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Innovation Analysis Bulletin

A tri-annual report from Statistics Canada with updates on:

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- **Industrial research and development**
- **Intellectual property commercialization**
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Financing innovation in new small firms—New evidence from Canada

Acquiring suitable financing for investments in R&D—investments that have been shown to bolster a firm's chances for growth and success—is often a major challenge for small firms. When it comes to supporting investments in innovation, certain financial structures may be more advantageous than others.

Study Background

The development of core functional competencies within a firm—basic skills related to marketing, management, production, financing and human resources—often distinguishes surviving entrants from failed ventures. While the development of these core business skills is a basic prerequisite for small-firm survival, it is specialized investments in knowledge creation, such as R&D and advanced technology, that serve as predictors of high-performance. Using an amalgam of firm-specific performance indicators (productivity, profitability and market share), Baldwin et al. (1994) demonstrated that small- and medium-sized enterprises that invest in innovation are more successful.

Research from Statistics Canada's business surveys has yielded new insights into the strategic foundations for growth and decline in the small-firm sector. An advantage of this survey-based research is that the analytical net is cast widely, focusing on all elements of business strategy, from core business skills (e.g., marketing, management, and production) to specialized innovation competencies (R&D and technology adoption). Baldwin, Gellatly and Gaudreault have extended earlier Statistics Canada research on small-firm financing by investigating relationships between capital structure and innovation.

The analysis is based on data collected from Statistics Canada's Survey of Operating and Financing Practices (SOFP) - a probability-weighted sample of approximately 3,000 small firms born between 1983 and 1986 that were still in operation in 1996. These firms operated in a large cross-section of industries, spanning both the goods and services sectors. The analysis provides detailed insights into an important segment of the small-firm population—successful entrants.

Challenge of financing small firms

Access to financing is a major challenge for small firms. Unlike large corporations, small firms are widely described as constrained by the operations of debt and equity markets. Yet, access to capital is crucial if small firms are to support their investments in innovation and growth.

Of ongoing interest is the extent to which financial constraints are more serious in debt markets than in equity markets. A particular financing problem is said to exist for investments in R&D and advanced technology—investments that have been shown to bolster a firm's chances for growth and success. These investments are difficult to finance because they are risky and they offer less hard collateral to provide guarantees for loan financing. In addition, firms that receive debt financing may have fixed payments schedules and performance conditions that restrict the type of investment activities that they can undertake.

There are two competing perspectives that shape the analysis of debt financing for small firms. On one hand, small firms may face greater restrictions on debt, because of higher risks associated with lending to these firms. On the other hand, some small firms may prefer more equity-based financial structures in order to support their investment activities.

The analysis investigated whether certain small-firm financial structures are more advantageous than others are when it comes to financing innovation. The study recognizes that small firms are heterogeneous in their investment decisions. It examines differences in financial structure across a range of factors—some of which relate to the firm's business and investment strategies and others to different aspects of the firm's industrial environment.

Small firms being profiled—start-ups or older entrants?

The analysis is based on an elite group of small businesses—entrants that have survived their first decade of operation. Only one in five new firms reach this milestone. As mature entrants, these firms have had time to develop their financing strategies, arranging their financial assets to better support their business activities. These businesses operate across a large cross-section of goods and services industries, and not simply in high-tech hubs, such as computer services and telecommunications. Retained earnings and bank loans constitute the major sources of funding for these businesses.

Is there evidence that successful entrants are constrained in debt markets?

Small firms in the study were found to use more equity than the corporate population as a whole. On average, equity accounts for almost one-half of financing for these small firms, and over 80% of this takes the form of retained earnings. By comparison, Canadian non-financial corporations reported that equity accounted

for only 33% of their assets. Should the fact that small firms use less debt be taken as evidence that they are constrained in debt markets? Simply stated, no. Small firms may also have less debt-intensive financial structures because these firms prefer to finance certain investments with internal equity if equity provides them with greater flexibility.

Where do differences in average capital structure emerge?

Are there specific industries in which equity is more likely to be used and debt is less likely to be used? Yes. Successful entrants that operate in knowledge-intensive environments rely less on debt financing, and more extensively on retained earnings, than their counterparts in less knowledge-intensive sectors. Once again, these differences may have more to do with the types of financing strategies that firms in high-knowledge environments prefer to adopt in support of their investment activities than with the alternative explanation that firms in knowledge-based industries face greater restrictions on debt.

Do certain financial profiles hamper investments in R&D and innovation?

One way of determining whether the structure of the small-firm balance sheet is a result of conscious choice on the part of manager/owners rather than the restrictions imposed by financial markets is to ask whether firms that choose a debt strategy end up doing less innovation.

Baldwin, Gellatly and Gaudreault addressed this issue by examining relationships between financial structure, R&D and innovation. The issue that guides the analysis is whether certain small-firm financial structures restrict firms from being innovative. If debt-intensive small firms are more likely to engage in R&D and commercialize new products and processes, then issues of funding gaps in loan markets come to the fore. If however, small firms prefer to support investments in knowledge with equity, as may be the case if equity affords firms greater flexibility, then the impact of funding constraints in debt markets might be less severe.

Relationships between R&D, innovation and capital structure

The analysis suggests that relationships between knowledge-intensity and capital structure run in both directions. After controlling for a range of industry-level and firm-specific factors, the authors conclude that small firms that devote a higher percentage of their investment expenditures to R&D also exhibit less debt-intensive structures. In addition, there is evidence that the presence of debt-intensive financial structures acts to constrain investments in R&D. These relationships, however, depend on the type of debt in the asset mix. It is the share of long-term debt to total assets that is negatively related to investments in knowledge.

To the extent that capital structure influences innovation, however, it does so through R&D. Firms with a larger share of long-term debt in their capital structure devote less of their investment expenditures to R&D. However, after accounting for differences in R&D profiles across small firms, there is little evidence of an additional link between financial structure and innovation, as the former has little bearing on whether or not small firms introduce new or improved products and services.

Small-firm financing is an important area of research, one that reaches a wide audience. Current and prospective entrepreneurs, suppliers of debt and equity, management consultants, business analysts, academic researchers and policy officials all benefit from new information on how small firms manage their financial assets, and use these assets to support innovation.

References

Baldwin, J. R., W. Chandler, C. Le and T. Papailiadis, 1994. *Strategies for Success: A Profile of Growing Small and Medium-sized Enterprises in Canada*. Catalogue No. 61-523. Analytical Studies Branch, Ottawa: Statistics Canada.

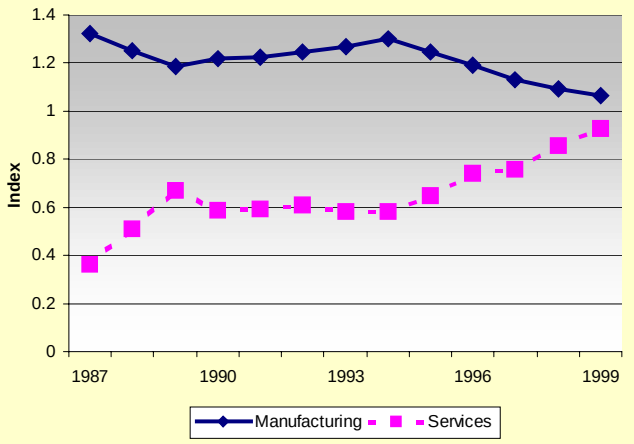
This article is based upon a paper entitled "Financing Innovation in New Small Firms: New Evidence From Canada", (Analytical Studies Branch Working Paper Series Cat. No. 11F0019MIE2002190) by John Baldwin, Guy Gellatly and Valérie Gaudreault of the Micro-Economic Analysis Division, Statistics Canada.

Service sector drawing attention of foreign-controlled firms for R&D

Once viewed as weak in R&D capabilities, the service sector is emerging as an increasingly attractive place for foreign controlled firms to do R&D in Canada. This is a reflection of the increasing technological opportunities and expertise offered by the service sector. Multinational corporations undertake R&D abroad to acquire new insights or apply the knowledge they already have.

An index of the involvement of foreign controlled firms in R&D in Canada shows that their relative contribution to the service sector R&D is catching up with their share of R&D performed in manufacturing industries. These two sectors together account for all but a small proportion of the R&D performed by all business enterprises and by foreign controlled enterprises in Canada. The analysis included only business enterprises and only the scientific R&D was covered because of its relationship with technological change.

Figure 1. Foreign controlled firms' R&D preference index



Source: Statistics Canada, various years, Research and development in Canadian industry, SIEID.

The index is calculated[1] as the foreign controlled firms' share of R&D performed in an industry in Canada divided by their share of R&D in all industries. An index equal to 1.0 is the threshold value. A value above 1.0 denotes a preference for that industry, whereas a reading of less than 1.0 is an indication of relatively less interest.

At a value of 0.93 in 1999, the service sector index was still below the critical value of 1.0. However, it is not necessarily a reflection on its attractiveness as a technology producer and innovator. To a degree, it is due to the ownership structure of the industry. By the very nature of the formula, the index has a low value for industries where there are restrictions on foreign ownership and control, and, at the extreme, a value of zero for industries that have no foreign controlled firms. The service sector includes a number of such industries: financial intermediaries, telecommunications carriers and broadcasters are subject to varying degrees of restrictions on foreign control and ownership.

Therefore, the trends (Figure 1) are more meaningful than comparisons at a point in time. Although the manufacturing sector remains the preferred sector with an index of more than 1.0, the involvement of foreign controlled firms in R&D in this sector is relatively less than before. On the other hand, there is a steady and significant rise in the service sector index over most of the period. In 1987, it was only one-fourth of that for manufacturing; by 1999, it had moved within 13 per cent.

The adoption of sophisticated technologies in a number of industries, the service sector's role in the production of information and communications technologies, and the shift towards human capital as the strategic asset of corporations are drawing an increasing amount of attention to the technological and innovation opportunities in the service sector.

Daood Hamdani, SIEID, Statistics Canada.

[1] For example, in 1999, foreign controlled firms accounted for 31.7% of the R&D expenditures in all industries. In services, they accounted for 29.5% of the R&D expenditures. The calculated index for services in 1999, therefore is 29.5 divided by 31.7 or 0.93.

Wireless technologies are gaining ground in a growing television programming distribution market

Television was one of the first widely available information technologies and Canadians have embraced it with enthusiasm from the very beginning. Today, a television set can be found in almost every Canadian household. Canada's cable penetration rate is among the highest in the world, a testament to the readiness of Canadians to pay for television services. Recent technological and market innovations are changing the way in which Canadians purchase and receive their programming.

Only a few years ago, consumers wishing to subscribe to television programming had to purchase a package from their local cable company. The situation has considerably evolved since 1997 when direct-to-home satellite was introduced. Competition in the program delivery market between cable and wireless operators is now well established. More Canadians than ever subscribe to television services, and digital technology is gradually replacing analogue technology.

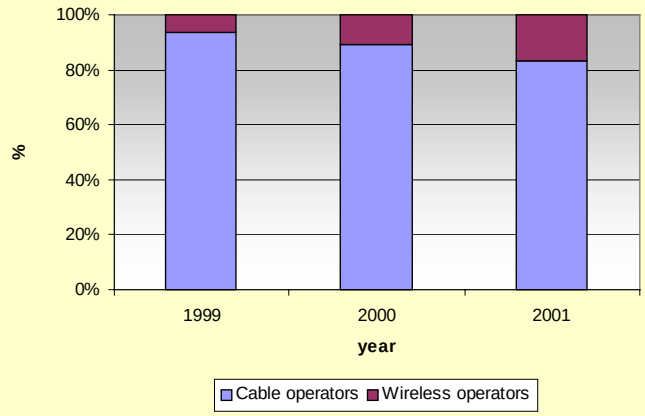
Wireless operators are taking a larger share of a growing market

The battle for customers between wireless and cable operators remained strong in 2001 and wireless operators are attracting consumers of television programming at a fast rate.

Wireless operators (satellite and MDS[1]) had captured 17.0% of the video programming delivery market at the end of August 2001, up significantly from 10.8% in 2000, and more than double the level of about 6.5% in 1999 (Figure 1). Wireless operators had 1.6 million subscribers in 2001, a 66.3% increase from 2000. Cable companies saw their subscription decline by 1.4% to 7.9 million subscribers.

The market share of Canadian wireless operators is approaching the level attained by operators in the United States (21.9% at the end of December 2001) despite the fact that they have been in operation for a shorter period of time.

Figure 1. Market share by type of supplier



The arrival of new suppliers and the introduction of new products in the second half of the 1990s have broadened the customer base of the industry. The number of subscribers to television programming grew 5.9% in 2001. This was the largest yearly increase since 1986. Since 1998 growth in subscriptions has accelerated every year and has outpaced the growth in the number of households. The impact of new wireless entrants became evident during that period.

This period of growth follows a period of stagnation. The rate of adoption of cable television had stabilised in the 90s after a long period of steady expansion. In the years leading to the introduction of competition, subscriptions to video programming grew at a rate similar to the growth in the number of households. However, in 1996 and 1997, the yearly increase in subscriptions had fallen to about 1%.

The battleground reached larger cities

In the early stages of the competitive regime, the alternative wireless providers made most of their gains in areas not served by cable operators or in small and medium-sized communities. The battleground for market share has now reached metropolitan areas.

The number of subscribers to cable services in census metropolitan areas declined in 2001 for the first time in the industry's history. As of August 31, 2001, there were 5.7 million subscribers to cable services in census metropolitan areas, down 0.2% from the year before. Subscriptions fell in 16 of the 25 largest urban areas. In 2000, the number of subscribers to cable services had increased in 13 of these metropolitan areas.

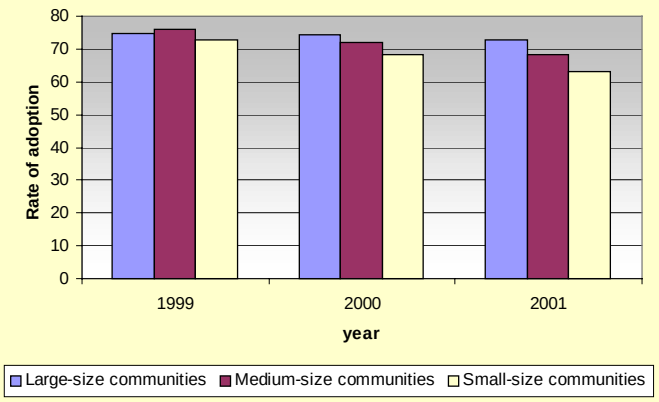
Cable operators in small and medium-sized communities continued to lose customers in 2001. The decline in subscriptions was fastest in small communities at 6.3% (Figure 2). Cable services penetration was below 70.0% in small and medium-sized communities at the end of 2001.

Analogue distribution is gradually being replaced by digital distribution

More than 25.0% of the 9.5 million subscribers to programming services were receiving their service in digital mode in 2001, up from 15.2% in 2000. The popularity of direct-to-home satellite television largely explains this change, but digital cable is also gaining ground. There were close to 812,000 subscribers to digi-

[1] Multipoint distribution systems.

Figure 2. Cable penetration by community size



tal cable on August 31, 2001, more than double the number in 2000.

Despite the strong growth in the adoption of digital television by Canadians, the transition to digital television lags behind that observed in the United States where approximately 35.0% of customers to programming services received a digital package at the end of 2001. The longer history of satellite television and the higher penetration of digital cable (20.0% of cable customers compared to 10.0% in Canada) in the United States largely explains this gap.

Definitions

The following definitions of community are used in this article.

A large-size community is a Census Metropolitan Area (CMA). A CMA is a very large urban area, together with adjacent urban and rural areas that have a high degree of economic and social integration with that urban area.

A medium-size community is a Census Agglomeration (CA). A CA is a large urban area, together with adjacent urban and rural areas that have a high degree of economic and social integration with that urban area.

A small-size community is a Census Division located outside a CMA or CA.

A list of CMAs and CAs can be obtained on Statistics Canada's web site (www.statcan.ca) under Statistical Methods: Standard Classifications: Geography.

More detailed information is available in the November issue of Broadcasting and Telecommunications, Vol. 32, no. 3 (56-001-XIE, $10/$32).

Daniel April, SIEID, Statistics Canada

High-speed Internet use, 2001

As high-speed connections become more readily available, interest has been growing in the quality of the Internet connection used from home. Additional questions were added to Statistics Canada's Household Internet Use Survey (HIUS) for 2001 to create an indicator of the usage rate of household high-speed connection.

Interest has been growing in the speed of Internet connection Canadians use from their homes. The newest indicator shows that 23.7% of households in Canada had a high-speed connection in 2001. The use of high-speed Internet increases from east to west (see Table 1 for more details).

Information presented in Table 2 provides regional data wherein comparison of the use of high-speed versus low-speed Internet is made **for those households regularly using from home**.

In the limited cases where the household respondents did not know the speed of connection, average monthly expenditures were used as proxies. This is the first time that these data have been derived from the HIUS.

*The **HIUS 2001** was originally released on July 25, 2002 in the Statistics Canada Daily.*

Jonathan Ellison, SIEID, Statistics Canada.

Table 1. Internet use at home by speed of access as a percent of all households

Province of Household	High-speed	Low-speed	Regular Home Internet Use
	% of all households		
Atlantic	15.4	23.6	39.9
Québec	17.9	24.1	42.7
Ontario	25.1	27.3	53.4
Manitoba/Saskatchewan	22.5	18.7	41.6
Alberta	28.7	22.3	51.8
British Columbia	32.6	19.7	53.7
Total	**23.7**	**24.1**	**48.7**

Source: Statistics Canada, HIUS 2001.
Note: High and low speed do not necessarily add to regular home Internet use due to non response for type, speed or cost of connection.

Table 2. Internet use at home by speed of access as a percent of home use

Province of Household	High-speed	Low-speed
	% of regular use from home	
Atlantic	38.6%	59.1%
Québec	42.0%	56.4%
Ontario	47.1%	51.2%
Manitoba/Saskatchewan	54.1%	44.9%
Alberta	55.4%	43.0%
British Columbia	60.8%	36.7%
Total	**48.7%**	**49.5%**

Source: Statistics Canada, HIUS 2001.
Note: High speed and low speed do not necessarily add to 100%, as some households did not know speed of access.

Electronic commerce: Household shopping on the Internet, 2001

One in five households, or an estimated 2.2 million households, spent almost $2 billion shopping on the Internet in 2001. These households placed 13.4 million orders over the Internet. Households in British Columbia have the highest average expenditure and those in Quebec have the lowest.

Internet shopping increases substantially

Previous survey estimates showed that 7.2 million households, or about 60% of all Canadian households, regularly used the Internet from various access points such as home, work, school, public libraries and other locations.

One in five households, or an estimated 2.2 million households, spent almost 2 billion shopping on the Internet in 2001. These households placed 13.4 million orders over the Internet. This level of electronic commerce was up substantially from the year before, although direct comparison with 2000 data cannot be made[1].

From January to December 2001, an estimated 4 million households, about one-third of all households in Canada, had at least one member that used the Internet to support purchasing decisions, either by window shopping or placing online orders. Just over 57% of these 4 million households made a commitment to order, and four out of five cases paid for items over the Internet. Furthermore, in 2001, 784 thousand households used the Internet to order products for the first time.

Canadians are increasingly using the Internet as a method to order

The value of orders placed over the Internet constituted a small fraction of the $621 billion in total household expenditure in Canada in 2001. However, the new data confirm that households increasingly used the Internet as a method of purchasing products from both foreign and Canadian vendors.

For every $10 spent by households on electronic commerce in 2001, $6.50 was spent on products purchased directly from Canadian sites. Canadians spent $680 million, or about 35% of their electronic commerce dollars, at non-Canadian Web sites.

Window-shopping

In addition to those making purchases, about 1.7 million households, or 14% of the total, window-shopped in 2001—that is, they used the Internet to narrow their purchasing decisions, but did not commit to ordering or purchasing online.

Average expenditure and type of product or service ordered

Households that ordered products or services online in 2001 placed an average of 5.9 orders from any location; the average value of an order was $148.

About 16% of electronic commerce households used the Internet to make travel arrangements. Households also used the Internet to order tickets to concerts, ballet, sporting events or movies.

Households were much less likely to commit to orders for bedroom suites or appliances, but as window shoppers, they used the Internet as a method of comparison-shopping. More than one-quarter of window-shopper households browsed for furniture and appliances.

Regional comparisons - households in British Columbia spent more online

Households in British Columbia had the highest average expenditure on the Internet in 2001, and those in Quebec had the lowest (Table 1). British Columbia has one of the highest adoption rates for Internet use and that Quebec has one of the lowest.

Households in British Columbia that ordered products online from any location reported an average annual expenditure of $1,394. The national average for households that ordered products was $880.

Electronic commerce households in Atlantic Canada had the highest average number of orders per household at 6.9 in 2001, above the national average of 5.9.

Table 1. Electronic-commerce households' average expenditure on orders, by region, 2001

REGION	Average expenditure	Average number of orders
	$	
Atlantic provinces	813	6.9
Quebec	566	4.6
Ontario	835	6.7
Manitoba & Saskatchewan	729	4.9
Alberta	890	5.3
British Columbia	1,394	5.6
Canada	**880**	**5.9**

Source: Statistics Canada, HIUS 2001.

[1] The change in survey collection constitutes a break in the data series, preventing a direct comparison of results of 2001 with those of previous years. Nonetheless, in 2000, an estimated 1.5 million households spent about $1.1 billion, placing 9.1 million orders from home.

Ontario remained the largest market for electronic commerce spending for personal or household expenditure (Table 2). In 2001, Ontario households from various locations purchased $828 million in goods and services over the Internet, accounting for 42% of the $2 billion total.

Table 2. Electronic-commerce spending in Canada and other countries, by region, 2001

	Canada		Other countries		TOTAL	
REGION	millions ($)	%	millions ($)	%	millions ($)	%
Atlantic provinces	90	7.0	40	5.9	130	6.6
Quebec	121	9.4	83	12.2	204	10.3
Ontario	523	40.4	305	44.7	828	41.9
Manitoba & Saskatchewan	51	3.9	46	6.7	97	4.9
Alberta	129	10.0	83	12.2	212	10.7
British Columbia	379	29.3	125	18.3	504	25.5
Canada	**1,293**	**100.0**	**682**	**100.0**	**1,975**	**100.0**

Source: Statistics Canada, HIUS 2001.

Despite security concerns, more households order online

More households opted to order products electronically than in previous years, despite the fact that concern about security and privacy remained relatively unchanged, according to the survey.

Households that only window-shopped and did not order over the Internet were the most concerned about the security of online financial transactions, with about 80% of window-shoppers expressing concern.

Although 72% of households that made payments online were also concerned about security, they used their credit cards online anyway.

An earlier version of this article was released on September 19, 2002 in the Statistics Canada Daily. Data tables related to the information presented are available on Statistics Canada's Web site (www.statcan.ca).

Jonathan Ellison, SIEID, Statistics Canada.

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Distribution of biotechnology innovator firms in Canada - 2001

In 2001 there were 375 biotechnology innovator firms in Canada, an increase of just under 5% from the 358 firms in 1999. Analysis beyond these overall statistics discloses a dynamic churning that is occurring between sectors, provinces and size groups.

This issue of the *Innovation Analysis Bulletin* includes three articles on biotechnology innovator firms[1]. This one covers changes in the number of firms, Lara Raoub investigates the implications for human resources and Namatié Traoré reviews changes in revenues and research expenditures. The articles are all based on data from the Biotechnology Use and Development Survey, 2001. Data highlighted in this discussion are found in Table 1.

Changes by sector

The greatest changes in terms of number of firms occurred in the human health and agricultural sectors.

The human health sector grew from 150 firms to 199 firms, representing 56% of biotechnology firms in 2001 compared to 42% in 1999.

The agriculture sector declined from 90 firms in 1999 to 67 in 2001. This decline can be attributed to several factors. The first is consolidation of several firms. The second is that firms are shifting from the agriculture sector to the food-processing sector. Finally, to a lesser degree, a number of firms have ceased operations.

The food-processing sector increased in size from 29 firms to 46 firms. This is due, in part, to a move into this sector of firms previously engaged in agricultural biotechnology. These agricultural based firms underwent a change in focus from developing to actually producing a product.

The natural resources sector showed a decline from 18 to 10 firms. Some of the decline is explained by a number of firms moving from developing new biotechnology products or processes to using those biotechnology products or processes in their day-to-day activities. This is expected as biotechnology matures from a developmental technology to one of production. Natural resource biotechnology products are amongst the oldest in use.

The number of firms in the bioinformatics sector also declined, but some of these firms shifted to the human health sector.

Table 1. Biotechnology innovative firms

	1999	2001
Sector	number of firms	
Human health	150	199
Agriculture	90	67
Food processing	29	46
Environment	35	31
Aquaculture	14	11
Bioinformatics	18	11
Natural resources	18	10
Total	**358**	**375**
Province		
Newfoundland & Labrador	x	x
Prince Edward Island	x	x
Nova Scotia	7	12
New Brunswick	x	7
Quebec	107	130
Ontario	110	101
Manitoba	6	11
Saskatchewan	16	17
Alberta	28	24
British Columbia	71	69
Total	**358**	**375**
Size class		
Small (0-50 employees)	270	267
Medium (51-150 employees)	51	62
Large (151 and more)	37	46
Total	**358**	**375**

Source: Statistics Canada, Biotechnology Use & Development Survey 1999 and 2001.

Notes: All data are revised.

x - suppressed to meet the confidentiality requirements of the Statistics Act.

Changes by province

Quebec experienced the greatest growth in firms, increasing 21% from 107 firms to 130 firms. Growth was also observed in Manitoba, Saskatchewan and the Atlantic Provinces. Declines were also noted with the number of firms in Ontario slipping from 110 to 101 firms, while British Columbia and Alberta also experienced small decreases.

[1] This sector has undergone a change in name from "biotechnology firms" to "innovative biotechnology firms". The change was made to more accurately reflect the nature of the sector. In previous articles, "innovative biotechnology firms" were referred to as "core biotechnology firms". The change in terminology was made to reflect the criteria used to select this sub-population amongst all users of biotechnology. Biotechnology is a set of techniques used by firms for various purposes, including the generation of new knowledge; biotechnologies embodied in production processes and use of biotechnology for environmental cleaning and remediation. An "innovative biotechnology firm" is a firm that uses biotechnology for developing new products or processes and is engaged in biotechnology related R&D activities.

Changes by size category

The small size firm category decreased to reaching 267 firms in 2001—down from 270 in 1999. The medium size category increased by 11 firms, about 3% more than in 1999. As firms bring products to market, it is expected that their size will increase.

Chuck McNiven, SIEID, Statistics Canada.

Characteristics and evolution of human resources in Canadian biotechnology firms[1]

After a 15% decline between 1997 and 1999, biotechnology employment grew by 54% in 2001. When data from the 2001 Biotechnology Use and Development Survey are analysed, several factors emerge that could explain the countercyclical trend exhibited by human resources in biotechnology. First, human resources are volatile and increasingly mobile, and the factors that contributed to the decrease in employment in 1999 seem to explain the growth in 2001. In addition, a trend toward the maturation of small firms is beginning to show up in the data.

Volatility and mobility of human resources

Human resources in biotechnology have not evolved constantly over time. In 1999, although all economic indicators were on the rise, biotechnology employment was down 15% from its 1997 level (Table 1). The results of the 2001 Biotechnology Use and Development Survey show a 54% increase in human resources with biotechnology-related activities compared to 1999. This increase in employment has a real component, since the number of employees with biotechnology-related activities continues to increase proportionally to the total jobs in the firm. Thus, the intensity of biotechnology employment (ratio of biotech jobs to total jobs) rose from 12% in 1999 to 19% in 2001.

Most of the increase in biotechnology employment between 1999 and 2001 was in full-time jobs (Table 2). Indeed, this category of jobs, which increased by 74%, accounted for 112% of the growth in total jobs, whereas part-time employment fell sharply (-40%). While scientific direction and technician positions together accounted for 49% of all jobs in 2001, much of the increase in full-time employment was in jobs associated with related services. The management/licensing/administration category accounted for 172% of the increase, followed by production (152%) and regulatory and clinical affairs (118%). The distribution of full-time positions remained almost the same for the two years, except for the finance/marketing category, which accounted for 8% of full-time jobs in 1999 whereas its share increased to 15% in 2001. In our analysis of the data from the 1999 survey, we explained the decrease in employment by a possible transfer of human resources to services. The conclusions drawn from the 1999 results would suggest that biotechnology personnel who left in 1999

Table 1. Evolution of selected indicators for biotechnology firms

Indicator	1997	1999	2001
Number of firms	282	358	375
Total number of biotech employees	9,019	7,748	11,897
Total number of employees	31,924	62,613	62,242
Biotech revenues ($ millions)	813	1,948	3,569
Biotech R&D expenditures ($ millions)	494	827	1,337

Source: Statistics Canada, Biotechnology Use & Development Survey 1999 and 2001.

Table 2. Number of biotechnology employees

	1999			2001		
Position	Full-time	Part-time	Total	Full-time	Part-time	Total
Scientific / Research Direction	1,891	209	2,100	2,744	92	2,836
Technicians / Engineering	1,621	303	1,924	2,646	221	2,867
Regulatory / Clinical Affairs	484	105	589	812	55	866
Production	1,424	306	1,730	1,639	232	1,871
Finance / Management	540	167	707	1,709	66	1,775
Management / Licensing / Administration	506	193	699	805	68	873
Other	-	-	-	766	43	809
Total	6,466	1,282	7,748	11,121	776	11,897

Source: Statistics Canada, Biotechnology Use & Development Survey 1999 and 2001.

[1] This article analyses data on **innovative** biotechnology firms. A firm is considered innovative if it meets at least one of the following criteria: it has products/processes on the market; it is currently developing products/processes that require the use of biotechnology; and it considers biotechnology important for its activities and strategies.

Figure 1. Distribution and intensity of biotechnology employment by size, 2001

Source: Statistics Canada, Biotechnology Use & Development Survey 1999 and 2001.

were primarily involved in marketing/distribution and regulatory and clinical affairs (Traoré et al., 2002). In 2001, on the other hand, these were the types of jobs that contributed the most to the increase in biotechnology personnel. Thus, the jobs lost in 1999 were recovered in 2001, and that might explain this trend reversal or recovery. It appears, then, that biotechnology firms are deciding to create these types of jobs themselves, rather than contracting them out or subcontracting them. This may be because biotechnology firms are achieving a certain maturity.

Small firms tending to mature

The maturation of young firms is beginning to show up in the data. It is mainly reflected in the change over time in the type of biotechnology positions.

While large firms employ the largest share of human resources in biotechnology (47%), their intensity in total employment is only 10% (Figure 1). Small firms concentrate more on highly skilled employment, with 60% of the jobs assigned to the scientific/research direction and technician/engineering categories.

In 2001, young firms tended to shift from part-time jobs to full-time jobs. In fact, small firms saw a decrease in part-time positions in all categories, while full-time positions increased except in the scientific/research direction and regulatory/clinical affairs categories. Small firms tend to contract out or subcontract regulatory activities because these are often costly; they prefer to concentrate on research and development activities. The scientific/research direction category declined by 13% for small firms but increased by 315% for medium-sized firms. The distribution of jobs by size of firm shows that between 1999 and 2001, the share of jobs for large firms remained almost the same, while the share for small firms decreased and the share for medium-sized firms increased (Figure 2).

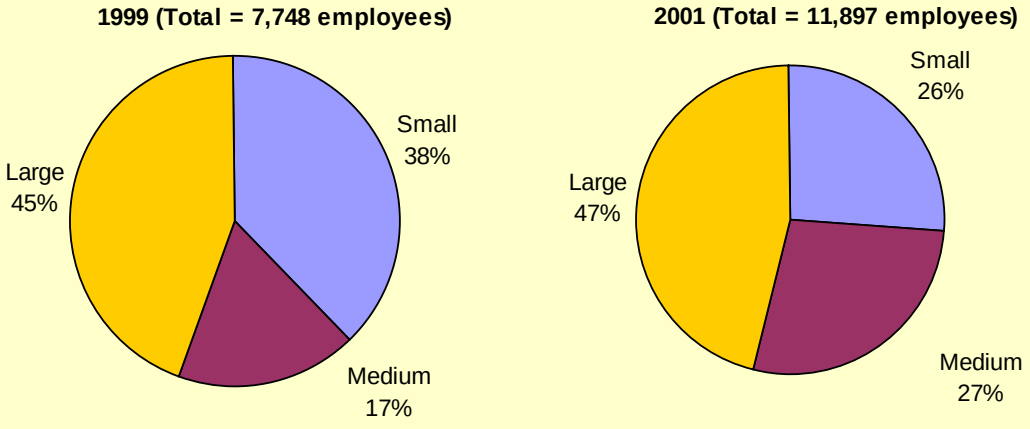
This indicates that small firms matured, increasing their size between 1999 and 2001. There was thus something of a transfer between small firms and medium-sized firms. Also, since small firms had more products reaching the marketing stage between 1999 and 2001, they might have decided to orient their work force more toward sales activities, thus reducing research positions.

References

Traoré, N. et al. (2002), *How is the Canadian biotechnology evolving: a comparison of the 1997 and 1999 biotechnology use and development surveys*, SIEID, Statistics Canada, forthcoming.

Lara Raoub, SIEID, Statistics Canada.

Figure 2. Distribution of biotechnology employment by size, 1999 and 2001



Source: Statistics Canada, Biotechnology Use & Development Survey 1999 and 2001.

Coming of age—biotech revenues are on the rise

Canadian biotechnology is gaining momentum. More firms are getting their products onto the markets and are increasing revenues. With the human health sector leading the way, biotech revenues rose by a massive 343% for the 1997-2001 period, reaching $3.5 billion in 2001. This happened while the number of firms increased by 33%.

Rise in biotech revenue and firms producing revenue

Canadian biotechnology, by many standards, is young. The average biotech firm is still in its "early teens" with a large portion (a third) having not yet earned any revenues from biotech activities. Nonetheless, biotech firms are quickly coming of age and their vitality as measured by revenues earned is growing. Both the number of firms declaring biotech revenues and the amount of revenues earned from biotech activities increased.

In 1997, 176 or 62% of the 282 firms that comprised Canadian biotechnology declared biotech revenues rising from 225 or 63% in 1999, and 252 or 67% in 2001. This is an overall increase of 43% in the number of firms declaring biotech revenues in the 1997-2001 period. Although significant, this rate of increase is dwarfed by increases in biotech revenues. Overall, revenues rose from $813 million in 1997 to $3.5 billion in 2001, a massive 343% increase.

Biotech firms—a special breed

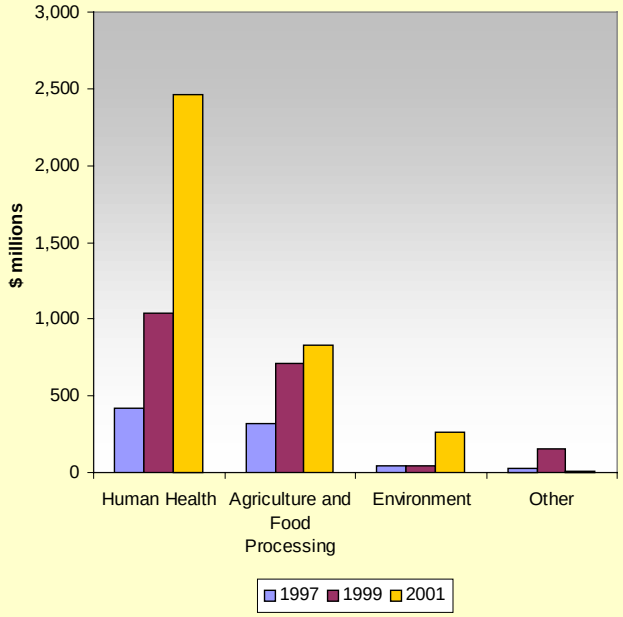
These increases in biotech revenues occurred despite two factors. From 1997 to 2001, the number of firms declaring biotech revenues went up by only 76. In addition, although, firms were 12 years old on average in 1997, at least one third of the firms declared not earning any revenues from biotechnology in either 1997 or 2001. The significance of this fact relates to the special nature of biotech firms - a special breed of firm that can survive years without earning any revenues. Presuming that revenues to firms are what water is to animals, in the business world, biotech firms are the camels of the firm species: they can go without revenues for years. However, once they reach the oasis, they gulp up large quantities of water.

How do biotech firms do it? Which sectors lead the way?

The obvious question is "How do they do it?" How does this increase in biotech revenues compare to total revenues? Even more importantly, how does it compare to current expenditures on biotech R&D - their lifeline.

As shown in Figure 1, all sectors contributed to the increase in biotech revenues. Human Health remains the dominant sector. Firms in this sector brought their revenues from $417 million in 1997 to almost $2.5 billion in 2001, a six-fold increase. The Agriculture and Food Processing sector is the second largest biotech revenue generator. Biotech revenues more than doubled in the 1997-2001 period, even though, the increase was less important between 1999 and 2001, from $709 to $827 million. After a slight decrease in biotech earning between 1997 and 1999, firms in the Environment sector earned over 5 times more from biotech activities in 2001 than they did in 1997. The fall in biotech revenues in the 1999-2001 period from the Other sector, had a moderating impact on the overall rate of increase in biotech revenues.

Figure 1. Evolution of biotech revenues by sector, 1997-2001



Source: Statistics Canada, Biotechnology Use & Development Survey 1997, 1999 and 2001.

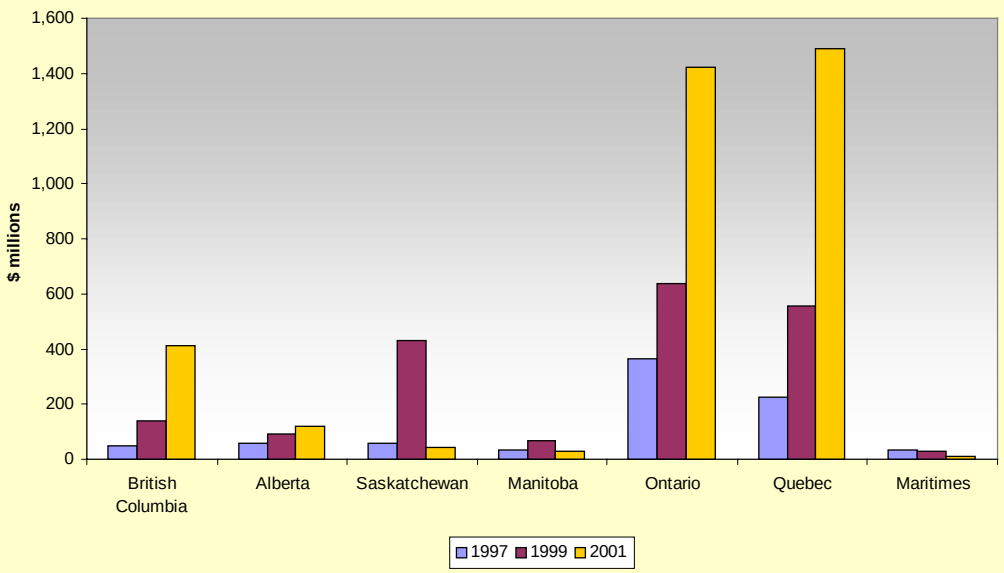
Big three provinces

Firms in Ontario and Quebec are the largest contributors to the increase in biotech revenues. Together, they contributed almost $3 billion in 2001, up from $1.2 billion in 1999 and $587 million in 1997 (Figure 2).

Firms in Ontario earned the largest portion of revenue for both 1997 and 1999. However, they were outpaced by Quebec based

firms in 2001 with $1.5 billion in revenues as compared to $1.4 billion for Ontario. British Columbia contributed $413 million to total biotech revenues in 2001, making firms in this province, the third largest revenue generator. Similarly, Alberta has steadily increased its share of biotech revenues from $56 million in 1997 to $90 million in 1999, and to $121 million in 2001. Manitoba, the Maritimes and Saskatchewan experienced a decrease in biotech revenues, with the latter leading the way with 91% loss in revenues.

Figure 2. Evolution of biotech revenues by province, 1997-2001



Source: Statistics Canada, Biotechnology Use & Development Survey 1997, 1999 and 2001.

How do biotech revenues compare to total revenues and biotech R&D?

As shown in Figure 3 in 1997, $6 dollars out of every $100 of revenue came from biotech related activities. This figure rose to $10 in 1999, and $13 in 2001. Thus, the share of biotech revenues to total revenues has more than doubled in the 1997-2001 period, implying the increasing importance of biotech products within a firm's portfolio. More importantly, it indicates the growing capacity of Canadian biotech firms to translate basic research into commercial successes. This conclusion is also supported by the increasing ratio of biotech revenues to biotech R&D expenditures steadily the ratio growing from 1.65 in 1997 to 2.67 in 2001(Figure 4).

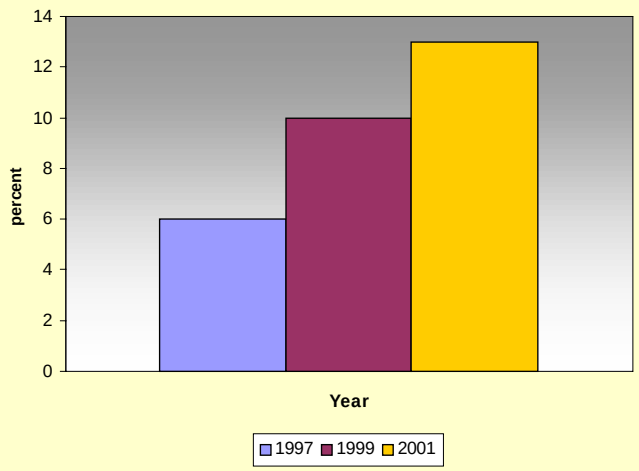
Conclusions

This increasing return on biotech R&D may translate into an enhanced capacity for Canadian biotech firms to finance intramural R&D, instead of relying on external sources of financing capital, which, given the current state of financial markets, may be hard to come by.

This article is based upon data from Statistics Canada's Biotechnology Use and Development Survey for the years 1997, 1999 and 2001.

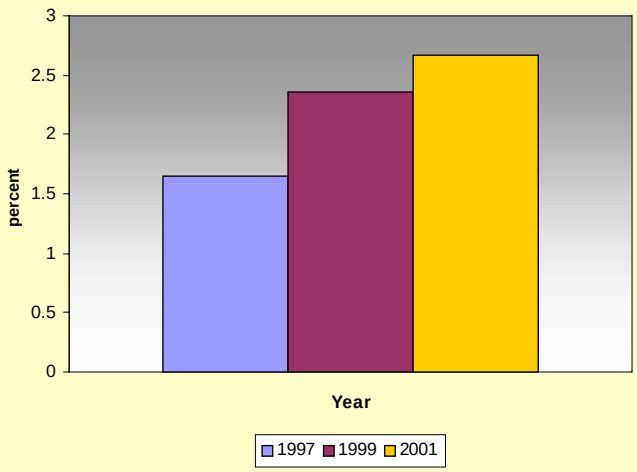
Namatié Traoré, SIEID, Statistics Canada.

Figure 3: Evolution of biotech revenues as a percentage of total revenues, 1997-2001



Source: Statistics Canada, Biotechnology Use & Development Survey 1997, 1999 and 2001.

Figure 4: Evolution of the ratio of biotech revenues to biotech R&D expenditures



Source: Statistics Canada, Biotechnology Use & Development Survey 1997, 1999 and 2001.

What's new?

Recent and upcoming events in connectedness and innovation analysis.

Connectedness

The next issue of Connectedness Series, Volume 9, *A Profile of Employment in Computer and Telecommunications Industries*, is scheduled for release this Winter. A further study on the demand and supply of broadband technology is also underway.

Telecommunications

Annual survey of telecommunications service providers

The results for the 2000 reference year are presented in *Broadcasting and Telecommunications Services Bulletin* (56-001-XIE, Volume 32. No. 4) published in January 2003.

Quarterly survey of telecommunications service providers

The results for the second quarter of 2002 are presented in *Telecommunications Statistics; second quarter* (56-002-XIE, Vol. 28, No. 2) published in November 2002.

The results for the third quarter were released in January 2003 (56-002-XIE, Vol. 28, No. 3).

Broadcasting

The results for the 2001 reference year for the Cable and Other Program Distribution Industry are presented in *Broadcasting and Telecommunications Services Bulletin* (56-001 XIE, volume 32. No. 3) was published in November 2002.

Household Internet use

A feasibility study for the redesigned electronic commerce component of the *Household Internet Use Survey* is complete. Consultation is occurring with potential survey sponsors.

Business e-commerce

Survey of electronic commerce and technology

Data collection for the *2002 Survey of Electronic Commerce and Technology* went to the field in November 2002.

Science and innovation

S&T activities

Research and development in Canada

The service bulletin, *Total spending on research and development in Canada, 1990 to 2002, and provinces, 1990 to 2000* was released in November 2002.

The service bulletin, *Research and development (R&D) expenditures of private non-profit (PNP) organizations, 2001*, was released in December 2002.

Federal and provincial S&T

Federal science expenditures

The service bulletin, *Federal government expenditures on scientific activities, 2002-2003* was released in October 2002.

The service bulletin, *Distribution of Federal Expenditure on Science and Technology, by province and territories* will be released in March 2003.

Higher Education Sector R&D

The service bulletin, *Estimation of research and development expenditures in the higher education sector, 2000-2001* was released in November 2002.

Provincial research organizations

The service bulletin *The Provincial Research Organizations, 2000* was released in December 2002.

International Comparison of R&D

A working paper entitled *A Comparison of International R&D Performance: An Analysis of Countries that Have Significantly Increased Their GERD/GDP Ratios During the Period 1989-1999* by Charlene Lonmo and Frances Anderson is now available. It uses R&D estimates collected by the OECD from various countries.

Human resources and intellectual property

Federal intellectual property management

Federal science expenditures and personnel 2001-2002, intellectual property management, fiscal year 2000/2001

Preliminary results from the 2000-01 survey were released in November 2001. The 2001-02 survey is in the field.

The higher education sector

Intellectual property commercialization in the higher education sector

Preliminary results on university and hospital spin-off companies (revenues, employment and other characteristics) were released in November 2001.

Innovation

Innovation in manufacturing

A working paper entitled *Survey of Innovation 1999 Statistical Tables-Manufacturing Industries, Canada* was released in January 2003. The 55 tables present estimates for all quantitative questions in the Survey of Innovation 1999 for 31 manufacturing industry groups.

Innovation in services

A working paper entitled *Determinants of Product and Process Innovation in Canada's Dynamic Service Industries*, authored by Julio Rosa, is now available. It includes analyses of data from the *1996 Survey of Innovation*, which collected data on communications, financial services and technical services.

This article is an exploratory study to help identify and characterize innovation practices in Canada's dynamic service industries. The author uses logistical estimates to demonstrate that innovation in the services sector is not homogeneous. For each type of innovation—product, process or both—there is a different business strategy. Small firms do more product innovation, and clients, along with fairs and exhibitions, appear to be the primary sources of information. Product innovation is generally done by technical services industries. Process innovation does not seem to favour any particular sector, but understandably, the factors that have the most impact on this type of innovation are company flexibility and information from patent literature, consulting firms and internal management. The most complex strategy—both product and process innovation—is particularly associated with large firms in the communications and finance sub-sectors. This type of innovation has a larger number of significant factors than the other two types. Finally, the author shows that there are differences between the forms of innovation, and these differences apply within individual sub-sectors.

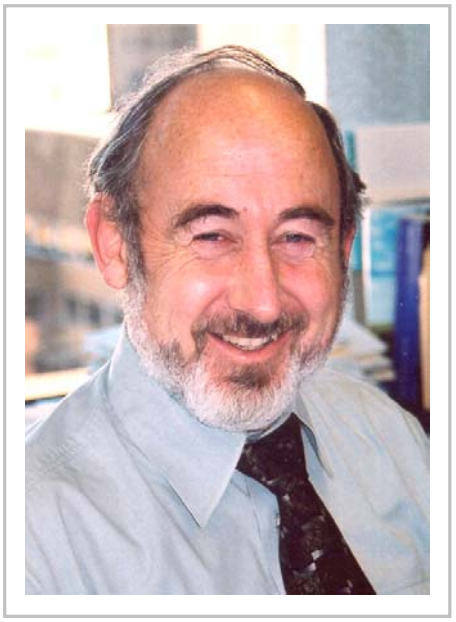
Biotechnology

Preliminary data are now available for the *Biotechnology Use & Development Survey, 2001*. Tables are available for revenues, R&D expenditures and human resources. Additional data will be available throughout spring 2003 and a working paper, examining data and methodology will also be released.

Knowledge management practices

The linked database for the *Knowledge Management Practices Survey* 2000 has been created.

Retirement of Bert Plaus



With the recent retirement of Bert Plaus, Statistics Canada said farewell to a major contributor to the science and technology community. Bert ended a 35-year career with Statistics Canada, wherein 28-years were spent in the field of science and technology. Bert's knowledge and hard work had tremendous impact—shaping the manner in which science and technology data and indicators are measured internationally. Bert's efforts had a major influence on provincial representatives in initiating and maintaining the cost sharing agreements we currently have with the provinces, enabling Statistics Canada to collect vital provincial government information.

Beyond that however, was the working environment Bert Plaus fostered. As a manager, Bert is known by his staff as a family-oriented man, always empathetic, understanding and flexible with his employees. This character trait of Bert was key to creating and nurturing not only a productive, but also a "family" oriented workplace. Simply, Bert's staff enjoyed working for him.

Clearly, Bert Plaus is well respected in the science and technology community that encompasses countless people representing numerous federal and provincial government departments. Respect, he has certainly earned. However, Bert Plaus will be missed most for the manner in which he worked with people—the good will he built with his staff will likely be irreplaceable.

Enjoy your retirement Bert—you have earned it!