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Innovators, Non-innovators and Venture Firms: What Is the Nature of Firms in Research and Development Services Industries?

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... not applicable
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0[s] value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
[p] preliminary
[r] revised
x suppressed to meet the confidentiality requirements of the *Statistics Act*
[E] use with caution
F too unreliable to be published

Note

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Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued cooperation and goodwill.

The science and innovation information program

The purpose of this program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors**: are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities**: include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages**: are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes**: are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts**: are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators to show *what* the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 **(Science and Technology Activities and Impacts: A Framework for a Statistical Information System**, Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193.

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The opinions expressed in this paper are those of the author and are not necessarily those of Statistics Canada.

Innovators, Non-innovators and Venture Firms: What Is the Nature of Firms in Research and Development Services Industries?

Introduction

Research and development (R&D), as a formal undertaking, has been part of industrial activity for over a century in developed economies. It was the foundation for growth of the chemical industry, particularly pharmaceuticals, the early electrical communications technologies and transportation industries. R&D services as a separate industry is, by comparison, a very recent phenomenon.

The purpose of the paper is to attempt to define the nature of firms classified as R&D services firms. This paper will begin with an examination of the definition of "R&D services" and the two industries that make up this industry group under the currently applied statistical industry classification system. **Section 2** consists of background information on professional services, including value-added, employment and R&D performance. **Section 3** provides an overview of theories on the roles of professional services businesses in the flow of knowledge through the economy as well as the phenomenon of "venture firms". **Section 4** highlights data from the Survey of Innovation 2003 to provide an understanding of what makes R&D services firms distinctive and what characteristics they share with other knowledge intensive services industries, particularly with those aspects related to knowledge. This is followed by summary of the findings. Finally, an appendix identifies what was not available from the Survey of Innovation 2003, with proposals for new work and suggested indicators that could be developed to further understanding of this industry group and address the questions raised by the available data.

Section 1. An overview "Research and Development Services", NAICS 5417

As a result of the North American Free Trade Agreement (NAFTA) the North American Industry Classification System (NAICS)[1] was developed and then implemented in 1997 for use in Canada, Mexico and the United States. The process of developing NAICS enabled a thorough review, as well as the option of restructuring industrial classifications. This restructuring was most notable in the service sector, where more detailed service industries and industry groups were created.

Among these new industry groups was "R&D services", NAICS 5417,[2] which is the focus of this paper. Prior to 1997 these firms would have been classified either to the industry they served or as "other scientific and technical services"[3] under the Standard Industrial Classification-1980. This industry group is part of NAICS sector 54 "Professional, scientific and technical services".[4]

1. North American Industry Classification System, 2002, see: http://www.statcan.ca/english/Subjects/Standard/naics/2002/naics02-menu.htm.
2. Note: Under NAICS the hierarchical structure is composed of sectors (two-digit code), subsectors (three-digit code), industry groups (four-digit code), industries (five-digit code) and national industries (six-digit code).
3. Standard Industrial Classification - Company SIC-C 6619 "Other Scientific and Technical Services" or SIC-E 7759 "Other Scientific and Technical Services", see: http://www.statcan.ca/english/Subjects/Standard/sic-c/sicc80-strucm.htm.
4. Industries from sector 54 will be referred to as "professional services" in this paper.

Unlike most industries, this industry group is not covered by any production survey.[5] The first Statistics Canada survey that sought to produce measures specifically for this industry group and its two component industries[6] was the Survey of Innovation 2003, which included a variety of professional services industries.[7]

NAICS classification is "a production-oriented, or supply-based conceptual framework in that establishments are grouped into industries according to similarity in the production processes used to produce goods and services… The activity of an establishment can be described in terms of what is produced, namely the type of goods and services produced, or how they are produced, namely, the raw material and service inputs used and the process of production or skills and technology used…"[8]

"R&D services" for the purposes of NAICS classification is defined as:

> "… conducting original investigation, undertaken on a systematic basis to gain new knowledge (research), and in the application of research findings or other scientific knowledge for the creation of new or significantly improved products or processes (experimental development)."

It is worth noting the centrality of "new" and "knowledge" in the definition for this industry group as both words appear twice, once in the context of creation and then in the context of application.

The R&D services industry group is broken into two categories, R&D services in physical, engineering and life sciences (PELS: NAICS 54171) and R&D services in social sciences and humanities (SSH: NAICS 54172).

"R&D services in physical, engineering and life sciences" is defined as:

> "… conducting research and experimental development in the physical engineering and life sciences, including electronics, computers, chemistry, oceanography, geology, mathematics, physics, environmental, medicine, health, biology, botany, biotechnology, agriculture, fisheries, forestry, pharmacy, veterinary and other allied subjects."

"R&D services in social sciences and humanities", by contrast, involves:

> "… conducting research and analyses in education, sociology, psychology, language, economics, law, and other social sciences and humanities."

Nothing in the definitions specify for whom the activity has been undertaken—that is, whether the firm is engaged primarily in R&D as its product for sale to others or whether the firm is engaged in R&D for its own use. Indeed NAICS was also intended to "be used to classify own-account production".[9] The Standard Industrial Classification

5. Production surveys are those whose primary purpose is to provide data for the National Accounts, most notably the estimation of contribution to GDP.
6. Note that this industry is also covered by both the Research and Development in Canadian Industry (RDCI) survey and the Biotechnology Use and Development Survey (BUDS). In the case of the RDCI, this industry is covered because all industries are covered. Any firm which reported more than $1 million in R&D expenditures is sent a questionnaire and data for those with lower R&D expenditures are obtained from administrative sources. The BUDS includes R&D services enterprises who indicated that they were using or developing biotechnologies.
7. The other professional service industries covered by the survey were: Engineering services, Geophysical surveying and mapping, Surveying and mapping (except geophysical), Testing laboratories, Industrial design, Computer systems design and related services, Management consulting services, Environmental consulting services, and Other scientific and technical consulting services.
8. http://www.statcan.ca/english/Subjects/Standard/naics/2002/naics02-intro.htm.
9. Ibid.

1980 (SIC) also focused on "activities" where "activities are understood in the broad sense of the type of production in which the economic agent is engaged."[10] However, the Standard Industrial Classification 1980, by implication assumed that "own-use" activities were undertaken completely outside the market, within the household sector, and therefore not covered.[11] This distinction of the classification systems may be particularly relevant when seeking to determine the nature of R&D services firms.

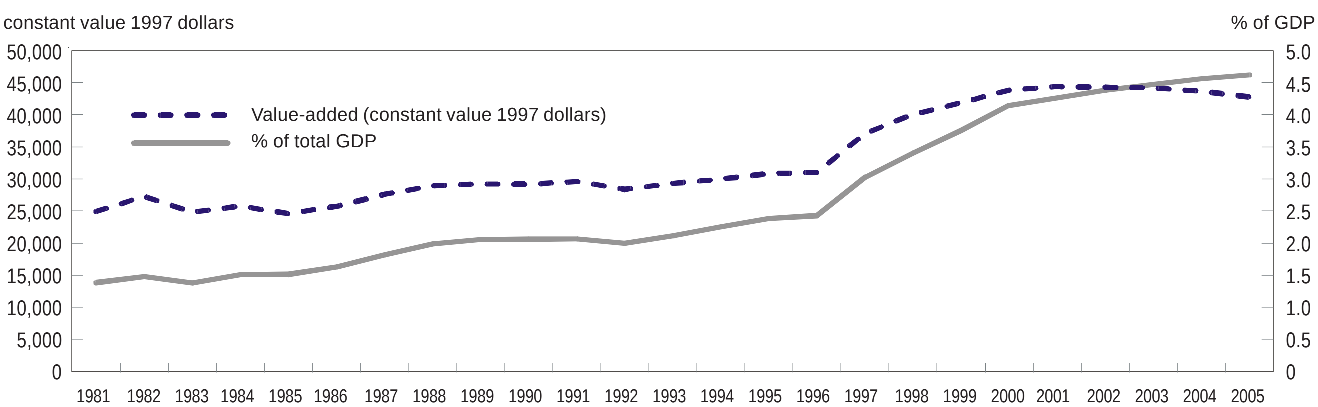
Section 2. Professional services in developed economies

2.1 Value-added of professional services

Professional services, such as legal and accounting services, have been provided for centuries but it is only recently that they have been viewed as a significant part of the economy of developed countries. Historically, many professional services activities were integrated into larger businesses. Firms of a certain size would have in-house professionals to provide advice for design, engineering, legal matters, accounting and bookkeeping. Over time, the complexity of issues facing businesses grew (for example corporate taxation, disclosure filings for publicly traded firms, environmental regulations, advances in new materials, new production processes, etc.) which led to growth in demand for more specialized expert advice. This coincided with growth in professional services firms as a proportion of the economy in terms of value-added and employment.

In 1981, professional services accounted for 2.5% of Canada's GDP; by 2005 the figure had grown to over 4%. The most noticeable shift took place between 1996 and 2005, reflecting the significant growth in value-added provided by professional services (and perhaps reflecting the impact of the implementation of NAICS.) In 1997 constant dollars, the value-added by all professional services increased from $15 billion in 1981 to over $45 billion by 2005 (Chart 1).

Chart 1
Professional services as a percent of GDP and value-added in millions of constant value (1997) dollars, 1981 to 2005



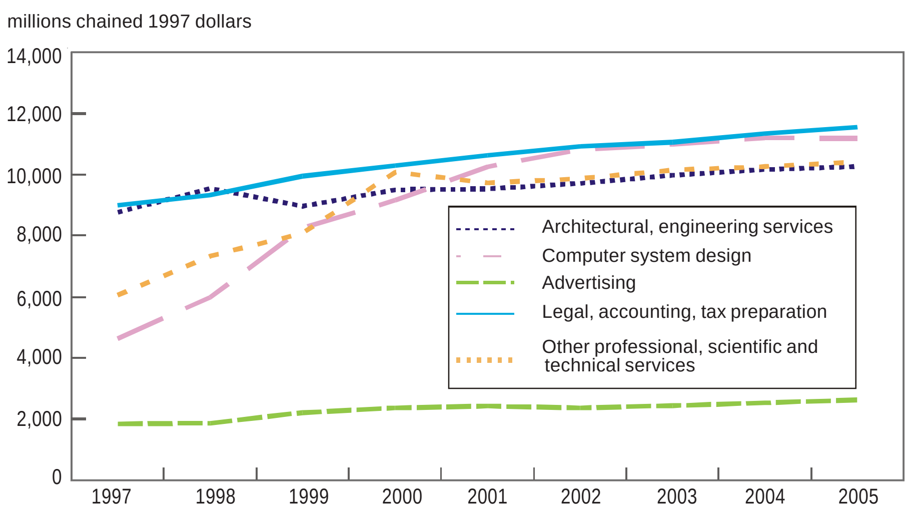
Source: CANSIM Table 379-0017.

10. Standard Industrial Classification 1980, Statistics Canada: 1980, p. 12.
11. Ibid., p. 11.

"Professional services" is a sector composed of a variety of services industries that share the characteristic of having a "product" which consists of knowledge in the form of a particular subject-matter expertise. Under NAICS, the professional scientific and technical services sector is composed of nine four-digit industry groups.[12]

Within the professional services industry groups different patterns of growth emerge. While advertising services, legal services and architectural and engineering services grew somewhat between 1997 and 2005, the growth experienced by the other industries in this sector was striking (Chart 2). Value-added by firms in computer systems design and related services more than doubled in real terms in less than 10 years. The total real value-added for all "other professional, scientific and technical services", which includes R&D services along with design, consulting and other scientific and technical services, grew by over 70%. Over that same period the comparable figures for the Canadian economy indicated real growth of 32%.

Chart 2
Value-added of selected professional services industry groups, 1997 to 2005



Source: CANSIM Table 379-0017.

12. Legal services (5411); Accounting, Tax Preparation, Bookkeeping and Payroll Services (5412); Architectural, Engineering and Related Services (5413); Specialized Design Services (5414); Computer Systems Design and Related Services (5414); Management, Scientific and Technical Consulting Services (5416); Scientific Research and Development Services (5417); Advertising and Related Services (5418); Other Professional, Scientific and Technical Services (5419).

2.2 Employment, wages and salaries

Professional services industries typically report among the highest wages and salaries in the economy, reflecting higher levels of education and training required to provide knowledge intensive services. In 2005, average wages across the economy were $703 per week, and while employees in all service producing industries earned on average $667 per week; by contrast, those in professional services earned $934 per week.[13]

The level of employment in professional services also grew rapidly from 1997 to 2005, increasing from 486,000 to 683,000 employees, an increase of 41% as compared with 20% for the economy as a whole.[14]

2.3 R&D performance

Growth in professional services was not limited to value-added and employment however. Data on R&D performance by Canadian industry indicate that both in terms of the number enterprises performing R&D and the amounts of R&D expenditures, professional services in general and R&D services in particular, reported rapid growth between 1997 and 2003.

When the new NAICS system was implemented one of the objectives was to improve the coverage of the service sector. In 1997, industrial R&D performed by the service sector already represented 28% of the total, by 2003 the figure was over 37% (Table 2.3-2). Canadian R&D statistics are collected without any preconceived idea of where within the economy those activities may be taking place. Thus Canadian industrial R&D figures were among the earliest to indicate a growing importance of R&D in service industries within OECD countries.[15] As noted by Rosa and Gault[16] growth within the ICT sector was significantly higher within the services component than within the manufacturing component. They further noted that many technology intensive activities, such as biotechnology, environmental, health and logistics services, were showing up in the service sector. These trends are particularly evident in figures relating to industrial R&D.

While the number of firms in all industries performing R&D grew by 48% between 1997 and 2003, the number of firms performing R&D in R&D services grew by 156% (Table 2.3-1).

Table 2.3-1
Number of business enterprises performing research and development

	1997	1998	1999	2000	2001	2002	2003
				number			
All industries	9,649	9,784	9,967	10,849	12,087	12,272	14,325
All services	4,578	4,535	4,683	5,269	6,021	6,114	6,941
All professional services	2,469	2,485	2,574	2,908	3,360	3,398	4,008
Research and development services	264	374	407	498	592	590	676

Source: Research and Development in Canadian Industry.

13. Statistics Canada, CANSIM Table 282-0072.
14. Statistics Canada, CANSIM Table 281-0024.
15. ANBERD 2002, OECD: 2002.
16. Rosa and Gault, Research and development in Canada's service sector, Analytical Paper Series—Service Industries Division, Statistics Canada, 63F0002XIE, p. 1.

The increases in expenditures on R&D by firms in R&D services are even more striking. Overall, the amounts spent by for-profit businesses increased by 38% between 1997 and 2003, but expenditures by enterprises in R&D services increased by 300% (Table 2.3-2).

Table 2.3-2
Total intramural research and development expenditures

	1997	1998	1999	2000	2001	2002	2003
	millions of constant value 1997 dollars[1]						
All industries	8,739	9,721	10,266	11,801	13,421	12,399	12,021
All services	2,478	2,739	2,850	3,218	4,225	4,373	4,417
All professional services	1,049	1,198	1,295	1,572	2,354	2,329	2,265
Research and development services	211	227	260	373	728	815	835

1. CANSIM Table 380-0056 was used to calculate constant value expenditures on research and development.
Source: Research and Development in Canadian Industry.

Given the exceptional increases in both the number of R&D performers and the dollar value of R&D they perform, understanding R&D services firms becomes increasingly important in understanding the R&D and Canadian innovation system. How do these firms compare with other professional services firms and what is their role in Canada's national innovation system?

Section 3. The role of professional services firms in a knowledge economy

Understanding the roles of professional services in the context of the larger economy was the focus of Miles et al. (1995) in *Knowledge-Intensive Business Services*. Knowledge-intensive services (KIBS) are, as the description suggests, those in which there is significant level of knowledge embedded in the service provided. This knowledge is typically a combination of formal training and experience, codified and tacit.

Miles et al. (1995) argued that the impact of knowledge-intensive business services is far greater than what is typically measured by their contribution to GDP and employment. Rather their true impact lies in their role as transmitters of knowledge throughout the economy, between different types of organizations, between firms and between industries. The interaction between the KIBS and their business clients generates a "virtuous circle" of learning (Muller, 2001) that can be concentrated either geographically or organizationally depending on development conditions (Davenport, 2005).

The growth in the scope highly specialized technical knowledge, and the number of businesses characterized by their precise expertise, may reflect the growing complexity of scientific discovery, transformation of scientific discovery into a product or process and bringing a complex product to the marketplace, which in turn adds to the complexity of the different organizations involved in these activities and their interrelationships (Chuma 2006, Fransman 2001).

It has been suggested that spin-offs, typically from universities and non-profit research organizations, are a means of sharing and shifting information out of the publicly funded laboratories and into the market. Work by some academics suggests that rather than a distinct demarcation between the traditional university laboratory undertaking basic science and the traditional manufacturing firms producing products for the market, there is instead a continuum of organizations whose emphasis shifts from "pure research" to pure focus on the market. This continuum includes "embedded firms" or "quasi-firms" inside public science organizations (Fransman 2001; Etzkowitz 2003), firms incubated under the protective wing of university (Rothaermel, 2005), and separate spin-offs from universities and public laboratories. Still other firms are labeled "serial innovators" who digest new technologies for the market and act as specialized suppliers of those new technologies to their clients (Dicks 2005). To add to the complexity of this picture, firms may shift their focus as they develop over time. Thus a firm may begin as a protected start-up in an incubator and then move to a service provider to other firms and then shift again to a product producer that is able to sustain itself through sales (Mangematin, 2003).

The people who are involved in the spin-offs from the start include the researchers and professors who have the greatest level of knowledge about the nature of their discoveries. They then combine with individuals with business skills to seek sources of financing for the development of their discovery into a product that will find customers. There are other means of transferring knowledge, such as licensing rights to patents from the universities, but even here the boundaries between the university and industry are not always clear (Lee, 2005).

These spin-offs can be characterized in a variety of ways. Mustar et al. (2006) synthesized a vast literature to identify key elements to understanding spin-offs. They proposed a classification based on the nature of the organization from which they were spun-off, the business model and the "resources of the firm", which they identified as technology, highly qualified people, financing and social networking. They then proposed that these factors be examined in terms of both the initial creation and subsequent development of spin-off firms.

All of these works provide insight into the nature and impact of professional services within the economy. Florida (1988) examined the concept of knowledge and new technologies coming to market from a different angle. He examined the information processing and coordination role of venture capital. Venture capitalists were identified in the late 1980s as key organizers of information, team builders who brought together financial institutions, universities, large corporations, small entrepreneurial firms and other organizations. He argued these collaborations were designed to reduce risk and overcome the barriers to innovation and that different types of venture capital organizations were specialized themselves. Their impact also shifted the focus of innovation away from incremental change and toward more disruptive technology breakthroughs.

Venture firms, those which rely on venture capital with the intent of future sales rather than current sales for their continued operation, are one more element in the varied types of firms that are involved in making use of knowledge typically from public sources, including government labs and universities. This knowledge can also come from private sources, such as companies who do not wish to pursue a particular technology arranging instead to spin-off a separate entity to bring that technology to market. It will be argued that a significant component of the R&D services industry group may consist of venture firms.

Based on the literature to date, knowledge intensive business services are characterized as very actively involved in research collaboration, with links to academe and other research organizations. Their primary asset is knowledge—both tacit and codified. The question then arises—are R&D services like other KIBS or are they perhaps a "super-KIBS", even more highly involved in the transfer of knowledge through the economy?

Section 4. Results from the Survey of Innovation 2003

The Survey of Innovation 2003 was the second survey to look at innovation in the service sector,[17] but the first to look at service industries under the NAICS classification and therefore the first to look at R&D services. The survey covered establishments in selected services industries with at least $250,000 in revenues and 15 employees.[18]

Innovation as a statistical concept is defined in the Oslo Manual (OECD, 2002).[19] Under the version of the manual in force at the time of the survey,[20] innovative firms are defined as those with a:

- new or significantly improved
- product or process
- introduced onto the market or into production
- within the previous three years

It is important to keep in mind that under the Oslo definition in force when the survey was undertaken, invention alone is not synonymous with innovation; to be “innovation” the invention must be commercialized. Thus it is possible for a firm that engages in R&D and other innovation activities may not be innovative. In addition to data on rates of innovation the survey also provides data on general firm characteristics, business success factors, the degree of novelty of new products and processes, the percentage of sales from innovative products, innovation activities, sources of information for innovation, cooperative and collaborative arrangements, problems and obstacles for innovation, impacts of innovation, use of intellectual property methods and use of government support programs.

As mentioned above, the key characteristic of R&D services for the purpose of defining an industry is the concept of “new knowledge”. The Survey of Innovation 2003 asks many questions which relate to knowledge, to the activities surrounding its creation, its transmission, its protection and to government financial support for knowledge generating activities.

Section 5. Data from the Survey of Innovation 2003

5.1 Rates and types of innovators

One might initially assume, given the importance of new knowledge in the definition of R&D services, that all establishments in R&D services would be innovative, but this is not the case.

17. The Survey of Innovation 1996 looked at selected services industries, including the following technical business services; computer services, related computer services, the offices of engineers, and other scientific and technical service industries, all under the SIC-E 1980 classification system.
18. For more detailed information on the survey, see http://www.statcan.ca/english/sdds/00177t.htm.
19. OSLO Manual—Guidelines for Collecting and Interpreting Innovation Data, OECD and Eurostat (Paris: 2005).
20. Note that the new version of the manual also includes organizational and market innovations. Of the five types of innovation originally identified by Josef Schumpeter, only resource innovation is not included in the manual. The criteria for determining the existence of innovation is now “implementation” of the new or significantly improved product, process, organizational change or marketing method which is somewhat looer than bringing a product to market or a process into production.

The Survey of Innovation 2003 provided estimates for both R&D services industries. The survey revealed that 68% of establishments in R&D services in physical, engineering and life sciences (PELS) were innovative, as were 60% of establishments in R&D in social sciences and humanities (SSH) (Table 5.1-1).

Table 5.1-1
Rates of innovation for selected professional services industries, 2003

	Innovators	Both product and process innovators	Product only innovators	Process only innovators
			%	
Engineering services	55	21	23	11
Industrial design services	54	28	23	4
Computer systems design	87*	35	45*	7
Management consulting	44*	27	9*	9
Environmental consultants	67	33	21	13
Other scientific consulting	52	24	17	11
Total research and development services	67	30	21	15
Research and development in physical, engineering and life sciences[1]	68	32	24	12
Research and development in social sciences and humanities	60	21	10*	29*

***** All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Note:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
Source: Survey of Innovation 2003.

The two industries differed in terms of the type of innovation they undertake. For PELS R&D services establishments the most common type of innovator was one who undertook both product and process innovation, while for the SSH R&D services establishment the most common type of innovator was a process only innovator. The difference between the two industries was most noticeable with respect to the proportion of establishments engaged in product only innovation where the proportion of establishments in PELS R&D services who were product only innovators was 24% of PELS as compared with 10% of SSH establishments.

The rate of innovation for both industries is generally comparable to other professional services industries, with the exception of computer systems design in which almost 90% of establishments were innovative and management consulting where 44% of firms were innovative.

5.2 Proportion of total staff with university degrees

A simple indicator of the knowledge intensity of the firm is the proportion of staff with a university degree. This provides an indication of a firm’s capacity to identify knowledge gaps, and to locate and absorb knowledge.

In 2003, just over one in five people in the workforce had a university degree.[21] As can be seen in Table 5.2-1, all of the services industries selected for this paper reported high proportions of staff with university degrees. In all but industrial design services, at least one half of all establishments have a staff composed of at least 50% university graduates. However, amongst several of the selected professional services industries there was a

21. CANSIM Table 282-0004.

significant difference between innovators and non-innovators in terms of what proportion of their staff has a university degree. By contrast, for establishments in both R&D services the figures did not differ significantly for innovators and non-innovators. The proportion of staff within R&D services establishments that had a university degree was generally high; over 75% of establishments reported that at least half of their staff had a university degree whether the establishment was innovative or not. Overall, there was a significant difference between non-innovators in R&D services and the other professional services in the proportion of establishments with at least 50% of staff having university degrees.

Table 5.2-1
Percentage of establishments where at least one half of all staff have a university degree, 2003

	All	Innovators	Non-innovators
Selected professional services		%	
Engineering services	53*E	63E	41*E
Industrial design services	35*E	32*E	38*E
Computer systems design	71E	70	F
Management consulting[2]	60E	74E	49*E
Environmental consultants[2]	91E	89E	33*E
Other scientific consulting[2]	60E	76E	42*E
Total research and development services	77E	75E	81E
Research and development in physical, engineering and life sciences[1]	76E	75E	77E
Research and development in social sciences and humanities	84E	78E	92E

* All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Notes:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
2. There is a significant difference between innovators and non-innovators within this industry.
Source: Survey of Innovation 2003.

5.3 R&D intensity

R&D activities are designed to create new knowledge that can then be exploited in the market to create strategic advantage for the firm. It can be risky and expensive. Most firms in Canada do not perform R&D as it is defined in the Frascati Manual.[22,23]

The Survey of Innovation 2003 asked establishments to indicate the “percentage of full-time employees in (the) business unit engaged in R&D activities”. Firms typically have staff engaged in a wide variety of activities: R&D, production, sales, administration and management. For most businesses, R&D staff comprise a small proportion of their total staff. Having at least 10% of a firm’s staff engaged in R&D demonstrates strong interest in developing advantages through novelty. Having 25% of staff engaged in R&D indicates a significant commitment to R&D that would distinguish most firms from their peers.

One would expect, given the nature of the product of R&D services firms, that a higher proportion of staff would be engaged in R&D activities and this is the case (Table 5.3-1).

22. Frascati Manual, OECD, 2002 defines R&D as “creative work undertaken in a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications” (paragraph 63).
23. In 2003 there were about 13,000 enterprises in Canada which reported performing R&D. The exact proportion of firms which are R&D performers depends on the denominator, the total number of enterprises. This can be defined in a variety of ways, including or excluding single person firms, for example.

Table 5.3-1
Percentage of establishments where at least one quarter of all full-time staff is engaged in research and development, 2003

	All	Innovators	Non-innovators
Selected professional services		%	
Engineering services	14*	18*E	10*E
Industrial design services[2]	41*E	56E	22*E
Computer systems design	44*E	46*E	F
Management consulting[2]	14*	28*E	3*
Environmental consultants[2]	23*E	30*E	10*E
Other scientific consulting[2]	32*E	49*E	13*E
Total research and development services	68E	69E	66E
Research and development in physical, engineering and life sciences[1]	74E	71E	81E
Research and development in social sciences and humanities[2]	42*E	60*E	14*E

***** All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Notes:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
2. There is a significant difference between innovators and non-innovators within this industry.
Source: Survey of Innovation 2003.

R&D services industry group was notable for the proportion of full-time staff who were engaged in R&D. Over two-thirds of all R&D services establishments reported at least one quarter of their full-time staff were engaged in research and development. This was much higher than in all of the other selected professional services. Another interesting aspect of R&D intensity is that for most of the other industries, particularly in the consulting services, innovative establishments were significantly more likely to have at least one quarter of staff engaged in R&D than non-innovators. Here again, establishments in R&D services stood out in that non-innovators were just as likely to have a high proportion of staff engaged in R&D.

When examined more closely however, significant differences appeared between the two types of R&D services. In PELS R&D three quarters of all establishments had a least one quarter of staff dedicated to R&D activities. By contrast, the figure was 4 in 10 for SSH R&D services. Another significant difference arose in the differences between innovators and non-innovators. For establishments in SSH R&D services there were significant differences between innovators and non-innovators, while for PELS R&D services there were no such differences.

Comparisons of non-innovative establishments in PELS R&D services with all of the other selected professional services industries indicate that non-innovators in PELS are much more likely to have at least one quarter of staff engaged in R&D activities.

Overall, with respect to both measures of knowledge capacity, levels of education of staff and staff engaged in R&D services, unlike establishments in most other professional services industries, those in PELS R&D report high levels of education and R&D, regardless of whether they are innovators or not.

5.4 Novelty of innovations

R&D activities enable discoveries of new phenomena and new applications. These discoveries may be new to the firm, new to market in which the firm operates or new to the world. The survey of innovation asks innovators whether or not they have a world first product or process innovation. Having a world-first innovation sets an establishment apart from all its competitors because the innovator has, for a time, a monopoly in the market.

About one third of all establishments in R&D services reported world-first innovations, significantly more than most of the other selected professional services and half of all innovative establishments in R&D services industry reported world-first innovations (Table 5.4-1). This was as a result of the high level reported by innovators in R&D services in physical, engineering and life sciences which was significantly higher than that reported by establishments in SSH R&D services. Only computer systems design reported a level of world-firsts that was not significantly lower.

Table 5.4-1
Percentage of establishments with world-first innovations, 2001 to 2003

	All	Innovators
Selected professional services	%	
Engineering services	11*	19*
Industrial design services	18*	33
Computer systems design	22	25*
Management consulting	6*	14*
Environmental consultants	13*	20*
Other scientific consulting	5*	9*
Total research and development services	35	52
Research and development in physical, engineering and life sciences[1]	39	58
Research and development in social sciences and humanities	14*	24*

***** All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Note:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
Source: Survey of Innovation 2003.

When narrowed to innovators only, establishments in PELS R&D services continued to stand out with almost 6 in 10 reporting world-first innovations. Only establishments in industrial design services were not significantly lower.

5.5 Revenues from innovation

Innovation, bringing a new or significantly improved product to the market, is important but so is the ability to generate an income stream from that innovation. The Survey of Innovation 2003 asked respondents what percentage of their revenues came from the sale of new or significantly improved products introduced during the period of 2001 to 2003.

While 24% of all innovative establishments in PELS R&D services reported that at least one half of their revenue came from innovative products, it was establishments in industrial design that were most successful in turning new products into a revenue stream (Table 5.5-1). For establishments in industrial design the “product” they provide is a continuous stream of new product designs. Those industries seeking new design may be those that need more frequent change of design to maintain their position in the market place. The industrial design firms serving such clients would therefore obtain a larger proportion of revenue from recent designs.

It is interesting to note that while over one half of all innovators in R&D services report world-first innovations, only one in five report more than half of their income from the sale of innovative products. By contrast, one third of innovators in industrial design have world-first innovations but one half are able to generate at least one half of their revenues from innovative products. This suggests that establishments in R&D services experience a lag between the delivery of a product and generation of revenues that is not experienced by establishments in industrial design.

Table 5.5-1
Percentage of establishments with one half or more of total revenues from innovative products, 2003

	All	Innovators	Product innovators
Selected professional services		%	
Engineering services	3*	6*	8*
Industrial design services	27	50*	54
Computer systems design	22	26	28
Management consulting	10	22	27
Environmental consultants	3*	5*	6*
Other scientific consulting	8	15	18
Total research and development services	14	22	28
Research and development in physical, engineering and life sciences[1]	17	24	30
Research and development in social sciences and humanities	5	8*	16^{E}

* All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.

Note:

1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.

Source: Survey of Innovation 2003.

5.6 Use of intellectual property protection methods

When a firm's product is knowledge, protecting the assets of the firm is not simply a matter of physical security of the business premises. Unlike a physical object, an expensive machine that performs a task efficiently for example, ideas can be shared. Two firms on different sides of the world can "possess" the same idea. Protecting the potential commercial advantage generated by a new idea therefore requires a strategy. Firms may either use secrecy and informal methods or formal intellectual property (IP) protection methods such as patents, trademarks and registration of designs. Before an idea is brought to the market place firms can secure their claim to an idea. This means that firms who have not yet brought a product to market have a reason to use IP methods. The Survey of Innovation 2003 therefore asked both innovators and non-innovators about their use of IP methods, including a variety of formal IP methods (patents, trademarks, copyright, etc.).

The data for use of patents for both innovators and non-innovators in PELS R&D services are striking. In virtually all industries innovators were more likely to report using patents (Table 5.6-1). The exception was R&D PELS where both innovators and non-innovators reported very high levels of patent use. Indeed, the levels reported by this industry are significantly higher than innovators in all other of the selected professional services.

Table 5.6-1
Percentage of establishments that reported using patents, 2001 to 2003

	All	Innovators	Non-innovators
Selected professional services		%	
Engineering services[2]	8*	13*^{E}	1*
Industrial design services[2]	22*^{E}	41*^{E}	0*
Computer systems design[2]	15*^{E}	17*^{E}	1*
Management consulting[2]	7*	16*^{E}	0*
Environmental consultants[2]	13*^{E}	19*^{E}	0*
Other scientific consulting	7*	5*	9*^{E}
Total research and development services	57^{E}	60^{E}	51^{E}
Research and development in physical, engineering and life sciences[1]	67^{E}	67^{E}	65^{E}
Research and development in social sciences and humanities[2]	18*^{E}	27*^{E}	4*

* All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.

Notes:

1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
2. There is a significant difference between innovators and non-innovators within this industry.

Source: Survey of Innovation 2003.

R&D services also reported very high use of trademarks, along with industrial design services and computer systems design, which reported use of trademarks that was significantly higher than even R&D services (Table 5.6-2). Amongst most of the selected professional services innovators were more likely to use trademarks but reliable data for R&D PELS for non-innovators were not available.

Table 5.6-2
Percentage of establishments that reported using trademarks, 2001 to 2003

	All	Innovators	Non-innovators
Selected professional services		%	
Engineering services	15*	19*	9*
Industrial design services[2]	50	75*	20
Computer systems design	41	43	F
Management consulting[2]	15*	27*	5*
Environmental consultants	14*	17*	5*
Other scientific consulting	9*	14*	3*
Total research and development services[1]	47	52	36
Research and development in physical, engineering and life sciences	50	54	F
Research and development in social sciences and humanities	33	42	19

***** All figures which are significantly different from the reference industry (Total research and development services) are denoted with an asterisk.
Notes:
1. The reference industry used to measure significant differences between industries is total research and development services.
2. There is a significant difference between innovators and non-innovators within this industry.
Source: Survey of Innovation 2003.

Were establishments who used formal IP methods able to quickly capture value from their protected ideas? Establishments were asked to indicate the proportion of revenues in 2003 that came from IP protected products.

Establishments in R&D services were more likely than establishments in other industries to report that their revenues came from products that were protected by formal IP methods (Table 5.6-3). Indeed, over 40% of establishments in R&D PELS reported that at least half of their revenues came from such protected products. The figure for industrial design was very low (0) considering that establishments in this industry reported heavy use of formal IP methods. By contrast, management consulting reported a considerable proportion of establishments with over half of their revenues from protected sources despite few reporting patent, trademark or copyright use.

Table 5.6-3
Percentage of establishments with at least half of total revenues from sales of intellectual properties protected products, 2003

	All	Innovators	Non-innovators
Selected professional services		%	
Engineering services	11*	9*E	13E
Industrial design services	0*	0*	0*
Computer systems design[2]	27E	30E	5*E
Management consulting	13*	22*E	6*E
Environmental consultants[2]	5*E	8*	0*
Other scientific consulting	5*	6*	3*E
Total research and development services[1]	38E	43E	28E
Research and development in physical, engineering and life sciences	43E	46E	F
Research and development in social sciences and humanities[2]	15	25E	0

***** All figures which are significantly different from the reference industry (Total research and development services) are denoted with an asterisk.
Notes:
1. The reference industry used to measure significant differences between industries is total research and development services.
2. There is a significant difference between innovators and non-innovators within this industry.
Source: Survey of Innovation 2003.

5.7 Government funds for R&D

When engaging in the expensive activity of R&D, firms are assumed to seek out all sources of funds to offset these costs, including support from government programs such as R&D tax credits and grants. Application for this form of financing requires some effort, but for small Canadian firms with significant expenditures on R&D the effort would result in funds regardless of income from sales of products.

Use of R&D tax credits was significantly higher amongst innovators than non-innovators, again with the exception of R&D PELS, where the majority of both innovators and non-innovators reported availing themselves of R&D tax credits (Table 5.7-1). Use of tax credits was quite low amongst R&D SSH establishments in comparison, most notably amongst the non-innovators. This may relate to the nature of activities which qualify for R&D tax credits that typically involve work in a laboratory or on a factory floor.

Table 5.7-1
Percentage of establishments that reported using research and development tax credits, 2003

	All	Innovators	Non-innovators
Selected professional services		%	
Engineering services	20*E	30*E	6*E
Industrial design services[2]	39*E	53E	23*E
Computer systems design	53E	58E	F
Management consulting[2]	7*	16*E	0*
Environmental consultants[2]	30*E	45*E	0*
Other scientific consulting	20*E	25*E	14*E
Total research and development services	58E	64E	47E
Research and development in physical, engineering and life sciences[1]	68E	71E	60E
Research and development in social sciences and humanities[2]	18*E	28*E	4*

***** All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Notes:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
2. There is a significant difference between innovators and non-innovators within this industry.
Source: Survey of Innovation 2003.

Government R&D grants are another means of obtaining government support for research activities and here again R&D PELS stands out, along with industrial design, amongst all selected professional services industries.

Again, R&D PELS does not report significant differences between innovators and non-innovators, unlike some of the other selected professional services industries (Table 5.7-2).

Table 5.7-2
Percentage of establishments that reported using research and development grants, 2003

	All	Innovators	Non-innovators
Selected professional services		%	
Engineering services[2]	6*	11*E	1*
Industrial design services	31E	38E	22E
Computer systems design	8*	8*	12*E
Management consulting	3*	6*E	2*
Environmental consultants	22E	28E	11*E
Other scientific consulting	7*	7*E	7*E
Total research and development services	34E	36E	31E
Research and development in physical, engineering and life sciences[1]	38E	38E	40E
Research and development in social sciences and humanities[2]	16*E	26E	0*

***** All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Notes:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
2. There is a significant difference between innovators and non-innovators within this industry.
Source: Survey of Innovation 2003.

5.8 Sources of information for innovation

The Survey of Innovation 2003 asked respondents to indicate the importance of a variety of sources of information for innovation. Amongst these sources were R&D staff, management staff and universities.

Table 5.8-1
Percentage of innovative establishments rating selected sources of information for innovation as important

	Research and development staff	Management staff	Universities
Selected professional services		%	
Engineering services	31*	67	9*
Industrial design services	87E	80*E	23*
Computer systems design	71*	58	4*
Management consulting	26*	68E	10*
Environmental consultants	54*	56	44
Other scientific consulting	56*	73	18*
Total research and development services	88	56	46
Research and development in physical, engineering and life sciences[1]	93	53	48
Research and development in social sciences and humanities	65*	71	38

***** All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Note:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
Source: Survey of Innovation 2003.

Amongst innovators in selected professional services, R&D staff was consistently identified as an important source of ideas for innovation (Table 5.9-1). Only in engineering and management consulting services did less than half of all innovative establishments rank them as “important” sources of information for innovation. Management staff was also consistently reported to be an important source of ideas, as were clients and customers and professional conferences. One source that was more likely to be use by R&D services establishments was universities, particularly for PELS R&D services where almost one half of all innovative establishments indicated universities were an important source of information for innovation. Only environmental services reported similar importance for this source.

5.9 Collaborations

Knowledge can be shared and by sharing it can be developed more quickly by accessing specialized expertise in a wide range of subject areas. Collaborations represent a means of obtaining detailed information from a particular source but they can also entail risk by exposing the firm’s knowledge to an outsider. Collaboration by knowledge-intensive business services is seen as a means of accessing information in an efficient way. These firms then process the information, making it accessible in turn to their clients.

While all innovative establishments in selected professional services industries reported collaborations to one degree or another, the rate of collaboration reported by R&D services establishments was among the highest reported. What is more striking is the tendency to collaborate with what might be termed “science-intensive” organizations which include universities, government labs and private non-profit research institutes. Only environmental consultants reported a similarly high rate of collaboration with science-intensive organizations.

Table 5.9-1
Rate of collaboration by all establishments in selected professional services industries, 2003

	All collaborations	University collaborations	Collaborations with science-intensive organizations
Selected professional services		%	
Engineering services	28*	11*E	16*E
Industrial design services	43	7*E	12*E
Computer systems design	50	17*E	18*E
Management consulting	30	2*E	10*E
Environmental consultants	40	32E	35E
Other scientific consulting	32*	15*E	15*E
Total research and development services	52	38E	42E
Research and development in physical, engineering and life sciences[1]	55	41E	45E
Research and development in social sciences and humanities	40	F	28*E

* All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Note:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
Source: Survey of Innovation 2003.

Collaboration with other firms or organizations for the purpose of innovation was reported by all of the selected professional services industries, but the practice was most common for innovative establishments in computer systems design and R&D services (Table 5.10-1). When narrowed to collaboration with science-based organizations the differenced become more significant. R&D PELS was much more likely to report collaboration with universities than establishments in the other selected professional services. Only environmental consulting reported figures that were not statistically significant different.

5.10 Success factors: satisfying clients, or not

All establishments, both innovators and non-innovators were asked to indicate the importance of various factors to the success of the firm. These factors related to markets and products, human resources, knowledge management and others. The factors most likely to be identified as “important” by R&D services firms were: hiring skilled workers (85%), quality control of products (77%), encouraging experience workers to transfer knowledge (73%) and satisfying existing clients (73%). For most other selected professional services industries, satisfying existing clients was the success factor the most likely to be identified as important. Typically 95% or more establishments indicated it was important; only industrial design reported also reported a level below 90%.

Table 5.10-1
Importance of satisfying existing clients, 2003

Selected professional services	%
Engineering services	99*
Industrial design services	84
Computer systems design	96*
Management consulting	92*
Environmental consultants	100*
Other scientific consulting	97*
Total research and development services	73
Research and development in physical, engineering and life sciences[1]	69
Research and development in social sciences and humanities	89*

***** All figures which are significantly different from the reference industry (Research and development in physical, engineering and life sciences) are denoted with an asterisk.
Note:
1. The reference industry used to measure significant differences between industries is research and development in physical, engineering and life sciences.
Source: Survey of Innovation 2003.

Further examination of the data revealed that amongst innovative establishments 82% of establishments in R&D services, 80% in PELS R&D and 91% in SSH R&D indicated satisfying existing clients was important.

Table 5.10-2
Percentage of firms in physical, engineering and life sciences services indicating the importance of clients by innovation status, 2003

	Client satisfaction	
	Important	Not relevant
	%	
Innovators	80[E]	4[E]
Non-innovators	11[E]	50[E]

Source: Survey of Innovation 2003.

Many of the establishments in R&D services who say that satisfying existing clients is not important are found within one sub-population: non-innovators in physical, engineering and life sciences. Amongst these firms, one half say it is not only “not important”, but in fact “not relevant” to the success of the firm.

What would account for this anomalous response? And, how can such firms remain in business?

Section 6. Discussion : R&D services firms as venture firms

Indicating that satisfying existing clients is “not relevant” to the success of the business is not a typical business strategy. In most of the industries it was a given that satisfying existing clients was important to the success of the firm. This begs a question: Exactly what kind of business thinks satisfying existing clients is not relevant to its success? Logically, for any establishment, it can only be one of three options: a business with no repeat customers whatsoever (and presumably one that does not care about word-of-mouth reputation), a business that serves only one customer and does not have to engage in competition for their business[24] or it could be a business that simply has no clients. This paper will argue that, while there may be instances of the second option, the latter option is the most probable.

With respect to the first option, there is presently no way to identify such an establishment. It is however difficult to imagine that there would be that many firms that had no repeat business; for many firms strategic advantage comes from learning the needs of their established clients and being able address those needs in a more sophisticated way over time. This is true of traditional professional services such as legal or accounting services. There is no obvious reason why this phenomenon would be limited only to firms in R&D services.

Limited data are available to illustrate the second possibility, which might be referred to as an “internal monopoly”. Of all of the establishments in R&D services one half belong to a larger firm and 12% existed solely to provide services to the larger firm to which they belong. Amongst non-innovators just over 60% of establishments belonged to a larger firm but no reliable estimate was available to indicate what percentage exist solely to provide services to the larger firm to which they belong. The rate of 12% of establishments existing exclusively to serve the internal needs of the firm to which they belong is significantly higher than for almost all other industries. Such an establishment may feel it does not have “clients” in the typical sense or that satisfaction of other divisions is not as important to their success within the firm. This does, however, leave the other 88% of all R&D services establishments who are not in such arrangements.

There are firms in existence that would meet the criterion specified in the third option, but they represent a very rare subpopulation of businesses. Some firms in early stages of development have no products (goods or services) ready for sale. They are very active in research and development, but much less so in marketing a product. They may have no products on the market at all. This means they have no sales, no revenues and no “clients” as the term is generally understood. In this paper these firms will be referred to as “venture firms”.

Venture firms are intensely engaged in research and development activities in the hope of bringing to the market a product that will be either positioned to meet a previously unmet need or will set a new world standard of quality and performance in addressing existing needs. In the interim, they rely on infusions of capital to sustain the business operations of the firm. Their capital suppliers are the closest thing they have to a client. To satisfy this type of “client” they do not need to show sales but rather continuous evidence of progress, provided though development of, and adherence to, a research and development plan with milestones both in terms of the timing of discoveries and the costs of research and experimental development. To the extent that a firm had economic activity as it is traditionally understood, it is R&D activity and thus it would make sense for this type of firm to be found in R&D services, and particularly in PELS R&D services. Given the explicit direction in NAICS that own-use products and services are factored into the classification of businesses, there is no other NAICS code that would provide a better fit. If it is the case that there are a significant number of these firms in this industry group, this would then represent not only a NAICS industry, but also a stage of development for such research-based firms. These firms, however, would be distinctive in that they are not acting in a manner that is consistent with how professional services have been traditionally viewed. Historically, the professional service firm provided a service to other companies or to individuals. They provided an outcome. The outcome could be the resolution of a legal

24. This would be an establishment within a larger enterprise which provides services solely for that enterprise. Such an entity may not feel that they have “clients” in the traditional sense.

claim, the design of a new kitchen gadget or audited financial statements. Professional services firms typically did not generate products for their own use. A law firm does not run a business of suing on its own behalf. An engineering firm may design factory equipment but they do not run the factory. Similarly, industrial design services firms design a new or improved product; they do not make it—if they did they would most likely be classified as a manufacturer. R&D services firms similarly may provide custom R&D services to their clients, but, as will be argued it this paper, it appears that a significant proportion of these firms may be providing R&D services for their own use and have no other significant economic activities.

These firms would not be "innovators" as defined by the Oslo Manual,[25] since they had not brought any product to the market or process into production to provide goods to the market. They illustrate the clear distinction between being "inventive" and being "innovative".

One would expect these "self-serving" venture firms would report a high proportion of university graduates and R&D staff (since they do not have a sales force or production staff) and many R&D establishments, particularly PELS R&D, do (Table 5.6-1). They would be likely to report high levels of world-first products or processes and PELS R&D establishments do so (Table 5.7-1). Further, such firms would be expected to be very aggressive in terms of the steps taken to protect their intellectual property since this would be the only asset of the firm that would have any value on the market (and thus provides some measure of security for those providing the money). One would expect therefore that the use of patents, in particular, would meet or exceed that of establishments in other industries and even innovators in the same industry, and in this instance they are amongst the highest users of patents (Table 5.9-1). These firms would be expected to be using tax credits and government grants to provide further resources to the firm, and in fact they are (Table 5.10-1). Finally, one would expect that, with respect to aspects of knowledge, innovators and non-innovators would be similar because, if they are simply in an early phase of development, they would have many of the characteristics of innovators but because they have no product on the market or formal production process in place, they would not qualify as innovators.

To examine whether or not the firms display any further characteristics that would be helpful to understanding establishments in the industry group, establishments were separated into four groups: innovators and non-innovators who indicated satisfying clients was important to the success of the firm and those who said it was either not important or irrelevant (Table 6.1-1).[26]

Table 6.1-1
Differences between innovators and non-innovators and establishment who reported satisfying clients was important, all Research and Development, 2003

	Innovators		Non-innovators	
	Clients not important	Clients important	Clients not important	Clients important
		%		
50%+ staff engaged in research and development activities	F	53	92	34
50%+ revenues from exports	F	41	9	F
Important to develop domestic markets	6	55	9	31
Important to be geographically close to clients	F	27	2	44
Proximity to venture capital	0	9	F	11
Patents	88	54	84	24
Used research and development tax credits	88	59	F	F

Source: Survey of Innovation 2003.

25. This is particularly true of the 1997 version of the Oslo Manual. The scope of the new definition in the 2005 manual has not yet been defined by practice.
26. Those who responded either 4 or 5 on a five-point scale of importance, where 5 indicates "high" importance, 1 indicates "low" importance and "0" indicates not relevant, where said to indicate the factor was important, while those who responded 1 to 3 or 0 where grouped into the other category.

Those who say that satisfying existing clients is not important are also, not surprisingly, less likely to report that developing domestic markets is important and being geographically close to their clients is important. Those who indicated clients were important were less likely to report the use of patents to protect their ideas, in keeping with the supposition that firms without ordinary clients would need to use patents to create some form of recognizable and tradable value in order to attract investment. Also, those who reported satisfying clients was not important were more likely to report that at least half their staff were engaged in R&D activities. One can also note that where complete data are available for establishments in R&D services, the importance of satisfying existing clients as a distinguishing characteristic appears to be more significant than whether an establishment is innovative or not.

The data from the Survey of Innovation 2003 suggest that R&D services, particularly PELS R&D services, is an unusual industry. The industry is very knowledge intensive by any measure. Compared to firms in other business services, firms in R&D services are more likely to have a high proportion of staff with university degrees, more likely to have a high proportion of staff engaged in R&D activities, more likely to use patents to protect their intellectual property and more likely to have world-first innovations. In addition, there is no clear distinction between innovators and non-innovators as there is for most measures and most industries. This suggests that the non-innovators may be much like the innovators but simply at an earlier stage of development.

One final question that could be raised is, what happens to these firms over time? It was noted that they cannot sustain themselves without infusions of capital and their funders are looking for a return on their investment. Once they are successful, once the drug is finally approved for sale on the market do they then become something else—a pharmaceutical manufacturing firm? Or something else? Do they remain as R&D performers in NAICS 5417 and continue with their focus on research, contracting out other activities to CMOs (contract manufacturing organizations) or selling their discovery to a multinational firm with global marketing capabilities? These questions and more could be examined in further study of this industry.

Section 7. Concluding remarks

The purpose of this paper was to begin the process of understanding the nature of establishment in a new NIACS industry called R&D services. The literature focuses of professional, technical and scientific services industries as a sector, but data from the Survey of Innovation 2003 indicate that there are differences between the industries within the sector. While professional services are acknowledged to be active in expediting knowledge transfer across the economy through interactions and more formal collaborations with a variety of types of firms and organizations, firms in R&D services are particularly active and especially active in their collaborations with organizations of higher learning.

Data from the Survey of Innovation 2003 also indicate that the two industries comprising the industry group “R&D services” often have distinct characteristics. While similar in some respects they differ in terms of an emphasis on product vs. process innovation, proportion of firms with world-first innovations, use of patents and use of R&D tax credits. There is also the absence of clear distinction between characteristics of innovators and non-innovators particularly in physical, engineering and life sciences R&D services. Generally, social sciences and humanities R&D services establishments are more likely to resemble those in other professional services while PELS R&D services establishments are something quite different.

The data also suggest that there are a significant number of firms whose classification indicates not only their primary activity, R&D services (particularly in physical, engineering and life sciences), but also reflects their stage of development, specifically, young, start-up firms, still in the process of preparing a novel product for the market and relying on funds from sources other than sales to finance their work. These firms are not typical firms but rather very R&D intensive, possibly venture firms seeking, but not yet fully succeeding, to bring world first innovations to the market. While the data from the survey are consistent with this possibility, data available through the Survey of Innovation 2003 do not include figures for revenues or value-added or R&D expenditures so this hypothesis could not be tested directly.

Appendix A

Further work on R&D services

While the Survey of Innovation 2003 collected many useful pieces of data on an industry that is not typically surveyed, the survey does not collect typical production type data such as the number of employees and revenues of the firm. There is one survey that may be able to provide further information that would enable the venture firm phenomenon to be assessed in R&D services and across all other industries.

The Research and Development in Canadian Industry (RDCI) database is composed of all firms who either perform $1 million of R&D per year and who complete a paper questionnaire on their R&D activities or firms whose R&D tax credit was approved by Canada Revenue Agency. This database does contain data on revenues, employees etc. and has the added advantage of being a longitudinal database. This means that if a working definition for venture firms could be developed, this definition could then be applied to track the transformation of these firms over time.

Other databases also have potential for the study of venture firms. Preliminary enquiry indicates that a significant number of the firms in R&D services on the RDCI are engaged in biotechnology.[27] This could be followed up by examining the Biotechnology Use and Development Survey (BUDS) database, which is currently being modified to become a longitudinal database. When this project is complete then it could be used in a manner similar to the RDCI.

Finally, the Longitudinal Employment Analysis Program database, know as LEAP, has been linked to the T2 corporate tax files, this database could also be used to study venture firms. This database would have the advantage of containing a census of all firms that submitted tax filings in Canada, with all revenue and expenditure figures, and so could be used to look for venture firms across all industries whether or not they filled an R&D tax credit application. One would hope that all firms found on this database are also included in the RDCI however.

In order to make use of these databases a workable definition of venture firm will need to be developed. The most severe definition would be to identify only firms with no revenues as venture firms. This has the advantage of being very simple but it would likely exclude too many firms that, while they are engaged in early market activities such as selling services based on early discoveries, remain dependent upon funds from investors for their ongoing operations. Firms whose R&D expenditures were greater than their revenues would also be easy to identify but this could include firms who were experiencing significant, but temporary, difficulties. Ideally, this measure would be applied over time, so that if a firm continues to report R&D expenditures greater than revenues over a fixed period of years it would be considered a venture firm.

Indicators

Once the appropriate data sets and variables have been determined, indicators can be developed to test the idea of the venture firm and to measure its extent amongst R&D performers and biotechnology developers. Some potential indicators include:

- Venture firms as a percentage of all R&D performers, by industry
- Percentage of all R&D performed by venture firms, by industry
- Number of years before revenues exceed R&D expenditures, by industry
- Average number of employees of venture firms, by industry
- Proportion of employees who are R&D staff in venture firms, by industry
- Change in employment of venture firms over a fixed period, by industry

One can assume that all venture firms are in NAICS 5417, but this may not be the case. These firms would not typically be surveyed, other than by the RDCI or BUDS, because production surveys have coverage thresholds based on size (based on income) so as not to burden typical small firms. This means that their classification would not be verified as part of a regular survey process.

For the longer term some means of tracking these firms through their disappearance would also be useful. The literature indicates that the venture firm phenomenon is a very dynamic part of the economy. Bankruptcies happen; some venture firms do not work out as planned due to a variety of reasons relating to the technology and the market. Mergers and acquisitions are also an important part the business plans of some of young biotechnology firms (Mangematin et al) but this is very difficult measure using existing databases. When a firm disappears from the RDCI there could be a variety of reasons that cannot be distinguished at present.

A final issue to be considered is classification. If it is established that there are a group of venture firms within NAICS 5417, should there be some means of identifying them within the classification system? For example, by adding a new NAICS industry? Whatever approach is chosen, these firms represent the edge of change within the economy and understanding their role and their growth trajectories would provide valuable information on how ideas move from basic science discoveries to products in the marketplace.

27. Source: RDCI database reports the percentage of R&D expenditures devoted to biotechnology.

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