similar approach as our study team in their development of an operational model for characterized the innovation process. This aspect of their study, along with the complementary non-assisted firms, assisted the study team in comparing, contrasting and interpreting our results.

6.2 Dun & Bradstreet Financial Profiles

Resident within IT&C is the D&B database on Canadian businesses. For the purposes of our study, two distinct database analyses using this file were suggested.

(1) For the selected (interview) companies, a separate, individual D&B search and basic data profiling analysis was undertaken. These data were compared with the EDP file review data and with the interviewees' answers. These comparisons served to independently assess the survey responses (i.e. address the issue of external reliability/validity), and also provided useful additional and/or complementary data to the field (firm) data; and

(2) For pre-specified company profiles, the D&B database was used to portray the background context re: industry/sector/regional business size groupings. The firm survey/interview data were then compared/contrasted to these broad profile data in order to obtain further insight, interpretation and, to some extent, reliability/validity of our findings. The subset of the general D&B database being in the six broad SIC groupings used in this study numbered 30,000 firms, which is 8% of the total D&B firms.

6.3 Statistics Canada R&D Data

Statistics Canada published such R&D statistics as:

- Current Intramural R&D expenditures by industry
- Capital Intramural R&D expenditures by industry
- Total Intramural R&D expenditures by industry and by region
- Current Intramural R&D expenditures by company sales size
- Sources of funds for Intramural R&D expenditures by industry
- Number of persons engaged in R&D by industry by category, and by region.

Although the data are published in aggregated form, upon some re-working of the sector groupings used in the study, a useful set of data was derived to guide, compare and assess our firm survey responses. Of particular relevancy, the SC: R&D expenditure data over time provide useful indicators or measures of innovation activity (i.e. using the R&D performance indicator: R&D expenditures over sales) in the context of both the EDP file review database comparison and the actual firm data profiles over time.

7.0 DATA QUALITY

The detailed context, scope and methodological assumptions underlying the sample data obtained for each program were addressed at the initial design stage, through the data collection process in the field, to the final stages of data analysis. The ultimate goal of the study design from a methodological perspective was to produce a relevant reliable body of data that is clearly interpretable vis-à-vis the study objectives.

Since different users/clients are likely to make different interpretations of the evaluative findings, a framework for assessing the validity and generalizability of the study results was developed. A more detailed discussion of this "data quality" framework is contained in Appendix H.

Given the small sample size of the study, the simplest and minimum criterion for assessing the quality of the data is "face validity" argumentation; that is, rigorously assessing the data findings (including implications, conclusions and recommendations) in light of the expert survey results, the government (program managers) survey results, and the external, independent database comparisons (e.g. Statistics Canada baseline R&D expenditure data; D&B financial profile and trend data).

In operationalizing this validity framework, the study team sought more than one perspective in the key issue development stage from its advisory and steering committee members; and built a free-flowing series of questions or probes into the field "questionnaire" (which was also used as a data recording and analysis instrument) in order to minimize the respondent's tendency to answer inappropriately (e.g. out of context) or in a constrained (artificial) sequential manner.

During the analysis stage, the collected qualitative survey information was critiqued and screened for consistency and reliability/validity of response. Unreliable responses (e.g. perceived high likelihood of out-of-context/"guess" response) were re-coded as non-responses, thus minimizing the potential bias they may have on the more reliable response set of data. In this manner, the reliable sample data were then used for projecting or entertaining inferences on the target populations of each program (i.e. all firms eligible for innovation assistance).

Generally speaking, the firm questionnaire was answered quite satisfactorily in terms of "face validity" credibility, validity and reliability arguments. One exception, however, was the "uncertain reliability" rating given to those questions concerned with self-reported firm/project-level cost data. Subsequent study implications, conclusions and recommendations derived from such data were, therefore, treated with caution in the text; this caution extends in particular to those readers interested in more disaggregated data analyses and summaries from the study's database using these cost data.

In summary, although the sample design of the study prevents us from obtaining statistically-valid (i.e. definitive) findings, nevertheless, strong indicative findings for the target population of the principal innovation program, EDP - substantiated by both quantitative and qualitative evidence - were obtained. Supporting quantitative evidence (e.g. using the ECC, D&B and Statistics

Canada databases) are appropriately highlighted in the text under the detailed analysis of each issue. Similarly, supporting qualitative evidence (e.g. independent assessments by government program managers and experts) is also noted in the text. Overall, the study was judged by its team members as highly successful in addressing the broad innovation and regional issues concerning: suitability; skewing; investment/incrementality benefits; and employment impacts of the innovation programs.