Science Council of Canada
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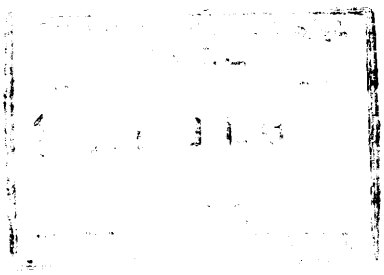
Partners in Industrial Strategy

The Special Role of the Provincial Research Organizations

Donald J. Le Roy
Paul Dufour



Background Study

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Partners in Industrial Strategy

The Special Role of the Provincial Research Organizations

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The Special Role of the Provincial Research Organizations

Donald J. Le Roy
Paul Dufour

Donald J. Le Roy

Donald J. Le Roy graduated from the double honours program in physics and chemistry and subsequently received his PhD in physical chemistry at the University of Toronto. After a period of research at the Ontario Research Foundation and the National Research Council (NRC), he spent over 25 years as a professor, including ten years as Chairman, in the Department of Chemistry at the University of Toronto. From 1969 to 1974, he took leave to serve as Vice-President (Scientific) of NRC, where he was responsible for its University Grants and Scholarships Program. After completing this term appointment, he chose to remain in Ottawa as a Principal Research Officer of NRC. He has been with the Science Council since 1979, where he holds the position of Special Adviser.

Paul Dufour

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UPDATE — 4 November 1983

Recent Appointments (cf. page 109)

Alberta Research Council:
Dr. Robert Green has been named Deputy President

New Brunswick Research and Productivity Council:
Dr. R.S. Boorman has been appointed Executive Director

Ontario Research Foundation:
Mr. W.P. Midghall has been appointed President

Saskatchewan Research Council:
Mr. Jim Hutch has been appointed President

Name Change

The branch of the Department of Supply and Services designated as the Science Centre in the study has recently been designated as the Science and Professional Services Directorate.

Provincial Ministries

Manitoba (cf. page 17)
The Manitoba Research Council is now associated with the Department of Industry, Trade and Technology.

Prince Edward Island (cf. page 111)
Industrial Enterprises Incorporated, the P.E.I. Market Development Centre and the Metals Industries Technical Support Centre now report to the Minister of Industry.

ERRATA

Page 37-Table II.4
CRIQ, 21.3
Should read
CRIQ, 23.1

Page 110
DELETE — Hariette de Kovan, Manager, Industrial Policies Branch, Ontario Ministry of Industry and Trade, Toronto

Foreword

Since its inception, the Science Council has had a continuing interest in the development of the research infrastructure in the provinces. The Provincial Research Organizations (PROs), specifically, were the subject of *Research Councils in the Provinces: A Canadian Resource.* Since the publication of that background study in 1971, much of the environment within which the PROs operate has changed. Both the federal and provincial governments have developed industrial and technological strategies and initiatives which implicate the PROs. Also, attention has focussed increasingly on addressing the needs of small and medium-sized businesses through various policies and institutions. As organizations with federal, as well as provincial connections, the PROs constitute a critical element in dealing with these matters.

It seemed appropriate, therefore, that the Science Council should look into the way in which the PROs have adapted to, and are affected by, this new environment. The result is *Partners in Industrial Strategy: The Special Role of the Provincial Research Organizations* by Donald J. Le Roy and Paul Dufour. This study contributes to the understanding of the role of the PROs as instruments for assisting small and medium-sized businesses, and provides an overview of current provincial and federal policies with which they have to contend. It also examines their relationship with the various sectors – industry, government and university. Specific recommendations are made which, if implemented, could serve to remove some serious impediments to their greater effectiveness. The work complements well Council's other initiatives in related areas, such as *Threshold Firms: Backing Canada's Winners* and *The Challenge of Diversity: Industrial Policy in the Canadian Federation.*

This study represents the authors' views, and not necessarily those of Council. It is an important contribution to our understanding of these unique, quasi-governmental organizations, and the Science Council is pleased to make it available to the public.

James M. Gilmour
Director of Research
Science Council of Canada

Acknowledgements

A number of people assisted greatly in carrying out this study. We would like to mention Maureen Carpenter, in particular. Thanks are also due to Frances Anderson and Olga Berseneff-Ferry for providing some of the historical background on the PROs; to Frances Bonney, Faye Borden, Francine Benoit and Elinor Clark, the library staff of the Science Council, for their marvelous assistance; to Lise Parks and Catherine Hopwood for preparing the manuscript. Finally, to all of the individuals who gave up their time to provide background information for the study and whose names may have been omitted in Appendix 3, our special thanks.

D. J. Le Roy
P. Dufour

I. Introduction and Overview

This study is about eight organizations: the Nova Scotia Research Foundation Corporation (NSRFC), the New Brunswick Research and Productivity Council (NBRPC), the Centre de recherche industrielle du Québec (CRIQ), the Ontario Research Foundation (ORF), the Manitoba Research Council (MRC), the Saskatchewan Research Council (SRC), the Alberta Research Council (ARC) and B.C. Research (BCR).

When these organizations were referred to in the 1970 report of the Senate Special Committee on Science Policy[1] as "The Provincial Research Organizations" (PROs), there was little doubt as to their identity. At that time, each of them held a unique position within its particular province, as the sole quasi-governmental, not-for-profit provincial agency dealing with the twofold objective of undertaking R&D of particular interest to the province, and providing technological assistance to industry. This uniqueness of the PROs extended far beyond provincial boundaries. A.H. Wilson, in a Science Council background study published in 1971, observed that "while several countries have institutes equivalent to our National Research Council, none has quite the same broad range of industrially and regionally oriented institutes in its states, provinces or districts."[2]

In 1969, Dr. E.J. Wiggins, President of ARC, testifying before the Senate Special Committee on Science Policy, offered an explanation for this situation:

> "The geographical dispersion of the Canadian population has caused the provinces to feel that their scientific and technological needs could not always be met by the central government, due to both distance and regional differences. Also, they have undoubtedly felt that an independent effort would give them an

advantage in developing their local economy and in broadening their industrial base."[3]

Dr. Wiggins's comment, albeit low key, epitomizes a characteristic feature of our federation. In Canada, the development of primary and secondary industry within its borders is a right which no province would willingly forego. One cannot visualize policies for industrial development being formulated and implemented through federal action alone. Despite their many differences, the PROs are viewed uniformly as agents for this development. Thus, their creation, although somewhat unique in the developed world, is entirely in keeping with the Canadian character.

The fact that in some provinces the establishment of the PROs took place much later than in others* was not because of any lesser concern for industrial development. Rather, it was a question of when the provincial authorities became convinced that the industrial development of their province could be stimulated through the agency of a provincially sponsored body specially dedicated to this purpose.** Two examples are cited.

Alberta was the first province to adopt this strategy. The Scientific and Industrial Research Council of Alberta was created by an order-in-council in 1921, "to ascertain more definitely the mineral resources of the country and the possibility of their development". This mandate was particularly significant because, at that time, Alberta had not yet succeeded in gaining legal control over its natural resources. It only gained this jurisdiction in 1930, and in the same year, it established the Research Council on a firmer basis through the Research Council of Alberta Act. Among the duties specified in the Act was "advising the Executive Council of Alberta on questions of scientific and technological methods affecting the expansion of industry or the utilization of the natural resources of Alberta".

The youngest of the PROs, CRIQ, was founded in 1969. Although its conceptual origins can be traced back many years earlier, it can be regarded as one of the many fruits of the Quiet Revolution. Its creation at the end, rather than at the beginning, of the lively decade of the 1960s did not arise through any lack of concern for the role of science in the development of Québec. Rather, it came as the result of the slow process of developing general recognition that provincial support was required, not only for the fundamental research of the

* ARC (1921), ORF (1928), BCR (1944), NSRFC (1946), SRC (1947), NBRPC (1962), MRC (1963), CRIQ (1969).

** Two provinces, Newfoundland and Prince Edward Island, have not yet established PROs. Newfoundland passed an act in the early 1960s that empowered the government to set up a Research Council, but it has never been implemented. More recently (1981), the government released a white paper, *Towards a Science Policy for Newfoundland*, which *inter alia* re-examined the merits of establishing a PRO. Some comments about the applicability of the PRO concept to these provinces are made in Appendix 2 of this study.

universities, but also for applied research, development and technology transfer on behalf of small and medium-sized companies.[4]

The PROs were not only established under quite different circumstances and at various times spread out over almost half a century; their constitutions are also diverse. MRC operates at present as essentially a branch of the Manitoba Department of Economic Development and Tourism, whereas BCR is an independent, nonprofit society incorporated under the Societies Act of British Columbia.

It is not difficult to find other ways in which the PROs differ. Consider, for example, the nature of the economies in which these organizations operate. In 1981, 19.9 per cent of employment in Saskatchewan was in agriculture and 5.8 per cent in manufacturing, whereas in Ontario, 3.4 per cent was in agriculture and 25.3 per cent in manufacturing.[5] Looking at the gross domestic product in the goods-producing industries of these provinces in 1980, the latest year for which data are available, in Saskatchewan, 41.6 per cent was in agriculture and 13.0 per cent in manufacturing, whereas in Ontario 5.7 per cent was in agriculture and 68.3 per cent was in manufacturing.[6]

Despite these and many other differences, the PROs have a great deal in common. Although all eight of them have the word "research" in their names, their purpose is not simply to carry out research. Rather, it is the much broader task of *making available the fruits of research that are likely to be beneficial to the province.* This is done in a number of different ways. In some cases it involves the actual carrying out of research and/or development. This can be either relatively long-term and exploratory in nature (frequently, but not necessarily, dealing with provincial resources and supported by provincial funds) or short-term, carried out for a client for a fee. In other cases, where the research has already been done, it is a question of bringing about technology transfer by making available technical information, advice, and know-how, and providing special analytical and testing services.

Each of the PROs does all of these things. Also, they provide many special services which vary in nature from province to province. For example, BCR and ORF maintain solar development test facilities for the National Research Council (NRC), ARC operates an Oil Sands Information Centre on contract with the Alberta Oil Sands Technology and Research Authority (AOSTRA), CRIQ publishes an up-to-date compendium of products manufactured in Québec, and NSRFC operates the Centre for Ocean Technology which, until recently, was partially funded by the federal Department of Industry, Trade and Commerce (IT&C). As a result, comparison of their activities is difficult.

The problem is further compounded when the PROs are asked to apportion time or expenditures into a limited number of arbitrary

categories. Table I.1 shows the total *current* expenditures of the eight PROs in 1981, together with their estimate of the percentage of these expenditures devoted to each of a list of activity categories specified by Statistics Canada. The relatively large percentage of expenditures assigned to the "Other" category, in some instances, seems to indicate that the categories used by Statistics Canada may not illustrate best what the PROs do. This raises the question of why the Association of Provincial Research Organizations (APRO) has not collaborated with Statistics Canada in devising a mutually satisfactory list of activity categories to provide a reasonably clear picture of what the PROs do and, at the same time, present a minimum of difficulty to them in apportioning their expenditures.

It is our understanding that Statistics Canada has asked for suggestions about how its questionnaire could be improved, but that little has come of this request. The reason appears to be that this aspect of public relations has not received adequate attention by the senior executives of the PROs. If APRO and the individual PROs are to receive the recognition they warrant, they will have to do a much better job of presenting themselves to Statistics Canada and, through it, to the country at large. We elaborate this point further in our recommendations.

There is considerable variation among the PROs, not only in the kinds of activities in which they are engaged, but also in the fields in which these activities are applied (see Table I.2). In particular, a significant amount of the activities of some of the PROs find application outside the secondary industry (manufacturing) sector.

The principal sources of the PROs' income are illustrated in Table I.3. Each of them receives a grant from its own province, varying in size from $600 000 in the case of NBRPC to $15 million in the case of ARC. In contrast to other sources of income, the provincial grants have few strings attached, and so, in principle, give the PROs a certain degree of freedom to undertake, for example, exploratory research, provide services to small companies on a no-cost basis, and promote innovation.* However, if the grant is small compared to total current expenditures, as is the case with some of the PROs, its chief use is to provide maintenance and cover salaries and other expenses during periods when contract income has fallen off and to cover the balance of expenditures only partially supported by "contributions". In such cases, the PRO is unable to make the kind of contribution to the provincial economy of which it is capable.

In the case of MRC, the provincial grant is appreciably larger than the current expenditures because of special circumstances surrounding the building of its two operating branches: the Industrial

* In the case of BCR, only $503 000 of the provincial government grant had "few strings attached" (see footnote c to Table I.3).

Table I.1 – Percentage Distribution of Current Expenditures According to Type of Activity, 1981[a]

	Scientific Research	Development	Resource Surveys	Analysis and Testing	Industrial Engineering	Other[b]	TOTAL ($ 000)
NSRFC	15	38	10	10	7	20	3 795
NBRPC	13	9	1	51	11	15	4 034
CRIQ	2	70	–	12	1	15	13 466
ORF	22	40	–	32	1	5	17 106
MRC	10	30	–	20	15	25	2 292
SRC	22	12	29	19	4	14	9 806
ARC	18	43	15	4	4	16	26 376
BCR	22	6	–	4	6	62	7 528
TOTAL							84 403

[a] Calendar year for ORF and BCR; 1 April 1981 to 31 March 1982 for the others.
[b] Feasibility studies $5.511M; library and technical information $5.087M; industrial innovation, $4.114M; and other $388 000.
Source: Statistics Canada, *Science Statistics Service Bulletin*, vol. 6, No. 11, Catalogue 13-003, Ottawa, October 1982.

Table I.2 – Percentage Distribution of Current Expenditures According to Field of Application, 1981[a]

Field of Application	NSRFC	NBRPC	CRIQ	ORF	MRC	SRC	ARC	BCR
Natural Resources	7	20	–	–	–	19	26	13
Primary Industry	18	6	1.1	10	20	26	47	56
Secondary Industry	58	23	61.1	50	80	14	14	11
Construction	–	–	0.2	9	–	9	3	–
Service Industry	2	–	17.4	–	–	5	1	6
Utilities	–	46	1.5	10	–	8	4	7
Environment	3	1	–	21	–	19	5	7
Other	12[b]	4[c]	18.7	–	–	–	–	–

[a] Calendar year for ORF and BCR; 1 April 1981 to 31 March 1982 for the others.
[b] Includes national defence and energy conservation.
[c] Includes developing countries.

Table I.3 – Principal Sources of Income of the Provincial Research Organizations[a] and their Relation to Total Current Expenditures, 1981[b]

	Total Current Expenditures	Provincial Government Grant		Provincial Government Contracts		Canadian Industry and Foreign Sources		Federal Government Contracts and Contributions	
PRO	($000)	($000)	%	($000)	%	($000)	%	($000)	%
NSRFC	3 795	1 300	34.3	344	9.1	1 459	38.4	848	22.3
NBRPC	4 034	600	14.9	794	19.7	2 304	57.1	680	16.9
CRIQ	13 466	7 500	55.7	942	7.0	2 870	21.3	674	5.0
ORF	17 106	3 428	20.0	787	4.6	9 352	54.7	2 424	14.2
MRC	2 292	2 823	123.2	–	–	495	21.6	63	2.7
SRC	9 806	3 065	31.3	1 500	15.3	4 464	45.5	1 142	11.6
ARC	26 376	15 000	56.9	12 904	48.9	1 466	5.6	524	2.0
BCR	7 528	1 375[c]	18.3[c]	1 316	17.3	3 528	46.9	907	12.0

[a] Does not include such sources as internal reserves, investment income, royalties, rentals and other contracts.
[b] Calendar year for ORF and BCR; 1 April 1981 to 31 March 1982 for the others.
[c] The outright "grant" was for $503 000, the balance was "core" funding, earmarked for specific activities, such as fish processing and coal liquefaction. The outright grant amounted to only 6.7 per cent of expenditures.
Source: Statistics Canada, *Science Statistics Service Bulletin*, vol. 6, no. 11, Catalogue 13-003, Ottawa, October 1982.

Technology Centre in Winnipeg and the Canadian Food Products Development Centre in Portage la Prairie. The additional funds were used for capital expenditures.

In most cases, provincial governments also have contracts with the PROs, usually between certain government departments and the PRO (see Table I.3, p. 21). In the case of ARC, a substantial portion of provincial contract money comes from AOSTRA to support the council's extensive oil sands research program. AOSTRA does not do research itself; it funds research undertaken by other bodies. The resource surveys undertaken by NSRFC, NBRPC, SRC and ARC (see Table I.1, p. 19) were funded, at least in part, through provincial contracts.

Foreign income is combined with income from Canadian industry because it is largely derived from contracts with foreign industry (Table I.3). In the case of ARC, the income coming from industry is a small percentage of total expenditures, partly because the amount of provincial money in the form of grants and contracts is so large. In absolute amount, ARC's industrial income is about the same as that of NSRFC, but is only one-third of that earned by SRC.

The income shown as being received from Canadian industry in Table I.3 is not the whole measure of the service provided to industry by the PROs. In addition to fee-for-service work, the PROs also devote a substantial amount of effort to the provision of technical information, advice and know-how, chiefly to small and medium-sized enterprises (SMEs), on a no-cost basis. In some cases, the expenditures incurred in doing this are covered by the provincial grant; in others, they are covered, in part, from funds provided by NRC.

The final source of income listed in Table I.3 is federal government contracts and contributions. It is made up largely of contracts with the Department of Supply and Services (DSS) on behalf of federal departments and agencies, together with the contributions from NRC (just mentioned). In both cases, the role of the PROs is to carry out federal policies aimed at industrial development.

The conditions under which DSS contracts are awarded are established under the Contracting-Out Policy (formerly known as the Make-or-Buy Policy) for research, development and related scientific activities (RSA). This policy has been the subject of a recent examination by the Economic Council of Canada (ECC),[7] but that study did not touch on certain aspects which are relevant to the present study and which are discussed in chapter III.

The contributions made to the PROs by NRC are tied to two of the six sub-programs of NRC's Industrial Research Assistance Program (IRAP): IRAP-C, the Field Advisory Service; and IRAP-F, the Technical Information Service. Although these are the only ones for which the PROs are reimbursed, the field advisory officers also serve as agents for involving companies in the other IRAP sub-programs. Occasionally, a PRO serves as the contractor for a project on behalf of a com-

pany that has received an IRAP award. In such cases, the income to the PRO would appear under the heading, "Canadian Industry and Foreign Sources" in Table I.3 (p. 21).

The close relationship of NRC with the PROs goes back many years – essentially to the time when the PROs were established. It has also taken many forms, in addition to those referred to here. It has had both high and low points insofar as effective collaboration is concerned. NRC operates exclusively on what might be considered a government grant, whereas, as can be seen from Table I.3, the government grant provides only a part (in some cases a very small part) of the resources of a PRO. Nevertheless, the fact that both NRC and the PROs are at arm's-length from government, and are run by scientists and engineers who are likely to have similar views about how science and technology can be applied for the benefit of society, makes them natural colleagues in the task of achieving federal-provincial collaboration. The attainment of closer and more effective relations between NRC and the PROs is important to Canada and is addressed in some detail in this study.

The Enterprise Development Program (EDP) of IT&C has also had an impact on a number of the PROs. It will reimburse a company for up to 75 per cent of the cost of an R&D project. In those cases where the company lacks in-house R&D capability, it can contract this out. Among the PROs, CRIQ has provided probably the largest amount of EDP-funded R&D for Canadian industry. Because of the importance of this program in bringing the fruits of R&D to industry, it is discussed at some length in this study.

In addition to their more or less direct involvement with federal programs like IRAP and EDP, the PROs, because of their close contacts with industry, are also effective in bringing to the attention of small and medium-sized companies the very extensive list of business assistance programs provided by both the federal and provincial governments.[8] Close collaboration frequently takes place between the field officers associated with the PROs and officials in the regional offices of the provincial departments that provide assistance to business. In such cases, the PRO and the provincial department provide complementary services, the PRO focussing on the technological side, the department usually only on the business side.

The type of company that is served by the PROs, on either a fee-for-service basis or a no-cost basis, is of particular significance. Some of these companies are largely self-sufficient in R&D capability and general technical competence, but come to the PROs to take advantage of their special expertise in certain areas, possibly to solve a problem, or to engage in a joint development project. However, on the whole, the industrial clientele served by the PROs belongs to a special class, frequently overlooked by policy makers in the science

and technology field. These are the SMEs that do not have, and are unlikely ever to have, a capability for in-house R&D.

In 1982, about 91.1 per cent of all industrial R&D expenditures were made by only 100 firms.[9] Yet, in the manufacturing sector alone, about 40 per cent of the manufacturing value-added and 46 per cent of all manufacturing employment was provided by the 32 800 companies each with fewer than 200 employees.[10] These firms must have access to the technical information, know-how, and state-of-the-art technology to keep competitive, but most of them cannot do this by mounting their own R&D effort. They need to acquire the fruits of R&D, and these the PROs can provide, in the form of contract R&D, on-the-spot advice and assistance and technical information. Fulfilling the needs of these SMEs is of particular importance at present, and some of the problems associated with this are discussed.

During this study, it became clear that through the kinds of activities they undertake and the particular clientele they serve, the eight PROs have acquired a unique and important role in maintaining and enhancing technological development, industrial productivity and innovation, and in implementing related federal and provincial policies. However, it also appeared that in a number of instances, the PROs are not meeting their full potential.

The reasons for this vary, and we directed much of the study to delineating some of them. We also make a number of recommendations which, we feel, could improve the effectiveness of the PROs. An important factor to be considered is that the circumstances under which they carry out their work have become considerably more complex during the past 10 or 15 years. For many years they were almost the only quasi-governmental bodies dealing with these matters at the provincial level. This is no longer the case.

For a decade and a half, Canada, possibly even more than the rest of the western world, has served as an arena for exercises in the "science of science policy". This was undoubtedly stimulated by the general disillusionment with existing science policies (or lack of them) that had largely failed to achieve the naive expectations associated with the massive post-Sputnik investment in research and higher education. Coupled with this was the challenge of a new and puzzling economic phenomenon: mounting unemployment combined with mounting inflation. The result has been a plethora of studies, recommendations and experiments dealing with science policy, too numerous to enumerate, let alone describe.

At the provincial level, this activity has opened up a new area in which the provinces can assert their autonomy. Numerous advisory bodies, quite separate from the PROs, have been created, such as the Science Council of British Columbia, le Conseil de la Science et de la Technologie in Québec, the IDEA Corporation (Innovation Development for Employment Advancement) in Ontario, and the Research

and Science Advisory Committee in Alberta. Many provincially sponsored studies have been made and policy papers issued, such as the Québec white paper, *Un Projet Collectif: Énoncé d'orientations et plan d'action pour la mise en œuvre d'une politique québécoise de la recherche scientifique* (1980); the *Report of the Task Force on Research and Technological Innovation* in Nova Scotia (1981); the report of the Council of Maritime Premiers' Committee on Research and Development, *Technological Innovation: An Industrial Imperative* (1981); and the white paper, *Towards a Science Policy for Newfoundland* (1981).

Numerous institutions have also been created through provincial action – institutions which could be regarded as complementing, or possibly, in some cases, supplementing or even duplicating, the work of the PROs. In British Columbia, the Science Council is not only an advisory body; it also awards grants and scholarships, an activity that, in Saskatchewan, is carried on by SRC. In the summer of 1982, the Alberta Department of Agriculture announced the start of construction on a Food Processing Development Centre in Leduc, whereas in Manitoba, the Canadian Food Products Development Centre in Portage la Prairie is a branch of MRC. In Ontario, the cabinet committee known as the Board of Industrial Leadership and Development (BILD) has undertaken to establish six Technology Centres in various parts of the province. In the words of the Premier, the Honourable William G. Davis,

> "Our role in this technology centres program . . . is not to compete with the private sector, but to assist and encourage it. I see this as being achieved by assisting industry to identify and apply state-of-the-art technology as a foundation for new product development, improved processes, and as a lynch-pin in building our competitiveness in world markets."[11]

This sounds very much like an excerpt from the mandate of a typical PRO.

The advent of these and other similar provincial initiatives does not necessarily mean that the PROs have been disregarded or sidestepped. In fact, in a number of instances they have assisted the provincial governments in launching these endeavours. It does indicate, however, that the scene is changing rapidly, and the PROs can no longer regard themselves as being the unique provincial agencies they once were. In particular, their relationship with Canadian universities merits closer examination as some of the PROs have developed research programs that were historically conditioned by close links with academe. Furthermore, the rise of university-based industrial research institutes directly affects the PROs. We will develop this relationship in chapter V.

The federal government, besides intervention at the program level through IRAP, EDP and DSS contracts, has also intervened

through institution building. In 1967, IT&C established the first of a series of Industrial Research Institutes (IRIs) in the universities. These are not research organizations *per se* but are offices for the generation and administration of research contracts to be carried out by faculty members. Among the objectives was "to encourage universities to provide scientific services and to conduct research and development projects for industrial firms."[12]

While the IRIs were intended to provide services to industry over the broad spectrum of university expertise, the Centres of Advanced Technology (CATs) were created, also by IT&C, "for the purpose of encouraging universities and other organizations with research capabilities to establish centres of expertise in specific technological areas of interest to industry".[13] The first CAT, the Canadian Institute of Metalworking, was established at McMaster University in 1970. Of the 15 CATs that have been established to date, six are attached to PROs. As in the case of the IRIs, the funds provided by IT&C were to support the administrative infrastructure for undertaking work for industry, although in a few cases the cost of specialized equipment was also covered. Both the IRIs and CATs were expected to become self-supporting after a period of five to seven years.

In June, 1981, IT&C announced that Microelectronics Centres of Technology were to be established at five universities. Since then, it has been decided to expand the number to ten, one for each province. These, like the IRIs and CATs, are to be funded to the extent of covering the costs, over a limited period, of the administrative infrastructure required for the university to undertake contracts for industry.*

These and other institutional approaches to the stimulation of technological development that have been taken by federal and provincial governments within the past 15 years suggest that more kudos goes to a minister for creating a new organization than for strengthening an existing one.

In the face of the ever-growing multitude of publicly funded institutions directed towards industrial development, one might reasonably ask whether the PROs are as relevant today as they were in the past. Do they still have a mission that they are particularly qualified to carry out? If so, are there impediments to their effectiveness that should be removed? These are fundamental questions. The present study was undertaken with the hope of contributing to their resolution.

* Complementing the establishment of these centres is the IT&C program, Support for Technology Enhanced Productivity (STEP), which will cover costs of feasibility studies as well as 75 per cent of implementation costs.

II. The Provincial Research Organizations and their Industrial Clients

Small and Medium-Sized Enterprises: Their Significance and their Needs

As already noted in the Introduction, most industrial clients of the PROs fall into the category of SMEs which do not have, and are unlikely ever to have, an in-house capability for R&D. The question naturally arises as to how important such companies are, as either employers or creators of wealth.

Because of their numbers, the proprietors of small businesses have considerable political influence and lobbying power through such organizations as the Canadian Federation of Independent Business and the Canadian Organization of Small Business. In recognition of this, the federal government created a Small Business Secretariat within IT&C about six years ago, and, more recently appointed a Minister of State for Small Business and Tourism (MSSB). Most of the provinces have also highlighted their concern for small business in various ways. Alberta has a separate Department of Tourism and Small Business and British Columbia, a Ministry of Industry and Small Business Development. Other provinces devote special attention to small business through a separate branch of a ministry, such as the Small Business and Field Services branch of the Ministry of Industry and Trade in Ontario, or through a Crown corporation, like the Nova Scotia Small Business Corporation.

In spite of the attention directed to small business on the part of the two senior levels of government, this segment of industry suffers from poor documentation, an inadequate statistical data base, and

even the lack of consistent definitions of what is meant by the terms *small*, *medium* and *large* as applied to businesses.

The 1981 publication *Small Business in Canada: A Statistical Profile*,[1] states that the relative sizes of businesses can be determined by using a variety of attributes, such as assets, sales, number of employees and type of ownership or management structure, but that annual sales volume was chosen because detailed statistics are consistently available only for that measure. The definitions chosen by MSSB are that *small* businesses are those with annual sales of less than $2 million; *medium*, those with sales between $2 million and $20 million; and *large*, those with sales of more than $20 million. According to the *Profile*, there were 723 591 businesses in all industrial sectors in 1978, of which 700 281 were *small*, 20 972 were *medium* and 2338 were *large*. Not included in these data were figures for those who derive the major portion of their income from self-employment: for example, farmers, fishermen, professionals and those working on commission.

To provide more comprehensive information, most of the data in the *Profile* are further restricted to the four commercial sectors: manufacturing, construction, trade and services. Together, these comprised 516 113 businesses in 1978, employing a total of 6 363 532 people. It is important to note that 64.4 per cent of these were employed in SMEs. Furthermore, these SMEs contributed 52.8 per cent of the Business Gross National Product deriving from the four sectors. Clearly, the SMEs are of paramount importance to the economy.*

To obtain a better appreciation of their nature, we can examine the SMEs, as defined by MSSB, in terms of their average number of employees. In this respect, there are significant differences among the four sectors and data for them are displayed separately in Table II.1.** Although they play a very important role in the economy, both as employers and contributors to the GNP, their size, in most cases, is likely to preclude them from having any capability for in-house R&D. This does not mean that the SMEs are lacking in entrepreneurial activity. Over the two-year period 1977 to 1979, when the number of manufacturing establishments increased by 6863 and total employment in manufacturing increased by 164 719, 98 per cent of the increase in the number of establishments and 44.6 per cent of the increase in employment[3] occurred in establishments with fewer

* The importance of the SMEs in a nation's economy is not confined to Canada. The Committee for Scientific and Technological Policy of the Organisation for Economic Co-operation and Development (OECD), defining a SME as one having fewer than 500 employees, found that in 15 OECD countries, the share of manufacturing employment provided by the SMEs ranged from a low of 40.9 per cent in Finland to a high of 72.9 per cent in Australia. In the same year (1976), the number given for Canada was 65.3 per cent; that for the United States (in 1972) was 58.2 per cent.[2]

** Following the practice of MSSB, the *small* category is divided into three subcategories, according to annual sales.

than 200 employees. If recent findings in the United States[4] by Birch have any relevance to Canada, the rate at which jobs are created by the SMEs is even greater than that indicated by these figures.

Table II.1 – Number of Businesses and Average Number of Employees per Business in the Four Commercial Sectors, 1978

Commercial Sector	Annual Sales Range ($000)				
	Small			Medium	Large
	Less than 50	50-250	250-2 000	2 000-20 000	More than 20 000
Manufacturing:					
No. of businesses	13 450	13 480	12 556	4 981	921
Average number of employees	1.8	5.6	23	123	1 511
Construction:					
No. of businesses	59 137	37 850	15 085	2 117	86
Average number of employees	1.6	3.7	11	54	473
Trade:					
No. of businesses	62 798	79 274	49 865	9 063	710
Average number of employees	1.5	3.5	9	46	974
Service:					
No. of businesses	85 381	51 233	16 520	1 516	90
Average number of employees	2.1	6.3	35	174	1 605

Source: Small Business in Canada: A Statistical Profile, Minister of State for Small Business and Tourism, Ottawa, 1981.

The Birch study involved analysis of data provided by Dun and Bradstreet on about 5.6 million establishments for four different years, 1969, 1972, 1974 and 1976. Attention was focussed on the contribution of individual firms to the "job flows" in various areas of the United States, both metropolitan areas and states. These flows are either: gains, through the creation of jobs when new firms start up, when existing ones expand, or when firms move into the area from elsewhere; or losses, when firms go out of business, lay off employees, or move out of the area. Any change in the number of jobs in the area within a given period is equal to the difference between the sum of the three gain flows and the sum of the three loss flows.

Several interesting observations emerged from the study:

1. Firms moving into or out of a metropolitan or rural area, although frequently a highly visible and controversial phenomenon, actually had little influence on the gain flows or loss flows in the area. The important factors were the starting up of firms, their expansion, their contraction and their closing down.
2. The net change in the number of jobs in any state during any one of the three periods, 1969-72, 1972-74 or 1974-76, was ap-

preciably smaller than either the number gained or the number lost; the net change was a relatively small difference between these two larger numbers.

3. The percentage of jobs lost per year through the loss flows was remarkably constant across the country during any particular time period, regardless of whether a region was undergoing an increase or a decrease in total employment. It was the number of jobs gained, or *created*, rather than the number lost, that had the dominant effect in changing the total employment of the region. During the period 1974-76, one group of states had an average annual growth in employment of 6.2 per cent. Although it had a job loss rate of 8.9 per cent, this was more than compensated by a gain rate of 15.1 per cent. On the other hand, another group of states, where there was an average annual decline in employment of 1.0 per cent during this period, had a loss rate of 9.3 per cent, not greatly different from that of the other group; what caused the trouble was that its job creation rate was only 8.3 per cent.
4. Although the Birch study did not disaggregate its findings according to the various classes of industry, it provides very significant information correlating job creation with company size (number of employees). In the United States as a whole, 66 per cent of the new jobs created between 1969 and 1976 were by firms having 20 or fewer employees, and 81.5 per cent were by firms having 100 or fewer employees. Firms with more than 500 employees contributed only 13.6 per cent of the jobs during that period.
5. Not only were the major suppliers of new jobs small, but also they were young enterprises. In the four main regions of the United States (North East, North Central, South and West), the percentage of new jobs provided by firms that had been established for four years or less ranged from 75.5 per cent to 80.9 per cent.

Unlike the "snapshot" data that provide our monthly unemployment figures, or the "turnover" data that reveal the flows of people into and out of the four labour force states (employed, unemployed, in or not in the labour force), the data obtained from the Birch study reveal some of the characteristics of the companies where jobs are actually created or eliminated. The importance of acquiring this kind of information for Canada should be obvious. There is no reason to suspect that the contribution of small and medium-sized companies to job creation would be any less important than the Birch study found it to be in the United States. If this turned out to be the case, this would have important implications for policy development and program planning for the revival and development of

our industry. In particular, this would place greater emphasis on the role of the PROs in serving the needs of small and medium-sized enterprises. We therefore recommend that *a study of the dynamics of job creation and elimination in Canadian industry should be undertaken as soon as possible by Employment and Immigration Canada, in collaboration with Statistics Canada and the Minister of State for Small Business and Tourism. The methodology should be similar to that used by David L. Birch, at the Massachusetts Institute of Technology, suitably modified and adapted for application in Canada.*

In view of the importance of the SMEs in the economy of Canada, it is reasonable to expect that their needs will be taken into consideration in federal and provincial industrial policies and programs. With many different perceptions as to the nature of these needs, it is sometimes difficult to get a balanced view. An exception is the report of the Search Conference, *The Future of Small Business in Canada.*

This conference, held in January 1982, was sponsored by the Small Business Secretariat of IT&C and was organized by the Niagara Institute. It brought together a carefully selected group of 30 owners or executives of small businesses, together with representatives of associations and organizations dealing with small business. The report shows that the problems faced by small companies are of two types: first, those arising from externally imposed obstacles, like interest rates, tax policy, lack of venture capital, government regulations and inadequately trained manpower; and second, those arising from a lack of knowledge. Prominent in the latter category was the common problem of lack of management expertise. Emphasis was also placed on the need for systems that would provide small business with information about government services, markets and technology. The report makes the interesting statement that "in the future, knowledge networks could be as important as manpower or financial resources."[5]

Free Services Provided by the PROs

The PROs are well placed to make important contributions to the lack-of-knowledge problems of the SMEs, particularly those relating to management and technological information.

Lack of expertise in management is frequently cited as an important cause of business failure. Although schools of business and management consulting firms are generally regarded as the sources of wisdom in this regard, the proper management of a company, particularly one of small or medium size, is likely to pose as many problems falling into the category of industrial engineering as into that of business management.

In comparison with the traditional engineering disciplines, industrial engineering is quite young – only a few decades old, but,

with 818 undergraduates registered in this discipline in 1981-82,[6] it outnumbered such traditional engineering courses as agricultural, geological and mining engineering, as well as metallurgy and metallurgical engineering.* Its growth has been stimulated by the market for its application: the need of industry to optimize its use of energy, space and capital, to provide a safe and healthy working environment, and to improve its productivity through the analysis of appropriate operational parameters and the judicious introduction of state-of-the-art technology. Practical industrial experience is essential in the training of a competent industrial engineer.

Application of industrial engineering methods to the needs of the SMEs was undertaken by NRC, in collaboration with the PROs, in 1962. This then comprised an additional facet of what was then called the Technical Information Service (TIS) of NRC.

Further information about NRC's involvement in the provision of technical information and industrial engineering advice is provided in chapter III, which deals more specifically with the links between the PROs and NRC. However, it can be noted here that although there continues to be a great need for these two services (now known as IRAP-C and IRAP-F), that need is not matched by adequate financial support. This situation appears to have arisen because of the almost nonexistent publicity associated with them, and the fact that the provision of a free service, no matter how important, lacks the glamour and visibility associated with a program involving the awarding of grants, for example. The tragedy of this is that any reduction in support for services like IRAP-C and IRAP-F, in relation to that provided for grants in support of R&D, is tantamount to withdrawing from many *small* companies the *only* kinds of technical assistance that they are capable of using.

ORF has classed the nearly 12 800 manufacturing firms in Ontario into three types, relating technological needs to size (see Table II.2). The three size categories are defined in terms of annual sales, using the same criteria as MSSB.[7] Also, information is provided on the number of employees in each category. If the percentage of companies in each size category in Table II.2 is calculated and compared with the corresponding data for the manufacturing industry in the country as a whole, given in Table II.1 (p. 29), it is found that the percentage of *large* manufacturing firms in Ontario is not much greater than the national average, roughly 2.3 per cent vs. 2.0 per cent; the percentage of *medium*-sized companies is somewhat greater, 20 per cent vs. 11 per cent; and the percentage of *small* companies is somewhat smaller, 78 per cent vs. 87 per cent. Thus, the needs of *small*

* McMaster University and the Royal Military College, which do not offer a degree in industrial engineering, offer one in engineering and management. Between the two establishments, 248 undergraduates were registered in 1981-82.

manufacturing firms throughout Canada for technological assistance that can be provided through technical information and industrial engineering advice (rather than through R&D programs) is, proportionately, even greater than that suggested by the data for Ontario (see below).

Table II.2 – Technological Needs of Manufacturing Firms in Ontario

Size	Number of Firms	R&D Capability	Technological Needs
Large [a]	300	Financially able to have in-house R&D capability.	Assistance outside their own specialty or when their own facilities are over-loaded.
Medium [b]	2 500	Can support and exploit R&D, but not "in-house".	R&D programs; design and engineering assistance; further technical support as needed.
Small [c]	10 000	Not capable of financing or exploiting an R&D program.	Technological information; product evaluation, production problem-solving.

[a] Large – Over $20 million annual sales, over 500 employees.
[b] Medium – $2-20 million annual sales, 50-500 employees.
[c] Small – Less than $2 million annual sales; less than 50 employees.
Source: Ontario Research Foundation.

Although the PROs do not arbitrarily restrict the provision of free industrial engineering advice and technical information to small companies, most of the companies receiving these services fall into that category. Quantitative statistical information correlating the number of companies receiving these services with company size is not readily available in a uniform format, although six of the PROs have been able to provide relevant data (Table II.3). Most of the companies that come to the PROs for technological updating and productivity improvement through these free services are of a size that precludes them from either financing or exploiting an R&D project. The need for technical information and industrial engineering advice, as stated by small business representatives at the 1982 Search Conference, is clearly reflected in the size-profile of the companies that use these services. Unfortunately, the amount of effort devoted to making these services available is far from ideal.

To provide a company with advice of an industrial engineering nature naturally requires personal contact between the engineer and the company. Even in cases where it is simply a question of technical information to solve a problem, personal contact with the company is also the best way of assessing the kind of information required. Field officers therefore play a crucial role in providing these two services. In many, but by no means all, cases these field officers

Table II.3 – Companies Utilizing Free Services Provided by the Provincial Research Organizations by Number of Employees (%)

	1-4	5-9	10-19	20-49	50-99	100-199	200-499	500-999	1000+
NSRFC[a]	22.1	15.8	16.3	16.9	6.8	4.7	6.8	1.1	1.6
NBRPC[b]	16.3	—39.5—		16.3	14.0	11.6	2.3		
CRIQ	10.0	14.0	17.5	19	10.5	11.0	5.0	6.0	7.0
MRC[c]	7.9	17.2	16.6	22.5	9.3	—18.5—		4.0	4.0
SRC[d]	—50—		—40—		—5—			—5[e]—	
ARC	——60.5——				14.2	—13.2—		5.8	6.3

[a] Fiscal year 1981-82; industrial engineering only. Free technical information was also provided in response to about 1200 enquiries from companies averaging about 50 employees.
[b] First eight months of fiscal year 1982-83. Does not include data for 7.9 per cent of the companies that were not classified according to size.
[c] January 1980 to March 1982.
[d] Approximate figures.
[e] Over 200 employees.

are either NRC employees or employees of the PROs whose salaries and expenses are subsidized by NRC. In the latter case, its contribution is on the basis of so much per person-year. Unfortunately, the total contribution of NRC to the supply of field officers amounts to the equivalent of only about 100 persons. Roughly half of these are stationed with the PROs; the others operate out of offices in various parts of the country, including Newfoundland and Prince Edward Island, where there are no PROs.

In view of the large number of small companies that could benefit from the services provided by field officers, as suggested by Tables II.1 and II.2 (pp. 29, 33), even 100 field officers is little more than a token. However, possibly because of external pressure to emphasize R&D and R&D targets, NRC's current policy would appear to place even less emphasis on providing scientific and technological assistance to this important segment of industry. In the Estimates for 1983-84, tabled in the House of Commons in February 1983, NRC's contribution to the "Provincial Research Organizations and Research Institutes" is slated to be $3.29 million, three per cent *less* than in 1981-82, two years before. We therefore recommend that *the National Research Council should revise its priorities in relation to its support for the application of science and technology to industrial development by placing greater emphasis on the needs of small companies.* More specifically, we recommend that *the National Research Council should plan on tripling the number of field officers attached to the Provincial Research Organizations within a period of two years, placing special emphasis on the introduction of new technology by using those trained in the principles of industrial engineering.**

* On 3 May 1983, the Honourable Donald J. Johnston, Minister of State for Science and Technology and for Economic Development, announced that $20 million would be

At no time in this generation has there been a greater need for small companies to have access to technological information and advice on methods and equipment for improving their productivity. At the same time, because of economic conditions, it is easier now than in the past to find adequately trained people to serve as field officers. The time is therefore opportune to triple their number. Doing so would not only provide employment for some currently unemployed engineers, but through their work, it would undoubtedly ensure employment for many other people as well.

Another matter that needs to be examined is the magnitude of NRC's person-year contribution to the PROs in support of field officers. Because they spend most of their time on the road, these people incur substantial expenses in addition to their salaries. It has been estimated that the total cost of keeping a field officer fully occupied in that capacity is of the order of $100 000 a year. The current NRC person-year contribution is about two-thirds of this; the balance has to be borne by the PROs. If the provincial grant is small, as for example, in the cases of NBRPC or BCR (see Table I.3, p. 21), this can be a serious drain on resources. The problem is further compounded if, as in 1982-83, NRC's person-year contribution is suddenly reduced after the beginning of the fiscal year.

The delivery of NRC's IRAP-C and IRAP-F by the PROs could provide a model of federal-provincial collaboration, but only if NRC regards its contributions as an element of a partnership, and not just a matter of providing federal benevolence. We therefore recommend that *the National Research Council and the Association of Provincial Research Organizations should make a detailed analysis of the costs of providing field officers for IRAP-C and IRAP-F, and agree to a cost-sharing arrangement that will provide for equitable and stable funding.*

Although much of the activity of the PROs in providing free technical information and industrial engineering assistance (chiefly to small and medium-sized companies) is associated with the delivery of NRC's IRAP-C and IRAP-F sub-programs, the PROs also supply such services using their own resources. A good example is the work of the Fisheries Technology Division of BCR. Its objectives are to "use provincial funds to provide free technical information services; to foster the introduction of appropriate technology, and to carry out research on behalf of the processing sector of the B.C. fishing industry."[8]

The division deals with a vast range of fish-processing companies spread along the BC coast whose sales differ by factors of more than a thousandfold from the smallest to the largest. In fulfilling its

made available to NRC over the next two years to expand its IRAP sub-programs serving small and medium-sized businesses (IRAP-C, -F, -H, -L, and -M), including the number of field officers attached to the PROs.

commitment to serve these companies, it places a great deal of emphasis on personal contacts through plant visits. These activities are supplemented by a *Newsletter, Technical Information Report, Industry Information Report* and more detailed technical papers. For the first three years of its existence, this division of BCR was funded as a "core area" exclusively by the province of British Columbia. In 1982-83, that part of the division's work having to do with the provision of free technical information and advice was supplemented by assigning to it the equivalent of one field officer per year out of the NRC's contribution for IRAP-C.

In reviewing their operations, the Fisheries Technology Division observed that the growing interest of the smaller processing companies in acquiring technical information appears to be a precursor to their demand for more sophisticated assistance of the type that is funded by NRC grants, IT&C and the provincial Ministry of Industry and Small Business Development. Thus, the provision of free technical information and advice to a small company that has no capability of financing or exploiting an R&D program can prove to be the starting point for that company to develop into a technologically and economically mature business. Governments, whether federal or provincial, should not neglect to support this important activity in favour of more glamorous and visible R&D grant programs.

Fee-for-Service Work for Industry

The fee-for-service work that the PROs undertake for their industrial clients, like the technical information and industrial engineering services, is also largely for the SMEs. Unfortunately, it was not possible to obtain detailed statistical information for all of the PROs relating this activity to the size of the companies concerned. However, four of them were able to provide such a breakdown (Table II.4). Because some of the size categories they used were different, the table is divided into two parts. In part A, a comparison is made of the percentage of companies in each size category served by MRC, CRIQ and NBRPC. In part B, the distribution for NBRPC is compared to that for ORF. Two important factors emerge from the table. The first is that there is a remarkable similarity in the distribution for these PROs in spite of the wide differences that exist in the nature of the economies and the populations of the provinces concerned. The second is that in their fee-for-service work, the PROs serve considerably more small and medium-sized companies than large ones.

NBRPC provided more extensive data than the other PROs on the kinds of activities comprised within the overall fee-for-service data given in Table II.4. Although it would not be appropriate to display these in detailed tabular form, certain features can be noted. Very few research contracts were undertaken for firms having fewer than 200 employees, but almost half of the development contracts were

Table II.4 - Percentage of Industrial Fee-for-Service Clients According to Size, 1981

A	Number of Employees				
	1-9	10-19	20-49	50-499	500+
MRC	20.0	17.3	25.3	28.0	9.3
CRIQ	21.3	14.7	21.8	32.0	8.4
NBRPC	—31.3—		16.0	24.7	27.7

B	Number of Employees			
	1-99	100-299	300-999	1000+
ORF	48	22	15	15
NBRPC	55	—25—		20

for firms in that size group. In the case of analysis and testing, 72 per cent of the companies having this kind of work done were in the less-than-200 employee class, but these generated only 30 per cent of the projects of that nature. Among the other activities undertaken by NBRPC for firms of this size were feasibility studies, market surveys and industrial engineering requiring more than the two or three days work that is normally provided free.

The nature of the fee-for-service work of the other PROs is similar to that of NBRPC. However, individual PROs usually also provide a range of special services that are related to their particular expertise and facilities. For example, the Textiles and Clothing Technology Centre at ORF has provided testing, research and evaluation services to that industry for over 50 years. In British Columbia, the provincial government has provided BCR with core funding, which enables it to do research, analysis and testing on coal, including liquefaction, materials handling and fluidized bed combustion.

The amount of work done for any individual client varies widely. Two of the PROs, ORF and SRC, provided data that showed the percentage of clients having an annual billing in any particular size category to be very much the same for the two PROs (Table II.5). Also, in both cases, almost two-thirds of the industrial clients have annual billings less than $1000 and only one or two per cent have billings of over $50 000. On the other hand, the large number of clients having small billings bring in relatively little revenue in comparison to those with larger individual billings.

Exploratory R&D

To the extent that the R&D activities of the PROs are directed towards industrial development, they can be classified as "applied". However, even within the limitations implied by this term, there is a great variation in the immediacy of the application.

Table II.5 – Size of Client Billing vs. Industrial Revenue, Ontario Research Foundation and Saskatchewan Research Council, 1981

Individual Annual Billing ($)	Companies (%)		Industrial Revenue (%)	
	ORF	SRC	ORF	SRC
Less than 1 000	63	64	6	3
1 000 to 5 000	25	22	15	7
5 001 to 20 000	8	10	20	13
20 001 to 50 000	2	2	18	8
Greater than 50 000	1	2	41	70

In those cases where the PRO is expected to contribute to the development of the natural resources of the province, its R&D program is likely to involve work of a fairly fundamental, exploratory and frequently long-term nature. An outstanding example is the research program of ARC on the *in situ* recovery of bitumen from the tar sands of the Fort McMurray district. The two existing plants, Suncor and Syncrude, do not use *in situ* technology, and with the Alsands project on hold, there is little prospect of other large plants of any kind being put into operation in the near future. However, because further development of the tar sands is considered to be of great importance to Alberta, ARC's multi-million dollar program on advanced tar sands technology is strongly supported by the province.*

The exploratory R&D of the PROs is not, of course, confined to the development of natural resources. As well as carrying out their normal, short-term R&D contracts, many of the PROs have found it possible to engage in exploratory investigations that have led to their becoming centres of excellence in various kinds of technology: for example, powder metallurgy at ORF and slurry pipeline technology at SRC.

An interesting example of a practical outcome resulting from exploratory research is the development of the RPC Sulphation Roast Process of NBRPC. Although the Bathurst-Newcastle area of New Brunswick is one of the world's most important mining regions, its ores, when treated by conventional methods, present complex metallurgical problems, resulting in high losses of copper, lead, zinc and silver. NBRPC, deciding that a better understanding of the mineralogy and chemistry of these ores was important for the eco-

* Alberta has good reason to appreciate the benefits of supporting exploratory research on the tar sands. The present (steam) method used in the two existing plants to extract the bitumen from the sand is based on the work of Professor K.A. Clark of the University of Alberta, which was funded by ARC many years ago, before it had its own laboratories.

nomic development of the province, in 1966 undertook fundamental studies on their properties and behaviour.

The undertaking of this research was made possible by a grant from NRC under its program of Consolidated Grants to the Provincial Research Organizations – a program since terminated. It was specifically designed to make it possible for the PROs to undertake longer-term exploratory research. In the case of NBRPC, the fundamental studies carried out under the NRC grant and, later, through provincial support, have led to a number of patents, the construction of a minipilot plant, the carrying out of a great many trials for mining companies, the planning and engineering design for a pilot plant (in conjunction with SNC, the consulting engineering firm) and preliminary engineering design and cost data for a full plant scale-up for a major international base metal company. With improved economic conditions, the RPC Sulphation Roast Process is likely to have wide application.*

An example of a different kind of spin-off from exploratory research carried out by a PRO occurred some years ago at BCR. In 1953, Dr. G.M. Shrum, President of BCR, reporting on the first year of tenure of its Consolidated Grant from NRC, said,

> "When the grant was made, it was understood that it was to be used for the encouragement and development of fundamental research .... Up until the time this grant was received, very little either basic or fundamental research had been undertaken in the laboratories of the [B.C. Research] Council. The deficiency in the research program made it difficult for the Council to either attract or retain competent research scientists and engineers.
>
> Rather than spread the funds thinly over the various fields in which the Council is interested, it was decided that two small teams of research workers should be organized, one in the field of organic chemistry and the other in metallurgy, two fields of research which are related to the basic industries of the province."[9]

Dr. Shrum's report then went on to say that in the field of organic chemistry he had hired a young scientist who had received his PhD from Liverpool University in 1948 and had just finished post-doctoral studies with two well-known chemists, Prelog in Switzerland and Todd in Great Britain. At BCR, this young man was able to develop a brilliant program of research which attracted widespread interest and drew to his laboratory many young researchers who have since distinguished themselves in Canada and abroad. The

* On 16 May 1983, the federal government announced a $15-million grant towards construction of a 15 tonne/day pilot plant in Chatham, New Brunswick to use the NBRPC process.

young organic chemist's name was Har Gobind Khorana. He remained at BCR until 1960, when he moved to the University of Wisconsin, where he was when he won the Nobel Prize for Medicine in 1968.

Some idea of the amount of exploratory R&D now being carried out by the PROs is provided in Table II.6, where the total R&D expenditures (shown in Table I.1, p. 19) are further broken down into exploratory and short-term. With the exception of ARC, no PRO devotes more than 11 per cent of its expenditures to exploratory research. The zero percentage reported by MRC is the result of a policy decision whereby, up to now, major emphasis has been placed on providing services to secondary manufacturing and on the commercialization of research carried out by others. As growth continues, this emphasis may change.

Table II.6 – Exploratory and Short-Term Research and Development as Percentage of Total Expenditure, 1981

	Exploratory (%)		Short-Term (%)	
Organization	Research	Development	Research	Development
NSRFC	2	0	13	38
NBRPC	10	2	3	7
CRIQ[a]	2	9	0	61
ORF	11	12	11	28
MRC	0	0	10	30
SRC	11	2	10	10
ARC[b]	(49)	(31)	(5)	(15)
BCR	2	3	20	3

[a] CRIQ's Five-Year Plan (1982-1987) provides for a substantial increase in longer-term exploratory R&D.

[b] The Alberta Research Council chose to split their R&D into Exploratory (Long- and Medium-Term) and Short-Term according to person-years, rather than expenditures. Table II.6 shows its distribution of person-years engaged in R&D on a percentage basis. The data for the Alberta Research Council in Tables I.1 and II.6 cannot be directly correlated.

Aside from the special case of ARC, we believe that the amount of effort devoted to exploratory research by the PROs is on the low side. The case for having adequate funds to undertake that type of longer-term applied research was made clearly and concisely by the president of ORF in 1966, and his observation is as true today as it was then.

> "The maintenance of a proper ratio between fundamental knowledge and applied contract work is the most urgent of the long term problems of the Foundation. Unless we can replenish and expand this knowledge (as new fields of technology develop), the Foundation will be unable to effectively carry forward ap-

plied research and development. Should this ever occur, our contract work for industry will ultimately dwindle and die."[10]

Few companies in the private sector have the cash flow to enable them to support exploratory R&D undertaken by the PROs, so if it is to be undertaken, it usually has to be supported by public funds. One such method has already been mentioned – the Consolidated Grants that NRC awarded to the PROs for many years. That program, launched in 1949, was set up deliberately to enable the PROs to engage in exploratory research. When the last grant was awarded in 1972, it marked the end of any federal program aimed exclusively at supporting exploratory research in the PROs.

In a few instances, contracts undertaken for one of the federal departments or agencies, and arranged through DSS under the Contracting-Out Policy (formerly known as the Make-or-Buy Policy), have helped to maintain and strengthen exploratory research in the PROs. However, because of the eligibility rules of that policy, the PROs are excluded from tendering on many DSS contracts. This problem is discussed further in chapter III.

In response to our query about the sources of funds for exploratory R&D in the year 1981, it turned out that with the exception of NBRPC, the principal source was the grant from the provincial government; in the cases of NSRFC and BCR that was the only source, whereas for NBRPC, CRIQ, ORF and ARC, provincial government contracts were also available for this purpose. About 75 per cent of the medium-term exploratory R&D of ARC came from AOSTRA, which does not award contracts extending over five years. NBRPC and ORF, whose provincial grants are quite small in relation to their total expenditures (see Table I.3, p. 21), financed roughly half of their exploratory R&D out of federal government contracts. NBRPC covered 17 per cent of its exploratory R&D out of industrial contracts.

In the course of our visits to the PROs, we gained the impression that in almost every case, their effectiveness in tackling problems associated with the development of provincial resources and in initiating new developments in support of industrial development in the province would be greatly enhanced if they were able to devote more effort to exploratory research. A good example is provided by the work of BCR in a branch of biotechnology that is of importance to the winning of minerals and metals from ores.

Over a period of years, BCR has developed expertise in the microbial leaching of minerals from both low-grade ores and concentrates. This expertise was recognized in the report of the Task Force on Biotechnology, established by the Minister of State for Science and Technology (MOSST):

"In Canada, the B.C. Research Council represents an internationally recognized authority on the scientific, technical and industrial exploitation of microbial leaching. While industrial

concerns in other countries are rapidly adopting this new technology, very little interest is evident in Canada. Any attempt to strengthen Canada's scientific and technical base in this area should be focussed on the existing expertise with concomitant encouragement to industry to take advantage of this Canadian capability. The importance of Canada's mining industry to the country's overall economic performance, coupled with this strong base of expertise in mineral leaching, substantiates this as a high priority area for the application of biotechnology in Canada."[11]

The microbial method of mineral refining, which has recently undergone a number of significant improvements, is both energy efficient and remarkably free of pollution problems. BCR's expertise is unique, but its scientists are concerned that without more adequate support for their exploratory research and development, it may fall behind. The preservation and further development of this expertise is important, not just for British Columbia, but for Canada.

In many cases, the exploratory R&D of the PROs has implications that reach beyond provincial boundaries and must, therefore, be taken into consideration at the national level. The mechanisms already in place in the federal Contracting-Out Policy in Science and Technology offer a convenient and effective way of providing complementary federal support for such work. In view of the close relations between the PROs and industry, and the fact that in a very real sense, they serve as the R&D arm of much of our industry, it is important to remove any barriers that might impede federal collaboration with the PROs, through the Contracting-Out Policy, in expediting the transfer of the fruits of exploratory research to industry.*

Another way in which federal-provincial collaboration could help to expedite the transfer of PRO-based technology to industry would be through the mechanism of NRC's Program for Industry/Laboratory Projects (PILP). This program was designed to assist industry to take over technology developed in NRC or in other federal laboratories. The possibility of extending it to include technology developed in the PROs is discussed in chapter III.

Special Mechanisms for Technology Transfer

The direct transfer of technology resulting from R&D carried out in a PRO to a company is most commonly achieved through a contract between the company and the PRO. In such cases, there is normally a clear understanding between the two parties as to what the R&D is

* In view of the comments in the MOSST report, quoted earlier, one might expect BCR to have received contracts for work on microbial leaching under the Contracting-Out Policy, but such has not been the case.

aimed at, and so there are no particular obstacles associated with the technology transfer that takes place. The company will own any patents that might be granted as the result of R&D carried out for the company by a PRO. For example, in the 10-year period 1970 to 1979, ORF filed patent applications (usually in several countries) for 26 different inventions on behalf of client companies where, if granted, the patents would be owned by the companies. During the same period, client companies themselves filed patent applications on a further 18 inventions on the basis of R&D carried out by ORF.

Another mechanism of technology transfer used by all of the PROs is to patent inventions made using their own resources (frequently arising from their exploratory research) and then to grant a licence to a company to use the invention in return for payment of a royalty. In the 10-year period 1970 to 1979, ORF filed patents on 33 inventions of this type. By 1980, 20 of these had resulted in patents being issued or pending and five of the patented inventions had been licensed.

Besides the patent/licensing mechanism common to all of them, most of the PROs have developed their own particular mechanisms for technology transfer. We cannot describe all of them here, but we can provide an arbitrary sample of some of the mechanisms that are used by some of the PROs.

Much of the effort of NSRFC has been directed to the development of ocean-related industry. In 1974, in recognition of its competence in this field, IT&C awarded NSRFC $1 075 000, spread over a period of seven years, to establish the Centre for Ocean Technology.* Besides the development of a number of products, some but not all of which are ocean-related, NSRFC found it desirable to establish a Marketing Group to identify user needs and to assist in initial market penetration. However, the transfer of the developed technology to Nova Scotia industry has not been easy. Although a number of products have been licensed, in other cases it was found that to interest industry in manufacturing new products, using new technologies and selling in new markets, NSRFC itself had to demonstrate successful innovation through development, manufacture and initial sales. In such cases, it has been its policy to subcontract as much of the manufacturing as possible, and this has served to stimulate industrial interest and to encourage technology transfer.

One particular type of product developed by NSRFC as the result of a perceived market is "zero leakage" magnetically coupled blowers and gas circulators. Over $400 000-worth of such hardware was exported between 1980 and 1982. After unsuccessfully trying to interest local companies in handling these products, NSRFC set up a

* See Table III.3, page 66.

wholly-owned subsidiary, Nova Magnetics Ltd., in 1981 to look after the manufacture and sales. Once commercial viability of Nova Magnetics Ltd. has been demonstrated, NSRFC hopes to sell it to the private sector.

Total sales of hardware developed by NSRFC amounted to over $1 000 000 in the year 1981-82.

CRIQ, like the other PROs, also uses patent/licensing mechanisms for the transfer of technology. Although it has had its own laboratories only since 1974, CRIQ holds 17 patents in its own right and 8 more are held by its clients, based on work done by CRIQ: 10 patents are still pending. Five licences have been granted by CRIQ, based on patents which it holds. But CRIQ has extended the patent/licensing approach farther than most PROs. It has made arrangements with almost all of the Québec universities to undertake the commercialization of inventions made by the universities if requested to do so.* In carrying out commercialization, CRIQ may undertake development work to improve the marketability of the invention and arrange for licences to be granted.

In 1979, the provincial ministère de l'Industrie, du Commerce et du Tourisme turned over to CRIQ the responsibility of bringing to the attention of Québec companies information on the availability of licensing agreements and joint ventures originating in both Canada and foreign countries. It does this by publishing and disseminating a bimonthly bulletin: "Produits nouveaux et Occasions d'affaires". When a Québec firm is interested in acquiring a technology in this way, CRIQ assists in the firm's negotiations and in various other ways; for example, by helping to define its technological needs. In 1981-82 alone, CRIQ participated in 45 such negotiations.**

Another activity that CRIQ has managed for a number of years is its inventors' assistance program, Assistance aux inventeurs. On behalf of independent inventors and inventors in business firms, CRIQ will examine inventions submitted to it from the point of view of technical feasibility and market potential. If an invention is judged to be promising, and if the inventor or company so wishes, CRIQ will then collaborate in carrying out the remaining steps in the innovation process. In 1981-82, 431 inventions were submitted to CRIQ for evaluation. CRIQ has an arrangement with the Centre d'innovation industrielle/Montréal at École Polytechnique (which also has an inventors' assistance program) whereby the two organizations share their expertise in the evaluation of inventions.

* These arrangements are discussed in greater detail in chapter V.

** With the recent creation of the ministère du Commerce extérieur, CRIQ has decided to reduce its activities in this area.

Another of CRIQ's mechanisms for technology transfer that probably deserves to be classed as "special" because of its magnitude is its policy of aggressively assisting Québec companies in applying for the various kinds of financial assistance for industrial R&D projects that are available from the federal government, particularly IRAP-L, IRAP-M and IRAP-P, managed by NRC, and EDP of IT&C. These programs are described and discussed in some detail in chapter III. In general terms, they provide three-quarters of the cost of an R&D project, the company being required to cover the remaining one-quarter. In many cases, the company, lacking the in-house capability to handle the project itself, will call on CRIQ, or some other organization, to carry out part or all of it. In 1981-82, CRIQ was involved in carrying out R&D related to 64 separate projects which were partially funded by government grants. From these, it will eventually recover $3.74 million, of which about 80 per cent will have come from projects supported by EDP and 12 per cent from the IRAP programs. A significant portion of this type of R&D (mostly development) results in the creation of either a prototype machine or device that will subsequently be manufactured in large numbers by the company, or a one-of-a-kind machine that will be used by the company to increase its productivity. CRIQ is, of course, not the only PRO that does this type of work.

The creation by a PRO of a wholly-owned "for-profit" subsidiary as a mechanism for technology transfer has already been mentioned in the case of NSRFC. Such subsidiaries have also been created by ORF, BCR and SRC. Sareco Holdings Ltd., the subsidiary of SRC, has been inactive for a number of years. However, it or some other type of subsidiary might, in time, become active as the result of the formation of the Canadian Centre for Advanced Instrumentation, initiated by a recent grant to SRC from IT&C (see Table III.3, p. 66).

Techwest Entreprises Ltd., a subsidiary of BCR, was created to market technology developed by BCR; efforts are currently being made to sell it to private enterprise. ORDCO Technology Ltd., the subsidiary of ORF, was originally created not to exploit its own inventions but rather to commercialize, by means of a licence, a series of patents for the wet oxidation of toxic wastes. These were owned by a Michigan university but were not being exploited. As a result of its many years of experience in dealing with problems related to the disposal of municipal and industrial wastes, ORF recognized the potential of the process, which can destroy the waste material without polluting the atmosphere and, at the same time, produce useful heat. Although ORF has made a number of improvements to the basic process, it turned over to ORDCO Technology Ltd. the responsibility for manufacturing and marketing the process. A $1.3-million system is now installed in an industrial chemical manufacturing plant in Ontario. ORDCO Technology Ltd. subcontracts the manufacturing for

this and other products in much the same way as do NSRFC and Nova Magnetics Ltd. In doing so, it has helped to develop special technological competence in a number of small manufacturing firms.

III. The PRO-Federal Relationship: The Need for a Partnership

> ". . . the Provincial Research Organizations appear to be caught between the 'Scylla' of the Provincial governments and the 'Charybdis' of the Federal Government. Thus, the Federal government tends to view them as "arms" of the Provincial governments and is therefore reluctant to provide financial support. Conversely, many Provincial governments tend to view them as independent agencies established primarily to serve the private sector and therefore, expect them to recover a substantial part of their operating costs from their industrial clientele."[1]

This citation illustrates well the perennial dilemma faced by these hybrid bodies, the PROs. It is one of their common features that is often overlooked. The fact is that these organizations not only operate within a regional context (after all, they are *provincial* research organizations), but also address issues on a national level. Although the PROs have attempted to make their dual role relatively clear, neither the provincial nor federal governments have yet fully understood the nature and role of the PROs. In this chapter we focus on one of these elements, the PRO-federal government relationship, in which interaction takes place at many levels. We outline some of the more important modes of interaction and analyze two particularly thorny, yet crucial interactive programs. Specifically, these involve the NRC-PRO interaction and the participation of the PROs within the federal Contracting-Out Policy in Science and Technology. Finally, we look at how these organizations have structured themselves through the Association of Provincial Research Organizations (APRO) to address the issue of their participation at the federal-provincial interface. In

reviewing the issues surrounding the PRO-federal government relationship, we make several recommendations which we hope can serve to clarify each partner's respective position, and thus contribute to a more effective understanding of the role of the PROs in the national R&D effort.

The PROs have always been careful to underline their position as active participants within the national R&D arena. Indeed, several of them made the point explicitly in their testimony to the Senate Special Committee on Science Policy, chaired by the former Université Laval economist Maurice Lamontagne. The PROs argued that they were anxious to play their part in developing Canada's scientific and technological infrastructure, and it was hoped that their capabilities would be used more frequently by the federal government.[2] This, of course, opens up the debate as to what constitutes a *national* scientific effort and whether it is not simply the sum of a multiplicity of science policies which take into account the diverse resource endowments and the specialized regional research infrastructure in the country. The Science Council of Canada has emphasized on several occasions that any national policy must include elements of provincial policies,[3] but this is a fundamental feature of the science policy landscape which, all too often, analysts have ignored or relegated to the bottom of their priority lists. Thus, when the PROs speak of their contribution to the national R&D effort, it is within this reality of the Canadian federal structure that it must be understood.

Participation by the PROs in the national scientific and technological effort can be assessed in many ways. ORF, for example, has been funded by NRC to maintain a national test facility for solar development. The facility was completed in 1980. Although owned by NRC, it is located at, and operated by, ORF and will provide "Canadian manufacturers with a capability for developing and testing solar energy collectors and components under controlled conditions using simulated solar radiation."[4] In other cases, some of the PROs (for example, MRC and CRIQ) maintain regionally based federal Metric Commission offices which will respond to enquiries. In still other instances, some of the PROs managed subventions received through various General Development Agreements negotiated between the federal and provincial governments. The Enterprise Manitoba cost-shared agreement resulted in an allocation of $16 million to MRC towards the establishment of the Canadian Food Products Development Centre and the Industrial Technology Centre. CRIQ, for example, was able to establish portions of its new facilities in the early 1970s through contributions from the Department of Regional Economic Expansion (DREE).

Other arrangements exist and should be scrutinized to understand some of the difficulties that still persist. Here again, the ques-

tion of financing looms large, as does a proper understanding by the federal government of the role of the PROs and effective communication by the PROs of their participation. At one level have been the arguments that federal funds might be more effectively used if a greater recognition of the PROs' capabilities existed. This argument has been made on numerous occasions. In 1978, at the Federal-Provincial Conference of Ministers on Industrial Research and Development, the Honourable Larry Grossman, Ontario Minister of Industry and Tourism, stated that the unique assets of the PROs have, all too often, been ignored. Indeed,

> "recognition of their capabilities by Federal Government Departments, especially with respect to small and medium sized firms, would significantly strengthen Canada's industrial R&D efforts."[5]

More recently, the PROs' expertise has been recognized in an editorial in *Canadian Research*, where it was argued that perhaps the federal contributions towards the creation of several university-based microelectronics centres might be spent more efficiently on the existing infrastructure within some of the PROs.[6] (Actually, one of the PROs (NSRFC) is involved directly with these centres, while another (MRC) provides some financial assistance.) The PROs themselves have presented this argument at every possible instance; "full advantage should be taken of the capabilities and growth potential of existing research organizations before new research groups are established with federal support."[7] There are indications that the federal government takes this advice seriously in some cases and ignores it in others. A proposed centre for industrial manufacturing technology in Winnipeg through collaboration of NRC and MRC*[8] and the establishment in the PROs of several federally sponsored CATs (discussed later) show that at least some branches of the federal government have recognized the validity of the PROs' arguments of 1969. On the other hand, their difficulties in convincing federal authorities responsible for the Contracting-Out Policy that eligibility guidelines should be reviewed demonstrates that the message is not always getting across.

Several programs initiated by the federal government have served to address some of the needs of the nation's industrial performers through the use of the PROs. These have met with varying success. We discuss here some of these programs and comment on their ability to deal with the need for the PROs to keep a research finger on the pulse of new developments in technology, while serving their main purpose of assisting Canadian industry.

* A $41-million Institute for Manufacturing Technology was officially announced on 13 May 1983 for Winnipeg. The institute is to be managed by NRC.

Relations with the National Research Council

Although the PROs have working relations with a number of federal bodies, relations with NRC have always had a special flavour because the organizations have a great deal in common. Both the make-up of their staffs, in terms of scientists, engineers, technicians and technologists, and their stated objectives are quite similar. Among NRC's Sub-Objectives is "the application and use of engineering and the natural sciences to assist industry in Canada with the development of new and improved processes, methods, products, systems, techniques and services"[9] – an objective which could apply equally well to any of the PROs.

That there should be some points of similarity between NRC and the PROs is, perhaps, not surprising. NRC, as it is structured today, owes much to the organizing genius of H.M. Tory, its first full-time President. When he left his position as President of the University of Alberta to take over the NRC post in 1928, he had already played a key role in the establishment of ARC in 1921.* Tory was also involved in the establishment of NSRFC. At the request of the Royal Commission on Provincial Development and Rehabilitation, he examined the research requirements of Nova Scotia and proposed that a Research and Development Board be established that would, among other things, "cooperate as closely as possible with the universities and the NRC in order to find solutions in the most economical way possible".[10] This resulted in the establishment of NSRFC in 1946.

When ARC and NSRFC were created, there was no provision for them to have their own laboratories; ARC only obtained its laboratory in 1954; NSRFC, not until 1969. A similar situation occurred in the case of NRC. Although it was established by an order-in-council in 1916, and by an act of Parliament in 1917, it did not get its own laboratories until 1932. The situation was quite different with ORF; it acquired laboratories at the time it was established, in 1928. This created some consternation at NRC under its newly appointed President, H.M. Tory; it was feared that this could dampen NRC's efforts to acquire its own laboratories, and give political credit to the Ontario Premier, G. Howard Ferguson.[11] As it turned out, these fears were unfounded. Although delayed by the onset of the Depression, NRC's laboratories were established in time for it to play a major role in Canada's war effort.

Although cooperation between NRC and the PROs has deep historical roots, their relations have frequently suffered from a lack of clarity or conviction as to the form they should take. In 1935, in response to the invitation of the Director of ORF to visit its laboratories "with the object of discussing the best possible working relationships", NRC's council agreed that cooperation between it and organi-

* ARC was originally established as the Scientific and Industrial Research Council of Alberta by an order-in-council in 1921. It was set up in its present form by an act of legislation in 1930.

zations like ORF should not include the granting of financial assistance for projects carried out under the auspices of such organizations.[12] However, this restriction was removed during the war when NRC awarded a great many contracts to ORF. Furthermore, in 1949, NRC went a step further and awarded ORF an automatically renewed Consolidated Grant of $25 000 a year to support research programs of a "continuing nature" – the kind of research that is referred to in this study as exploratory. Eventually, six of the present eight PROs received Consolidated Grants, $25 000 a year to ORF and BCR, $10 000 a year to ARC, SRC, NBRPC and NSRFC.*

Although NRC adhered to the principle that these grants were for fundamental exploratory research, they were not increased as time went on, and consequently they gradually lost their relative value. Because governments tend to be preoccupied with short-term solutions, it is not surprising to find them reluctant to acknowledge the necessity of supporting an adequate amount of exploratory R&D. In the case of NRC, however, while there was no lack of appreciation for that kind of R&D, there was a lack of conviction as to its responsibility for supporting it in the PROs. This eventually led to the decision to phase out the Consolidated Grants. The last of these was awarded in 1972.

The history of NRC's collaboration with the PROs in providing technical information and advice to industry is a happier one. In 1945, the Honourable C.D. Howe, Minister of Reconstruction and Supply, and Dr. C.J. Mackenzie, then the President of NRC, conceived jointly a program to offer to industry the wealth of available scientific and technical information. Initially, much of it was information that had accumulated during the war years. Originally established in Mr. Howe's department, the Technical Information Service (TIS) was transferred to NRC in 1946, because it had better technical facilities and information channels.

From the beginning, TIS was directed primarily towards the needs and opportunities of small firms, particularly those in the manufacturing sector.** Then, as now, the social and economic importance of such firms was highly significant from the point of view of both the number of people employed and the value-added. The kind of service provided by NRC through its TIS program was, of course, very similar to what one might expect the PROs to provide. In

* During the period 1968-69 to 1972-73, a Consolidated Grant of $10 000 a year was also given to Industrial Enterprises Incorporated, a Prince Edward Island Crown corporation.

** In 1944, H.B. Speakman, President of ORF, commented that: "If scientific research and improved technology are the life-blood of the large firms and groups, how much more necessary are they if small plants are to maintain their efficiency and service? It is sometimes forgotten that their survival is not merely a question involving owners or shareholders but work people and the social fabric of many small communities. In

fact, ORF had developed a similar program. In 1951, the Director of ORF wrote to the President of NRC to say that whereas the two groups of field officers were cooperating very effectively, there were problems in having the two independent groups engage in the same kind of activity. The President of NRC replied that:

> "without going into detail I can say that my own opinion is that provincial organizations are more likely to prove effective in direct dealings with local industry than federal institutions. If your organization feels it would like to do the [work], we would be quite willing to withdraw our representatives from the Ontario field or make arrangements for any cooperative scheme which seems desirable."[14]

As a result, NRC proceeded to conclude agreements with each of the PROs to take over the field work associated with the delivery of TIS to firms in their provinces. The PROs hired the field officers and were reimbursed by NRC on a flat rate per person-year basis. The field officers could either provide the required information from the resources of the PRO or refer the request to NRC in Ottawa. There, people with appropriate training and experience could develop responses using either the resources of NRC's National Science Library (now the Canada Institute for Scientific and Technical Information (CISTI)) or the expertise of the scientists and engineers in its own or other federal laboratories.

There have been a number of changes, over the years, in the way TIS has been managed by NRC. Rather than discuss these, it is more relevant to describe briefly the two main programs and the range of sub-programs for industrial development that NRC administers today, and then to examine the role of the PROs with regard to these.

PILP

The Program for Industry/Laboratory Projects (PILP) was established in 1975 as a mechanism for transferring technology developed in NRC and other federal laboratories into industry. It is analogous to the program of PRAI grants (Project Research Applicable in Industry) initiated by NRC in 1971 (now awarded by the Natural Sciences and Engineering Research Council) to transfer research results from university laboratories to industry. Because firms receiving PILP grants are expected to have sufficient in-house R&D capability to develop the technology to the production stage, this grant program, in its present form, has little direct relation to the PROs.

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most cases, it is not economic for such units to maintain even a well-equipped control laboratory, to say nothing of research. . . "[13]

IRAP-P

The other industrially oriented program, the Industrial Research Assistance Program (IRAP), consists of six program elements or sub-programs. One of these, now called IRAP-P, is the original IRAP, which was initiated in 1962 to provide financial assistance for research projects proposed and carried out by firms having an in-house capability for R&D.

IRAP-M

In 1978, NRC launched a mini-IRAP program, now called IRAP-M, which was designed for manufacturing firms having 200 or fewer employees and little or no technical staff. Its purpose was to encourage small companies to solve specific technical problems either with their own staff, or with the help of some research organization. IRAP-M awards are limited to a maximum of $30 000 and are tenable for a maximum of 12 months.

IRAP-L

This program was initiated in 1981 to enable companies with up to 200 employees and no R&D or problem-solving capability in the company, to contract problem-solving investigations to appropriate research laboratories, institutes or consulting firms. The total cost of any project is limited to $6000, of which NRC will reimburse the company for 75 per cent. The IRAP-L sub-program is very similar to the Small Industries Development Program (SID Program) which was proposed by APRO in a submission to IT&C in 1977. Although the APRO proposal was not taken up by IT&C, it appeared in NRC a few years later in the form of IRAP-L.

IRAP-H

This sub-program, started in 1978, was formerly known as the Scientific and Engineering Student Program (SESP). It pays the salaries of university and college students in the upper years who spend their summers in small firms working on problems related to production, manufacturing and preparation of product designs. NRC also pays stipends to qualified senior people in universities, industry or government who supervise the work of these students.

IRAP-F

This is the designation given to the original TIS. It is of special importance to small and medium-sized companies that have little or no technical library facilities, engineering or research staff. Larger firms also use this service to help their technical staff keep up-to-date with new information.

IRAP-C

IRAP-C is the field advisory service, covering the stationing of roughly 100 field officers in a number of locations across the country. About half of these are employees of the PROs, for whose services the PROs are reimbursed on a flat rate per person-year. The remainder are NRC employees. Most of the latter group are stationed in a number of locations in Ontario and Québec, as well as in Newfoundland and in Prince Edward Island, the two provinces that do not have PROs. Within the past year or so, NRC has started an experimental procedure in which NRC employees are stationed at a PRO. At present, this is confined to MRC and CRIQ, but it seems likely that it will be extended to other PROs in the near future.

In almost all cases, the field officers, whether they are employees of NRC or the PROs, are qualified industrial engineers, or people with similar qualifications. They not only arrange for firms to receive the kind of technical information they require, but they are also able to provide advice and guidance on industrial engineering methods and techniques to develop better systems for improving the effectiveness of company functions and production operations. In doing this, they will spend as much as two or three days with a company, at no cost. They are also expected to acquaint companies with other types of assistance available from NRC and other sources (see also pp. 31-36).

Besides the six sub-programs, NRC also makes contributions, ranging from a few thousand to $100 000 a year, to about a dozen specialized institutions.* This is done with the understanding that these will make available to companies information and advice of a type that is not readily available through the normal channels used by IRAP-C and IRAP-F.

The six IRAP sub-programs cover a remarkably wide range of mechanisms for making the benefits of science and technology available to industry. With a repertoire ranging from IRAP-P, at one extreme, to IRAP-C and -F at the other, they take cognizance of the very wide range in the size and research capability of our industrial firms (see Table II.2, p. 33).

IRAP-P and -M grants are only awarded to those relatively few companies that have an indigenous R&D capability, or at least, in the case of IRAP-M, sufficient in-house competence to tackle technical problems with some outside assistance. Together, these two sub-programs accounted for expenditures of $24 million in 1981-82, or almost 80 per cent of the funds that NRC assigned to IRAP that year.

IRAP-L and -H, as well as -C and -F, are directed at the type of SMEs that comprise the majority of our industrial firms, and the major

* For example, the Welding Institute of Canada, the Centre for Cold Ocean Resources Engineering (C-CORE), and Forintek Canada Corporation. About $600 000 was used for this purpose in 1981-82.

proportion of the clientele of the PROs. The launching of IRAP-L in 1981 was enthusiastically supported by the PROs, as might be expected, because, as mentioned previously, it was modelled after a program that had been proposed by them in 1977. It was also welcomed by the SMEs. However, the funds assigned to it were far too small; less than $800 000 in 1981-82. When it was announced, with a certain amount of fanfare, in various parts of the country, a great many companies submitted applications, only to be told that the funds were exhausted. This caused some hard feelings and remarks about federal programs that are strong on words and weak on deeds.

In our discussions with the PROs and others, they told us that the "market" for IRAP-L was far greater than the funds available. This assessment must be taken seriously, because the field officers attached to the PROs under IRAP-C not only deal with the SMEs on a regular basis, but they are also responsible for handling applications for IRAP-L.

In chapter II, in discussing the free services provided by the PROs, we made the general recommendation that NRC revise its priorities to place greater emphasis on the needs of smaller companies. We also recommended specifically that it triple the number of field officers attached to the PROs in connection with IRAP-C, and that it collaborate with the PROs to establish an equitable and stable arrangement for funding them. Here, within the spirit of the same general recommendation, we recommend that *the National Research Council, in cooperation with the Provincial Research Organizations, should examine the possibility of increasing the productivity, competitiveness and innovative capability of small and medium-sized enterprises in all 10 provinces through the mechanism of IRAP-L, and be prepared to increase greatly the financial resources assigned to that sub-program, should such action appear to be justified.*

As it is now constituted, PILP has little direct relation to the PROs. However, with slight modification, it could prove to be quite effective in transferring technology from a PRO to industry. Inasmuch as PILP's ultimate objective is to assist the acquisition of technology by industry, it would not be unreasonable to extend the range of sources from which that technology is drawn to include the PROs, and, indeed, any other provincial technology-generating organizations, as well as NRC and other federal laboratories. By modifying PILP in this way, NRC would be playing an important role in furthering federal-provincial collaboration on industrial development. We therefore recommend that *the National Research Council should give serious consideration to extending the scope of its Program for Industry/Laboratory Projects (PILP) to include the transfer of technology from Provincial Research Organizations and other provincial technology-generating organizations to industry.*

One class of provincial technology-generating organizations is, of course, the universities. Over two years ago it was announced that

NRC was working on a plan to add the universities to the possible sources of industrially applicable technology under PILP.[15] The proposal made here would be along similar lines, but would be broader in scope.

The PROs and the Federal Contracting-Out Policy

Initiated in 1972, the Make-or-Buy Policy (now known as the Contracting-Out Policy in Science and Technology) was created to stimulate the innovative capability within Canadian industry by contracting out the science and technology requirements of the federal government. Of all the various modes by which the PROs interact with the federal government, the Contracting-Out Policy has remained probably the thorniest.* Despite recommendations and numerous presentations by the PROs, recognition by the federal government of the valuable and unique role performed by the PROs has been slow. As Table III.1 shows, the PROs ranked far below the 'service industry' in receiving contracts for the fiscal years 1979 to 1981. In fact, they were significantly lower than 'universities and other non-profit institutions', and are only above 'other governments' and 'primary industry' when it comes to the total value of contracts awarded, at least for the first two fiscal years. This has been true since the Science Centre of DSS was established 10 years ago in 1973. Over this period, the PROs combined have averaged 47 contracts or 1.4 per cent of the total number awarded per fiscal year. In value, this has averaged just over $2 million, or 1.6 per cent of the total value of contracts awarded per fiscal year.

The situation is anomalous. What are the reasons for this and what are the arguments of the various participants with respect to this situation? As we shall see, the PROs' major contention centres on the policy as *implemented*, not the policy as it is *written* nor the *intent* of the policy.** For its part, the federal government maintains that the PROs have an important brokerage role to play in stimulating and increasing the innovative capability of the private sector and in that capacity should be used more as subcontractors where appropriate. To trace this complex development, it is necessary first to sketch briefly the evolution of the Contracting-Out Policy.

It is generally agreed that the roots of the Make-or-Buy Policy, as it was originally called, can be traced back to the major critics of

* The reader should bear in mind throughout this section that not all of the PROs have necessarily the same views on their individual situations with respect to the Contracting-Out Policy. Nevertheless, the consensus has been that their participation within this policy has not been free of problems.

** Dr. Claude Bursill, Executive Director of NBRPC, put the issue more bluntly: "We do get used to the fact that rules, certainly policies, often lie in the performance."[16]

Table III.1 – Distribution of Contracts Awarded by the Science Centre, Department of Supply and Services, [a] 1979-1982

	1979-80 Contracts				1980-81 Contracts				1981-82[b] Contracts			
	No.	%	Value $M	%	No.	%	Value $M	%	No.	%	Value $M	%
Total Awards	2 213		148.6		2 557		194.9		3 125		207.1	
Primary Industry	13	0.6	0.9	0.6	11	0.4	2.0	1.0	41	1.3	3.6	1.7
Secondary Industry	153	6.9	45.9	30.9	128	5.0	82.1	42.1	224	7.2	54.6	26.4
Service Industry	1 073	48.5	72.8	49.0	1 360	53.2	81.6	41.9	1 576	50.4	97.5	47.1
Individuals	392	17.7	3.7	2.5	484	18.9	4.9	2.5	498	15.9	5.7	2.8
Other Governments	26	1.2	1.9	1.3	18	0.7	0.9	0.5	37	1.2	7.6	3.7
Universities and Other Non-Profit Institutions	502	22.7	20.5	13.8	505	19.7	20.3	10.4	667	21.4	31.5	15.2
PROs	54	2.4	2.9	2.0	51	2.0	3.1	1.6	82	2.6	6.6	3.2

[a] Unsolicited proposals not included.
[b] Does not include contracts awarded by the Canadian Commercial Corporation or through the Defence Industry Productivity Program
Source: Data derived from information provided by the Science Centre, Department of Supply and Services.

Canadian science policy; the Glassco Commission, the Science Council, OECD and the Senate Special Committee on Science Policy. All of these bodies were unanimous in the view that one cause for Canada's particularly weak industrial research and development was the predominant role of federal intramural R&D activities. Indeed, compared to other western industrialized nations under scrutiny at that time, in Canada, a significantly larger proportion of R&D was performed within the government sector. This greatly uneven sectoral distribution of the performance of R&D had led to some serious accusations, not least of which was the claim that the government selected R&D projects inappropriately and inadequately exploited research results.[17]

To correct this problem, the federal government announced, in 1972, the establishment of the Make-or-Buy Policy, whereby all new mission-oriented research and development that was funded by the federal government should be contracted out to industry, except in special cases. It is probably fair to say that many, including most of the PROs, supported this move by the federal government* and welcomed a policy whose long-range objectives were "to create more industrial innovation in Canada, to enlarge the industrial share in the national science effort, and to ensure that the scientific activities of government will have economic and technological spin-offs that would be impossible if the research were done in-house."[20]**

Shortly after the announcement, the Science Council of Canada published a commentary on the Contracting-Out Policy, making two points relevant to the present study: first, that the PROs should be involved in the contracts obtained by industry, preferably as subcontractors; and secondly, that the Make-or-Buy Policy, like all government policies, should continue to evolve and prove itself flexible as circumstances change.[21] Subsequent to this and other advice – particularly an evaluation undertaken by MOSST[22] – the Make-or-Buy Policy underwent modifications in 1976. The policy, now known as the Contracting-Out Policy, was extended to apply to ongoing as well as new requirements in science and technology within the federal R&D establishment. Also included were RSA, as well as science and technology requirements in the human and social science fields of

* The policy, however, did not please everyone. The Manitoba Ministry of Industry and Commerce, addressing the Senate Special Committee on Science Policy, argued that the policy was counterproductive "since research and development that would otherwise have been carried out by federal laboratories in Manitoba may, with the new policy be carried out in another province, particularly Ontario and Québec".[18] Others, particularly those with a stake in federal government in-house research activities, were particularly disturbed by the 'universal' application of the policy.[19]

** The Make-or-Buy Policy is only one element of the federal government's procurement policy framework, and does *not* include the general contracting policy nor the contracting for services guidelines.

urban, regional and transportation studies. The Unsolicited Proposals Program, created in 1974, was added as an adjunct to the policy.*

In addition to these changes in the policy, Treasury Board's manual *Science and Technology – Contracting Out*, issued in 1978, stated that a major factor that must be taken into account in the contracting-out process was the pursuit of *other objectives* (inherently political) of the government. More specifically, an attempt was to be made to distribute contracts on a regional basis. The guidelines also specified that the "highest priority was to be accorded to Canadian industrial performers" in awarding the contracts. When such a performer could not be identified, other performers were to be considered, including the PROs. Furthermore, in selecting alternative performers, "*due consideration should be given to the extent to which the selection of the performer would indirectly promote the policy objective of stimulating industrial innovation*** (for example, the capability of the performer to transfer technology to industry; the reputation of the performer; and whether the performer is under-pricing due to public subsidization)."[23] It would be difficult, given these criteria, not to rate the PROs high on the list of potential contractors. The PROs' raison d'être is to stimulate industrial innovation, as we have outlined in chapter II. Furthermore, their capability to transfer technology to industry as well as their independent status has led to widespread recognition of most of them. Thus, as secondary performers, the PROs should be encouraged to hold industrial R&D contracts arranged by DSS. As Table III.1 (p. 57) shows, this is simply not the case. In many instances, they have not been invited to tender for proposals and therefore have not been kept aware of government needs and have not been able to bid on contracts. One example can be cited to illustrate this point. In November 1982, a contract for the construction of computer files on coal data in southern Saskatchewan was let to an Edmonton-based consulting firm, yet, despite the fact that SRC is a major, if not *the*, data centre for coal in the province, it was not even provided with a copy of the initial Request for Proposal. Other such examples could be cited, which lead one to ask: what are the factors that have led to continued misunderstanding between the PROs and the federal government on this issue? The answer appears to be that this situation has arisen more because of genuine bureaucratic complexities than anything else. In an attempt to rectify the problem, DSS has recently restated its internal policy of circulating information copies of all competitive Requests for Proposals to all of the PROs.

* We have not treated the Unsolicited Proposals Program specifically in this section, though its importance is increasing. In 1981-82, 187 contracts valued at $27.7 million were sponsored by the various client departments.

** Our emphasis.

Although it is difficult to identify a single cause for the situation in which the PROs have found themselves over the past decade, one general explanation rests on their inability to make their case clearly understood to those who are in a position to rectify the problem, combined with a general misunderstanding on the part of the federal government as to the unique nature of the PROs. This latter perception is well illustrated in the continued lumping of the PROs in the "non-profit institutions" category by DSS. There is considerable confusion here, as Statistics Canada does *not* include the PROs within its own definition of "private non-profit organizations". Yet we find the PROs in the DSS category among such diverse organizations as the B.C. Cancer Foundation, Kingston General Hospital, Massett Indian Band, and the New Brunswick Electric Power Commission. All of these organizations have widely ranging mandates, not to mention significantly different functions. The continued inclusion of the PROs in the category defined as "non-profit research institutions" only serves to perpetuate a misconception as to the work of the PROs. We therefore recommend that *the Department of Supply and Services, in matters relating to the awarding of science and technology contracts, should consider treating the Provincial Research Organizations as a category in its own right.* This would be a first step towards recognizing the PROs both as unique, quasi-governmental provincial agencies and as legitimate alternative performers in their bids for industrial R&D contracts. It would also serve to remove a source of federal-provincial friction.

However, the issue is far more complex than one of definition. Another major impediment to the resolution of this problem has been the difficulty in knowing who, at any one time, is responsible for the policy. Apart from the fact that the DSS Science Centre has had several directors over the decade, thus making it difficult for the PROs to address and to see action from the same individual, there has been an added dimension in that, in addition to the federal departments or agencies for whom the work is to be performed, three other federal organizations are directly involved with the policy: DSS is responsible for implementing the policy and 'setting patterns of delegation'; MOSST has the duty of periodically evaluating the overall effectiveness of the policy; and Treasury Board has been instructed by Cabinet to provide guidelines for the requirements of the federal agencies in science and technology. Under the circumstances, it is not surprising that the PROs have been uncertain as to whom they should direct their complaints regarding misinterpretations of their participation within the Contracting-Out Policy. This contributes to the impression that there is no minister whose duties include recommending or making changes to the policy. Unless steps are taken to rectify this, the policy will remain fixed as it is, with no one having any real responsibility for it. As we discussed earlier, the Science

Council has underlined the importance of maintaining flexibility in any government policy.

Two damaging misconceptions regarding the PROs were made in the 1975 evaluation of the policy by MOSST.* The first was that "it appears that the non-profit institutes have tended to regard federal research contracts simply as an immediate source of funding".[24] This has been discussed earlier in this chapter, and there are clearly more legitimate reasons for the PROs' interest in participating in federal programs. The second was that "in those provinces where the research councils must derive most of their income from contract research, they tend to compete with the very industry they are meant to support."[25] Although it would be difficult to ascertain just how much these remarks affected future awards of contracts to PROs, we can at least assume that they did not help.

The second statement suggests an unfamiliarity, not only with the nature of the PROs and their activities, but also with the realities of Canadian industry and its research capabilities. As we have mentioned earlier, the vast majority of the industrial clients of the PROs have no research capability. Far from competing with them for R&D contracts, the PROs serve as their R&D arm. As for the firms that do have an R&D capability, any work that the PROs do for them is by mutual agreement, not through competition.

The bulk of the expenditures of the PROs are related to primary and secondary industry (see Table I.2, p. 20). These are sectors that the respective provinces expect their PROs to support, and which received only 8.5 per cent of the DSS contracts and 28 per cent of the funding in 1981-82 (see Table III.1, p. 57). Most of the contracts and money went to the service industry, individuals, other governments, universities and other nonprofit institutions. Because of the extensive involvement of the PROs in providing technical assistance to the SMEs, particularly to those in the primary and secondary sectors, they are specially qualified to transfer to those sectors the knowledge gained in fulfilling federal requirements for science and technology. Clearly the PROs are just as qualified as the service industry, and more qualified than some of the others to participate in the Contracting-Out Policy.

APRO articulated some of these points in its brief to the Senate Special Committee on Science Policy in February 1977.[26] The brief presented a much wider perspective of the role of the PROs in industrial development, but it focussed mainly on a critique of the Contracting-Out Policy. In its argument, APRO pointed out that the policy was applicable to only a minute proportion of Canada's manufacturing establishments and had little direct relevance to the major

* We understand that another evaluation of the policy has recently been prepared by MOSST.

clientele of the PROs, namely, the 99 per cent of manufacturing concerns which have no in-house research capability. Furthermore, the brief challenged the government's apparent inconsistency of awarding significant proportions of contracts to the service sector, most of whom provide similar scientific and technical services to secondary industry. If the service sector with its expertise in engineering and RSA could meet the requirements of the policy and be recognized as legitimate performers (see Table III.1, p. 57), why should the PROs not qualify as well? Clearly, some of the PROs have considerable expertise in RSA (see Table I.1, p. 19); that is, scientific data collection, the provision of scientific information, testing and standardization and feasibility studies. In the case of BCR, this type of work, along with industrial innovation, constituted 62 per cent of total expenditures in 1981.

The PROs have established a track record and accumulated in-house expertise, and they have consistently maintained that greater access to DSS contracts will help preserve and expand their technical capability. Onil Roy of CRIQ made the point well:

> "The work we receive from these small and medium-sized companies is not of a sufficiently technical level to allow us to retain people who have the background and knowledge required to provide the best assistance. If we were able to get some of these higher calibre contracts, contracts which consist of a technical content of a higher level, it would certainly help us in retaining the capacity from a technical point of view, to serve the main purpose for which we exist, which is to provide assistance to the smaller industrial companies.... "[27]

Another not-unrelated factor among the reasons for the PROs' semi-exclusion from the Contracting-Out Policy revolves around the eligibility criterion of the Treasury Board that attention should be paid to whether or not the performer is underpricing due to public subsidization. The issue of unfair competition surfaces regularly and has been levelled at the PROs from time to time. Usually, such charges coincide with economic downturns, for when contract money is scarce, criticism arises. The PROs have tried to protect themselves against such charges by arguing that they often levy more than the going market price when selling their expertise. In many cases, of course, the PROs possess resources or facilities that are unique and the client will logically contract with these organizations. Furthermore, much of their so-called "subsidy" goes to cover free or nonprofit services not provided commercially. Also, most PROs have specific policies that remove them from competitive bids if the expertise or equipment is found elsewhere.* Indeed, two of the PROs,

* ORF, for example, has a rule that if an industrial engineering contract requires more than 50 person-days, it must go to a commercial firm.

CRIQ and ARC, publish lists of the firms providing testing, consulting and laboratory services in their respective provinces. In several cases, the PROs have links with consulting firms to undertake joint contracts. In others, they have kept their communication channels open by appointing executives of consulting engineering firms to their Boards. They have also invited the local Associations of Consulting Engineers to visit their laboratories and become familiar with each other's expertise.* Thus, the problem seems largely overblown; the consulting sector's major bones of contention are mainly ones grounded in principle rather than in practice.**

More substantive in nature, however, are the arguments that because of their quasi-governmental status, the PROs should not have *direct* access to contracts under a policy whose initial objective was to redistribute more of the public sector R&D activity to the private sector. The concern has been that any alteration in the guidelines to permit PROs greater direct access to federal contracts will only result in an increase, rather than a decrease, in the share of public sector R&D performance. This line of reasoning maintains that the PROs have a tendency to act in an hegemonic fashion, and retain in-house expertise gathered as a result of a contract, so little by way of technology transfer to the private sector can result. Although sympathetic with the thrust of these concerns, we feel that proper recognition of the character and role of the PROs should dispel them. Furthermore, with the federal government wanting industry to spend more on R&D, and with a great majority of firms clearly in no position to qualify for available funds, the need for such organizations as the PROs, that can provide a bridging function in bringing firms up the learning curve in science and technology, is all the more important.

To the extent that the PROs have participated in the Contracting-Out Policy, not all of them have the same stake in the policy (Table III.2). Although Unsolicited Proposals have not been included in this table, we can nevertheless conclude that those PROs that derive a high proportion of their income from industrial contract work are likely to receive more DSS contracts than others (see Table I.3, p. 21). In particular, ORF has had a vastly larger proportion of all contracts DSS awarded to the PROs, but this, in part, reflects the regional distribution of DSS contracts, which is concentrated in Ontario. The $1.5

* Québec's consulting engineers have recently pointed out some of CRIQ's activities that could be performed jointly.[28]

** The importance of alleged unfair competition in the eyes of the consulting engineers is illustrated in the failure to mention this, even as a minor issue, in a recent report of a committee drawn from the Canadian consulting engineering industry and chaired by S.J. Cunliffe.[29] This is not to deny that instances of direct PRO competition with the private sector may not have occurred in the past or may not continue to occur; these instances are, however, usually not deliberate.

million awarded to ORF in 1980-81 constituted only 1.4 per cent of the total value of contracts awarded to Ontario-based industrial performers. The $267 280 awarded to NBRPC, on the other hand, represented 10.6 per cent of all contracts awarded to New Brunswick's industrial performers. Thus, the gross figures can be deceiving.

Table III.2 – Contracts Awarded by the Science Centre, Department of Supply and Services, to Provincial Research Organizations, 1979-1982

	1979-80		1980-81		1981-82	
PRO	No.	Value ($)	No.	Value ($)	No.	Value ($)
NSRFC	8	404 355	6	321 456	11	422 871
NBRPC	5	163 957	10	267 280	9	327 437
CRIQ	2	48 670	2	314 500	5	511 709
ORF	25	1 532 886	24	1 487 376	41	3 510 517
MRC	–	–	–	–	1	7 639
SRC	5	507 955	4	176 578	7	1 395 412
ARC	–	–	1	42 100	3	64 797
BCR	9	347 443	4	500 810	4	302 886
TOTAL	54	2 905 266	51	3 110 103	82	6 550 807

Source : Data derived from information provided by the Science Centre, Department of Supply and Services.

Another issue relates to the regional offices of the Science Centre of DSS in Vancouver, Edmonton, Winnipeg, Toronto, Montréal and Halifax. These are staffed by science procurement officers whose duties are to handle and manage contract requests originating largely from federal establishments based in those regions. Indeed, the existence of these offices is an attempt by the headquarters' office in Ottawa to decentralize, and use more local expertise. For the PROs to become more visible within this policy, they must clearly do a much better job in marketing their expertise, not only to the regionally based DSS officers, but also to the local sponsoring federal establishments. Some of the PROs have been deficient on this account. By undertaking a more aggressive stance, they would be in a better position to submit Unsolicited Proposals to sponsoring agencies, for example.

Despite the many arguments presented in favour of the PROs' greater participation within the Contracting-Out Policy, it still appears that their role remains misunderstood by the federal government. The PROs have not argued that they be placed on the same level as Canadian industrial performers; they have insisted that they be placed on a par with the service sector.[30] Indeed, the Senate Special Committee on Science Policy made the following recommendation to DSS following presentations by APRO: "In the awarding of R&D contracts, provincial research organizations should be given

the same priority as other agents of the service sector."[31] We support this recommendation with the caveat that selection of a PRO should be based on technical merit. We therefore recommend that *when considering the award of contracts to organizations outside the primary and secondary sectors, those responsible for the Contracting-Out Policy should recognize the ability of the Provincial Research Organizations to tender, where technically appropriate, on the same basis as the service sector.**

Relations between the PROs and federal officials involved in the Contracting-Out Policy have not always been well developed, and, to some extent, the PROs have to assume responsibility for this situation. We would recommend that they make a systematic effort to strengthen ties with both the federal contracting agencies and departments in their regions, as well as with the officials responsible for managing the Contracting-Out Policy. Furthermore, because of their brokerage mandate, we would recommend that *the Provincial Research Organizations should, when technically qualified to bid on DSS contracts, consider submitting proposals jointly with industrial performers, and further, they should adopt a more aggressive stance in marketing their eligibility as subcontractors for work contracted out to these industrial performers.* By developing and strengthening this aspect, we believe that they would be in a better position to undertake their role of transferring technology to Canada's industrial sector.

Other Federal Programs

Some of the programs of IT&C whose objectives focus mainly on encouraging new technological developments and assistance to small and medium-sized enterprises are the Centres of Advanced Technology (CATs) program, the Product Development Management Program (PDMP) and the Enterprise Development Program (EDP). All relate directly to the role of the PROs.

Centres of Advanced Technology Program

Coincident with the enormous resurgence of interest in science policy at the federal level during the late 1960s and early 1970s, the federal government, perceiving the political credit possibilities of addressing the issue of regional development through science and technology, began a series of assistance programs designed to promote

* The reader should bear in mind that the category "service sector" is a very ill-defined one, ranging as it does from small management consulting concerns to large consulting engineering firms. Precision in the term would certainly benefit the application of the guidelines.

industrial research and development. One of these was the CATs program of IT&C. Initiated in 1970, its aim was to encourage universities and PROs to establish centres of expertise in areas of specific technological interest to industry. 'Seed' money was provided to these centres in the expectation that they would develop as technically and financially successful entities that could provide services to industry on a continuing basis after the financial support was terminated. Several of the PROs put together submissions for funding. The result was the establishment of the Centre for Powder Metallurgy at ORF, the Centre for Ocean Engineering at BCR, the Centre for Ocean Technology at NSRFC, the Canadian Food Products Development Centre and the Health Industry Development Centre at MRC, and, very recently, the Canadian Centre for Advanced Instrumentation at SRC (see Table III.3).

Table III.3 – Centres of Advanced Technology at Provincial Research Organizations

	Grant ($)	Term (yrs.)	Termination Date
Centre for Powder Metallurgy, ORF	450 000	3	30 June 1974
Centre for Ocean Engineering, BCR	1 225 000	3	14 March 1976
Centre for Ocean Technology, NSFRC	1 075 000	7	31 May 1981
Canadian Food Products Development Centre, MRC	550 000	5	31 Dec. 1979
Health Industry Development Centre, MRC	225 000	3	31 Dec. 1979
Canadian Centre for Advanced Instrumentation, SRC	1 000 000	5	March 1987

Note: Other CATs in postsecondary institutions include the Systems Building Centre and Biomedical Instrumentation Development Unit at the University of Toronto, the Canadian Institute of Metalworking at McMaster, the Centre de technologie de l'environnement at l'Université de Sherbrooke, Systems Analysis, Control and Design Activity at the University of Western Ontario, Waterloo Centre for Process Development at the University of Waterloo, the Centre for the Measurement and Control of Particles and Vapours at McGill University, the Canadian Centre for Fisheries Technology at Technical University of Nova Scotia and the Atlantic Coal Institute at University College of Cape Breton.

The available evidence from the few evaluations so far performed on the success of this program indicates mixed results.[32] A more elaborate evaluation of the results of this program would be

highly desirable to indicate its weaknesses and strengths, particularly as the program (now included in the Institutional Assistance Program) is still operational.

Total funds from IT&C to the PROs for CATs have not been lavish (Table III.3). Any one of NRC's regional laboratories recently established has received significantly greater financial support. The Ontario government's commitment of $120 million to six technology centres is far greater as well. In comparison, the CATs in the PROs have been unrealistically funded, and some of the PROs have met with difficulty in maintaining them. This, combined with the sponsoring federal department's apparent lack of concern for their performance, has led to a situation where at BCR, for example, the Centre for Ocean Engineering has constituted a drain on the organization's financial resources and its future status is now under serious evaluation by BCR management.

In the case of MRC's Health Industry Development Centre and the Canadian Food Products Development Centre, their continued success is probably due, in large part, to a critical influx of funds from other sources. Both centres emerged as a result of intentions expressed by the federal and provincial governments at the Western Economic Opportunities Conference held in Calgary in July 1973. A submission, presented jointly by the four western provincial Premiers on 'Economic and Industrial Development Opportunities', stressed the need for industrial centres of excellence funded by the federal government that would involve the participation, among others, of the PROs.[33] Out of this initiative, the two Manitoba-based CATs were established in 1975 on a 50-50 cost-sharing agreement between IT&C and the Manitoba Department of Industry and Commerce. MRC was charged with the operation of these centres. In 1978, the agreement was renegotiated as part of a $45-million shared-growth program known as Enterprise Manitoba; $16 million of this amount went to MRC, which, in turn, used $4.5 million for the Canadian Food Products Development Centre at Portage la Prairie. The location was the result of a deliberate attempt to promote regional development outside Winnipeg. The remaining $11.5 million was reserved for the establishment of the Industrial Technology Centre in Winnipeg. The latter incorporated the Canadian Health Industry Development Centre, which, in turn, recently provided assistance to the Rh Institute Inc. to establish a blood plasma fractionating facility on the campus of the University of Manitoba.

In the case of NSRFC's Centre for Ocean Technology, it would appear that the longer lead time in 'seed' money (seven years) has been beneficial. The centre has, along with the Engineering Physics Division, contributed to a number of ocean-oriented initiatives already discussed in chapter II.

Product Development Management Program

PDMP is an interesting twist to the design of traditional federal programs. Initiated in early 1979, the program is federally sponsored through IT&C's Design Canada in collaboration, at present, with eight provincial governments. The program requires a matching contribution from, and is delivered by, the provincial governments. It is they who are responsible for the marketing and publicity associated with PDMP which is aimed primarily at small and medium-sized businesses. PDMP encourages product design and development through management training and technical advisory assistance. It is claimed that the list of participating companies is relatively large, this being a reflection of the fact that their maximum contribution to the program will never exceed 25 per cent of project costs. In several cases, the provincial governments have delegated the responsibility of delivering PDMP to the PROs. Thus, SRC, BCR and CRIQ have become the provincial delivery agents for the program. Total PDMP contributions in these provinces is very small, however, amounting to only about $370 000 in 1981-82. In other cases, such as in Ontario, PDMP has been administered by the provincial Ministry of Industry and Trade.

Preliminary indications are that the program has support of industrial participants as well as the PROs, which deliver PDMP. As of the year 1980-81, the total expenditures of the program have been about $1.6 million, with work being provided for over 250 firms. It has been estimated that the program has led to the creation of several hundred new jobs and assisted products sales of over $20 million.[34] It is undergoing evaluation to determine whether it should be continued after the phase which terminates in 1984.

Enterprise Development Program

Administered by IT&C, EDP was established in 1977 as the result of a merger of several other assistance programs. One part of the program provides for the contribution of up to 75 per cent of the direct costs of the development of new or improved, technologically advanced products or processes. Although EDP does not disqualify any company, its focus is on small and medium-sized businesses, due largely to a requirement that the cost of a project and its implementation must represent a significant burden on the financial resources of the participating company. The program is accessible throughout Canada, with regional Enterprise Development Boards established in all the provinces which have the authority to distribute grants of $200 000 or less.* EDP also provides the money (up to 75 per cent)

* The federal government, it appears, is re-appraising the structure of these regional boards, and is considering reducing their powers by building into their structure greater accountability.[35] Other changes in the program are also under consideration.

to assist firms to engage consultants for market feasibility studies, productivity enhancement studies, product development and design, and pollution technology projects.

With its focus on SMEs in the manufacturing and processing sectors, the EDP scheme is particularly well suited to the capabilities of the PROs. SMEs, which have little or no in-house expertise in technical matters, are sometimes assisted by the PROs in preparing an application for an EDP grant. Usually, this is done without charge by the PROs, though occasionally a minimum charge is levied. If the application is successful, the participating company may then subcontract the necessary services from the PROs using the federal contribution to help defray the cost. The bulk of the grants are awarded to Ontario and Québec firms in Canada's manufacturing heartland. In 1981-82, 576 EDP grants totalling $119 million were awarded, of which about $98.2 million went to Québec and Ontario. It is therefore not surprising to find that both ORF and CRIQ have participated in this program quite regularly. This source of income, indirectly from EDP, is 'hidden' in the sense that it is reported under the heading 'Canadian Industry and Foreign Sources' (see Table I.3, p. 21). The EDP-financed work of the PROs constitutes an important element of their bridging function in developing both future markets for their expertise, and in assisting SMEs in 'going up the learning curve' with respect to research and technical development. ORF has estimated that perhaps 40 per cent of its industrial contract revenue for 1981 could be attributed to funds received from industrial clients who had been successful in obtaining EDP grants. As for CRIQ, the importance of EDP is reflected in the total revenue generated from this source. In 1981-82, CRIQ received $3 120 630 in contract value from 28 clients who had been awarded EDP grants. As CRIQ's total income from contracts signed with the private sector for that year was $5 142 439, this represented 61 per cent of CRIQ's income generated from the industrial sector.

Thus, the PROs are particularly well-placed, independent bodies that can act effectively as research arms for firms with little in-house research capability but that wish to develop new products or processes to remain competitive. In this capacity, the PROs are in an ideal position to know the needs of the SMEs, and therefore, they are not out of line in undertaking such contract work. Quite the contrary, Canadian industry's R&D "contact system", as Steed has coined it,[36] will clearly be ameliorated by the PROs continuing this activity. We would therefore recommend that *all of the Provincial Research Organizations should make a systematic effort to use the Enterprise Development Program as a means of enhancing their delivery of technological assistance to small and medium-sized enterprises.* In so doing, they will contribute to enhancing the technological sophis-

tication of the SMEs, and thereby add to the nation's industrial productivity.

The Association of Provincial Research Organizations: Strengthening the Federal-Provincial Dialogue*

Clearly, the PROs' ability to be aware of and to assist in delivering federal government technical assistance programs, as well as their own ability to structure themselves in a fashion to deal effectively with issues that affect them all, is critical to the PRO-federal relationship. Over and above the look-out function that they conduct regularly within their respective environments, the PROs learn of, and communicate on, new federal government initiatives largely through two methods: informal communication among one another at both the executive and staff levels; and regular meetings of APRO in which the chief executive officers participate.

The historical interaction between NRC and the PROs has been based, in part, on informal communication at the working level, whereas interprovincial cooperation at the national level is maintained mainly through APRO. The association had its genesis through a suggestion made by Senator Bourget of the Senate Special Committee on Science Policy that the PROs, because of their common difficulties, consider forming a group to present their views on a national level.[37] The PROs, who, prior to 1969, had met from time to time on an informal basis, took the suggestion and formed the Non-Profit Industrial Research Association of Canada, now called APRO. The association meets regularly (almost quarterly), usually in Ottawa, to hear from and to present to federal representatives views that affect the PROs' ability to operate effectively at the national level. The meetings serve several functions: first, they give the PROs an opportunity to exchange ideas among themselves and develop strategies; secondly, they raise the level of awareness of the PROs and their capabilities to outsiders (for example, the nascent Department of Regional Industrial Expansion (DRIE)); thirdly, they permit the PROs to learn of developments within federal departments or organizations (for example, Transport Canada's research program); and lastly, they enable them to press their case jointly in connection with problems that may exist with policies or programs of federal departments such as MOSST or DSS. Furthermore, the informal nature of the meetings permits the PROs to respond to those who wish to learn more about the PROs as models (for example, a senior official from the government of Newfoundland and Labrador attended several of the PROs' meetings to obtain information and views concerning the possibility of creating a PRO-like organization in Newfoundland).

* The intra/interprovincial role of APRO is discussed in chapter IV.

All of these facets show that APRO can serve as a useful vehicle for federal-provincial collaboration in the application of science and technology to industry. However, the informal role of this association and its ability to deal with common problems at the working level is handicapped to a certain extent by two factors.

First, the PROs are not always able to react quickly and effectively to emergency situations affecting all of them. This has been exacerbated by the fact that they have no central clearinghouse or coordination office that could mobilize necessary information. As indicated in the opening chapter, they do not report their financial status and other statistical information in the same fashion. This creates a poor image of APRO as an organization and makes it difficult to use data in a comparative way, particularly when presenting briefs on policy issues affecting them.* In our view, such a coordinating office or position is essential if the PROs are to be successful in speaking authoritatively in federal-provincial dialogues. We are aware that they have discussed this matter from time to time and we therefore urge that *the Association of Provincial Research Organizations should give serious consideration to the establishment of a permanent clearinghouse office (secretariat) that will act as a service arm to the organizations by providing information and data on matters that affect all of them.*

Secondly, the danger of its increasing politicization is gradually affecting the very existence of APRO. Because science and technology have, over the past decade, become increasingly associated with major thrusts in provincial economic developments, the probability of conflict or tension with the federal government has increased. Philippe Garigue has put the matter succinctly:

> "In the past, science was outside the main preoccupations of political leaders because it was not perceived to involve the question of national unity. Lately, however, it has become a source of possible tensions between federal and provincial governments because . . . it is involved in the distribution of political decision-making."[38]

As part of their respective provincial governments' efforts in scientific and technological research, the PROs, in varying degrees, reflect the decision-making aspects of governments. To a large extent, this is a result of the status that certain PROs possess within the economic development strategies of their respective provinces.** The issue of 'length of the arm' of PROs to provincial governments is a

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* It is only to be expected that because of their differing constitutions, their annual reports and other data requirements will be far from uniform. However, this does not prevent the PROs from also creating a uniform data format.

** For an analysis of the wider issue of federal-provincial relations regarding industrial policies, see Michael Jenkin.[39]

critical one and, in certain instances, directly affects federal-provincial relations.* Furthermore, the creation of functionally equivalent infrastructures within the provinces to deal with the federal government has meant that the activities of the PROs outside their provinces (through APRO, for example) are, in some instances, monitored by Ministries of Intergovernmental Affairs or their homologues. This has resulted in bringing the PROs more visibly into the political arena, a consequence which could jeopardize open and informal discussions within APRO.

There is no equivalent of a Council of Ministers of Education or Council of Resource Ministers in the domain of science and technology. It is not surprising, therefore, that APRO or, more specifically, its members have from time to time been looked upon as logical representatives of the provinces when it comes to matters of science and technology. Thus, when the Science Council of Canada held an Interprovincial Conference on Industry and Technology Policies in January 1981, the chief executive officers of the PROs from Alberta, Manitoba, Saskatchewan, New Brunswick and Nova Scotia took part. And when the government of Newfoundland and Labrador held its Seminar on Science Policy in March 1982, the PROs from Manitoba, Saskatchewan and New Brunswick participated.[40]

Naturally enough, the absence of an official intergovernmental body dealing with science and technology policy has provoked some to argue that there is a need for such a body to act as a focal point for federal-provincial discussions on science and technology. Such a proposal was laid out by the Ontario Minister of Industry and Tourism in January 1981. In his report, the Honourable Minister, Larry Grossman, claimed that there is "a lack of co-ordination, sharing, or joint-venturing among the provincially owned research facilities and no agreement upon strategy of specialization."[41]** With no basis to support this contention, he recommended the establishment of a Canadian Council of Research and Technology Centres with representatives from federal and provincial departments of economic development. Although such a council might have some merit and might complement the work of APRO, most provincial governments made little effort to comment on the report and its recommendations. The PROs, through their association, did, however, respond and

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* See chapter IV, pp. 76-78 for a further discussion of this.

** "Coordination" has always had a great appeal to the politician. Fifty years ago, in a letter to Sir Joseph Flavelle, Chairman of the Board of ORF, the Ontario Premier, George Henry wrote:

"I understand there is a considerable amount of feeling throughout the country that there is duplication of services as between Ottawa and the various provinces, and that a considerable economy could be had if there were an attempt to co-ordinate the whole service and definitely divide between federal and provincial jurisdictions" (23 Dec. 1932).

sent a reply to the Ontario government. They pointed out, with the aid of examples that, in fact, there was a good deal of joint-venturing and cooperation among the members and argued that there was no significant duplication as they each serve the differing needs of their respective provinces.

The PROs in their Federal Environment

With the lack of a central clearinghouse and increasing politicization impinging on the PROs, their continued success will depend on their capability to increase their visibility and engage actively and effectively in the national R&D effort. Conditioned by the increasingly complex environment within which they operate, the PROs are no longer virtually the sole quasi-independent R&D organizations operating regionally. They have had to contend with the creation of new, specialized agencies, research institutes and technology centres. Some of these, created by the provinces, are discussed in chapter IV.

Within the federal context, the establishment, under the aegis of IT&C, of various programs from the late 1960s to the present served to change a landscape largely devoid of R&D institution building. The result has been the creation of eleven university-based IRIs, twenty-five CATs and Microelectronics Centres, two Industrial Innovation Centres, and five Industrial Research Associations. On a somewhat more lavish scale, NRC has established several regionally based laboratories, including the Arctic Vessel and Marine Research Institute in St. John's, and Institut de génie des matériaux in Montréal, and is presently contemplating others in New Brunswick, Québec, Manitoba and Alberta.*

Given the extent of this institution building, it is understandable that the PROs have found it necessary to re-assess not only their own operations, but also their relations with these other institutions. Where their roles appear to overlap with those of others, they consider joint arrangements. For example, when the Centre d'innovation industrielle/Montréal (CIIM) was established with funding from IT&C in 1979, the provision of invention evaluation as one of its main objectives overlapped with one of CRIQ's subsidiary roles. A formal agreement has since been developed between the two organizations whereby both have combined their respective resources and expertise in invention evaluation. Also, until recently, one of the staff of CRIQ was on the Board of CIIM. Furthermore, in its recent dissemination of brochures on technical assistance to small and

* The creation of 15 new or expanded research centres was proposed in the recently announced $290-million Special Recovery Capital Projects Program of the federal government (3 May 1983). Some of these will be managed by NRC.

medium-sized businesses, CIIM has highlighted the special expertise of CRIQ, notably in the area of technical and scientific information.[42]

Through these and other joint arrangements, the PROs can continue to serve the SMEs in Canada. Much of the success of the PRO-federal relationship is contingent on the ability of the federal government to articulate quickly and clearly its intentions with respect to the ongoing re-organization of the delivery system into the regions, particularly through the various funding and procurement programs such as EDP and the Contracting-Out Policy. With the termination or expiration of most of the General Development Agreements, combined with the appointment of senior federal economic development coordinators within each province,* the need is urgent for organizations such as the PROs to keep the channels of communication open and the federal-provincial partnership dynamic. Recent meetings of APRO with federal officials in DREE and IT&C** and the Ministry of State for Economic and Regional Development indicate that the PROs recognize the importance of such dialogue. We urge that the federal government, through its various 'regionalization' or 'deconcentration' schemes, continue its dialogue with the PROs and thus contribute to the active encouragement of economic growth in the country as a whole.

The Need for Partnership

The fundamental problem associated with the PRO-federal relationship appears to be that the federal actors have failed to appreciate fully that there must be a partnership between them and the PROs, in order that they can strengthen each other in the common task of assisting Canadian industry through science and technology. Problems have arisen frequently because the federal government has not understood the nature of the PROs, and has tended to treat them simply as beneficiaries of federal largesse, rather than as partners. To paraphrase from a report on the relationship of the federal government to the universities, substituting [PROs] for [universities],

> "The [PROs] for their part have been all too willing to approach the federal government, hat in hand with an attitude that they will be respectfully grateful for small mercies. These attitudes, happily, are disappearing, and we urge both the [PROs] and the

* The senior federal coordinators have the following stated objectives: advise Cabinet on proposed regional economic development policies; help coordinate the activities of other government departments in the field; *promote cooperative and joint planning with the provincial governments* (our emphasis); consult business, labour and municipal governments; feed regional considerations into the Cabinet decision-making process; and help transmit government policy back into the regions.

** Both of these departments are to be merged into one, DRIE. This new ministry will incorporate all existing programs into seven major ones, the principal being the Industrial and Regional Development Program.[43]

federal government that they approach the subject of research and technological assistance in a spirit of partnership in which indispensable contributions to Canada's welfare are being provided by each partner. It also follows that such a partnership requires that each partner accept his full responsibility."[44]

IV. Intra and Interprovincial Relations of the PROs

The Arm's-Length Relationship

Although it is only a little more than a decade since the term "Provincial Research Organizations" was first applied to the eight organizations that form the subject of this study, during the intervening period, some of them have seen their position as *the* provincial research organization in their province eroded by the creation of other organizations whose terms of reference seem to overlap their own. Even in provinces where this has not happened, the PROs do not always receive the recognition from their provincial governments that their purported roles would be expected to justify.

There are many reasons for these apparent anomalies, and we do not propose to examine all of them here. However, there is one factor that is common to all of the PROs which makes them susceptible to such situations, and that is their "arm's-length" relationship with their provincial governments. Although no two of them have the same legal status and corporate structure, every one of the PROs was established deliberately by its government in such a way as to ensure its freedom from the kind of direct ministerial control that is characteristic of a department or ministry. If governments did not appreciate that there are advantages in having organizations with this type of relationship to government, they would not have created them. However, in any government, whether it be federal or provincial, ministers and their senior officials are often of two minds with regard to the degree of independence they feel should be allowed to such organizations.

In favour of giving the PROs a substantial degree of independence is the enhanced public support that is given to organizations whose activities appear to be free of any political bias. So, too, is recognition of the ability of such organizations to undertake actions that are recognized as being necessary, but that might be politically awkward or suspect if directed by a minister.

On the other hand, if a relatively independent body is felt by government to be performing badly or not facing up to its mandate, some officials will see this as justification for reducing its degree of independence, even if the necessary housecleaning could be brought about without taking such a drastic step. At a somewhat lower level is the tendency, in some instances, for government bureaucrats to regard such quasi-independent bodies as obstacles to, or possibly as potential colonies for, their own empire building.

The *effective* degree of independence of an organization like a PRO, or its ability to take independent action, is the net result of many factors, in addition to those mentioned. Its particular legal status, frequently set by an act of the provincial legislature, has some bearing on this but is by no means determinate. Of far greater importance is the degree of respect and trust that exists between the chief executive officer of the PRO and the minister or senior government officials with whom he deals on matters of policy and budget. In two of the PROs (NSRFC and CRIQ), the chairman of the governing body or council is also the executive director or president (see Appendix 1, p. 109). In the other six PROs, these two positions are filled by different people, but this does not absolve the executive director or president from the need to establish and maintain rapport with the senior people in government who are in a position to help or hinder the activities of the PRO.

If it is to play an effective role in applying its scientific and engineering capabilities to the needs and opportunities of its province, the PRO must show a sympathetic understanding of the political factors that are likely to influence government action. Otherwise, it will not be invited to make its independent scientific or technological contribution. The result can then be that the government, lacking such input from a competent body of scientists and engineers dedicated to the best interests of the province, may become subject to other advice or propositions that could turn out to have less than ideal consequences or, in the worst instance, could result in technological and economic, if not political, embarrassment. Examples will not be cited, but observers of the passing scene will have little difficulty filling this lacuna.

The first PRO (ARC) was established 62 years ago, the youngest (CRIQ), 14 years ago, and yet there have been few times in the past when the provinces were in greater need than they are today for the kind of help that can be provided by a well-run and adequately sup-

ported PRO. With massive unemployment, economies that are in deep trouble, declining tax revenues and mounting public debt, provincial governments are often tempted to grasp at technological straws of questionable merit proffered to them by eager proponents of pet projects, particularly those falling within such popular but vaguely defined categories as "hi-tech" or "energy". Under such circumstances, senior provincial officials should be able to rely on the confidential advice and assistance of a broadly based, quasi-independent PRO that is scientifically and technologically up-to-date and in close touch with industry.

A facile, but not infallible measure of the state of health of the provincial government-PRO relationship is the size of the provincial grant in relation to the total expenditures of the PRO (see Table I.3, p. 21). There is no magic percentage, but if it is too low, the PRO will not be able to serve the best interests of the province. Reference was made in chapter II to the special mission and capability of the PROs to serve the needs of small and medium-sized enterprises by providing free or low-profit services. Mentioned also was their role in undertaking longer-term applied research and development that is directed towards the economic development of the province. It is not possible for any PRO to do these things, to keep abreast of new scientific and technological developments and to maintain continuity in its operations, if it has to depend, to too great an extent, on contract income.

There is a point of view, by no means universal or well substantiated, that the degree of government control over an organization like a PRO is likely to be greater if the provincial grant is large than if it is small, and, in the interest of preserving freedom of action, too much effort should not be devoted to trying to get the grant raised. However, if a PRO were to adopt such a policy, it would not be in the best interests of its province, and in the long run, it would weaken its own stature and influence.

This study is not the place to make detailed recommendations about the financial affairs of individual PROs, but we do feel that the size of the provincial grant has a very important bearing on the ability of a PRO to play an effective role in the service of its province. We therefore recommend that *if the provincial grant to a Provincial Research Organization is in the order of 30 per cent of its total expenditures or less, the province should recognize that its best interests may be in jeopardy, and take immediate steps to investigate and remedy the situation.*

Effect on the PROs of other Provincial Initiatives

Within the past decade or so we have seen the creation of a variety of publicly funded institutions directed towards industrial develop-

ment through technology. Many of these are federally funded, and have been mentioned in chapter III, but in some cases they have been set up by provincial governments. In such cases, it is only reasonable to ask what effect this has had on the stature and relevance of the PROs. Is the use of the term "Provincial Research Organizations" now a presumptuous misnomer when confined to the eight organizations with which this study is concerned? Or, is there still something unique about the PROs? In this section we examine some of the aspects of these questions.

The newly created provincial agencies, like the PROs themselves, have taken on a variety of constitutional forms, but their terms of reference generally relate to one or more of three types of activity:

- giving advice to the provincial government on broad policy issues;
- awarding grants, contracts and sometimes scholarships, to enhance the application of science and technology to provincial objectives;
- operating facilities in support of industrial activity.

Most of the PROs have, at one time or another, been involved in all three of these activities. Why then, do we find the provinces setting up new agencies? One factor that bears on this question is that the creation of additional provincial agencies has generally taken place after the PRO had established its own laboratories. Before they had their own laboratories, NSRFC, NBRPC, MRC, SRC and ARC, besides their advisory roles, had responsibility for dispensing provincial funds on projects and, in some cases, on scholarships.

BCR, soon after its creation in 1944, had its original laboratories on the campus of the University of British Columbia, and a mandate and funds to undertake research aimed at the development of new or existing industries, and as a result it did not become involved in providing grants, contracts or scholarships to accomplish this on behalf of the province.* This function, as well as an advisory role, was assigned to the Science Council of British Columbia when it was established in 1978.

ORF, which also started off having its own laboratories when it was established in 1928,[1] was given a mandate to devise new methods, develop natural resources and their use, and carry out research to solve local problems in all sectors of the economy.** No provision was made for aiding this through the awarding of grants, contracts or scholarships on behalf of the province. Only much later, and then only for a short period, did ORF become involved in this activity.

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* BCR does, however, use its own funds to award three postgraduate scholarships annually, tenable for up to three years at a BC university.

** To carry this out, it was provided with an endowment of $3 200 000, half of which was pledged by member firms of the Canadian Manufacturers' Association, with a matching sum provided by the province.

Following the surge of industrial activity brought about by the war, there was a renewal of provincial interest in research, and the Ontario Research Commission was set up to "enquire into and report upon all matters concerned with scientific and industrial research as they affect the Province of Ontario."[2] Following recommendations of the commission, the Research Council of Ontario was established to coordinate provincial research activities, administer university grants and scholarships and, with the aid of a number of committees, to serve as a policy adviser. By embracing the first two activities mentioned above, the Research Council of Ontario did not impinge on ORF's activities in the third; in fact, ORF's facilities were expanded at the same time.

The Research Council of Ontario existed for less than a decade. In 1955, it was dissolved and most of its activities were transferred to ORF. Thus, in contrast to what happened with the other PROs, ORF was given responsibility for awarding university grants and scholarships some 25 years after it had set up its own laboratories. However, this period of responsibility was short-lived. When the Advisory Committee on University Affairs* was established in 1961, the university grants and scholarships program was transferred to it.

In Québec, there was never any question of CRIQ having responsibility for the provincial program of university grants and scholarships. In 1966, two bills were presented to the legislature; one was to establish a scientific research council, which would advise the government and support and coordinate research but not engage in research itself (the first two activities mentioned above); the other was to establish a Centre de recherche industrielle with its own laboratories (the third activity). Both bills received first reading but were never implemented because of a change in government. The research-support function of the proposed scientific research council later appeared in the form of rattrapage grants** (1968, 1969) and then in 1969-70, as a major program for Formation des chercheurs et actions concertées (FCAC), under the ministère de l'Éducation rather than as an advisory council. This program, FCAC, has played an important role in developing research and research competence in Québec universities.

CRIQ was established in 1969; it reports to the legislature through the ministre de l'Industrie, du Commerce et du Tourisme. The science policy advisory function was only given an institutional structure some years later, and, since then, has had a somewhat turbulent history. The first step was the creation of a cabinet committee on science policy, le Comité inter-ministériel de la politique scien-

* The precursor of the present Ministry of Colleges and Universities.

** "Development" grants, designed to accelerate research, particularly in the francophone universities.

tifique. On the recommendation of this committee, a science policy advisory body, the Conseil de la politique scientifique, was created by an order-in-council in 1972. In 1975, the cabinet committee was abolished and its secretariat, the Bureau de la science et de la technologie, put under the administrative responsibility of the Minister of Education. The Bureau, an internal branch of the government, was subsequently attached to the ministère d'État au développement culturel et scientifique, the Québec analogue of MOSST, when the ministère was set up about two years ago. However, the ministère d'État has had a briefer existence than MOSST. In September 1982, it was abolished and replaced by a structure somewhat similar to the Science Secretariat that had existed within the federal Privy Council before MOSST was created in 1971. The bureau, now associated with the Secrétariat à la Science et à la Technologie, is within the Conseil exécutif, the executive committee of the Cabinet, and under the supervision of a designated minister, the Ministre délégué à la Science et à la Technologie. During much of its existence, the science policy advisory body, the Conseil de la politique scientifique, has been relatively inactive. However, it has recently undergone a "rebirth", and appears to be performing a useful "bridging" function between the public and the government. It meets both privately and publicly in various regions of the province. In the latter type of meeting, it attempts to bring together representatives of, for example, educational institutions, government agencies, municipalities, industry, and labour to discuss the scientific and technological resources of the region or possibly to discuss proposed government policy on science or technology. It reports to the Conseil exécutif through the Ministre délégué.*

In British Columbia, it has been said that there are four pillars to the province's science and technology strategy: BCR, the Science Council of British Columbia, the Discovery Foundation and the Internal Research Advisory Committee. The last-mentioned body is a subcommittee of the Cabinet; the other three report through, and are funded by, the Ministry of Universities, Science and Communications. The Science Council was established in 1978 to serve in both an advisory capacity and to award grants and scholarships to encourage the development of improved technology and retention of skilled research personnel in the Province. Served by a small but efficient secretariat, the Science Council appears to be operating quite effectively in both types of activity.

* Science policy structures in Québec are undergoing further changes as a result of current legislation. There will be a science minister responsible for the ministère de la Science et de la Technologie, and the science council will be renamed Conseil de la Science et de la Technologie.

The Discovery Foundation's mandate differs from the three activities mentioned earlier. It was established in 1979 to stimulate the development of science-based industry through such mechanisms as developing venture capital schemes and assisting groups in preparing limited partnership tax shelters. Its wholly owned subsidiary, Discovery Parks Incorporated, is essentially a real estate operation, concerned with enticing industrial firms to establish R&D facilities in research parks adjacent to, or on the campuses of, the Universities of British Columbia, Victoria, Simon Fraser and the British Columbia Institute of Technology. Although a number of agreements have been concluded, its efforts are meeting with an understandable degree of difficulty at the present time.

In Saskatchewan, SRC still operates a modest program of grants and scholarships and is the only PRO that continues to do this. The concept of a special body to provide advice on science policy has met with less enthusiasm in the province. The Saskatchewan Science Council was established in 1975, together with a secretariat. However, as a result of budget cuts and resignations, it has been without a secretariat since the fall of 1979. Meanwhile, an Office of Science and Technology Policy has been established in the Office of the Minister of Continuing Education; this "inside-government" activity has led to a number of policy proposals, some of which were revealed in the Speech from the Throne at the opening of the Legislature in mid-March 1983. One such proposal was the establishment of industrial high-technology research and development centres. These would be built onto existing centres of competence, such as the universities and SRC. In this respect, they would resemble the CATs, established by IT&C, rather than the Technology Centres instituted by the Ontario government under its BILD program.

Although this was not specifically mentioned in the Throne Speech, it seems likely that the Saskatchewan Science Council will be reconstituted and strengthened to better carry out its twofold task of advising government and keeping the public aware of important issues in science policy. As a result of a recent announcement by the Premier, it appears that Saskatchewan will have a minister responsible for science and technology, as well as an advisory body that will supersede the Science Council.[3]

Thus it appears that in those provinces that have PROs, and have also created separate, formal bodies, specifically charged with advising on science policy (and, in some instances, awarding grants and scholarships), namely, Québec, Saskatchewan, British Columbia and, for a brief period, Ontario, these bodies have not interfered with, or lessened in any way, the role of the PROs. Even in fulfilling their advisory roles, the science policy councils have tended to complement the informal, confidential advisory capability that exists in all of the PROs. In Newfoundland, which currently has neither a PRO

nor a science policy advisory council, consideration is being given to establishing one or possibly both types of organizations. This, and the situation in Prince Edward Island, which also has no PRO, is discussed in Appendix 2.

The case of Alberta is rather special in that the PRO, ARC, is, through its president, closely associated with a separate formal policy advisory structure. The recently created Research and Science Advisory Committee (1982), chaired by the president of ARC, is charged with the responsibility of advising the government on matters relating to science and technology. It does so by reporting to the Cabinet Committee on Research and Science Policy. The Advisory Committee is served by a secretariat, called the Office of Science and Technology, under a director. The Cabinet Committee is chaired by a member of the Legislature who also serves as chairman of ARC.

It is only to be expected that elected government officials and senior public servants usually seek advice and opinions from whomever and wherever they wish, and there is nothing unique about science, technology or science policy in this regard. A well-run PRO is, on many such matters, particularly well qualified to provide its province with sound advice, and will continue to do so even if its government sees some advantage in setting up a separate, formal, advisory structure. The evidence to date suggests that such bodies are complementary to the PROs and do not tend to reduce their importance, stature or effectiveness. This can take place, however, if the province creates bodies which, like the PROs themselves, carry out the third function designated earlier, namely, the operation of facilities in support of industrial activity.

The provinces that have PROs have generally avoided creating additional quasi-governmental, not-for-profit organizations which, like the PROs, would have mandates and facilities devoted to the scientific and technological support of industrial activity. This is understandable, particularly in the smaller provinces, if for no other reason than the need to avoid fragmentation and duplication of already modest resources. However, in all provinces, pressures can arise for the creation of special organizations. On occasion, these could be considered to fill perceived gaps in the PRO's activities.

In some cases, this may be related to a particular type of industrial activity. This was undoubtedly one of the factors that recently led the government of Alberta to create the Food Processing Development Centre at Leduc. In other cases, the gaps in the PRO's activities might be geographical in nature. With the exception of CRIQ, which has laboratories in both Montréal and Québec, the PRO's R&D facilities are confined to a single city or metropolitan area, although some of them have offices in other centres. The lack of a PRO's presence in certain regions of a province can lead to dissatisfaction and to political pressure on the government to rectify the situation. We

detected some evidence of this in New Brunswick, although Ontario is the province that has demonstrated the greatest inclination to establish a multiplicity of technology centres in various parts of the province to provide scientific and technological assistance to industry.

In Alberta, a number of organizations have been set up with missions which could, conceivably, have been encompassed within that of ARC: The Petroleum Recovery Institute and the Computer Modelling Group in Calgary, and the Coal Mining Research Centre in Edmonton. However, these are not strictly provincial bodies, in that they have been jointly funded through the Alberta-Canada Energy Resources Research Fund (ERRF).

In Ontario, over $100 million has been committed to a Technology Centres Program as one facet of the $1.5-billion five-year economic development program announced in January 1981 under the name of BILD. The program is named after the Board of Industrial Leadership and Development, a Cabinet Committee of eight ministers whose portfolios encompass "economic development and regional interests". Technology Centres have now been opened in six different localities: Resource Machinery in Sudbury, Farm Equipment and Food Processing in Chatham, Automotive Parts Technology in St. Catharines, Microelectronics in Ottawa, Advanced Manufacturing (CAD/CAM*) in Cambridge and Advanced Manufacturing (robotics) in Peterborough. Thus, within a period of two years, the Ontario government has multiplied by a factor of seven the number of localities where it can be seen to be providing scientific and technological assistance to industry.**

Each of the new centres is a separate Crown corporation, with its own president and board of directors responsible for program development and direction.*** The government has said that "because of the overlapping nature of so much high technology development work, all the technology centres will be interlinked through a computer data network which could allow information and ideas to be shared among them".[4] Furthermore, all of the centres are under the purview of a general manager, Development and Coordination, in the Ministry of Industry and Trade. Nevertheless, one cannot avoid being concerned with the lack of coordination as well as the difficulty of avoiding fragmentation and duplication of effort as these centres try to tackle the common problem of assisting small and medium-sized manufacturing firms to acquire and use modern technology.

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* Computer-Aided Design and Computer-Aided Manufacturing.

** ORF is located in the Sheridan Park Research Community in Mississauga, between Toronto and Hamilton.

*** The two Advanced Manufacturing Centres have the same president and board.

It seems quite evident that the activities of most of these centres could have been embraced within the repertoire of ORF. Indeed, ORF had previously made proposals on some of them. In the case of the Automotive Parts Centre, ORF was asked for help in the preparation of the business plan. Why, then, did the province choose to use six or seven different agencies to carry out a task that could have been given to one?

Rather than attempting to answer this question as it relates specifically to Ontario, we will consider it in the generic sense, because the factors that can affect such decisions are in no way unique to that province.

The PRO as a Central Agency

In the foregoing, we have concluded that the only kinds of quasi-governmental, science and technology-oriented provincial bodies that are likely to impinge on the role and effectiveness of the PROs are those dealing with the provision of scientific and technological assistance to industry, particularly to small and medium-sized enterprises.*

In earlier chapters, we have illustrated a number of ways in which the PROs perform this service, and something about the nature, size and number of companies served. The diversity of needs of thousands of client companies has given the PROs a character somewhat like that of a modern medical clinic, where expert diagnostic capability is backed up by in-house, as well as outside, specialists. On the other hand, to set up a specialized centre dealing with a certain kind of technology, and then require it to look for likely clients, is like asking the brain surgeon or the heart specialist to advertise for patients who might need their unique services, rather than having them referred by the diagnostician or the general practitioner. The PROs tell us that a great many of their clients are unable to make a precise diagnosis of their technical problems, and hence to decide on the nature of the particular technological "fix", if any, that they need.

Thus, attractive as it may sound to create a specialized institution named after and devoted to some exciting new technology, that may not be the most effective method of implanting that technology in industry. If, for any reason, a province feels that the creation of such specialized institutions is necessary, or at least desirable, then it should, at the same time, ensure that they are closely linked with the province's PRO. In that way they can take advantage of the PRO's knowledge of the needs of the small and medium-sized companies in

* We are not referring to the numerous university-based institutions, some mention of which is made in chapter V.

the province. At the same time, the individual centres, by being directly linked to the PRO, would be better able to take advantage of joint federal-provincial arrangements and programs in which the PRO serves as the provincial link; for example, the various elements of NRC's IRAP (IRAP-C, -F, -H, -L, -M, and -P), discussed in chapter III.

The central agency concept is likely to be attractive to federal departments and agencies because it provides a simple and direct way to touch base with relevant provincial agencies and issues. In line with this is the recently restated policy of the Science Centre of DSS to provide the PROs with information copies of all competitive Requests for Proposals for contracts to be awarded under the Contracting-Out Policy. In this way, advantage can be taken of the wide knowledge that the PROs have of industry in their provinces.

The Council of Maritime Premiers Committee on Research and Development has also visualized a central agency type of role for the PROs (in this case, NSRFC and NBRPC). In its 1981 report, the committee noted that "the large and growing number of organizations which can provide scientific and technical services to industry necessitates the establishment of a means for matching firms which require such services with the organization which can best provide them".[5] It then goes on to recommend that "the Provincial Research Organizations expand their roles as reference sources for locating the scientific and technical skills required by industry, whether they be found in the public or private sectors, within or outside the region".

The past decade has seen a significant increase, on the part of the provinces, in the importance attached to science and technology as a determining factor in economic progress. This interest is likely to continue and to increase even further as they proceed to develop their industrial policies. If a province is to achieve optimum benefit from its own incentives and to deal with federal departments or agencies in an effective and cooperative way, it cannot afford to fragment its efforts. We therefore recommend that *provincial governments should give serious consideration to the benefits that would accrue if each were to recognize its own Provincial Research Organization as the central provincial agency in matters dealing with the delivery of scientific and technological assistance to industry.*

In making this recommendation, we do not wish to imply that none of the PROs is now regarded as a central or lead agency in its province; some of them are. Furthermore, it is not just up to the provincial government to regard the PRO as a central agency; the PRO itself must be willing and able to play this role. Not all of them are prepared to do so. We therefore recommend that *every Provincial Research Organization should make an objective examination of the state of its relations with its provincial government, of its degree of awareness of the political factors likely to influence government*

policy, and of the steps that it should take to justify serving as the province's lead agency in the delivery of scientific and technological assistance to industry.

The Association of Provincial Research Organizations: Its Intra and Interprovincial Role

We have already noted in chapter III that a strengthened APRO could serve more effectively as a vehicle for federal-provincial collaboration. A strengthened APRO could also contribute a great deal to the more effective use of the wealth of resources and expertise that the provinces themselves now devote to industrial development through science and technology, particularly if each of the PROs could act as a central or lead agency within its own province, as suggested above.

If APRO has been only modestly successful in this regard in the past, it is not because it is a voluntary organization, created by the PROs themselves, rather than one created by the provincial governments. However, this explanation seems to have been the one adopted by the Honourable Larry Grossman, former Ontario Minister of Industry and Tourism,* when he proposed the creation of a Canadian Council of Research and Technology Centres as a formal national organization "reporting to Ministers".[6] This proposal (already discussed in chapter III) has not been taken up by other provinces; nor has it been followed up in Ontario.

Although each of the PROs is at "arm's-length" from its provincial government, they differ widely in the nature of their constitutions and in the portfolios of the ministers through whom they report to the legislatures and to the provincial governments. This does not impede in any way their ability to cooperate, exchange information or engage in joint projects, but these differences would place major obstacles in the way of creating a body that would be "coordinated" through ministers.

However, if APRO is going to serve the best interests of the provinces, it will have to become more than just an association of the eight chief executive officers. It will need a secretariat, headed by a full-time executive director, who, by becoming familiar with all aspects of the individual PROs and other relevant provincial bodies, will undoubtedly uncover many avenues for fruitful collaboration across and within provincial boundaries. There is no need for the upgraded APRO to become a large and cumbersome bureaucracy, and it should definitely avoid being regarded as a lobbying body looking for federal handouts. We therefore recommend that *the aforementioned Association of Provincial Research Organizations' secretariat (see chapter III, p. 71), headed by a full-time executive director, besides servic-*

* Now the Ministry of Industry and Trade.

ing the needs of the Provincial Research Organizations at the federal level, should also have the function of becoming familiar with all aspects of the individual Provincial Research Organizations, as well as other relevant provincial bodies, and thus contribute to the development of avenues for fruitful collaboration across and within provincial boundaries.

V. The Provincial Research Organizations and Academe: An Essential Linkage*

If effective partnership arrangements between the PROs, industry and governments are essential to Canada's increased technological performance, so too are strengthened linkages between the PROs and academe. These ties are important not so much simply because it is currently a practice in many industrialized nations to marry applied university research to technological applications, but because the PROs and academe have enjoyed a rather unique partnership that has been historically conditioned, thus placing the PROs in a particularly strong brokerage role for enhancing university-industry ties. Before the establishment of the older PROs, the provincial universities, in most instances, provided the research infrastructure. Little by way of research and development activity existed elsewhere. Consequently, it was not surprising to find the political decision makers considering the establishment of these PROs from two perspectives:

- the physical location of the PROs on or near a university campus so that fruitful interchange between the two organizations might result; and
- the establishment of the PROs as funding agencies, at least at the outset, to sponsor applied research projects undertaken at provincial universities.

* The examples cited in this chapter are meant to be illustrative of the initiatives in the PRO-academe linkage, and are not comprehensive.

Furthermore, some of the younger PROs in their formative years, such as CRIQ, developed close associations with universities by using their facilities until they obtained separate laboratories.

All of the PROs have had direct, informal links with universities. In some cases, such as ARC, the university was instrumental in providing both a location and research directions for the PRO. In others, such as NBRPC and SRC, the provincial universities received grants-in-aid for projects administered by the PROs; in the case of NBRPC, until its own research laboratories were established. In yet other cases, such as ORF, the original physical location near the university campus* was considered necessary to encourage meaningful interactions between the PRO staff and academic faculty. There have also been experiments to strengthen the regional coverage of PROs' activities through collaborative arrangements linking the expertise of provincial universities and colleges, such as that recently developed by CRIQ. These are simply some examples of the wide range of linkages that exist between the PROs and academe. Many other types exist, some of which we note in the text. As in most collaborative efforts, the partnership has had both positive and negative effects. We will discuss some of these issues within the context of the historical evolution of PRO-academe links.

The Historical Record and Issues Arising

Probably more so than the NRC-PRO relationship, the linkage between the PROs and postsecondary institutions has had greater historical roots, and has, in many cases, conditioned the evolution of the PROs' technical assistance and research programs.**

A case in point is the early history of the first PRO to be established, the Scientific and Industrial Research Council of Alberta (SIRCA, later to become ARC). Created through the efforts of provincial government officials, businessmen and academics at the University of Alberta, SIRCA's structure was to be largely influenced by the university's President, Dr. Henry Marshall Tory. He was particularly taken by the model of the American Federal Bureau of Mines and the University of Ohio whereby US authorities arranged for the funding of economic and industrially oriented research to be conducted by university researchers at the university. Modifying the concept, Tory succeeded in convincing provincial authorities to help fund the establishment of an Industrial Research Department in 1920 within the University of Alberta which would look specifically into the areas of mineral and metallurgical research. A year later, it

* ORF was originally located on Queen's Park Crescent, adjacent to the University of Toronto.

** Although it is tempting to generalize here, we draw the readers' attention to the specificity of PRO-academe linkages.

was felt that a separate organization should be established to pursue this work, and SIRCA was born in January 1921. As a condition of its establishment, the organization signed an agreement with the university,

> "for the services of members of the University staff to prosecute the various classes of research work decided upon by the Council and for the time, materials, laboratory and other accommodation required for the efficient performance of such work."[1]

Thus, the legacy of PRO-university linkage was created from the outset. In the case of ARC, the relationship with the University of Alberta was special. Its 1930 Act stipulated that the director of research for the organization would be the president of the university. During the Depression, the provincial government was forced to terminate funding of ARC, and the University of Alberta stepped in and absorbed ARC's staff and laboratories in 1933, thus enabling its work program to continue. This situation prevailed until 1942 when a decision was made to reconstitute ARC under the terms of its 1930 Act. By the late 1940s, it became apparent that ARC's research direction could no longer be maintained by the busy president of a growing university, and an amendment to the Research Council Act was introduced, allowing the provincial executive council to appoint a director of research. ARC's first fulltime incumbent to this position, Dr. Nathaniel Grace, was appointed in 1951. With a new research building established on the Edmonton campus in 1955, ARC was able to pursue and expand its work in the area of industrial research. Along with encouraging students to undertake their MSc theses while in the employ of ARC, the council instituted postdoctoral fellowships in the late 1950s to attract graduate students. ARC has since severed all formal ties with the university, though it has some facilities on campus. It still considers the university linkage essential and this is maintained by its amended Act (1981), which stipulates that two council members be nominated jointly by the governors of the Universities of Alberta, Calgary and Lethbridge. Also, ARC is the only PRO that has, at present, a position at the management level designated "Liaison with Universities and other Institutions". In its long-range plan of 1979, ARC noted that its scope of contacts with the universities would be extended, including "exchange of staff, participation of graduate students in research programs, joint seminars, visiting professors, shared facilities and projects, university staff on Research Council, advisory committees, employment of university staff as consultants and research contracts with universities."[2] One should also add that like all the other PROs, ARC promotes NRC's IRAP-H program, and the staff of ARC occasionally undertake technical direction of work done by university and technical college students for industrial firms.*

* In 1982, 17 undergraduate students were employed in participating firms across Alberta and were supervised by ARC staff. The students were from several educational in-

In having such a long and strong association with academe, ARC has constantly had to be vigilant lest the linkage with the universities affect its research program in such a way that the balance between short-term and exploratory work becomes tilted too heavily towards the latter. This could create problems in a hybrid research organization such as a PRO because it would have a tendency to orient the research programs into areas which would not necessarily respond to current needs of the province's industrial infrastructure. What some have called 'fundamentalization', or goal displacement in such applied research institutes is a common phenomenon.[4] In the case of ARC, criticisms in the past were made of its overly 'academic' thrusts, and one corrective measure can be seen in the current directions of the organization to increase the short-term contracting activity for the manufacturing sector in relation to exploratory work.

ARC is not alone in having to address its organization's tendency for goal displacement. All of the PROs have had to deal with the issue of balance in their research program at one time or another. Indeed, William Stadelman of ORF probably summed up the perennial dilemma facing his and other PROs when he said,

> "once, we were an elite, aloof and academic body that condescended to suspend our scientific preoccupations to deal with industrial problems brought to us by industrial research associations. Now we are an intensely industrially oriented body that sells industrialists our services in the knowledge that they are immediately relevant to particular companies."[5]

Of course, Stadelman and his confrères have continued to recognize the need for a healthy mix between exploratory and short-term research work within the PROs.

The establishment of independent facilities and laboratories by the PROs can be regarded as an indicator of their maintenance of an "arm's-length" relationship with universities. In the case of ARC, an independent laboratory building was erected and occupied in 1955. Although both ORF and BCR had their own facilities from the outset, on or near university campuses, ORF physically relocated to Sheridan Park in 1967, which was partially a reflection of the contract and industrial re-orientation of the organization. This move had been preceded in 1966 by the transfer of ORF's parasitology group to the University of Toronto, the termination of its Department of Mathematical Statistics, and the transfer of its scholarship and research grants activity (carried on since 1955) to the precursor of the present Ministry of Colleges and Universities.

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stitutions including the Universities of Alberta and Calgary, the Southern Alberta Institute of Technology, Lethbridge College and Olds Agricultural College.[3]

Both SRC and NBRPC followed similar paths in their formative years. Each served as a grants-in-aid agency to foster university-based research for mission-oriented projects: NBRPC, until 1965 when it established a laboratory on the campus of the University of New Brunswick; and SRC, until 1958 when it became a full-fledged independent research establishment.* It is worth reviewing, in the case of SRC, the limitations imposed by its early history when it was solely a university research funding agency. In its brief to the Senate Special Committee on Science Policy, SRC claimed that because of this:

- work was not easily intensified upon the most urgent or important projects;
- the research program could be expanded according to need but was dependent in magnitude on the availability of graduate students;
- projects requiring the participation of several academic disciplines were difficult to organize;
- continuance of a research project through development to application was difficult.[6]

Essentially, these impediments to conducting applied research and technical assistance programs for industry arose largely from having to operate within the institutional style of a university dedicated to teaching and fundamental research, both of which were largely outside the scope of SRC's mandates. The resulting tension was inevitable. SRC, however, still maintains ties with the Universities of Saskatchewan and Regina. Like ARC, its amended Act (1978) stipulates that at least three council members should come from the faculty of these universities. Furthermore, SRC is the only PRO to maintain a scholarship and grants-in-aid program in areas significantly beneficial to the development of the province. The rationale for continuing the university program, according to SRC's executive director, is that the organization, as the only provincial research body capable of providing such funds, has a responsibility to foster this work. In 1981, SRC administered 18 grants-in-aid totalling $108 000.[7]

SRC also maintains effective links with academics, particularly through collaborative work in the slurry pipeline transport studies. For their part, Saskatchewan's universities use SRC's expertise and facilities on an irregular basis. SRC obtained $200 000 in contract work from the universities as clients in 1981-82.

The two newest PROs, although not directly linked with universities at the outset, exhibited comparable developments. Each had a prolonged start-up phase. MRC, although established in 1963, was not very active until 1971, when it served in the provision of direct technical assistance to industry as well as grants for research in the

* SRC continued its grants-in-aid program, however.

universities and the private sector.* Its first permanent buildings were opened in 1978 (Canadian Food Products Development Centre) and 1980 (Industrial Technology Centre).

CRIQ had some initial start-up difficulties in 1969. It rented laboratories in Québec, Sherbrooke and Dorval until 1975, when its proper facilities within the Complexe scientifique in Sainte-Foy (a suburb of Québec) were completed, and the Université de Sherbrooke microelectronics group was transferred to Montréal. CRIQ's establishment of its own laboratories was a question of serious debate by the academic community prior to its creation. As early as 1961, the Principal of McGill University, F. Cyril James, voiced the concerns of many university researchers when he testified to Québec's Royal Commission on Education:

> "I think that we feel rather opposed to the development of laboratories and institutes for research in the hands of government .... And we feel, therefore, that in this Province of Québec, and indeed in other contexts too, as much as possible of the fundamental research which the government and business are financing should be conducted by university people inside the university and that the creation of outside laboratories and institutes separate from the university should be kept to the barest minimum, even if it exists at all".[9]

Such a sweeping statement did not foresee, of course, the rise of university-based research institutes *per se*, but its philosophy expresses relatively well the tensions between those responsible for advocating the creation of CRIQ in 1969,** and portions of the academic community. In fact, early versions of a PRO-like, quasi-governmental organization in Québec envisaged a body that would assist the development of academic rather than industrial research, and the fear was that if such an industrially oriented body created its own laboratories, depletion of good researchers from the universities would result.

It was within this context that CRIQ, in its early years, had to operate, and whereas its mandate was explicitly in the area of research in applied science and the gathering and diffusion of technical and industrial data, pressures from academe nevertheless served indirectly to focus CRIQ's directions. With an examination and reorientation of its objectives in 1975 towards "contribuer au développement économique du Québec en favorisant l'innovation dans les sociétés manufacturières québécoises"[10], CRIQ chose to focus deliberately on Québec's small and medium-sized businesses.

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* In 1969, the University of Manitoba had proposed the organization of an Institute for Development and Applied Research. The institute was to have provided a resource for contract R&D to Manitoba's small and medium-sized manufacturers, but it never got off the ground.[8]

** Notably, the Chambre de commerce du Québec, the ministère de l'Industrie et du Commerce and l'Association canadienne-française pour l'avancement des sciences.

One could argue that CRIQ's subsequent development has been conditioned, to a certain extent, by events in its early period. Currently, it is the only PRO, with the exception of NBRPC, to have formal agreements with the university sector. In this context, CRIQ acts as a technology broker for some Québec universities by helping commercialize worthwhile research projects. The arrangement is a nonexclusive one, allowing participating universities to turn to other organizations for assistance if they so wish.

CRIQ markets the results of university research by conducting innovation and technical feasibility studies, market assessments, development for production, licensing and follow-up. CRIQ has agreements with Université Laval (1979), l'Institut national de la recherche scientifique (1980), Université de Sherbrooke (1980), École Polytechnique de Montréal (1981) and McGill University (1983). The CRIQ-Laval entente is the earliest and probably the most developed agreement. According to some sources, the university deliberately avoided creating its own infrastructure for industrial research (currently fashionable in many Canadian universities) and used the expertise at hand in CRIQ. CRIQ evaluates market possibilities of university inventions and has been instrumental in finding commercial partners to undertake the results of university-based research. To date, 25 projects have been initiated, of which three have led to commercialization.[11] The agreement also provides for Laval graduate students to undertake thesis work at CRIQ under salary.

Most recently, CRIQ has been participating in the elaboration of specialized technical centres within Québec's community colleges, Collèges d'enseignement général et professionel (CEGEPS). The concept of these specialized centres attached to CEGEPs was first mooted in the Québec government's 1978 white paper on colleges[12] as a method of increasing CEGEPs' interaction with local business communities and contributing to the technological development of key sectors of the province's economic activity. While not disturbing the teaching function of the colleges, this mandate would extend their role into applied research, technical assistance and information dissemination. Following the white paper, Québec's Conseil des Collèges was asked to formulate advice to the Minister of Education suggesting ways in which these centres could be implemented.[13]

As a result of this initiative, about 20 CEGEPs have undertaken the development of feasibility studies for Québec's Minister of Education identifying areas of strength that would be particularly suitable for establishing specialized technology centres. In several instances, CEGEPs possess equipment and laboratory facilities that apparently are under-used and could be promoted more aggressively towards regionally based industries, particularly Québec's "petites et moyennes entreprises" (SMEs). CRIQ's established expertise in disseminating industrial and technical information to this sector has made it a logical partner and adviser for assisting the CEGEPs in these

matters. Currently, the CEGEPs in Trois-Rivières, Saint-Hyacinthe and Victoriaville are exploring, through CRIQ's assistance, the possibility of establishing specialized technology centres. Each of these CEGEPs has a particular strength: Trois-Rivières, in metallurgy and welding; Victoriaville, in furniture design; and Bourgchemin (Saint-Hyacinthe), in textiles. Although none of these has yet created a specialized centre, serious negotiations, in which CRIQ will play a significant role, are underway with the Québec government. The creation of the first of several regionally based technology centres linked to CEGEPs is imminent. As an interactive concept, the idea of linking a province's research infrastructure through its educational institutions with a PRO's well-established expertise is a fascinating experiment and one which can only be multiplied throughout Canada in the near future.*

This is a concept we find highly attractive, as it will allow the PROs to expand their regional presence. We therefore recommend that *the Provincial Research Organizations should give due consideration to expanding their linkages to the technical and community colleges within their respective provinces, as well as with the universities, with a view to enhancing technical assistance programs for industrial sectors whose needs have not always been addressed in the past.*

The Changing Landscape

In many cases, history has conditioned the relationship between the PROs and academe. However, what has been the effect on the PROs of the almost exponential growth of university-based industrial research institutions in Canada, particularly since the mid-1960s?** Has this institution building made the work of the PROs irrelevant? Have there been attempts to urge the PROs to collaborate and participate in creating these institutions? What have been the academic institutions' responses to the PROs' work? What has been the strategy adopted by the PROs in response to these initiatives?

These, of course, are crucial questions in assessing the role of the PROs within their respective regions, but complete answers can only be given pending a comprehensive review and assessment of the current political economy of university research in Canada. However, preliminary evidence indicates that the situation varies from province to province. Some argue that the PROs have "missed the boat" in not taking active roles, if not leadership, in the development of industrially oriented, university-based research centres. In fact, some

* British Columbia's Discovery Foundation is now experimenting with the concept of developing high-technology business centres linked to several regional college campuses.[14]

** We have addressed this question in discussing federally initiated programs in chapter III.

even claim that the PROs were unaggressive in not seizing an opportunity to add to their network of research and technical capabilities. On the other hand, there are those who are thankful for the non-hegemonic tendency of the PROs, and consider the vast array of institution building at the university level a healthy contribution to the research infrastructure. Indeed, some of the PROs have been guilty, on occasion, of believing defensively that contract work would be lost with the creation of new specialized research institutes.

The PROs have continually wrestled with the effects of this changing landscape. Take the example of industrial research institutes within Canadian universities charged with the administration and public relations of contract research of the academic staff. It has been suggested that these institutes could be associated with the PROs. In many cases, a referral service could be instituted whereby specialized work or expertise that does not exist within a university could be performed by the PRO. Also, PRO membership on the governing board of universities would encourage collaboration. This has been one proposal put forth for strengthening the PRO-academe relationship. It is at the root of the stance developed by the Council of Maritime Premiers Committee on Research and Development when, in its report on technological innovation, it recommended that:

> "the Provincial Research Organizations expand their roles as reference sources for locating the scientific and technical skills required by industry, whether they be found in the public or private sectors, within or outside the region."[15]*

Although the recommendation was directed solely at NSRFC and NBRPC, we feel that based on our interviews, such a role should be encouraged in all the PROs.

Recent Trends

Despite sporadic difficulties and *ad hoc* linkages that have emerged in the past, it is increasingly evident that the PROs must play a more active and collaborative role in relation to university-industry interaction. Provincial governments are recognizing the pivotal role that the PROs can play, and already there are indications of this realization. CRIQ's role as a chosen instrument has been noted. In another instance, NBRPC, along with the New Brunswick Community College,** the University of New Brunswick and Université de Moncton, will provide the locus for a manufacturing technology centre sponsored by the provincial Department of Commerce and Development. Furthermore, both NBRPC and the University of New Bruns-

* We stress this same point in chapter IV, p. 85-86.
** With branches in Saint John, Moncton and Bathurst.

wick have recently struck a joint committee to address potential areas of collaboration.

NSRFC, an organization which in its early years promoted the use of research facilities at the Nova Scotia Agricultural College and Acadia University, is currently actively involved in the development of the Applied Microelectronics Institute with Dalhousie University and the Technical University of Nova Scotia.

BCR has become involved in several ways with the local universities. The core grant from the provincial government for research on compressed natural gas as an alternative motor fuel requires close cooperation with the University of British Columbia. BCR's efforts in promoting a Western Foundation for Advanced Industrial Technology has also involved the active participation of academics. These and other initiatives at the PRO-academe interface have demonstrated the growing prevalence of collaborative efforts.

It should be noted here that the initiatives are *two-way*, with the PROs taking the lead in some instances, and the academic milieu in others. One final example will serve to illustrate how this interaction benefits both institutions. All of the PROs are currently involved in delivering NRC's IRAP-H program, which pays the salaries of university and technical college students who assist small businesses with various technically related problems. The benefits of such a program are several: the PRO is put in contact with students; the academic institution is able to expose its students to the industrial milieu; and the business can benefit by way of cost savings or ultimate employment of the student. Furthermore, the program permits either a staff member of a PRO or a faculty member of the academic institution to act as a technical adviser on various projects, a situation that can lead to further work under IRAP-H, and provide both organizations with better information on the industrial engineering problems in small firms. We therefore recommend that *the National Research Council should undertake an evaluation of IRAP-H as a mechanism for achieving collaboration between the Provincial Research Organizations, academe and industry, and be prepared to increase financial support for it, if warranted.*

We have seen that the evolution of the PRO-academe interface has had a somewhat checkered course. To argue that the path has always been straight and will remain so would be fatuous. However, the changing landscape needs to be seriously addressed by both partners, the PROs and the academic community alike. Current trends appear to indicate that collaboration is increasing, if only because action to the contrary would be counterproductive. The legacy of PRO-academe linkages is well established, and it is essential that joint collaboration be maintained and enhanced where appropriate. Furthermore, in the present environment of increasing interaction between university and industry, the PROs 'hands-on' experience

with both sectors places them in a unique position to play a brokerage role and to effect stronger and more appropriate ties between these solitudes.

VI. Summary and Recommendations*

This study has dealt with the unique, quasi-governmental, not-for-profit provincial agencies known as the Provincial Research Organizations. They are eight in number: B.C. Research, Alberta Research Council, Saskatchewan Research Council, Manitoba Research Council, Ontario Research Foundation, Centre de recherche industrielle du Québec, New Brunswick Research and Productivity Council, and Nova Scotia Research Foundation Corporation. Although their individual constitutions vary from province to province, their common purpose is to make available the fruits of research likely to be beneficial to the provinces and to the nation as a whole, with particular emphasis on industrial development. This they do by undertaking research and development work and by making available technical information, advice, and know-how, as well as by providing analytical and testing services. In assuming this role, they serve as veritable research arms for thousands of small and medium-sized enterprises, an important segment of industry for employment and the creation of wealth in the country. They also serve as significant instruments in realizing both federal and provincial strategies for technological development by maintaining and enhancing technology transfer, industrial productivity and innovation.

The PROs, however, do not operate in a vacuum. They have been conditioned, to a large extent, by their environments, with their historical, socioeconomic and political factors. We have attempted to delineate the characteristics of these factors and their impact on the

* This chapter can be viewed as an "executive summary". However, although it contains all of the major recommendations made in the previous chapters, it omits most of the background behind those recommendations as well as several subsidiary recommendations.

effectiveness and relevance of the PROs. In doing so, we first presented, in chapter I, some factual information about the organizations, together with a very broad overview of the changing environment in which they find themselves. We followed this in chapters II, III, IV and V with a closer look at their relations with four different sectors in turn: industry, federal departments and agencies, provincial governments and, finally, universities and colleges.* This approach was somewhat arbitrary because of the many interactions that occur among these sectors, and, as a result, recommendations addressed to the same body sometimes appear in different chapters of the study.

Whereas this approach seemed best for the purpose of developing our recommendations, it is not the best for displaying them in the most coherent form. Therefore, in the present chapter, we have chosen to summarize our findings and present our recommendations in a sequence more closely related to the bodies concerned. In this connection, it seems appropriate to consider, first of all, those findings that relate to situations that are under the sole control of the PROs themselves.

Our study has left us with no doubt about the important role that the PROs can play, both provincially and nationally, and testimony to this appears throughout the study. However, in some cases, they have tended to lag behind the rush of events, rather than becoming involved in them. We therefore recommend that:

1. **Every Provincial Research Organization should make an objective examination of the state of its relations with its provincial government, of its degree of awareness of the political factors likely to influence government policy, and of the steps that it should take to justify serving as the province's lead agency in the delivery of scientific and technological assistance to industry.**

(pp. 77, 86-87)

The ability of the PROs to react in unison to issues that affect them all, both at the federal and provincial levels, has traditionally found expression in the Association of Provincial Research Organizations (APRO). In our view, this vehicle should be strengthened. As a voluntary body, APRO has largely been reactive, and it has had virtually no permanent capability to marshal and communicate information and data of concern to its members and, indeed, to the public at large. We therefore recommend that:

2. **The Association of Provincial Research Organizations should give serious consideration to the establishment of a**

* An early draft of chapters I, II and III, including the recommendations made in those chapters, was circulated among members of the Science Council and a number of federal government officials in February 1983.

permanent clearinghouse office (secretariat) that will act as a service arm to the organizations by providing information and data on matters that affect all of them.

(pp. 18, 71)

Furthermore, a strengthened APRO could also contribute a great deal to the more effective use of the wealth of resources and expertise that the provinces themselves now devote to industrial development through science and technology. Thus, if APRO is going to serve the best interests of the provinces, it will have to become more than just an association of eight chief executive officers. We therefore recommend that:

3. **The proposed Association of Provincial Research Organizations' secretariat, headed by a full-time executive director, besides servicing the needs of the Provincial Research Organizations at the federal level, should also have the function of becoming familiar with all aspects of the individual Provincial Research Organizations, as well as other relevant provincial bodies, and thus contribute to the development of avenues for fruitful collaboration across and within provincial boundaries.**

(pp. 87-88)

One of the potentially fruitful areas for intraprovincial, and possibly even interprovincial linkages is with the academic sector, an avenue already pioneered by CRIQ. Such collaboration has historical roots and has conditioned the evolution of the PROs to some extent. We therefore recommend that:

4. **The Provincial Research Organizations should give due consideration to expanding their linkages to the technical and community colleges within their respective provinces, as well as with the universities, with a view to enhancing technical assistance programs for industrial sectors whose needs have not always been addressed in the past.**

(pp. 95-96)

There have been few times when the provinces were in greater need of the kind of help and advice that can be provided by a well-run, broadly based PRO, scientifically and technologically up-to-date and in close touch with industry. One measure of the state of health of the provincial government-PRO relationship is the size of the provincial grant in relation to the total expenditure of the PRO. If this figure is too low, the PRO will not be able to serve the best interests of the province. If it is to address the needs of small and medium-sized enterprises through the provision of free or low-profit services, and also undertake longer-term research and development directed towards the economic development of the province (exploratory R&D), reliance on contract income to too great an extent makes it difficult for the PROs to maintain themselves as viable organizations.

Thus, we feel that the size of the provincial grant has a very important bearing on the ability of a PRO to play an effective role in the service of its province. We therefore recommend that:

5. **If the provincial grant to a Provincial Research Organization is in the order of 30 per cent of its total expenditures or less, the province should recognize that its best interests may be in jeopardy, and take immediate steps to investigate and remedy the situation.**

(pp. 38-42; 78)

However, the province must do more than this. If it is to achieve optimum benefit from its own initiatives, and also have dealings with federal departments and agencies in an effective and cooperative way, it cannot afford to fragment its efforts. We therefore recommend that:

6. **Provincial governments should give serious consideration to the benefits that would accrue if each were to recognize its own Provincial Research Organization as the central provincial agency in matters dealing with the delivery of scientific and technological assistance to industry.**

(pp. 85-86)

A significant part of the activity of every PRO consists of the implementation or delivery of federal programs directed to the application of science and technology to industrial development, particularly those concerned with small and medium-sized enterprises that comprise the bulk of the PROs' clientele. By far the majority of these firms do not have, and are unlikely to ever have, their own indigenous R&D capability, and yet they provide a very significant part of our employment as well as of value-added. Very few of them fall into the class of glamorous "hi-tech" firms, and yet recent studies of a new type, undertaken in the United States, suggest that they may be even more important as creators of employment than one might expect from the kind of surveys that are currently carried out in Canada. We therefore recommend that:

7. **A study of the dynamics of job creation and elimination in Canadian industry should be undertaken as soon as possible by Employment and Immigration Canada, in collaboration with Statistics Canada and the Minister of State for Small Business and Tourism. The methodology should be similar to that used by David L. Birch, at the Massachusetts Institute of Technology, suitably modified and adapted for application in Canada.**

(pp. 29-31)

NRC was the first federal agency to address the scientific and technological needs of Canadian industry. Almost 40 years ago, it undertook to provide technical information, primarily to small and medium-sized enterprises with no R&D capability, and over 20 years

ago it initiated a program of grants-in-aid for projects in companies that had such a capability. At the present time, its Industry Development Office operates two broad programs of remarkable scope: PILP, designed to transfer technology developed in government laboratories to industry, and IRAP. The latter, through six sub-programs (IRAP-C, -F, -H, -L, -M and -P), addresses the needs and capabilities of a wide variety of industrial concerns, both large and small. IRAP-C and -F provide technical information and industrial engineering advice, primarily to small and medium-sized companies, through the agency of field officers. IRAP-H covers the salaries, during the nonacademic term, of upper-year students in colleges and universities who undertake projects in small firms under the guidance of faculty members or members of the professional staff of a PRO. IRAP-L provides funds to a company to cover the cost of a project carried out by a consulting firm or a PRO. IRAP-M is designed to encourage companies to solve their technical problems either with their own staff or with the help of some research organizations, such as a PRO. IRAP-L and -M grants are restricted to firms having fewer than 200 employees. IRAP-P is the original IRAP, initiated in 1962; it covers about half the cost of research projects carried out by companies that have their own R&D capability.

As a result of long-standing arrangements with NRC, about half of the field officers associated with the implementation of IRAP-C and -F are stationed at PROs and subsidized, in part, by NRC. These people serve as a vital link in helping the smaller companies, in particular, to acquire the essential technical information and advice necessary to improve their productivity and competitiveness and to keep at the forefront of technological developments. However, possibly because of external pressure to emphasize R&D and R&D targets, NRC has tended to waver in its support of PRO-based field officers, and in the Estimates for 1983-84, tabled in the House of Commons in February 1983, its contribution to "Provincial Research Organizations and Research Institutes" is slated to be three per cent less than it was in 1981-82, two years before. We therefore recommend that:

8. **The National Research Council should revise its priorities in relation to its support for the application of science and technology to industrial development by placing greater emphasis on the needs of small companies.***

(p. 34)

With particular reference to its support for IRAP-C and IRAP-F, we recommend that:

* On 3 May 1983, the Honourable Donald J. Johnston, Minister of State for Science and Technology and for Economic Development, announced that $20 million would be made available to NRC over the next two years to expand its IRAP sub-programs serving small and medium-sized businesses (IRAP-C, -F, -H, -L, and -M), including the number of field officers attached to the PROs.

9. **The National Research Council should plan on tripling the number of field officers attached to the Provincial Research Organizations within a period of two years, placing special emphasis on the introduction of new technology by using those trained in the principles of industrial engineering.**

(pp. 34-35)

In implementing the last recommendation, cognizance must be taken of problems that have arisen in the past regarding the amount of the person-year contribution made to the PROs in support of field officers. This has even been changed in the middle of a fiscal year. We therefore recommend that:

10. **The National Research Council and the Association of Provincial Research Organizations should make a detailed analysis of the costs of providing field officers for IRAP-C and IRAP-F, and agree to a cost-sharing arrangement that will provide for equitable and stable funding.**

(p. 35)

Besides carrying out their responsibility for implementing IRAP-C and IRAP-F, the field officers attached to the PROs also "market" the other IRAP sub-programs for NRC, particularly IRAP-L, -H and -M, which relate to smaller companies. As a result, the PROs have a very good idea of the number of companies that could benefit from these programs. Our enquiries, directed to the PROs and others, elicited the view that there were far more small and medium-sized companies that could benefit from IRAP-L than could be handled with the funds available. We therefore recommend that:

11. **The National Research Council, in cooperation with the Provincial Research Organizations, should examine the possibility of increasing the productivity, competitiveness and innovative capability of small and medium-sized enterprises in all 10 provinces through the mechanism of IRAP-L, and be prepared to increase greatly the financial resources assigned to that sub-program, should such action appear to be justified.**

(p. 55)

The IRAP-H sub-program has the interesting feature that it can use the expert knowledge of the PROs to identify companies that can best take advantage of the assistance provided by college or university students. We therefore recommend that:

12. **The National Research Council should undertake an evaluation of IRAP-H as a mechanism for achieving collaboration between the Provincial Research Organizations, academe and industry, and be prepared to increase financial support for it, if warranted.**

(pp. 97-98)

Our final recommendation relating to NRC has to do with PILP. At present, this program is restricted to the transfer to industry of technology developed in federal government laboratories. We recommend that:

13. **The National Research Council should give serious consideration to extending the scope of its Program for Industry/Laboratory Projects (PILP) to include the transfer of technology from Provincial Research Organizations and other provincial technology-generating organizations to industry.**

(pp. 55, 56)

IT&C has also developed a number of programs that have involved the participation of the PROs, such as CATs, PDMP and EDP. With its focus on assisting small and medium-sized enterprises in the manufacturing and processing sectors, EDP is particularly well suited for the capabilities existent in the PROs. Some of them, in fact, have assisted the SMEs in applying for EDP grants. In doing so, the PROs are usually in an excellent position to receive subcontracts from successful applicants. The EDP-financed work of some of the PROs constitutes an important element of their bridging function in developing both future markets for their expertise, and in assisting SMEs to achieve a starting point from which to develop into technologically mature businesses. We therefore recommend that:

14. **All of the Provincial Research Organizations should make a systematic effort to use the Enterprise Development Program as a means of enhancing their delivery of technological assistance to small and medium-sized enterprises.**

(pp. 68-69)

Many of the difficulties that have arisen between the PROs and federal departments and agencies derive from their unique nature – quasi-governmental and not-for-profit – and yet receiving much (in some cases, most) of their income from contracts with industry. Although Canada has not been without its unique features and institutions, their existence tends to worry many individuals, who prefer to deal with conventional concepts and categories. This appears to be at the root of most of the problems that have arisen in connection with the federal government's Contracting-Out Policy for requirements in science and technology. In many cases, the PROs have had difficulty in being recognized as legitimate performers. In fact, they have succeeded in averaging only 1.6 per cent of the total value of contracts awarded by DSS since the Contracting-Out Policy was instituted in 1973. In large part, this is a result of the inability of the PROs to make their case clearly understood to those who are in a position to rectify the problem, combined with a general misunderstanding on the part of the federal government as to the special nature of the PROs. One step towards eliminating this problem would be for the

federal government to recognize the status of the PROs as unique, quasi-governmental research organizations when categorizing them. We therefore recommend that:

15. **The Department of Supply and Services, in matters relating to the awarding of science and technology contracts, should consider treating the Provincial Research Organizations as a category in its own right.**

(p. 60)

However, the issue is more complex than one of definition. The PROs have maintained that greater access to DSS contracts would help to preserve and expand their technical capability and, consequently, would increase their ability to assist the large number of industrial firms that have difficulty in undertaking their own research and development. Thus, the need for the PROs to ameliorate their bridging function in bringing firms up the learning curve in science and technology can be substantially enhanced through their greater participation in the Contracting-Out Policy. Furthermore, the PROs have a legitimate argument in maintaining that they be placed on a par with the service sector, a recommendation that was, in fact, supported by the Senate Special Committee on Science Policy. Thus, where a PRO is clearly qualified to fulfill a specific science and technology requirement, the award of a contract should be based strictly on technical merit. We therefore recommend that:

16. **When considering the award of contracts to organizations outside the primary and secondary sectors, those responsible for the Contracting-Out Policy should recognize the ability of the Provincial Research Organizations to tender, where technically appropriate, on the same basis as the service sector.**

(pp. 63-65)

The PROs, for their part, must make a greater effort to market their expertise to the client departments concerned, and to communicate more effectively their mandates to senior officials responsible for the policy. Also, the PROs' brokerage mandate, to link their expertise with that available in other organizations, should be enhanced. We therefore recommend that:

17. **The Provincial Research Organizations should, when technically qualified to bid on DSS contracts, consider submitting proposals jointly with industrial performers, and further, they should adopt a more aggressive stance in marketing their eligibility as subcontractors for work contracted out to these industrial performers.**

(p. 65)

In considering the implementation of these recommendations, the PROs, NRC, governments and other actors should bear in mind the spirit within which we have made these remarks. Collaborative and

effective *partnership* would best describe the underlying message. If the PROs are to play a full and successful role in evolving industrial and technological strategies, then both the PROs and those with whom they interact must approach the subject in a spirit of partnership. Indispensable contributions to Canada's welfare will be required from each partner. It follows that such a partnership requires that each partner accept his full responsibility.

Appendices

Appendix 1 - List of the PROs*

Alberta Research Council (ARC)
4445 Calgary Trail South, Edmonton, Alberta, T6H 5R7
Chairman of the Board of Directors: Mr. E.C. Musgreave, Member of the Legislative Assembly
President: Dr. G.G. Cloutier

B.C. Research* (BCR)
3650 Wesbrook Mall, Vancouver, British Columbia, V6S 2L2
Chairman of the Board of Management of the British Columbia Research Council: Mr. W.R. Steen, Vice-President Finance and Secretary, B.C. Forest Products Ltd.
Executive Director: Dr. V. Alan Mode

Centre de recherche industrielle du Québec (CRIQ)
333, rue Franquet, Sainte-Foy, Québec, G1V 4C7
Président et directeur général: M. Guy Bertrand

Manitoba Research Council (MRC)
533 – 155 Carlton St., Winnipeg, Manitoba, R3C 3H8
Chairperson: Marion Vaisey-Genser, Associate Dean and Acting Dean, Faculty of Graduate Studies, University of Manitoba
Executive Director: Dr. G.S. Trick

New Brunswick Research and Productivity Council (NBRPC)
College Hill Rd., Fredericton, New Brunswick, E3B 5H1
Chairman: Dr. K.V. Cox, President, New Brunswick Telephone Company
Executive Director: Dr. Claude Bursill

* The executive directors of three of the PROs, SRC, ORF and NBRPC, are retiring in 1983, and Dr. Cloutier of ARC is resigning to become Vice-Président, Technologie et Affaires internationales of Hydro-Québec.

Nova Scotia Research Foundation Corporation (NSRFC)
100 Fenwick St., Dartmouth, Nova Scotia, B2Y 3Z7
Chairman of the Board and President: Dr. J.E. Blanchard

Ontario Research Foundation (ORF)
Sheridan Park Research Community, Mississauga, Ontario, L5K 1B3
Chairman of the Board of Governors: Dr. D.A. Chisholm, President, Innovation and Development, Northern Telecom Ltd., and Chairman of the Board and President, Bell Northern Research Limited
President: Mr. W.R. Stadelman

Saskatchewan Research Council (SRC)
30 Campus Dr., Saskatoon, Saskatchewan, S7N 0X1
Chairman of the Council: The Honourable Gordon Currie, Minister of Telephones
Executive Director: Dr. T.P. Pepper

* * *

Association of Provincial Research Organizations (APRO)
President: Dr. T.P. Pepper, Executive Director, Saskatchewan Research Council
Vice-President: Mr. W.R. Stadelman, President, Ontario Research Foundation
Secretary-Treasurer: Dr. Claude Bursill, Executive Director, New Brunswick Research and Productivity Council

Harriette de Kovan, Manager, Industrial Policies Branch, Ontario Ministry of Industry and Trade, Toronto.

* B.C. Research is the technical operation of the British Columbia Research Council.

Appendix 2 – Relevance of PROs to Prince Edward Island and Newfoundland

Reference has been made in this study to the important role that a PRO can play in its own province. One might then ask why PROs have not been established in Prince Edward Island and Newfoundland.

The relatively small population of Prince Edward Island would not, in itself, preclude the setting up of a PRO, if the services that it could provide were needed and not otherwise available. However, a quasi-governmental, laboratory-based organization like a PRO should not be created unless there is a market for its "products".* When the present eight PROs were established, there was a clear need for their services, which was not being fulfilled by other provincial bodies. But, even under those circumstances, only ORF and BCR started off with their own laboratories. The others took advantage of existing organizations to handle problems that came within their purview. At that time, the universities were the main source of such assistance; nowadays, there are other bodies as well.

Prince Edward Island has two Crown corporations dedicated to industrial development: Industrial Enterprises Incorporated and the P.E.I. Market Development Centre. The former has operating divisions devoted to industrial development and industrial support, the latter has divisions for marketing and product development. These two corporations, which report to the Minister of Fisheries and Industry, carry on some of the activities that might be expected of a PRO. Indeed, for a number of years prior to 1972, Industrial Enterprises Incorporated was treated like a PRO by NRC, to the extent of receiving a Consolidated Grant (see page 39). Until it was transferred to the Department of Fisheries and Industry within the past year, the Metals Industry Technical Support Centre in Charlottetown was operated by Industrial Enterprises Incorporated. Among the facilities it provides are a technical reference library, a testing and analytical laboratory, space for small-scale prototype work and the services of a qualified metallurgist.

In most provinces, the technical information and industrial engineering services of NRC are carried out by the PROs, but in Prince Edward Island, and also in Newfoundland, these services (IRAP-F and IRAP-C) are carried out by NRC employees stationed in the provincial capitals. These field officers also handle applications for NRC's other IRAP sub-programs: IRAP-H, -L, -M, and -P (see chapter III).

Another factor to be considered in connection with Prince Edward Island is that it tends to compensate for its small size by engaging in joint activities with New Brunswick and Nova Scotia un-

* This does not mean that this was the dominant factor in the establishment of all the existing PROs; political factors were also involved.

der the umbrella of the Council of Maritime Premiers. The council has a full-time secretariat stationed in Halifax. In 1981, its Research and Development Committee published the report, *Technological Innovation: An Industrial Imperative.** While this report emphasizes the importance of NBRPC and NSRFC, it does not suggest that there is any need for a PRO to be established in Prince Edward Island.

In Newfoundland, interest in having a PRO became evident in the early 1960s as the result of the activities of the Newfoundland Research Committee. This group, consisting of senior civil servants and members of the faculty of Memorial University, met regularly to discuss research being carried out in Newfoundland. Open meetings, to which representatives of industry were invited, were held about four times a year.

Through the efforts of the committee, an act was passed in the legislature authorizing the setting up of a research council, which was to be similar to NSRFC. The committee disbanded to make way for the new council, but it was never incorporated. Attempts were made from time to time to re-activate the proposal, but little was done about it until the publication, in November 1981, of the white paper, *Towards a Science Policy for Newfoundland.***

The white paper is careful to point out that any statement on science policy must be viewed as being only one element in an overall development policy, and must be in keeping with its guidelines. These had been enunciated about a year before in *Managing All Our Resources.**** In that plan, the long-term development of the province is visualized as being based on the control, management and development of its *renewable* resources. To this end, the economic rent extracted from both renewable and nonrenewable resource developments is to be applied to developing further the primary, secondary and tertiary aspects of renewable resources to ensure long-term economic and social development in the province.

In line with these guidelines, the white paper delineates three broad sectors of renewable resources to which science policy should be applied: fisheries, forestry and energy, the renewable forms of the last being hydro, wave, wind, wood and solar sources. But, in addition to considering the needs of these separate sectors, it was recognized in the white paper that:

> "the needs of the fisheries in such areas as biological research, ice and cold ocean research, resource harvesting technology development (including vessel design and maintenance, location

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* Council of Maritime Premiers Committee on Research and Development, *Technological Innovation: An Industrial Imperative*, Halifax, October 1981.

** Government of Newfoundland and Labrador, *Towards a Science Policy for Newfoundland*, St. John's, November 1981.

*** Government of Newfoundland and Labrador, *Managing All Our Resources: A Development Plan for Newfoundland and Labrador, 1980-1985*, St. John's, October 1980.

and detection device development, etc.) are also required for application in other marine areas including offshore oil and gas developments, Arctic and Labrador marine resource developments, and sub-sea mining.

Because of these considerations and the ultimate recognition that the Province's future is bound to its marine environment, *the priority area for Governments scientific thrust in the immediate future should lie in all aspects of the marine sciences as they relate to the Newfoundland environment.*"*

The white paper then proposes that a Newfoundland Science Council be established as an advisory body to government. One of the duties of that council would be "to investigate and define the need for common user facilities and to recommend a program and mechanism to carry out this function". One form that the "common user facilities" could take would, of course, be that of a PRO.

The Newfoundland white paper was discussed in a seminar on "A Science Policy for Newfoundland and Labrador: The Future Shape of Provincial Support for Science and Technology in this Province", sponsored by the Department of Development and held in St. John's on 17, 18 March 1982.** The pros and cons of establishing a science council and/or a PRO were discussed at length, and representatives of three of the PROs, NBRPC, MRC and SRC made invited presentations.

Our perception of the situation is that it would be of considerable help to the provincial government if it were able to consult an independent Newfoundland-based advisory body or council on matters relating to the application of science and technology to industrial and resource development. One of the hazards in setting up such a body anywhere is that the number of people who would like to provide advice is likely to exceed the number who are best fitted to do so by quite a large margin. The government would therefore have to take such precautionary measures as making sure that the initial appointments were for not too long a time. However, after a "shakedown" period, an advisory body or science council could be of considerable help to the government of Newfoundland and Labrador.

The need for a PRO is not as clear, particularly if it were to have its own laboratory facilities immediately. The advent of the 200-mile limit with regard to fisheries, combined with the under-sea oil drilling activity off the shores of Newfoundland and Labrador, has resulted in a remarkable amount of technological activity in the province. The major elements are the Newfoundland Oceans Research

* *Towards a Science Policy for Newfoundland, op. cit.*, p. 5. Farther down on the priority list were the forestry-related sciences and renewable energy resources, in that order.

** The authors of this study had the privilege of participating in this seminar.

and Development Corporation (NORDCO), 90 per cent owned by the province, but not a Crown corporation; C-CORE, associated with Memorial University; and the Arctic Vessel and Marine Research Institute (AVMRI), a $55-million laboratory facility now being built by NRC. However, in addition to these, there are a number of engineering consulting firms and also several small, high-technology firms that have spun-off from C-CORE and Memorial University.

Most of the participants at the seminar felt that there was no clearly delineated technological gap that pointed to the immediate need for a PRO. However, the nature and needs of the small and medium-sized enterprises in the province were not specifically highlighted at the seminar. In particular, relatively little consideration was given to the need for technological development and productivity improvement in the socially and economically important fishing and fish products industries. We would therefore express the view that if and when Newfoundland establishes a science and technology advisory council, that body would undertake an examination of the need for an organization that would address the technological needs and potentialities of the SMEs and, in particular, those that are involved in the fisheries. The experience of the Fisheries Technology Division of BCR (see pp. 35-36) would be of some interest in that regard, although it would not be a substitute for the development of a made-in-Newfoundland approach.

In the wake of the Kirby Report,* it seems inevitable that various forms of additional support for the fisheries will be forthcoming. If these were to include outright subsidies, they could be counterproductive insofar as the penetration of foreign markets is concerned. On the other hand, if the government spent money on the application of technology to productivity improvement, product development or quality control through R&D, it could improve the economics of the industry without running the risk of being charged with unfair trading practices.

* Canada, Task Force on Atlantic Fisheries, *Navigating Troubled Waters: A New Policy for the Atlantic Fisheries*, Minister of Supply and Services, Ottawa, 1982.

Appendix 3 - Consultations

We would like to express our appreciation to the following individuals for the time they spent in providing us with information and comments on various aspects of our study. Our special thanks to APRO for allowing us to attend their meetings held in Ottawa, and to the members and staff of the Science Council of Canada for feedback on the progress of our study.

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Hans Baumans, Directeur, Secteur électronique, CRIQ, Montréal.

Richard Beaudry, Directeur, Direction de la planification et du contrôle, CRIQ, Québec.

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Guy Bertrand, Président, CRIQ, Québec.

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Roger A. Blais, Directeur, Centre d'innovation industrielle/ Montréal.

Jonathan E. Blanchard, President, NSRFC, Dartmouth.

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R.W. Keyes, Chairman, Science Council of British Columbia, Vancouver.

D. Kirby, Vice-President, Atlantic Region, Wajax Industries Ltd., Dartmouth; Member, Council of Maritime Premiers' Voluntary Advisory Committee on Regional Economic Development.

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François Labrousse, former Directeur de l'information technologique, CRIQ; conseiller principale, CGI Inc., Québec.

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John Maybin, Executive Director, Petroleum Recovery Institute, Calgary.

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Glossary

AOSTRA	Alberta Oil Sands Technology and Research Authority
APRO	Association of Provincial Research Organizations
ARC	Alberta Research Council
AVMRI	Arctic Vessel and Marine Research Institute
BCR	B.C. Research
BILD	Board of Industrial Leadership and Development
CATs	Centres of Advanced Technology
C-CORE	Centre for Cold Ocean Resources Engineering
CEGEP	Collège d'enseignement général et professionel
CIIM	Centre d'innovation industrielle/Montréal
CISTI	Canada Institute for Scientific and Technical Information
CRIQ	Centre de recherche industrielle du Québec
DREE	Department of Regional Economic Expansion
DRIE	Department of Regional Industrial Expansion
DSS	Department of Supply and Services
ECC	Economic Council of Canada
EDP	Enterprise Development Program
EIC	Employment and Immigration Canada
ERRF	Alberta-Canada Energy Resources Research Fund
FCAC	Formation de chercheurs et actions concertées
IDEA Corporation	Innovation Development for Employment Advancement Corporation
IRAP	Industrial Research Assistance Program
IRIs	Industrial Research Institutes
IT&C	Industry, Trade and Commerce
MOSST	Ministry of State for Science and Technology
MRC	Manitoba Research Council
MSSB	Minister of State for Small Business and Tourism
NBRPC	New Brunswick Research and Productivity Council

NORDCO	Newfoundland Oceans Research and Development Corporation
NSRFC	Nova Scotia Research Foundation Corporation
OECD	Organisation for Economic Co-operation and Development
ORF	Ontario Research Foundation
PDMP	Product Development Management Program
PILP	Program for Industry/Laboratory Projects
RSA	related scientific activities
SESP	Scientific and Engineering Student Program
SID Program	Small Industries Development Program
SIRCA	Scientific and Industrial Research Council of Alberta
SMEs	small and medium-sized enterprises
SRC	Saskatchewan Research Council
STEP	Support for Technology Enhanced Productivity
TIS	Technical Information Service

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Partners in Industrial Strategy

The Special Role of the Provincial Research Organizations

Donald J. Le Roy
Paul Dufour

Summary

This summary represents the views of the authors and not necessarily those of the Science Council of Canada.

Introduction

According to a 1978 survey, 721 253 of the 723 591 businesses in Canada in all industrial sectors in that year were small or medium-sized enterprises (SMEs).* Between them, they provided 64 per cent of the jobs in manufacturing, construction, trades and services and contributed 53 per cent of the Business Gross National Product deriving from these four sectors. Fully 46 per cent of all new jobs created in manufacturing between 1977 and 1979 occurred in companies having fewer than 200 employees.

Clearly, the SMEs are a vital part of Canada's economy. Yet the problems they face are formidable. In order to remain competitive, they must have access to technical information, know-how and state-of-the-art technology. But research and development (R&D) for new products or processes is enormously expensive. Few SMEs have either the resources or the expertise to mount their own R&D effort.** In addition, a recent report on *The Future of Small Business in Canada* identified a lack of information about government services, markets and technology, including a lack of management expertise, as a major problem faced by the SMEs. For these firms, the report stated, "Knowledge networks could be as important as manpower and financial resources."***

*The survey, published by the Minister of State for Small Business and Tourism in 1981, defined SMEs as firms grossing less than $20 million in sales annually.

**In 1982, 91 per cent of all industrial R&D expenditure in Canada was made by only 100 companies.

***Search Conference, *The Future of Small Business in Canada*, The Niagara Institute, Niagara-on-the-Lake, 1982.

The PROs: What Are They?

The Provincial Research Organizations (PROs), established by 8 of Canada's 10 provinces, meet many of industry's needs for information and research. The PROs are quasigovernmental, not-for-profit agencies designed to provide technological assistance to industry and to undertake R&D of particular interest to their province. Although all of them have the word "research" in their names, they do much more than research. They make available the fruits of research that are likely to benefit their provinces. Some of the companies served by the PROs are largely self-sufficient in R&D and general technical competence. These companies take advantage of the PROs' special expertise in certain areas, hiring them to solve a problem or engage in a joint development project. But by and large, the PROs have come to serve a special class of industries that is frequently overlooked by policy makers in the science and technology field. These are the SMEs, most of whom do not have, and are unlikely ever to have, a capability for in-house R&D.

The Provincial Research Organizations (PROs)
Alberta Research Council (ARC)
B.C. Research (BCR)
Centre de recherche industrielle du Québec (CRIQ)
Manitoba Research Council (MRC)
New Brunswick Research and Productivity Council (NBRPC)
Nova Scotia Research Foundation Corporation (NSRFC)
Ontario Research Foundation (ORF)
Saskatchewan Research Council (SRC)

Established under different circumstances at various times over almost half a century, the PROs were, until relatively recently, the only organizations of their kind in their respective provinces. In the last decade, however, provincial and federal governments have come to see science and technology as major determinants in economic progress, and have established

many new institutions to advise on science and industrial policy and to carry out research, testing and development. Many of these institutions provide services that complement, supplement or even duplicate the work of the PROs. Though the PROs have in some cases helped governments launch these institutions and are involved in managing some of them, they are no longer the unique provincial agencies they once were.

The PROs do continue to serve an important function in maintaining and enhancing technological development, improving industrial productivity and implementing related federal and provincial policies, but are they meeting their full potential? How well are they coping with current federal and provincial policies and programs? In view of the ever-growing number of publicly funded institutions devoted to scientific research and industrial development, do the PROs still have a mission they are particularly qualified to carry out? In attempting to answer these questions, the authors examine, in turn, the relationships of the PROs with industry, federal departments and agencies, their provincial governments and the universities.

The PROs: Meeting the Needs of Industry

The PROs provide a wide variety of services to industry, some at no cost, others on a fee-for-service basis. Field officers provide a significant amount of free assistance, mostly to SMEs. Many of these officers have their salaries and expenses subsidized by the National Research Council (NRC); others are supported entirely by the PROs, using their own resources. In addition to technical information, they also provide free industrial engineering advice: how to make the best use of available energy, space and capital, how to provide a safe working environment, how to improve productivity through judicious use of new technologies, and so on. They also supply information on the extensive array of business assistance programs provided by both federal and provincial governments.

The free information and advice provided by the PROs often gives a young company the boost it needs to develop into a technologically and economically mature business. But the PROs have not received the support they need to carry on with this work. Until now, NRC's total supply of field officers, for example, has amounted to about 100 persons per year, about half of whom are attached to the PROs. In view of the large number of companies that could benefit from the services of field officers, such a contribution is little more than a token. Until very recently the situation was expected to become even worse. For 1983-84, NRC's assistance to the "Provincial Research Organizations and Research Institutes" was planned to be 3 per cent less than in 1981-82, two years before.*

The PROs also provide services to clients for a fee. Again, the SMEs are the chief beneficiaries of these services, which include research and development as well as analysis and testing of products and processes. In addition, individual PROs provide special services related to their particular expertise. For example, the Textiles and Clothing Technology Centre established by the Ontario Research Foundation (ORF) has performed product research, testing and evaluation for that industry for over 50 years, the Manitoba Research Council (MRC) operates a Food Technology Centre and the BC government has provided its PRO, B.C. Research (BCR), with funds to support a program of research, analysis and testing on coal, including liquefaction, materials handling and fluidized bed combustion.

In addition to the fees earned for work performed under contract, the PROs also receive annual operating grants from their provincial governments. These vary from $600 000 in one case to $15 million in another. Other funds come from contracts and contributions from federal departments and agencies.

* NRC Estimates for 1983-84, tabled in the House of Commons in February 1983. However, the message appears to have been received. One element of the Technology Policy announced by the Honourable Donald Johnston in May 1983 provides for increasing the number of NRC-supported field officers attached to the PROs.

The PROs also engage in exploratory or long-term research and development. For example, the Alberta Research Council (ARC) is engaged in a multimillion-dollar program of research on advanced tar sands technology in Alberta; and the Saskatchewan Research Council (SRC) has become a centre of expertise in slurry pipeline technology. A long-term program of exploratory research by the New Brunswick Research and Productivity Council (NBRPC) has recently resulted in the creation of a $20-million pilot plant for mineral treatment in Chatham, New Brunswick. Frequently, the exploratory R&D performed by a PRO is important to Canada as a whole. BCR, for example, has won international recognition as an authority on microbial leaching of ores – an energy-efficient, pollution-free method of refining minerals using advanced techniques of biotechnology.

Yet, with the exception of ARC, no PRO is able to devote more than 11 per cent of its expenditures to exploratory research. This figure is too low. By engaging in more exploratory R&D, the PROs could be more effective in developing provincial resources and initiating new advances in support of industrial development. As few companies have a sufficient cash flow to support this kind of R&D, greater government support is therefore essential.

Over the years the PROs have developed a wide range of special mechanisms for transferring to industry technology developed as a result of work either contracted to them by their clients or undertaken on their own initiative. Among the mechanisms referred to in the study are the patenting by client companies of technology developed by the PROs, the licensing by companies of patents held by the PROs and the purchase by a PRO of a licence to a foreign invention to enable the technology to be transferred for the benefit of Canadian companies. Several of the PROs have established subsidiary companies to market technology they have developed. Others operate inventors assistance programs to assess the feasibility of inventions submitted by individuals or companies.

The PROs and the Federal Government

The PROs have provided the clearest statement of the dilemma they face:

> "The federal government tends to view [the PROs] as 'arms' of the provincial governments and is therefore reluctant to provide financial support. Conversely, many provincial governments tend to view them as independent agencies established primarily to serve the private sector, and therefore expect them to recover a substantial part of their operating costs from their industrial clientele."*

The fact is that although the PROs operate in a regional context, they also address issues on a national level. Yet neither the federal government nor the provincial governments have understood their proper role. On the one hand, the PROs have been used for various federal initiatives (in establishing the Centres of Advanced Technology (CATs), for example), while on the other, they have been virtually ignored in the federal government's Contracting-Out Policy. Although the federal government has initiated several programs, using the PROs, to address the needs of the nation's industrial performers, many of them have had limited success.

NRC administers several programs related to the PROs. Three IRAP** (Industrial Research Assistance Program) sub-

* Association of the Provincial Research Organizations, brief on "The Role of the Provincial Research Organizations in Industrial Development," presented to the Senate Special Committee on Science Policy, February 1977, p. 13.

** IRAP-C provides industrial assistance through field officers; IRAP-F provides technical information and research services to firms having limited or no library facilities or research staff; IRAP-L enables companies with fewer than 200 employees to contract out investigations to research laboratories, institutes or consulting firms. The Program for Industry/Laboratory Projects (PILP), another NRC initiative, is designed to transfer technology developed by NRC and other federal laboratories to industry. This program does not now include technology developed by the PROs or other provincial bodies.

programs, IRAP-C, -F and -L, are especially important to the SMEs. But the continuing need for services provided by these programs has not been matched by adequate financial support. Free services may not be as glamorous as those involving large grants, but undercutting them would be tantamount to withdrawing from small companies the kinds of technical assistance they most need and, in many cases, the only kind they can use. Governments, both federal and provincial, should not neglect this important activity in favour of more visible and currently more popular R&D programs.

The Department of Industry, Trade and Commerce (IT&C) also administers programs which provide assistance to industry and are directly related to the role of the PROs. The CATs program, initiated in 1970, encourages universities and the PROs to establish centres of expertise in areas of specific interest to industry. IT&C provided "seed money" to these centres in the expectation that they would develop into technically and financially successful entities. However, financial support has been limited, making it difficult for several of the PROs to maintain their centres.

The Enterprise Development Program (EDP) contributes, among other things, up to 75 per cent of the direct cost of developing any new or technologically advanced product or process. PROs often help SMEs to prepare applications for these grants, and sometimes a successful applicant subcontracts the necessary services from the PROs using the federal contribution to help defray costs. In 1981-82, 576 EDP grants were awarded. In Ontario and Québec, which received 83 per cent of the grants, ORF and the Centre de recherche industrielle du Québec (CRIQ) derive substantial portions of their industrial contract revenue from EDP recipients. The program allows these PROs to develop future markets for their expertise while helping SMEs grow in technological sophistication. Other PROs would do well to examine the greater applicability of this program.

One of the biggest thorns in the side of the PRO-federal government relationship has been the federal Contracting-Out Policy. Since 1972, the federal government has been contracting out many of its R&D needs in science and technology to industry. In awarding contracts, preference is given to "Canadian industrial performers," in accordance with Treasury Board guidelines. But the guidelines also stipulate that, in selecting alternative performers, the federal government should give due consideration "to the extent to which the selection of the performer would indirectly promote the policy objective of stimulating industrial innovation."* Given this criterion, it is difficult to see why the PROs should not be high on the list of potential contractors. Yet since 1973, only 1.4 per cent of the total number of contracts awarded have gone to the PROs each year.

The PRO-federal relationship is influenced by the ability of the PROs to act in unison on matters that affect them all. Cooperation among the PROs at the national level is maintained largely through a rather informal body known as APRO, the Association of Provincial Research Organizations. The association meets regularly in Ottawa to hear from and present to federal representatives views on matters of mutual concern. But the PROs' ability to operate effectively at the national level is now seriously undermined by the lack of a central clearinghouse or coordinating office that, by mobilizing the necessary information, would enable them to react quickly and decisively to policy changes.

In the face of the ongoing creation of new institutions by the federal government, the PROs have had to reassess not only their own operations, but also their relations with these new institutions. Where services provided by PROs clearly overlap those supplied by other agencies, the PROs will have to consider joint arrangements if they are to continue serving the SMEs in

* Treasury Board of Canada, *Science and Technology – Contracting Out*, an administrative policy manual, Ottawa, 1978, chap. 314, p. 10.

Canada. Above all, the PROs must work to keep the channels of communication open and the federal-provincial partnership dynamic. For its part, the federal government must recognize the unique character of the PROs and their potential for effective federal-provincial cooperation. Through its various "regionalization" or "deconcentration" schemes, it should draw the PROs into a closer partnership in the common task of assisting Canadian industry through science and technology.

The PROs: Intra and Interprovincial Relations

The PROs' "arm's-length" relationship with their provincial governments has given them freedom from direct ministerial control, and the concomitant enhanced public support in recognition of their political neutrality. Nevertheless, if they are to continue meeting the needs of their respective provinces, the PROs must establish and maintain a close rapport with those in government who are in a position to aid or hinder their work.

It is in the best interest of provincial governments to support the quasi-independence of their PROs. At a time when governments are often tempted to grasp at technological straws to solve problems of massive unemployment, economic stagnation, declining revenues and mounting public debt, senior provincial officials should be able to rely on the confidential advice of a broadly based, semi-independent and competent PRO that is scientifically and technologically up-to-date and in close touch with industry. A provincial government, however, should not expect its PRO to perform its many functions solely on the basis of contract income. In fact, if a provincial grant is 30 per cent or less of the PROs' total expenditure, the province's best interests may be jeopardized.

During the past decade, provincial governments have created a variety of new institutions for promoting industrial development through science and technology. If the purpose of these institutions is to offer policy advice and award grants,

contracts and (sometimes) scholarships, the evidence to date suggests that they complement rather than reduce the PROs' importance, stature or effectiveness. However, problems can arise if such institutions or centres are provided with facilities in support of industrial activity. Even if communications networks linking such centres are set up, some fragmentation and duplication of effort is inevitable. There appears to be no conclusive reason why the activities of some of them could not be undertaken, or at least coordinated, by the PROs.

In their search for industrial strength and productive federal-provincial cooperation, provinces cannot afford to fragment their efforts. All provincial governments should seriously consider the advantages of recognizing their PRO as the central agency for providing assistance to industry. While some PROs are already on good terms with their provincial governments, others must work to build better relationships. They must demonstrate a sympathetic understanding of the political factors that affect government decisions and take the steps that will justify their serving as the provinces' central agencies for the delivery of scientific and technological support to industry.

The PROs and Academe: An Essential Linkage

Strengthened ties between the PROs and academe are also essential to Canada's technological performance. Historically, the PROs have had strong links with the universities. In several instances the mandate of the PROs was first carried out in university laboratories by faculty members, giving their research a rather academic flavour. But as federally and provincially funded research centres attached to universities have proliferated, the PROs have concentrated less on pure research and more on programs for industrial support. The creation of separate PRO laboratories marked the beginning of an "arm's-length" relationship between the two groups.

However, the PROs and universities still collaborate on projects of mutual interest. The Nova Scotia Research Foundation Corporation (NSRFC), for example, is cooperating with Dalhousie University and the Technical University of Nova Scotia to develop the Applied Microelectronics Institute. In Québec, CRIQ markets the results of university research and, in an attractive and innovative program, is collaborating with community colleges in establishing technical centres which can use the specialized equipment in the colleges – a program other PROs might well consider duplicating in their own provinces.

It is currently a practice in many industrialized nations to marry university research to technological applications. The PROs' long-standing association with universities and their indepth knowledge of industry in their province places them in a particularly strong position to serve as brokers between academe and industry. The IRAP-H sub-program, which pays the salaries of university and college students who assist small businesses with technical problems, provides an avenue for effective two-way interaction between the PROs and academe. This program, and others aimed at promoting fruitful collaboration between PROs, universities and industry, should be given the fullest support.

Conclusion and Recommendations

The eight Provincial Research Organizations play an important rôle in Canada, both provincially and nationally. Through their work in research and development, and by providing advice, information and know-how, they serve as veritable research arms for thousands of SMEs – a crucial sector for the creation of jobs and prosperity in Canada. By promoting technology transfer, productivity and innovation, they also serve as significant instruments in the implementation of both federal and provincial industrial development strategies. In *Partners in Industrial Strategy: The Special Role of the Provincial Research Organiza-*

tions, the authors make several recommendations aimed at enabling the PROs to perform these important functions more effectively, and serve as full-fledged partners with federal and provincial bodies in applying science and technology for the benefit of the Canadian economy.

- Every Provincial Research Organization should make an objective examination of the state of its relations with its provincial government, of its degree of awareness of the political factors likely to influence government policy, and of the steps that it should take to justify serving as the province's lead agency in the delivery of scientific and technological assistance to industry.
- The Association of Provincial Research Organizations should give serious consideration to the establishment of a permanent clearinghouse office (secretariat) that will act as a service arm to the organizations by providing information and data on matters that affect all of them.
- The proposed Association of Provincial Research Organizations' secretariat, headed by a full-time executive director, besides servicing the needs of the Provincial Research Organizations at the federal level, should also have the function of becoming familiar with all aspects of the individual Provincial Research Organizations, as well as other relevant provincial bodies, and thus contribute to the development of avenues for fruitful collaboration across and within provincial boundaries.
- The Provincial Research Organizations should give due consideration to expanding their linkages to the technical and community colleges within their respective provinces, as well as with the universities, with a view to enhancing technical assistance programs for indus-

trial sectors whose needs have not always been addressed in the past.

- If the provincial grant to a Provincial Research Organization is in the order of 30 per cent of its total expenditures or less, the province should recognize that its best interests may be in jeopardy, and take immediate steps to investigate and remedy the situation.
- Provincial governments should give serious consideration to the benefits that would accrue if each were to recognize its own Provincial Research Organization as the central provincial agency in matters dealing with the delivery of scientific and technological assistance to industry.
- A study of the dynamics of job creation and elimination in Canadian industry should be undertaken as soon as possible by Employment and Immigration Canada, in collaboration with Statistics Canada and the Minister of State for Small Business and Tourism. The methodology should be similar to that used by David L. Birch, at the Massachusetts Institute of Technology, suitably modified and adapted for application in Canada.
- The National Research Council should revise its priorities in relation to its support for the application of science and technology to industrial development by placing greater emphasis on the needs of small companies.*

* On 3 May 1983, the Honourable Donald J. Johnston, Minister of State for Science and Technology and for Economic Development, announced that $20 million would be made available to NRC over the next two years to expand its IRAP sub-programs serving small and medium-sized businesses (IRAP-C, -F, -H, -L, and -M), including the number of field officers attached to the PROs.

- The National Research Council should plan on tripling the number of field officers attached to the Provincial Research Organizations within a period of two years, placing special emphasis on the introduction of new technology by using those trained in the principles of industrial engineering.
- The National Research Council and the Association of Provincial Research Organizations should make a detailed analysis of the costs of providing field officers for IRAP-C and IRAP-F, and agree to a cost-sharing arrangement that will provide for equitable and stable funding.
- The National Research Council, in cooperation with the Provincial Research Organizations, should examine the possibility of increasing the productivity, competitiveness and innovative capability of small and medium-sized enterprises in all 10 provinces through the mechanism of IRAP-L, and be prepared to increase greatly the financial resources assigned to that sub-program, should such action appear to be justified.
- The National Research Council should undertake an evaluation of IRAP-H as a mechanism for achieving collaboration between the Provincial Research Organizations, academe and industry, and be prepared to increase financial support for it if warranted.
- The National Research Council should give serious consideration to extending the scope of its Program for Industry/Laboratory Projects (PILP) to include the transfer of technology from Provincial Research Organizations and other provincial technology-generating organizations to industry.

- All of the Provincial Research Organizations should make a systematic effort to use the Enterprise Development Program as a means of enhancing their delivery of technological assistance to small and medium-sized enterprises.
- The Department of Supply and Services, in matters relating to the awarding of science and technology contracts, should consider treating the Provincial Research Organizations as a category in its own right.
- When considering the award of contracts to organizations outside the primary and secondary sectors, those responsible for the Contracting-Out Policy should recognize the ability of the Provincial Research Organizations to tender, where technically appropriate, on the same basis as the service sector.
- The Provincial Research Organizations should, when technically qualified to bid on Department of Supply and Services' contracts, consider submitting proposals jointly with industrial performers, and further, they should adopt a more aggressive stance in marketing their eligibility as subcontractors for work contracted out to these industrial performers.