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Research and Development Services in Canada - A Discussion Paper

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Introduction

The increasingly competitive global marketplace dictates that in order for firms to maintain profitability they must continually develop new or improved products and production processes while at the same time reduce their costs as much as possible. Firms are experiencing difficulties dealing with the tremendous competitive pressure to cut costs and develop new products. To meet the challenges of the knowledge-based economy, firms are required to innovate constantly in order to react quickly to changes in the global marketplace. In this, a time of short product life cycles, overall corporate rationalization and downsizing, firms have begun to explore tho use of external sources of research and development (R&D) in Canada and around the world. Contract Research Organizations (CROs), as a result of their flexibility, efficiency and specialized knowledge, have been able to offer an affordable solution to the many problems experienced by firms today.

Contract research is the "activity by which a client hires the services of an external organization to carry out a specific piece of R&D."[1]. The contract between the two parties clearly defines the parameters of the R&D to be conducted including the clarification of the approach to be used; any specific milestones; the project costs; the assignment of intellectual property (IP) rights; the rights and obligations of each party and, of course; a description of the desired end product.

Industry Canada has recognized the R&D services sector not only as expanding quickly in popularity and relative importance but also as having the ability to play a significant role in a growing, competitive, knowledge-based economy. Moreover, this industry is highly export oriented and competitive in the international marketplace. In order to develop a greater appreciation of this important growing industry, better data and information on the industry and the factors promoting its growth and development are required.

Objectives:

This overview of the R&D services industry in Canada provides a "snapshot" of the industry and is meant to serve as a catalyst for future discussion with stakeholders. It has the following objectives:

- to identify what information gaps exist and how they can be addressed;
- to gain an understanding of the size, structure, specializations and practices of this newly emerging activity;
- to understand why the use of CROs has grown in popularity and importance; and,
- to uncover what sort of issues the industry, its firms and its consumers face.

Approach:

A thorough literature review was conducted as the basis for this document. As a part of this review, numerous bibliographical databases, Statistics Canada, Revenue Canada, and the Conference Board of Canada were tapped for information. A search for relevant industry associations in North America and Europe was conducted and numerous dialogues were initiated on the topic with association officials, academics, industry representatives and other knowledgeable persons.

In order to begin developing a better understanding of the industry, two initiatives were undertaken to solicit the views of the industry's stakeholders. First, two workshops were held with users of contract R&D services. The workshops' main shared objective was to obtain the views of business leaders on contract R&D and to understand the practices employed in the outsourcing of research projects. Second, an ongoing consultative process with CROs has commenced in an effort to better understand the industry as seen by its firms.

Some inconsistencies between sources of information were revealed and this document makes an effort to present all these perspectives. It should be noted that the views and conclusions within the overview are based on interpretation of the quantitative data, a literature review and discussions with knowledgeable people. As a result, the conclusions presented herein are preliminary and may not represent the views of all stakeholders. They are presented here simply in an effort to initiate further dialogue with stakeholders and through them help to develop a clearer picture of the industry.

[1] G. Haour (1992), "Stretching the knowledge-base of the enterprise through contract research," R&D Management 22(2): p. 178.

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Contract Research

Rationale:

Firms outsource R&D for a number of reasons. These fall into a few broad areas including; a changing organizational focus; a lack of resources; and, a recognition of the increasing specialization and expertise of others outside the firm. This process is often driven by shortages of resources including equipment, expertise, qualified staff, time, space and money, brought about by the occurrence of technical advance, restructuring and the emergence of the knowledge based economy.

It has become exceedingly difficult, not to mention costly, for organizations to develop and maintain an in-house expertise in more than a very few technologies since the level of knowledge embodied within these has increased so dramatically. Firms are focusing more and more on core competencies, resulting in gaps in other areas which force them to tap expertise outside their organization. This includes the area of R&D. Contracting out R&D provides firms with the opportunity to focus on the most important aspects of their R&D regime or on their other core competencies. A jack of all trades is the master of none. With an increasing number of knowledge-based firms competing in winner-take-all markets, the importance of being the master of one, or of a few trades, cannot be underestimated.

The need to focus on core competencies has also led to a greater focus on mission, market positioning, restructuring, re-engineering, and reorganization, all of which help explain the "tightening up" that many firms have been experiencing. In other words, firms are increasingly concentrating their efforts on tasks which build a competitive advantage and outsourcing tasks that they do not specialize in. Furthermore, core competencies are not static but are constantly evolving. Outsourcing also allows firms to investigate, with very little initial capital investment or risk, a new technology, technological process or product to determine whether its characteristics are such that it would be advantageous for the firm to develop its core competency further.

All industry has experienced the cutting back of non-operating expenditures which created shortages over the last decade. From the pharmaceuticals industry to oil refining, the trend towards rationalization has often impacted R&D in industry. In an effort to streamline operations, decrease overhead and increase returns to shareholders, R&D laboratories have frequently been called upon to provide better results, more quickly and in less time using fewer resources. Many firms have had to cancel longer term projects in favour of more focused short term projects that have a more immediate impact on the bottom line.

Shortages can also arise as a result of unexpected overloads making a firm unable to deal with its R&D requirements. Often, during the course of a project, problems arise that need to be addressed immediately in order that the project can continue on schedule. In these instances, firms may be inclined to outsource to other companies to either regularly replace their lack of resources or simply to temporarily augment their resources.

Sometimes, even if a firm has all the resources necessary to conduct a particular research activity in-house, it will choose to outsource as part of due diligence and in order to generate favourable consumer opinion towards the contracting firm. If a firm feels that consumers or even regulatory bodies may perceive the results of the firm's R&D activities as being self-serving or biased, it may choose to outsource that piece of work in order to ensure that the results are considered objective and that no self-serving ends are perceived.

As mentioned, in order to collect more information on the outsourcing practices at the company level, two workshops were held with representatives from thirteen companies participated. These included research and technology executives from a number of high-tech and other manufacturing sectors, and some from energy-based utilities. Most of these were larger firms, representing both large and small R&D spenders. All were involved in R&D outsourcing, but to different extents.

Industry Breakdown:

The R&D services industry is comprised of a number of different kinds of organizations from both the private and public sectors. CROs include:

1. Private firms whose primary business operation is the provision of R&D services for a fee
2. Private firms who provide these same services only as a business complement to their core competencies
3. Universities and their related organizations who undertake R&D for a fee
4. Revenue dependent publicly funded organizations and not-for-profit organizations performing R&D on a fee-for-service basis
5. Testing laboratories

The majority of private sector CROs fall under Standard Industry Classification (SIC) code 7759, Other Scientific and Technical Services, which consists of four subcategories; surveying and mapping services, environmental services, laboratory testing and research services and other scientific and technical services. Of particular interest are commercial services offering laboratory testing and research services which are found mainly in the later two categories. Medical laboratories which are classified elsewhere are excluded.

For commercial R&D services, the area of particular interest is often referred to as fee-for-service or contract R&D. Testing laboratories and contract R&D services are quite distinct; testing laboratories provide analysis or testing of existing materials, products or processes, while, contract R&D, in its general form, involves the creation of new materials, products or processes. Also, the results of R&D work are uncertain, i.e., the possibility of obtaining a particular technical advance can not be seen in advance. Testing laboratories, however, are not a growth area, partly due to their limited export potential. They are largely driven by government regulation or company standards. Furthermore, laboratories are becoming more automated and their human resource requirements will likely fall as capital costs rise. Despite these factors, some laboratories do have an ability to provide R&D services as well, in conjunction with their regular services. Testing laboratories will be looked at more closely in future research.

In Canada, CROs operate in all regions of the country but tend to be concentrated where economic activity is greatest. For example, Ontario is home to the largest proportion of CROs. Furthermore, CROs tend to establish themselves in close proximity to organizations which share common interests. For example, the Maritime provinces are the home of many CROs associated with research related to the fisheries.

CROs tend to be small in terms of number of employees. There also seems to be a dichotomy in organizational types. On the one hand, there are the small firms whose success depends on the viability of a major owner/operator. These make up the majority of Canadian CROs. Alternatively, there is a small number of large organizations that are divisions of large corporations, independent corporations or government agencies.

There does not seem to be any standard way in which CROs specialize their research activities. Evolution of research activity by type does not seem to occur. Some CROs become very specialized around particular products, technologies or processes, while others carry out their activities more broadly around the needs of entire industries.

Information Required:

A strong R&D services industry fully supports the Federal Government's S&T strategy whose underlying premise is that S&T and innovation are essential ingredients to achieve jobs and growth. It is imperative that the contributions of the CROs and testing laboratories are well understood by all stakeholders. It is also important to develop a better understanding of this sector's structure and performance and its contribution to the economy as well as the opportunities and challenges it faces. As such, data to support a thorough analysis of the industry is needed.

A comprehensive understanding of competitiveness issues affecting the industry including investment, trade and export strategies, technological innovation and adaption, human resources, the environment and sustainable development also is essential to ensure an appropriate framework for the dynamic growth of the R&D services industry.

At the most basic level, industry specific data on the size of the industry in terms of employment, revenues, operating expenses and number of firms are needed in order to place the R&D services industry within the context of the Canadian economy as a whole. To fully understand the industry, however, much more information needs to be collected on variables such as capital spending, trade flows, additional employment characteristics, financing and productivity. The decision-making process would be further facilitated by the availability of firm specific data such as specialization, location, investment patterns, marketing efforts and business dynamics. In conjunction with the collection of these data, a consultative process, already initiated, should also be continued in order to generate a more comprehensive picture of the industry.

Ideally, distinct data, presented in a historical perspective, on all four groups of CROs as well as independent testing and inspection laboratories should be made available so that issues can be addressed at a variety of levels. Independent testing and inspection laboratories, by virtue of their design, can, and do, provide some R&D services and as such should be examined along with the other CROs.

Statistical Review:

The relative lack of homogeneity and rapid growth of the R&D services industry has hindered the collection of the complete range of data mentioned above. Traditional sources of data such as Statistics Canada, while they generate a great deal of information on R&D, provide little specific data on the R&D services industry. To this end, special requests were put forward both to Statistics Canada and to Revenue Canada for better industry specific information; less conventional sources were examined; and, data from multiple sources were combined and blended in order to conduct as rigorous an analysis as possible.

The Revenue Canada data represent total domestic demand for R&D services from Canadian sources in that they are generated from claims related to the Scientific Research and Experimental Development (SR&ED) investment tax credit program as presented in Form T661[2] which establishes total expenditures on outsourced SR&ED both at arm's length and non arm's length. Also included are expenditures on SR&ED paid to third parties such as approved associations, universities, institutes, colleges, non-profit SR&ED corporations resident in Canada and, granting councils. In sum, these data represent the total amount of R&D activities that are outsourced by Canadian firms to other related and non-related organizations in Canada.

The Statistics Canada data are more narrowly defined. These data were derived from responses to Statistics Canada's Research and Development in Canadian Industry Surveys. The numbers represent the amount of funds designated for R&D by source. In other words, this survey is sent to all firms conducting R&D; these firms in turn indicate what were the sources of the funds they used to conduct R&D. These include self funding, affiliated firm funding, government funding, funding from other firms (payments for contract research), international sources and so on.

All these, and many other sources, were consulted in an effort to make sense and develop as accurate an estimate of the supply of and demand for R&D services as possible. While the data that was collected do not yield ideal supply and demand figures, they do demonstrate an undeniable trend towards the industry's growth in size and relative importance.

Canadian Supply Capability:

The supply of R&D services is comprised of sales of these services by Canadian organizations to organizations based in Canada and abroad. Statistics Canada's Research and Development in Canadian Industry Survey, Canada's system of national accounts and a number of more focused sources were used to estimate Canada's total supply of R&D services from the private and public sectors.

Private sector:

The Statistics Canada survey suggests that Canadian based firms provided $544 million worth of R&D services to other firms in Canada of which $301 million were transactions between affiliated firms and $243 were transactions between non-affiliated firms. Since 1985, the proportion of services provided to non-affiliated firms has been increasing steadily. The survey considers firms whose primary work is the provision of R&D services as well as those firms and companies for whom it is not, but perform R&D work for others in order to increase their bottom line as a business sector, if applicable, to enhance their worth within the larger organization and raise funds for other activities.

The second component of supply is the amount of R&D services that are sold abroad. Canada's System of National Accounts estimates exports of $1,724 million in 1996, representing a growth of 146% since 1990. Canada's most dominant trading partner is the United States and the majority of trade in R&D services is conducted between affiliated firms.

Table 1
Private sector supply

	Domestic Sales		Exports	Total
	Affiliated firms	Non-Affiliated firms		
	millions of dollars			
1993	301	243	1006	1550
1991	239	162	803	1204
1989	292	164	761	1217
1987	225	125	667	1017
1985	220	97	458	775

Source: Statistics Canada (1997), a custom run commissioned by Industry Canada and Statistics Canada, Canada's international transactions in services, cat. no. 67-203 (Ottawa, 1987-1996).

It is of note that private sector sales of R&D services both to organizations in Canada and abroad have increased more rapidly than has total intramural spending on R&D in Canada. This shows that not only have R&D services grown in terms of sales, they have grown in relative importance when compared to other R&D activities. Table 1, above, presents a historical perspective of private sector supply.

Organizations whose primary work is contract research:

There are many firms in Canada whose primary operational focus is the provision of R&D services for a fee. A customized Statistics Canada data run suggests that, in 1993, there were 76 firms that derived more than 50 percent of their revenues from the sale of R&D services and, combined, had over $220 million in total sales. Table 2 presents a historical review of these firms' sales. It shows that the actual number of firms experienced a healthy increase between 1985 and 1993. Their total revenues show an even more robust nominal growth of 362% over the same period. Additionally, revenues from contracts with other Canadian firms grew by 267% and revenues from contracts with foreign firms grew an even greater 398% (nominal growth). This latter fact emphasizes the growing importance of foreign contracts to the industry[3].

Table 2
Firms Generating more than 50 Percent of their Revenues

from R&D Contracts

Year	Number of R&D performers	R&D contracts with other Canadian firms	R&D contracts with foreign firms	Total revenues
	number	$ 000	$ 000	$ 000
1985	44	23,662	15,535	47,800
1987	66	34,098	30,972	77,074
1989	64	56,558	38,164	114,588
1991	80	57,368	49,997	130,559
1993	76	86,888	77,326	220,625

Source: Statistics Canada (1997), a custom run commissioned by Industry Canada.

Non-private sector:

The non-private sector also provides a great deal of R&D services to the market place. This sector is comprised of publicly funded and not-for-profit organizations: for example, the commercial R&D activities of Provincial Research Organizations (PROs), of federal and provincial laboratories, of technology centres, of the National Research Council of Canada (NRC), as well as of, public institutions, such as universities and their related organizations.

One of the largest players in this sector is believed to be the Canadian university sector. University based CROs perform contract research for a wide variety of clients including the Federal and Provincial governments, large and small firms and associations. In addition to their yearly budget, universities could once depend on many other sources of funds, including grants from government, associations and industry, for an adequate level of R&D funds. This is less the case today. Furthermore, industry now demands a return on much of the support they give to universities. These trends have impacted the R&D activities of university-based research organizations dramatically and have forced them to address the issue of contract research very closely.

In 1995, some of the largest universities in terms of sponsored research (which includes research funded by federal, provincial and other government grants and contracts, bequests, donations, non-government grants, investment income and sales of services and products) were the Universities of Toronto, Montreal, Alberta and British Columbia and McGill University[4].
The eight PROs across the country also play a substantial role in this sector. They are the Nova Scotia Research Foundation Corporation, New Brunswick Research and Productivity Council, Centre de recherche industrielle du Quebec, ORTECH Corporation (Ontario), Economic Innovation and Technology Council (Manitoba), Saskatchewan Research Council, Alberta Research Council and Nunavut Research Institute. In 1994, these organizations employed 1,658 people of which scientists and engineers accounted for almost half. The British Columbia Research Corporation became insolvent in 1993 and its assets were purchased by private sector interests.

The PROs are becoming more active doing fee-for-service R&D in both the national and international marketplaces. Clients are usually small and medium sized companies with limited in-house technical services. After reaching a peak in the early 1990s, the total expenditures of these organizations have fallen gradually to $146 million in 1995. Contracts with the provincial governments, federal government and Canadian industry accounted for 5.9 percent, 7.4 percent and 31.7 percent of this total respectively in terms of the source of these funds. The majority of foreign sources of funding which accounted for 8.3 percent of the total can also be attributed to contracts. Since the early 1990s, PRO funding from provincial and federal contracts has been on the decline, while funding from Canadian industry contracts has held stable and foreign funding has been increasing. The vast majority of the remainder of funding comes directly from the provincial governments themselves[5].

Table 3, below, shows the sources and types of funds by institute in 1995. These figures encompass all activities including scientific research, development, resource surveys, analysis and testing, industrial engineering and industrial innovation. At this time it is impossible to know under which activities the various contracts are categorized; however, development and scientific research activities accounted for approximately 47 percent of total expenditures in 1995. This represented an increase in total expenditures for that category

from 1994. Expenditures related to secondary industries accounted for 58 percent of the total followed distantly by those related to primary industries and the environment.

Table 3

Institute	Provincial government subsidies, grants and contributions	Contracts: Provincial governments	Contracts: Federal government	Contracts: Canadian industry	Contracts: Other Canadian sources	Contracts: Foreign sources	Total
	thousands of dollars						
Nova Scotia Research Foundation Corp.	2786	968	1245	1512	276	175	6962
New Brunswick Research & Productivity Council	780	491	1270	4454	733	135	7863
Centre de recherche industrielle du Qubec	22283	1185	1105	9983	241	130	34927
ORTECH Corporation	11308	299	2031	11680	1004	5041	31363
Economic Innovation and Technology Council	5212	1954	702	1590	84	0	9542
Saskatchewan Research Council	3963	1465	2789	9509	0	341	18067
Alberta Research Council	22547	4523	1790	7747	-24	5655	42238
Nunavut Research Institute	0	0	156	0	1699	0	1855
Total	**68879**	**10885**	**11088**	**46475**	**4013**	**11477**	**152817**

Sources and types of funds by institute, 1995

Source: Statistics Canada, Service Bulletin, Science Statistics 21(3), Cat. No. 88-001, April 1997.

PROs were established in order to provide technical support to primary and secondary industries, to assist in the exploitation of provincial natural resources and to enhance the economy of their respective provinces. With the exception of those from the Northwest Territories and New Brunswick all of these organizations are members of the Association of Provincial Research Organizations (APRO). APRO is now a part of the Alliance of Manufacturers and Exporters of Canada.

The NRC, based in Ottawa, has been the principal science and technology agency of the Canadian federal government for more than 80 years. Its mission is to support national science and engineering activities, perform and stimulate investment in research and development, and develop vital expertise and knowledge. With 16 research institutes located in eleven major centres across the country, the NRC is well-positioned to foster regional economic innovation. At the end of 1996 it employed the equivalent of approximately 2,700 full time employees of which 1,765 were research staff. Contract research accounted for about $17.5 million (roughly 60 percent of all external revenues) of the total NRC budget of approximately $250 million in the 1995-1996 fiscal year. The council conducts research across a great number of sectors including biotechnology, aerospace and telecommunications[6].

In 1994, higher education and private non-profit organizations received R&D funding from foreign sources of $18 million and $10 million respectively[7], while in 1995 PROs received $12 million[8]. It is unknown how much of this funding was associated with contract research and how much came in the form of grants or donations but it has been suggested that contract research monies account for a large proportion.

Total Canadian supply capacity:

By using 1993 figures from the Statistics Canada R&D survey to estimate private sector supply domestically, including sales of firms who provide R&D services as their primary function and those who do not; 1996 figures from the system of national accounts to estimate private sector exports; and, various years of other sources to estimate the non-private sectors supply of R&D services, total Canadian supply of R&D services is estimated to be worth approximately $2.35 billion.

Demand for Canadian R&D Services:

Demand for Canadian R&D services is comprised of purchases of these services from organizations in Canada and abroad. Data on domestic and international transactions were collected from Revenue Canada's Scientific Research and Experimental Development (SR&ED) investment tax credit program and from Canada's system of National Accounts.

According to the Revenue Canada data, total expenditures on the outsourcing of R&D activities to organizations in Canada by Canadian firms nearly tripled in real terms to $1.621 billion from 1987 to 1992[9]. Over this same time period, Canada's gross domestic expenditure on R&D (GERD) only increased by approximately 22 percent [10], Ottawa. Furthermore, in 1987, 40% of those firms reporting R&D expenditures outsourced some of these activities and in 1992, this figure increased to 45% indicating that the importance of outsourcing has increased. These statistics, like those from Statistics Canada, suggest that firms have been becoming much more inclined to outsource their R&D activities instead of conducting them "in-house" on their own.

One interesting trend that is demonstrated by these data is that the growth of expenditures on outsourcing of R&D by firms who conduct R&D themselves has grown much more rapidly than growth of expenditures by firms not performing R&D "in-house". These firms have increased their expenditures by more than three and a half times in real terms between 1987 and 1992. Expenditures on the outsourcing of R&D activities by those firms who do not conduct any R&D themselves have experienced sporadic and much weaker growth in relation to that of R&D performers over the same period. In nominal terms, firms who conduct some R&D themselves spent almost five times as much on contracting out R&D activities than did firms who did no "in-house" R&D in 1992.

Apparently, it can be said that some sort of "in-house" research based structure and a good understanding of the risks, rights issues, time lines and processes associated with R&D is essential to fully exploit new discoveries and to derive the most benefit from contracting out of R&D. Also, firms are increasingly in need of at least some R&D regardless of whether they now conduct R&D themselves or not. As some firms have no capacity to conduct R&D activities themselves, this leaves these firms no other alternative but to purchase R&D services elsewhere.

For comparative purposes, in the US, company financed R&D contracted to outside organizations increased 21% from 1991 to 1993 while company and other sources of funds (except Federal) for R&D performance increased only 4.2% over the same period. In terms of absolute figures, large firms in America do account for the greatest proportion of contracted out R&D; however, smaller firms have been experiencing the fastest rate of growth of expenditures on outside contracting[11].

US data on the R&D services industry and on contract R&D are also incomplete and in need of improvement if a study of the industry in the US is to be conducted. The data that do exist, when compared to those found in Canada, do not have the same coverage, are under-reported and do not appear in as much detail. They are, however, often of higher quality than that which are found in Canada. The US data have been cross-checked with both contractor and contractee, and identify more closely actual contract R&D.

Between 1990 and 1996, Canadian consistently maintained a substantial positive trade balance. In 1996, Canada enjoyed a trade surplus of $845 million (exports equaled $1,724 million while imports equaled $879 million) [12]. As with exports, import trading partners were usually affiliated firms and were located mainly in the United States. Table 4 provides a historical perspective of Canadian imports and exports of R&D services (payments represent imports and receipts represent exports).

Table 4
R&D services' international transactions

	US	EC	Other countries	Affiliates	Total Other	Total
Receipts (millions of dollars)						
1995	1123	258	127	1319	188	1507

1994	988	104	255	1173	174	1347
1993	723	107	176	880	126	1006
1992	542	84	114	646	95	741
1991	674	78	51	760	44	804
1990	575	67	58	659	41	700
Payments (millions of dollars)						
1995	463	253	25	679	62	741
1994	463	232	33	679	49	728
1993	388	162	19	522	46	568
1992	396	146	7	515	36	549
1991	403	87	6	467	29	496
1990	398	78	7	461	21	482

Source: Statistics Canada, Canada's international transactions in services, cat. no. 67-203 (Ottawa, various years).

Total demand for Canadian R&D services:

Using the 1992 data collected through Revenue Canada's SR&ED tax credit program and the 1996 figures from the system of Canadian National Accounts, total demand for Canadian R&D services is estimated to be valued at approximately $3.13 billion.

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[2] The SR&ED tax credit program is designed to promote research and development activities carried out in Canada. It provides generous tax credits for most expenditures associated with SR&ED including salaries, capital purchases and overhead. In order to claim the tax credit, filers fill out the seven page T661 form and attach it to their T2 form, Corporation Income Tax Return. Credits are based on a percentage of total approved expenditures as well as firm specific criteria.

[3] It is important to keep in mind that the growth rates can be affected by yearly differences in the way the data was assembled and the composition of the firms involved.

[4] Statistics Canada data prepared for the Canadian Association of University Business Officers (1996).

[5] Statistics Canada, Service Bulletin, Science Statistics 21(3), Cat. No. 88-001, April 1997.

[6] Finance and Information Management Services, National Research Council, 1997

[7] Statistics Canada (1996), Estimates of Canadian Research and Development Expenditures (GERD), National 1963 to 1996, and by Province 1979 to 1994, ST-96-08: p. 19.

[8] Statistics Canada, Service Bulletin, Science Statistics, 21(3), April 1997: p. 5.

[9] It must be noted that these figures are derived from original claims filed by organizations and not actual approved expenditures. As such, the figures could represent an inflated estimate of actual demand. Regardless, the numbers are still significant.

[10] Industry Canada, "Science and Technology Data, 1995"

[11] National Science Foundation, Research and Development in Industry: 1993, NSF 96-304.

[12] Statistics Canada, Canada's international transactions in services: 1961 to 1996, Cat. No. 67-203, June 1997.

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Contract Flows

Knowledge of the size of an industry is useful to provide a context as to how an industry fits into the economy as a whole. An understanding of the flow of an industry's transactions between sectors and firms is far more revealing when determining the policy implications of various issues. Statistics Canada, in a recently released paper by Antoine Rose entitled "Transfers of Funds for Research and Development in Canadian Industry, 1993" [13], examines the flow of funds for R&D between firms and industries.

The study covers only companies that completed the detailed 1993 Industrial R&D Survey, excluding small firms which completed the short form of the survey and includes only those transactions for which both the payment and the receipt could be traced and were conducted by firms in Canada. Furthermore, the transfe discussed can either represent those made in the sense of a service contract or those made within an alliance structure. Nevertheless, the study does give us a better idea of outsourcing trends at an overall industry level.

The study indicates that $516.5 million was exchanged in 590 transactions and that $295.3 million and 77 of these transactions were associated with what respondents self identified as related firms. No concrete definition was used for the term "related", firms were simply asked if their transaction was with a related firm. Small firms not covered by this study accounted for about $31.4 million in transfers involving 189 recipient firms.

The study reveals that most industries are involved in the transfer of funds for R&D purposes. Firms in the Communications, Computer and Other Service Industries category were by far the most active in terms of payments with $249.0 million being transferred to other firms for R&D activities. Firms in the Telecommunications, Electronic and Electric Equipment Industry; Engineering and Scientific Services and Management Consultant Industry; Transportation Equipment and Machinery Industry; and Pharmaceuticals and Medicines Industry categories followed with between $27.0 and $38.1 million worth of payments.

Firms in the Communications, Computer and Other Services Industries category and the Engineering and Scientific Services, and Management Consultant Industries category experienced the largest inflow of funds with $176.4 million and $153.8 million respectively. The Telecommunications Equipment, Electronic Equipment and Office Machine Industry category followed distantly with inward transfers of about half these amounts.

Both inward and outward transfers in terms of total R&D spending varied greatly between firms Of note, however, is the fact that both the Communications, Computer and Other Service Industries category and the Engineering and Scientific Services and Management Consultant Industry category had among the highest transfers to intramural R&D expenditure ratios meaning that inward and outward transfers played a significant role in their R&D strategies.

Table 5 provides a graphical matrix of how inter-firm transfers of funds designated for R&D flow between industries in Canada. The darker the square, the greater the volume of funds that flows between the corresponding industries. This table suggests that the greatest volume of transfers involves those industries that

could be considered to be in the "hi-tech" industries The Communications, Computer and Other Services Industry category is , by far, the most active in terms of both receipts and payments. The Engineering and Scientific Services and Management Consultants category receives substantial transfers for R&D from every industry identified. Among the least active, both in terms of payments and receipts, are secondary industries.

Table 5
Input/output matrix for transfers of Canadian funds for R&D, 1993

Please download Table 5 in order to view.

[13]A. Rose (Statistics Canada), "Transfers of funds for research and development in Canadian industry, 1993", Ottawa, 1997.

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Addressing the Gaps

Due, in part, to the rapid growth and complexity of the R&D services industry, there exist very few sources of data designed to capture information on it and as a result, the data currently available is clearly insufficient to conduct a rigorous analysis of the trends and competitiveness issues facing it. While the data that have been collected have not yielded a clear picture of the absolute size of the industry in terms of revenues or employment, they have demonstrated an undeniable trend towards the industry's growth in sales and relative importance. Consultations with industry, academia and other stakeholders support this view.

Perhaps the three broadest problems with the existing data are the lack of sources specifically designed to capture information on the industry; the methods used to group the data; and, the lack of firm level data on the industry on both the supply and demand side. These three factors are the largest stumbling blocks to an appropriate analysis of the industry.

Most of the data collected, including those from Statistics Canada and Revenue Canada, come from sources which, in their generation, viewed the collection of data on the R&D services industry to be of secondary importance. This often lead to situations where the data collected did not provide a complete picture of the industry and, as a result, multiple sources had to be used, then combined, which in turn lead to inconsistencies and gaps in the data. For example, an estimate of the supply side of the industry was calculated using a number of different sources which each had their own description of what they considered to be contract R&D or affiliated firms. Additionally, each individual source was interested in collecting data on a particular subject other than R&D services and therefore only gave cursory coverage to these services. This made the aggregation of the data somewhat difficult and lead to poor and incomplete coverage of the non-private sector of the R&D services industry.

Another factor which made the analysis of the industry difficult was the way in which the various sources of data categorized R&D services. In some instances, the Revenue Canada data for example, the source made little effort to distinguish between transactions involving affiliated and non-affiliated firms. This is of particular interest in the case of R&D services due the dynamics of subsidiary-parent firm relationships. In other cases, the grouping of R&D services together with other services or sources of funds made some data unusable. For example, data on revenues from R&D services in universities were grouped together with non-granting agency government funding and miscellaneous funding, making a review of R&D services in universities next to impossible.

Finally, and perhaps the most difficult obstacle to overcome, there is the lack of firm level, industry specific information. It has already been noted that in order to fully understand how policy issues affect individual firms, it is imperative that some sort of understanding of how firms react to different variables in the business environment. For example, how firms specialize and how firms react to technological change in terms of investment in capital or human resources are very important factors when developing strategies that address the industry's competitiveness. Furthermore, understanding how organizations involved in providing R&D services are related to those firms purchasing these services would be useful in determining whether the R&D

services sector is important because it is an industry by itself or because it is an important component of something broader.

Due to an inhibiting lack of data, providing a concise picture of the industry and its contribution to the jobs and growth agenda is difficult. To do so, a concerted effort must be undertaken to address the gaps in the data describing this industry. In order to better understand this evolving industry, existing data sources must either be redesigned or new ones developed.

The forthcoming, North American Industrial Classification System (NAICS), developed jointly by the United States, Canada and Mexico to replace their existing industrial classification systems with a common one, may serve as a useful opportunity to source new data on the R&D services industry. Under the new arrangement, a new category, Scientific Research and Development Services, NAICS code 5417, will be further broken down into such activity in the physical and engineering sciences, in the life sciences and in the social sciences and humanities. Meanwhile, all testing laboratories, including environmental ones, but excluding medical labs, will be under the new NAICS code, 54138. The earliest this data could be made available will be in 1999.

In order to ensure the success of the NAICS as a source of information on the R&D services industry, a number of factors must be addressed. First, as comprehensive as possible coverage of these firms during the data collecting stage is necessary. At present, data being collected by Statistics Canada on "Other Scientific and Technical Services" are not as comprehensive as needed. Second, complimentary data on the non-private sector must be collected so that a complete and consistent picture of the industry can be developed.

The creation of an exhaustive list of CROs would be a valuable asset in the collection of industry data at both the industry and organization level. The list would include organizations in both the private and non-private sectors and would enable the distribution of an industry survey designed to collect organization specific data to occur. The survey could deal with issues like specialization, human resources, investment, innovation and others likely to have a impact on the firm. At present, there is no easily accessible vehicle to collect this information.

Currently, there is no industry association for the R&D services industry. The creation of such an organization would not only facilitate the collection of more industry specific information but also would provide a common voice for the industry and a forum through which the issues that it faces could be discussed.

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Issues

Competition Human Resources

In conducting the research for this preliminary review of the R&D services industry, a number of important issues related to increasing competition at home and abroad and human resources were revealed. These are by no means the only issues facing the industry but it is hoped that follow-up to this report in conjunction with further research and consultations will lead to a better understanding of those identified.

Competition:

Progress toward a knowledge-based economy coupled with advances in telecommunications and the transportability of research dollars and technology has provided firms with the opportunity to easily access the best resources in the world and to improve their return from R&D. These developments have both developed Canadian CROs and exposed them to increasingly fierce competition from around the world. Firms no longer hesitate to conduct R&D across borders or all over the globe in order to access the best resources available. While it is impossible for Canadian CROs to be world authorities on the development and application of all technologies, they must aggressively maintain their leadership in those in which they have an edge and continuously attempt to develop new competencies in those which may prove profitable in the future.

The outsourcing of R&D to service organizations outside of Canada is a very real issue. Many firms, despite the fact they would qualify for substantial tax credits if they chose to have their R&D conducted in Canada, choose to forgo these credits and contract out to foreign organizations.

Human Resources:

Firms want to spend as little time as possible administering and managing their outsourced projects and at the same time maximize their returns from R&D. Firms, therefore, have stated that CROs must be client oriented, adherent to research timetables and deliverables, transparent in their work, accessible and proficient writers of business plans and documents. Many Canadian CROs, however, may not possess the business skills that are being demanded of them. Existing Canadian CROs are often small and, as a result of financial constraints, have a staff made up almost entirely of technically educated researchers who usually have had very little experience or training in these business skills.

Increasing competition in the R&D services industry often provides the consumers of these services greater opportunity to seek out CROs who are able to both develop close business relationships with their clients and conduct first rate research. Firms are viewing these business relationships as increasing in importance and seek out those CROs that possess the necessary business skills to develop and maintain them.

Marketing skills are also growing in importance. Firms can now access R&D services around the world and

from a growing number of CROs, making a CRO's presence in the marketplace very important. Some popular methods of marketing currently used include participation in organizations and committees, attending conferences and trade shows, direct mailings and calls to potential clients, pamphlets, listings in directories, holding workshops, and offering use and tours of research facilities. CROs also appear to depend a great deal on word of mouth and on their reputation to generate new business opportunities.

As an example, university based CROs have found these issues to be exceptionally trying. It has been very difficult for university-based researchers to move from an environment where they could access equipment and funding to conduct research focused on their area of interest, to one where equipment has become more scarce and used more intensely due to growing demand and a lack of funds to replace or repair obsolete and broken equipment; where time is at a premium; where funding is very strictly controlled and shrinking; where research must increasingly be directed to satisfy industry needs; and, where a new focus on marketing and client services has become necessary to compete for the industry dollar. Furthermore, some firms find it difficult to deal with universities with regard to intellectual property. They suggest that university property rights policies can be too rigid and need to be reviewed to make outsourcing easier.

These issues are by no means unique to the R&D services industry as a whole. Many young, rapidly growing, knowledge-based industries have experienced similar problems. Joining business, administrative and marketing skills with research skills is a human resource problem that the R&D services industry needs to address.

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Conclusion

This overview was written with the hope of continuing discourse on the R&D services industry that has gone on before and to generate a "snapshot" of the industry today. The need for a continuation of the discourse was clearly indicated in the workshop evaluation and in the considerable amount of interest in this topic that has been shown in Canada and abroad by both the private and public sectors.

Not only has the paper addressed the characteristics of CROs, themselves, it has attempted to present the industry sector in terms of supply and demand. Both of these conditions heretofore have remained very vague concepts. The paper also discusses some of the issues that face the R&D services sector and some of the firms who take advantage of its growing services. These issues and others including the increasingly complex nature of R&D in terms of intrafirm and interfirm relationships need elaboration and additional careful thought.

The paper describes the industry as well as it can given the inadequate supply of data; however the analysis remains weak and could be strengthened with the development of data sources that are specifically designed to collect information on the industry. The data collected need to be more comprehensive in their scope and provide information at the firm level. While the paper provides a somewhat incomplete picture of the industry, its analysis does clearly show that it is growing in absolute terms and relative importance. For this reason alone more work needs to be done.

The next step in this process is not to only develop improved data and information on the industry but also to use this work as a basis for continuing discussions with stakeholders in industry, both public and private, in order to make sure that the issues presented here and others that emerge are thoroughly discussed and analysed. In turn, such consultations can be used as a springboard for the development of a Sector Competitiveness Framework to provide more focussed, timely and relevant information about the industry and the challenges and opportunities it faces. The authors are looking for commentary and critique in order to enrich the debate and attain these goals.

It is hoped that new data and information can be developed in order to facilitate a more precise and thorough analysis of the industry. To this end, SICP will work closely with Statistics Canada to closely examine the revised industrial classification system and to develop more industry specific data sources including a new industry survey. The R&D services industry is obviously growing in importance and, as such, warrants this closer observation.

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