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Innovation Analysis Bulletin

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

Government science and technology activities
Industrial research and development
Intellectual property commercialization
Advanced technology and innovation
Biotechnology
Connectedness
Telecommunications and broadcasting
Electronic commerce

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Get connected with us

Besides the articles referred to in this bulletin, Statistics Canada's Web site provides a wealth of statistics, facts and research papers on a variety of related topics. As well, most of the questionnaires we have used to collect the information are available for research purposes.

As of October, there were:

- *Six titles in Downloadable publications ($) (including:*
  - *88-204-XIB **Federal scientific activities***
  - *88-001-XIB **Science statistics** (33 issues)*
  - *88-517-XIE **The defining characteristics of entrants in science-based industries***
  - *88-522-XIE **Science and technology activities and impacts: a framework for a statistical information***
  - *88-523-XIE **A five-year strategic plan for the development of an information system for science and technology***
- Six research papers, 33 working papers and 21 questionnaires in Downloadable Research papers (free) under Science, Innovation and Electronic Information Division.

Cellular communications: evolution of a high-growth industry

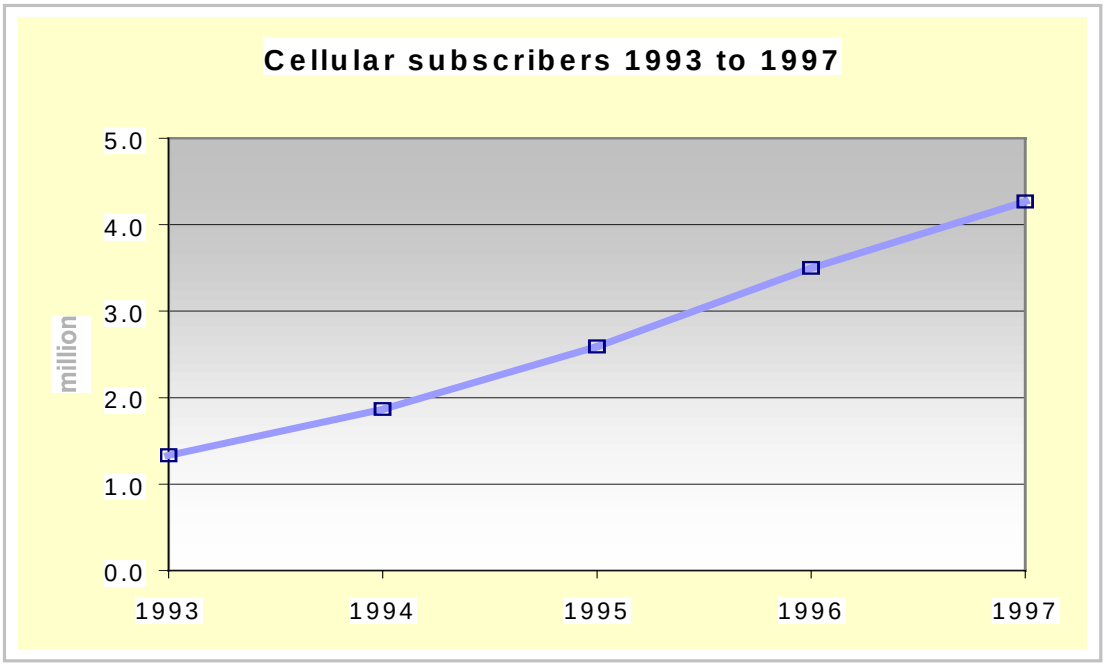
Whether you keep a cell phone in your car in case of emergency, use it as a lifeline for your business, or clip one on your teen in an effort to keep in touch with them, chances are, someone in your household is a cellular subscriber.

The wireless communications industry has experienced tremendous growth both internationally and in Canada since cellular telephone service was first introduced in the mid 80's.

Between 1985 and 1996, Canada's cellular telephone industry was a regional duopoly with only two firms competing in the industry in each geographic market. Now the market has opened up to several service providers, bringing about increased competition, enhanced product value, heightened security and accelerated downward pressure on prices.

Revenue and Subscriber Growth

In just over a decade, the cellular telephone industry has grown (in terms of revenue) to close to one fifth the size of the traditional telephone segment of the industry, experiencing an annual revenue growth rate between 22% and 29%.



By December 1997, there were just over 4 million cellular telephone subscribers in Canada—a 22% increase over the previous year—more than double the level of subscribers in 1994.

Most of the growth since 1994 was achieved in the personal-use segments of the markets as opposed to business-use segments.

Penetration Rates

In addition to Statistics Canada's survey of the industry, a household survey was conducted in 1997. It reported that 19% of Canadian households had a cell phone for personal use (excluding cell phones provided by an employer). Research shows that cellular telephone penetration rates are related to income, but are not very sensitive to the education level of the household.

Household Expenditures in Cellular Services

Based on results from the 1997 Survey of Household Spending, the average annual expenditure on cellular services amounted to $457.

The top 25% of subscribers (those who spend at least $540 per year) actually spend $1,001 on average. This quartile of households is largely made up of more than one subscriber.

Cellular communication extends "connectedness" from the formerly fixed or stationary service to one allowing people to be connected while on the move. As easy to use as the traditional wireline telephone, the learning curve is next to none, making it accessible to almost everyone regardless of their comfort level with technology. Reduced prices coupled with refined features such as Internet access and messaging will ensure continued industry growth and market penetration well into the new millennium.

A full paper, titled ***The Cellular Telephone Industry: Birth, Evolution, and Prospects*** *was published in the August 1998 issue of Canadian Economic Observer (Cat. No. 11-010-XPB). Updated statistics are now available.*

Further information: Haig McCarrell, Telecommunications, SIEID, Statistics Canada, (613) 951-5948, Haig.McCarrell@statcan.ca

Advanced technology and competitiveness in Canadian manufacturing

Results of a new survey build on earlier research into advanced technology. The study looks at use and planned use of advanced technologies in the Canadian manufacturing sector. It also examines four key elements: business practices, communications networks, use of the Internet and the shortage of skilled workers.

Adoption of advanced technologies is a key element of firms' strategies to adapt to, and benefit from, scientific and technological progress. A new study, **Technology Adoption in Canadian Manufacturing: Survey of Advanced Technology in Canadian Manufacturing**, provides new information.

"The survey asked firms to rank themselves against their American competitors with respect to the use of technology," explains Antoine Rose, who was involved with the survey. "It also looked at business practices, communications networks, Internet use and skilled workers, and how they relate to advanced technology. We now have a more recent picture of how advanced technologies are used in Canadian manufacturing."

Seventy percent of manufacturing establishments surveyed use the Internet, mostly for conducting web searches and advertising their goods and services. Fifty-seven percent have a home page on the World Wide Web.

According to the study, three-quarters of manufacturing establishments use at least one of 26 advanced technologies. The most popular technologies were computer-aided design and engineering, programmable logical controllers, local area networks, company-wide networks, computer-aided design and manufacturing, and the sending of computer-aided design files by e-mail.

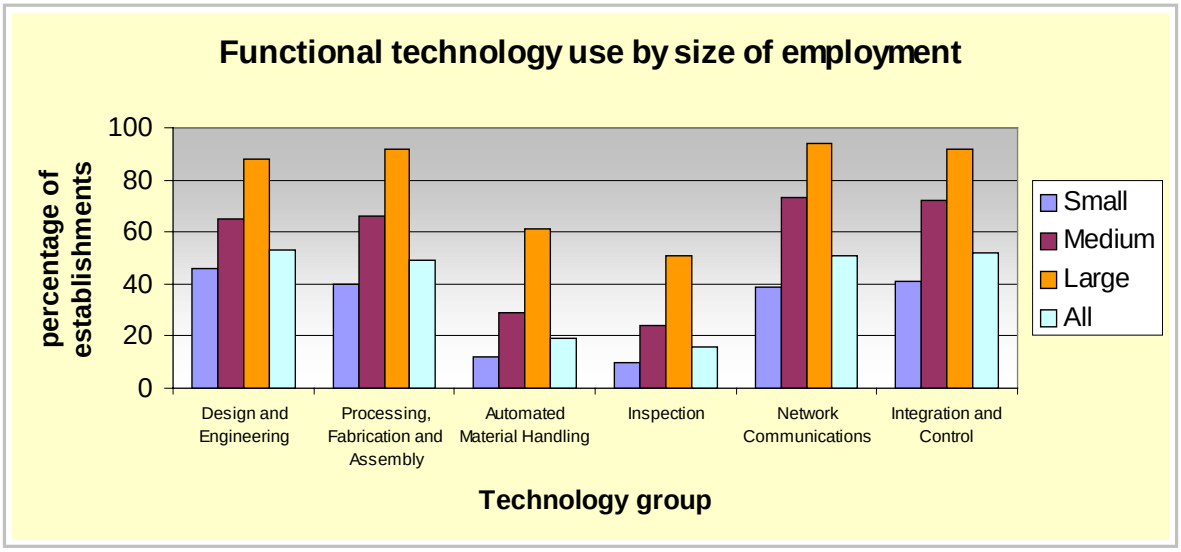
The use of advanced technology depends a lot on the firm's size. Some 90% of large plants, for example, have adopted at least one technology from each of four technology groups—network communications, processing and fabrication, integration and control, and design and engineering.

Moreover, technology use varies across industries. Firms in beverages, primary textiles, paper and allied products, primary metals, and electrical and electronic products tend to use advanced technology more than other groups. The beverage industry, for example, has the highest adoption rates of all industries for both network communications, and integration and control technologies.

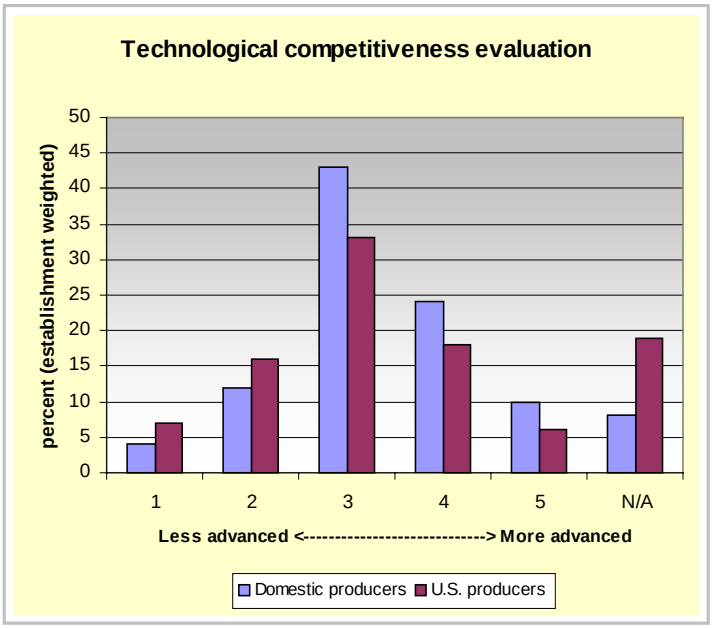
Competition is fierce in the manufacturing sector. "Close to half of the surveyed firms face more than 20 competitors apiece. "In this environment," notes Mr. Rose "advanced technologies can often mean the difference between success and failure." In the survey, 77% of Canadian plant managers felt their production technology was as good as, or better than, their domestic competitors. Against their U.S. counterparts, however, they were less confident. Only 57% believed their technologies were as good as, or better than, their American competitors.

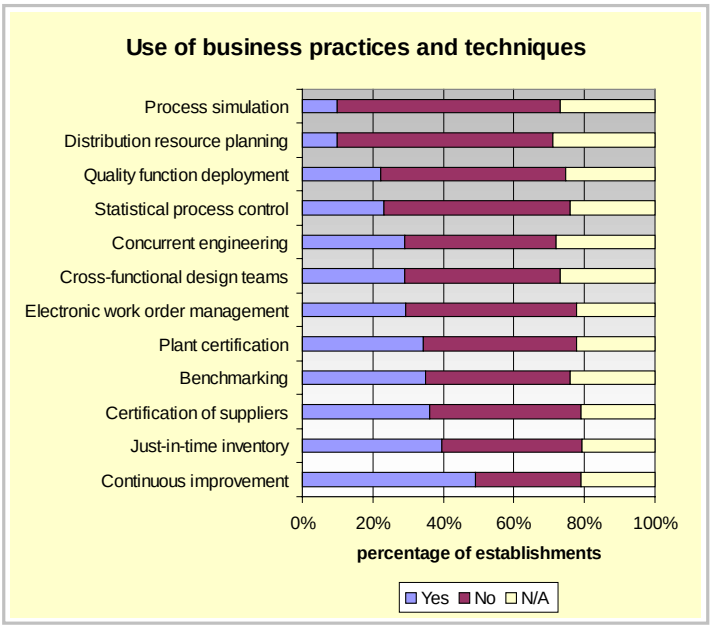
Business practices

The survey builds on two other studies that focused on the role of business practices. The first study, completed in 1995, reported that business practices provide more successful plants with a comparative advantage. A 1999 study of technology use in Canadian food processing firms found that business practices complement advanced technologies. In fact, the study found that engineering practices are as important to the innovation process as R&D.



The current study took the earlier research one step further, rating the use of 12 business practices used by manufacturing firms. Nearly half of the surveyed firms used "continuous improvement"—an incremental approach to improve quality. The next most important practices were "just-in-time inventory"—a low inventory system that allows sup-





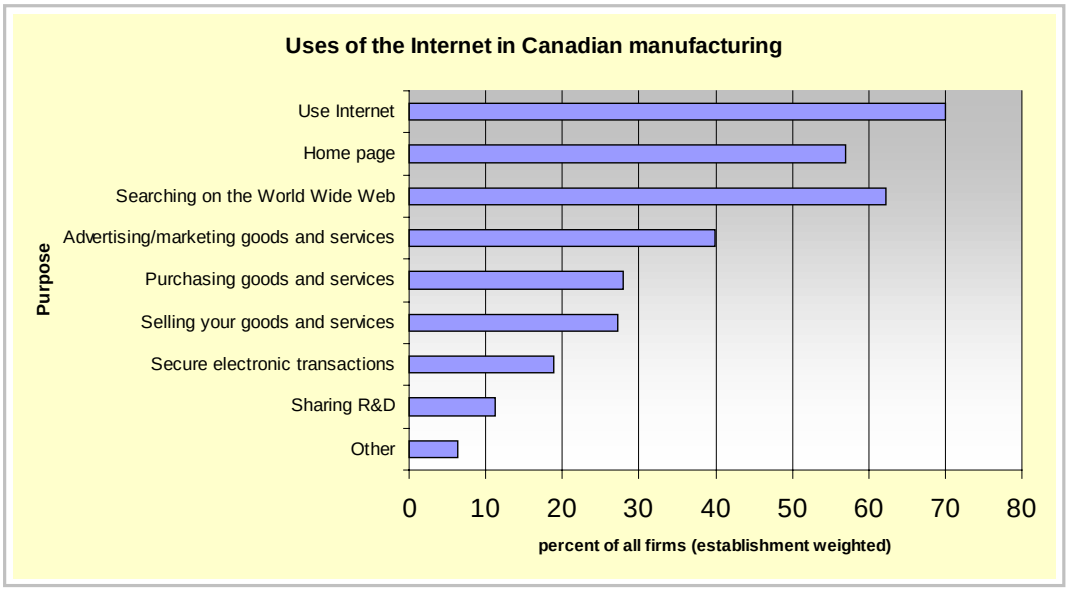
pliers to deliver a product immediately on request; benchmarking, the ongoing practice of comparing a plant's standards against those of industry leaders; and quality certification by a third party such as ISO 9000.

Communications networks and Internet use

Communications networks are fast becoming an integral part of the day-to-day operations of many companies. According to the study, half of all manufacturing plants have adopted at least one type of advanced network communications technology. About one-third, for example, have adopted either local area networks, which exchange information within different parts of one firm, or Intranets, which allow a company to communicate beyond a single site. Extranets, which connect firms with other companies such as suppliers and subcontractors, were in place in 29% of the surveyed firms.

Firms used their communications networks for a variety of tasks such as financial transactions, sales and inventory tracking, and the flow of distribution and production. More than half used their network for general reference, marketing and customer service, and accounting

Seven out of 10 manufacturing establishments use the Internet, and, of these, 40% buy and sell goods and services and 60% advertise on the net. The Internet has also become the channel of choice for electronic data exchange (EDI).



Skilled workers

Over the past few years, Statistics Canada research has identified the shortage of skilled workers as a primary obstacle to both technology adoption and innovation. In this new study, three-quarters of technology-using plants had trained their employees in technology use over the last three years. Not surprisingly, nearly 90% of firms provided training to improve technical skills while almost as many had provided computer literacy training

Overall, two-thirds of technology users experienced skill shortages in the past year, particularly in the professional and skilled trades categories. For professional occupations, the greatest shortages were for industrial and manufacturing process engineers, and electronic engineers. For skilled trades, the

most critical shortages were for machine operators and machinists.

Just over three-quarters of plant managers facing shortages took action to deal with the problem. Most said they searched for skilled personnel, but many also trained existing personnel to make up the shortfall.

The original working paper, titled ***Technology Adoption in Canadian Manufacturing: Survey of Advanced Technology in Canadian Manufacturing*** *is available, free of charge on the Statistics Canada Internet site under Downloadable Research Papers (see instructions on page 2 for download instructions).*

Further information, contact Antoine Rose, Statistics Canada, Life Sciences Unit, SIEID, (613) 951-9919.
Antoine.Rose@statcan.ca

Sample Questionnaires

Have you ever wanted to know how we collect all the information necessary to produce all these analyses? Much of the work in developing a new statistic or indicator is in creating the questionnaire and conducting the survey.

The questionnaire contains the actual questions being asked of the respondent. Developing one requires:

- extensive research into the analytical and policy questions that need to be addressed,
- an understanding of existing data sources, as well as
- a good understanding of what kinds of questions the respondents are willing and able to answer.

Most of our questionnaires are extensively pre-tested with a group of respondents. If some of the questions are difficult to answer, they are revised before going out to the full sample.

So that people can better understand the source of our information we have made most of our questionnaires available for downloading free of charge on Statistics Canada's Web site. See page 2 for instructions on how to download them.

The questionnaires are organized by project, much like the **What's New?** Section:

Science and technology activities

- Federal science expenditures and personnel 1998/99: activities in the natural sciences
- Federal science expenditures and personnel 1998/99: activities in the social sciences

Industrial research and development

- Research and development in Canadian industry - 1997
- Research and development in Canadian industry - INPI - 1997
- Research and development of Canadian private non-profit organizations - 1997

Human resources and intellectual property

- Survey of intellectual property commercialization in the higher education sector - 1998
- Survey of intellectual property commercialization in the higher education sector, 1999
- Federal science expenditures and personnel 1998/99, intellectual property management 1997/98 fiscal year

Advanced technologies

- Innovation, advanced technologies and practices in the construction and related industries survey
- Survey of advanced technology in Canadian manufacturing - 1998

Innovation

- Survey of innovation - 1999 (manufacturing industries)
- Survey of innovation - 1996 (services industries)

Biotechnology

- Survey of biotechnology use in Canadian industry - 1996 and biotechnology firm survey -1997

Telecommunications

- Survey of Telecommunications Service Providers, 1997
- Telecommunications Statistics - Quarterly Report: Wireline Telecommunications Service Providers
- Telecommunications Statistics - Quarterly Report: Wireless Telecommunications Service Providers
- Survey of Wireline Telecommunications Service Providers, 1998
- Survey of Wireless Telecommunications Service Providers, 1998

Broadcasting

- Annual Return of "Broadcasting Distribution" Licensee, 1998
- Annual Return for Radio and Television Programming Undertaking(s) (including Networks)

Electronic Commerce

- Information and Communications Technologies and Electronic Commerce

Household Internet Use

- Household Internet Use Survey, November 1999

Money in the bank and banking on the net: the Internet and electronic commerce in the financial services industry

A new Statistics Canada study analyzes the preparedness of Canadian business to take advantage of the opportunities created by new technologies. It provides new indicators of electronic commerce, and the relationship between the Internet and a firm's ability to innovate.

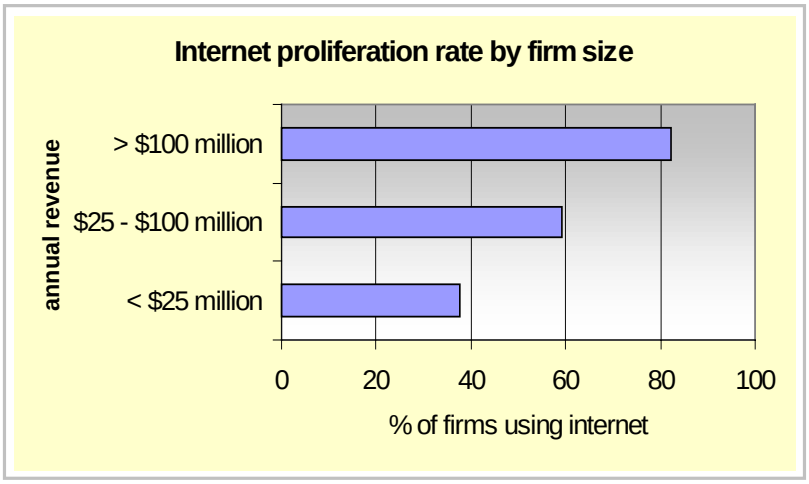
Many Canadian financial institutions were connected to the Internet in 1996, but very few used it to sell products.

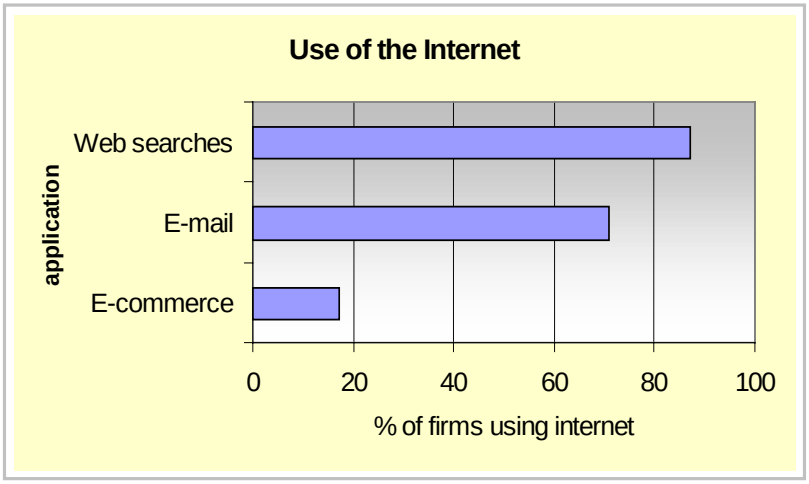
Supplementing Statistics Canada's work on the measures of households' access to the Information Highway, this groundbreaking study examines the use of the Internet banks, trust companies, life insurers, and property and casualty insurance companies.

"The Internet is creating a new business environment which requires new indicators and measures," says Mr. Hamdani. The study focuses on financial services because this sector is on the leading edge of technological change and its products are very suitable to Internet transactions.

In all, 56% of the financial and insurance institutions had Internet technology in 1996. Statistics Canada did not survey all sectors, but the study notes "based on private sector estimates, these data confirm the leadership of the financial services sector, in particular, the banks, in the adoption of Internet technology. An economy-wide survey recently launched will provide more comprehensive data."

Proliferation of Internet technology varies significantly from industry to industry within the sector. While 73% of the banks were connected, less than one-half of the property and casualty insurance companies used the Internet for their business in 1996.





The firm size also matters—the Internet proliferation rate rises with size. While more than four in five large firms were connected to the Internet, small firms still have to go a long way to catch up. Only 38% of the firms with annual revenue below $25 million had adopted the latest technology. However, these firms made more intensive use of it with 18% said that all of their employees had access to the Internet from their own desks. In comparison, only 8% of the large firms (annual revenue above $100 million) could make the same claim.

In spite of the substantially lower cost of doing transactions on the Internet as compared with the other electronic technologies such as automated banking machines and telephone banking, only 17% of those connected reported selling products on the Internet. "There are many reasons", explains Mr. Hamdani, "e-commerce was only beginning to attract attention in 1996, and just over 7% of the Canadian households had access to it. Moreover, the industry also has to cater to those who do not have access to the Internet or who do not want to use it as the point of access."

Connected firms use the Internet technology to gain a competitive advantage. "With the advent of the Internet" the study notes, "every transaction an individual makes leaves a vast amount of information about his product preferences and investment patterns in the hands of businesses." Institutions mine this information to create value for their customers, retain their loyalty, and increase market share.

Firms that use the Internet are not only more innovative than non-users but they also introduce more new products. Over one-fifth of the Internet users introduced more than three new products during the reference period as compared with just over 6% of those that were not connected to the internet.

"As the Internet technology is proliferating rapidly, the data are become dated as fast" notes Mr. Hamdani. These estimates serve as useful benchmarks in the development of business indicators of the information society."

The full paper, titled ***The Use of the Internet and Electronic Commerce in the Canadian Banking and Insurance Industry*** *was published in a book this year:* **Information, Innovation and Impacts**, *John de la Mothe and Gilles Pacquet (Eds.) by Kluwer, Norwell, Mass.*

Further information: Daood Hamdani, Chief, Innovation Section, Statistics Canada, (613) 951-3490. Daood.Hamdani@statcan.ca.

Total Spending on Research and Development in Canada

Research and Development (R&D) spending estimates for 1999 are $14.9 billion, an increase of 3.5% from the preliminary estimates for 1998 ($14.4 billion).

In 1999, the business sector will perform 63% of the total R&D, higher education 24% and the federal government, 11%.

The preliminary expenditures for 1998, $14.4 billion, represent an increase of 3.8% over the 1997 expenditures on R&D.

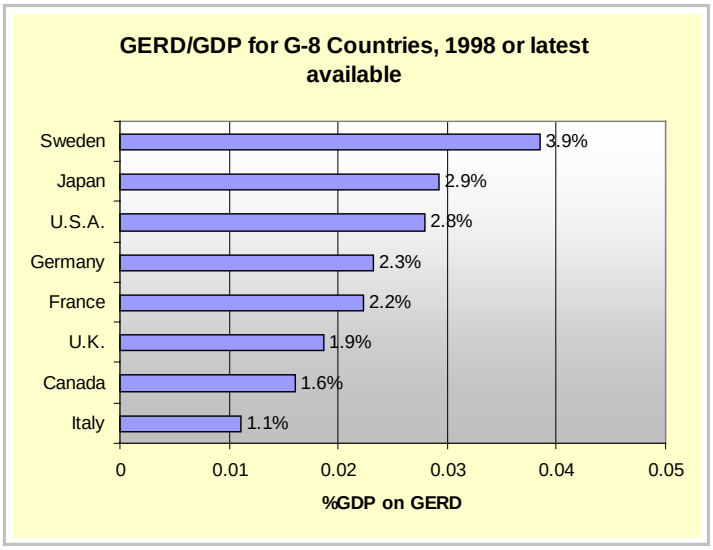
At 1.61% of Gross Domestic Product in 1998, Canada's planned R&D effort was similar to the percentage recorded in 1997 (1.60%). This ratio is lower than that of all G-7 countries, except for Italy (1.1%).

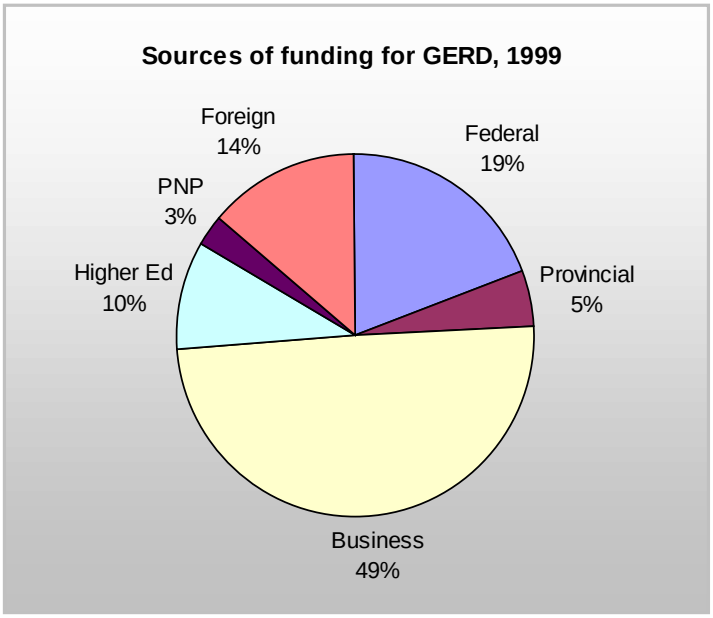
During the period 1988 to 1997, Ontario led Canada in business R&D spending. However, its share of the total for Canada declined from 59% to 53%. Québec traditionally invested substantially less in business R&D, but its share of the total rose from 25% to 31% over the same period.

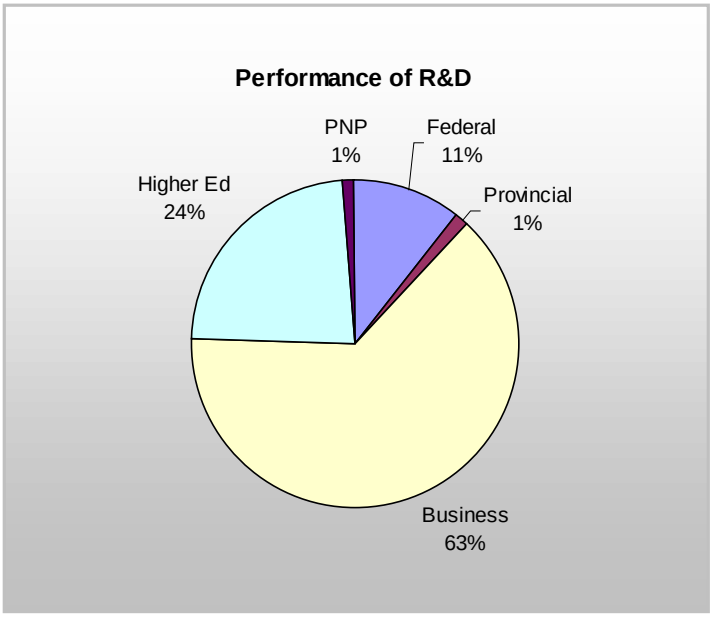
In 1997, 73% of Canadian R&D was performed in Ontario and Québec. This level of concentration has been maintained for the last five years.

The estimate for R&D in the higher education sector has been revised to include estimated values for R&D in hospitals not covered by university reports and not previously included. These values have been previously identified in Vol. 23 No. 4 of the service bulletin **Science Statistics** (Cat. No. 88-001-XIB).

Further information: Bert Plaus, Science and Innovation Surveys Section, (613) 951-6347. Bert.Plaus@statcan.ca.







Defining the information and communication technology sector

For years, policy makers and analysts in Canada and around the world have been interested in understanding and measuring the so-called "ICT" sector. With no standard definition, it has been difficult to monitor its development, make international comparisons and develop policies.

In 1996, Statistics Canada and Industry Canada published a working document, titled **Measuring the Global Information Infrastructure for a Global Information Society.** The purpose of this working paper was to propose a definition for the ICT sector based on the existing Canadian Standard Industrial Classification (CSIC) and to present a statistical profile of the Canadian ICT sector.

The proposed definition suggested that the ICT sector should include industries "primarily engaged in producing goods or services, or supplying technologies, used to process, transmit or receive information."

For the first time, a standard list of industries was adopted to describe the ICT sector and Industry Canada prepared and published a statistical review of the ICT sector based on this definition.

The OECD Definition

Shortly thereafter, the OECD and the Committee for Information, Computer and Communications Policy (ICCP) established an *ad hoc* statistical panel to address the issue of indicators for the information society. They developed a definition of the ICT sector based on a list of industries drawn from the International Standard Industrial Classification (ISIC).

Although the OECD definition of the ICT sector differs somewhat from the definition used in Canada at that point in time, the underlying principle is very similar.

Defining the ICT Sector in Terms of National Standards

The purpose of the OECD definition was to provide a framework to compile statistics that are comparable from country to country. Given that ISIC is not used in North America, it was necessary to develop a list of industries in terms of the national standard that is as close as possible in scope to the ISIC based definition.

The industry standard currently in use in Canada is the 1980 Canadian Standard Industrial Classification (1980 SIC). Canadian ICT statistics are produced on the basis of this standard. The 1980 SIC will be gradually replaced by the new North American Industry Classification System (NAICS).

1980 SIC Based Definition

Industry Group/ SIC	Industry Title
Manufacturing	
3341	Record Player, Radio and Television Receiver Industry
3351	Telecommunications Equipment Industry
3352	Electronic Parts and Components Industry
3359	Other Communication and Electronic Equipment
3361	Electronic Computers and Peripheral Equipment
3362	Electronic Office, Store and Business Machine Industry
3369	Other Office, Store and Business Machine Industries
3381	Communications and Energy Wire and Cable Industry
3911	Indicating, Recording and Controlling Instruments
3912	Other Instruments and Related Products Industry
Goods Related Services	
5743	Electronic Machinery, Equipment and Supplies Wholesale
5744	Computer and Related Machinery, Equipment and Software Wholesale
5791	Office and Store Machinery, Equipment and Supplies, Wholesale
9913	Office Furniture and Machinery Rental and Leasing
Intangible Services	
4814	Cable Television Industry
4821	Telecommunication Carriers Industry
4839	Other Telecommunication Industries
7721	Computer Services
7722	Computer Equipment Maintenance and Repair

The NAICS based definition will be presented in the next issue of this bulletin.

For further information on this topic contact: Daniel April, Chief, Telecommunications Section, SIEID, Statistics Canada (613) 951-3177. Daniel.April@statcan.ca

Plugged into the Internet

Canadian households are rapidly becoming more connected. More and more people are using the Net to stay in touch with each other, to bank, to shop, to search for medical information, to participate in on-line education programs, to browse for information, to play games, or to make travel plans.

Our jobs, communities, leisure activities and patterns of commerce are changing at a dizzying pace—the Internet is literally transforming the way we live, work and play. In 1998, 36% of Canadian households were regular users of computer communications – up sharply from 29% in 1997. And this technology revolution is not over yet!

Internet use most often from work or from home

Although household members may access the Internet from school, public libraries, cybercafés or their place of work, many people access the Internet from home. In fact, home use is a growing trend, and is rapidly catching up to access from work—in 1997, the prominent location of use was the workplace.

E-mail most popular use of the Internet at Home

Electronic communications continue to be used by households for a variety of purposes. But, whether they're sending messages to friends on the other side of the world, or proudly sending photos of the kids to family members just around the corner, e-mail is the most widely used Internet application. In a typical month, 86% used e-mail and 78% used the Internet for general browsing. A high proportion of households also searched the World Wide Web for specific information, such as to research a topic for a school project.

Well-educated, high-income households most likely to use the Internet

In 1998, the highest regular Internet use (65%) was among members of the top income and education households. This group was far more likely to use the Internet at work, school, public libraries and other places (as well as at home) than persons living in households with lower income or less education.

Younger generation more connected

Internet use is highest among households headed by a 35 to 54 year-old (47%). This may be partly due to the fact that middle-aged households have higher incomes. After accounting for income differences, young households and households with children under age 18 are more likely to be users of computer communications than older or childless households. Many parents may view Internet access as a way of preparing their children for the future and providing them with an advantage over peers who don't have access.

More and more Canadian households are embracing Connectedness. Alberta, British Columbia and Ontario top the list for use from any location, followed closely by Nova Scotia. People living in cities are more likely to be connected than those living in small towns and rural areas are.

Connectedness indicators, such as those mentioned in this article will continue to be monitored through ongoing surveys. At the same time, measurements of new aspects of household connectedness are planned. For instance, e-commerce will be explored in the 1999 survey, as well as non-users and dropouts of the Internet.

The full paper, titled ***Getting Connected or Staying Unplugged: The Growing Use of Computer Communications Services*** *was published in the July 1999 issue of* ***Services Indicators*** *(Cat. No.*

Computer communications at home are used for various purposes

	Penetration rates				percent of households spending less than 10% of their time on this activity		percent of households spending less than 50% of their time on this activity	
	percentage of all households		percent of regular home user households					
Purpose of use	1997	1998	1997	1998	1997	1998	1997	1998
E-mail	13.3	19.3	83.1	85.6	39.8	36.8	78.1	80.5
Electronic banking	3.1	5.5	19.6	24.4	66.0	67.0	89.5	90.0
Purchasing	1.5	2.5	9.2	10.9	88.1	91.6	98.3	99.3
Search for medical info	-	9.6	-	42.5	-	74.8	-	97.2
Education/training	-	6.8	-	30.0	-	32.3	-	79.9
Look for government info	-	8.2	-	36.4	-	75.9	-	97.9
Look for other information	-	15.3	-	67.9	-	28.5	-	80.1
General browsing	-	17.6	-	78.1	-	29.9	-	80.0
Playing games	-	7.8	-	34.4	-	48.4	-	90.1
Chat groups	-	5.7	-	25.4	-	52.4	-	88.4
Other Internet services	2.2	2.6	13.7	11.6	66.1	71.7	90.5	96.5

Note: Several new categories were added in the 1998 survey.

63-016-XIB). A summary was published in the December issue of ***Canadian Social Trends*** *(Cat. no. 11-008-XPE).*

Further information: Jonathan Ellison, Household Internet Statistics Unit, SIEID, Statistics Canada, (613) 951-5882 Jonathan.Ellison@statcan.ca

Estimates of Federal Government Expenditures on Scientific Activities, 1999-2000

After a stable percentage of 3.6% of the federal budget, in recent years, 1997-98 S&T values increased to 3.7% of the federal budget, 1998-99 to 4.0%, and 1999-2000 an estimate of 4.2%.

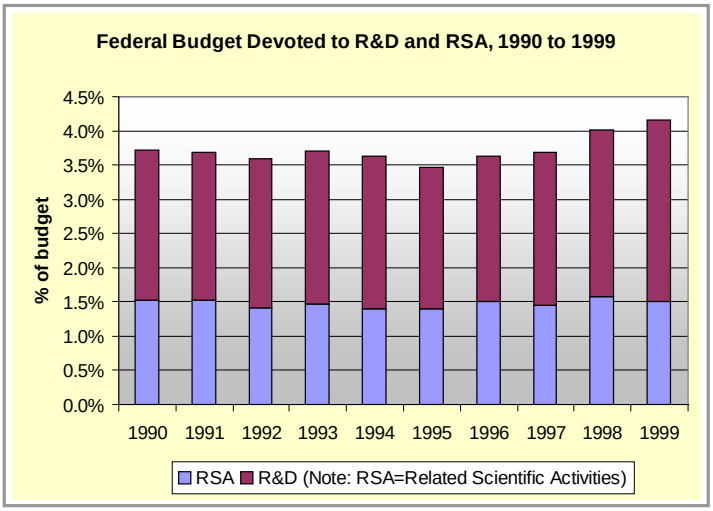
S&T spending intentions for 1999-2000 are $6.3 billion, an 8.0% increase of value forecasted for 1998-99.

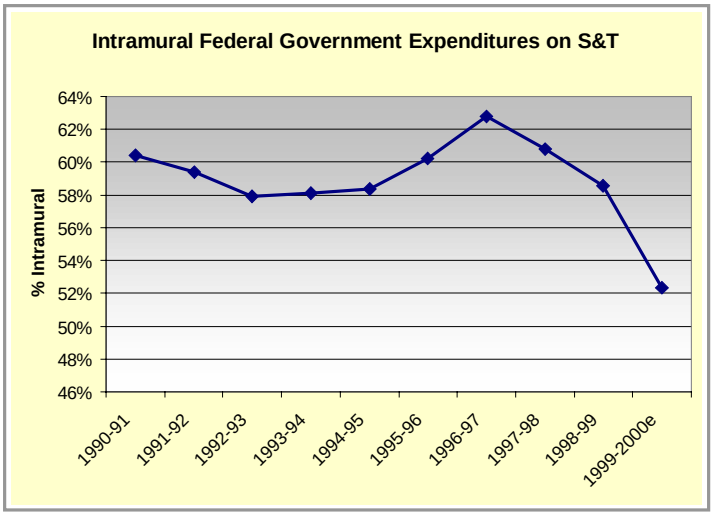
The federal government funding of R&D expenditures is over $3.5 billion for 1998-99 and is estimated at $4.0 billion for 1999-2000, a 13% increase. The increased federal expenditures are due to the funding of the Canada Foundation for Innovation (CFI) to the higher education sector. Established by the Government of Canada, CFI's mandate is to increase the capability of Canadian universities, colleges and hospitals to carry out world class R&D by investing in research infrastructure.

About 52% of science expenditures are spent on activities performed by the federal government itself (intramural).

The government also funds S&T activities in business enterprise, higher education, provincial governments, private non-profit organizations and other Canadian and foreign organizations. Extramurally, the largest recipients of federal government funds in 1999-2000 are the higher education sector with 26% and the business enterprise sector receiving 16%.

The departments with the largest estimated expenditures on natural science activities in 1999-2000 are the Canadian Foundation for Innovation (CFI), the National Research Council, the Natural Sciences and Engineering Research Council and Environment Canada. In 1999-2000 they will account for 34% of the government's total expenditures.





Statistics Canada is the government's major spender of social sciences funds, $419 million in 1999-2000 a decrease from $457 million in 1998-99.

Due to reviews of science reporting methodologies by several major departments, historical revisions have been incorporated back to the year 1992-93.

Activities in the natural sciences and engineering receive over 78% of the total expenditures in 1999-2000, of which 77% is to be spent on research and development (R&D).

The data in this publication are consistent with expenditures of departments and agencies as reported in the Main Estimates 1999-2000, but do not reflect changes to 1999-2000 spending plans which may result from supplementary estimates or other departmental planning decisions.

The full text of the service bulletin **Science Statistics** (Cat. No. 88-001-XIB Vol. 23, No. 5) may be downloaded from the Statistics Canada Internet site under Downloadable Publications ($). An annual publication**, Federal Scientific Activities**, Cat. No. 88-204 was released in December 1999. Please see page 2 for instructions.

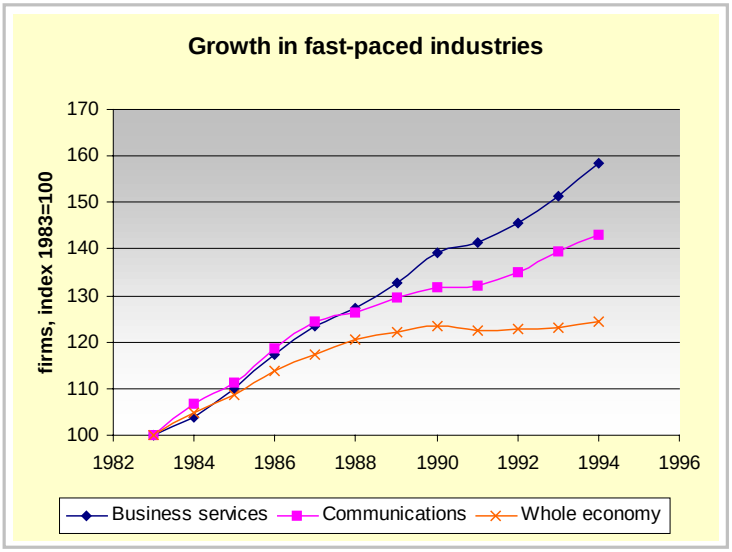
Further information: Bert Plaus, Science and Innovation Surveys Section, (613) 951-6347. Bert.Plaus@statcan.ca.

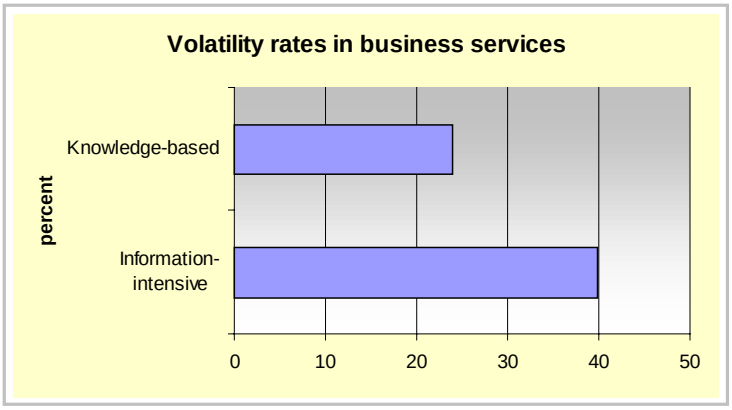
Business start-ups and closures provide clues to innovation

A Statistics Canada study uses business demographics to learn about innovation and technological change and uncovers interesting patterns.

The high risk of failure does not deter innovators from entering the market to test their products in the marketplace. Fast-paced, technologically sophisticated industries attract more new firms than other industries even though the closure rates are high.

This is the finding of a study that is part of Statistics Canada's work on developing indicators of science and technology. The study constructs volatility indexes by combining new business starts and closures to measure what economists call creative destruction. "The start-up of a new firm and the closure of an old one are both signals of economic and technological change. Together, they provide useful insights into the magnitude of innovation activity," says Daood Hamdani, chief of Statistics Canada's Innovation Section.





Contrary to expectations, the author uncovered considerable creative destruction in the service sector. The volatility rate for this sector was 31%, compared with 23% for the manufacturing sector. Firms that do not innovate frequently are replaced by new ones that have new or improved products to offer or employ more efficient methods of production and delivery. Low up-front costs of setting up a business in many service industries make entry and exit of firms relatively easy. Little physical capital is required because the core asset of service firms is knowledge of their employees. Building a factory, by contrast, requires a sizeable amount of money and liquidating it can result in a significant loss.

Carrying the analysis to a finer industry detail, the study found that life spans of products and firms are shorter in the innovative and fast-paced business services (including professional services, advertising and software development) and communications industries. Still, they are the fastest growing industries in terms of the number of firms.

When the data for the business services industry were broken down into finer detail, information intensive industries were found to be much more volatile than the knowledge-based industries. The volatility of information-intensive industries (comprised of advertising and computer services) was almost double that of knowledge-based industries (covering accountants, lawyers, architects and engineers). Fewer firms enter and leave knowledge-based industries because the "cost both of entering and of leaving a professional service is very high in terms of human capital and it takes a long time (nearly two decades of schooling and training) to accumulate enough capital. Switching professions means writing-off a huge amount of human capital", writes Daood Hamdani, the author of the study.

The full paper, titled "Business Demographics as Indicators of Innovation Activity" is available from Statistics Canada's Internet site. It was published under the title ***Business Demographics: Volatility and Change in the Service Sector*** *in Service indicators (Cat. 63-016-XIB), 2nd Quarter 1997 and reprinted in Canadian Economic Observer, March 1998 (Cat. No. 11-010-XPB).*

Further information: Daood Hamdani, Chief, Innovation Section, Statistics Canada (613) 951-3490. daood.hamdani@statcan.ca.

Biotechnologies adopted in many firms despite obstacles

Some analysts suggest that biotechnology may trigger a revolution equal to the one prompted by information technology. Various sectors of Canadian industry are already actively using biotechnologies for purposes ranging from research and development to pollution control. Many still see obstacles to adopting new biotechnologies including lack of information and government regulation.

The modification of living organisms—biotechnology—goes back at least to ancient Egypt where yeast was used to make beer. Since then, humans have modified both plants and animals to improve agriculture yields and breeding. Newer biotechnologies rely on science and engineering to modify living organisms and create new products.

Drawing on a 1996 survey on biotechnology use, Statistics Canada has produced two recent reports entitled: ***Biotechnology Use by Canadian Industry*** (1998) and ***Diffusion of Biotechnologies in Canada*** (1999). Together, the studies provide valuable insight into how Canadian firms use biotechnology.

"Some believe that biotechnology will trigger the next technological revolution," says Antoine Rose, a researcher with Statistics Canada's Life Sciences Unit. "That is why it's important to track the adoption of biotechnologies by Canadian industry. For policy purposes, it's also important to better understand the obstacles to adoption."

For all its importance, there is still no universally recognized definition of biotechnology. It can range from older techniques such as fermentation, and traditional breeding of animals and plants to more advanced techniques such as gene therapy. For the survey, biotechnologies were broken down into three categories:

- **bio-selection** (the analysis of components and processes of living organisms to understand or modify their characteristics, including recombinant DNA and gene therapy)
- **bio-environment** (the use of microrganisms to treat industrial waste and pollution, including processes such as bioaugmentation, bioremediation and biological gas cleaning)
- **bio-culture** (the use of living organisms, in whole or in part, in production processes such as tissue culture, biopesticide and classical breeding)

Biotechnology in action

The survey covered over 2,000 firms in industries that were likely to use biotechnology: aquaculture; forestry; agro-industry manufacturing; wood, pulp and paper products; oil and gas extraction and refining; and chemical industries including pharmaceuticals.

Overall, 14% of the respondents use one or more biotechnologies. However, two sectors—food and paper and allied products—account for more than half of all biotechnology use 95% of all bio-user firms are concentrated in eight sectors. Only: 8% of firms with fewer than 50 employees use biotechnologies compared with 44% of firms that have more than 1,000 employees.

Many firms are active in more than one sector. The food and pharmaceutical sectors, for example, dominate both bio-selection and bio-culture activities. Meanwhile, resource sectors dominate bio-environment activities, particularly bioremediation, which breaks down hazardous substances. Generally, more firms are active in bio-culture and bio-environment activities compared with bio-selection (see Table 1). This isn't surprising given that bio-selection technologies are generally more advanced and require greater knowledge.

Table 1. Number of firms using biotechnologies - 1996

	Number of firms	% of firms	% of total revenue	% of total employment
Firms using at least one biotechnology	272	14%	53%	43%
Bio-selection	47	2%	9%	7%
Bio-environment	167	8%	39%	24%
Bio-culture	138	7%	25%	26%
Biotechnology planned use within two years	65	3%	9%	10%
Already using biotechnologies	39	2%	5%	6%
Non-users of biotechnologies	26	1%	3%	4%

Source: Statistics Canada

There are four stages of biotechnology use: research, use in the production process, use in a product and pollution control. Bio-selection activities focus on research; bio-environment processes tackle pollution; and biological material technologies are most often used in the production process. Few firms sell biotechnologies as part of their product line. As a result, the study concludes that biotechnology is primarily used as an input into existing programs. This may create problems for its future diffusion since firms can often draw on alternative production or pollution control methods.

Barriers to adopting biotechnologies

Some recent estimates suggest that biotechnology is likely to spread quickly, particularly in the agriculture and food sectors. However, the study reports that few current users plan to adopt new biotechnologies within the next two years.

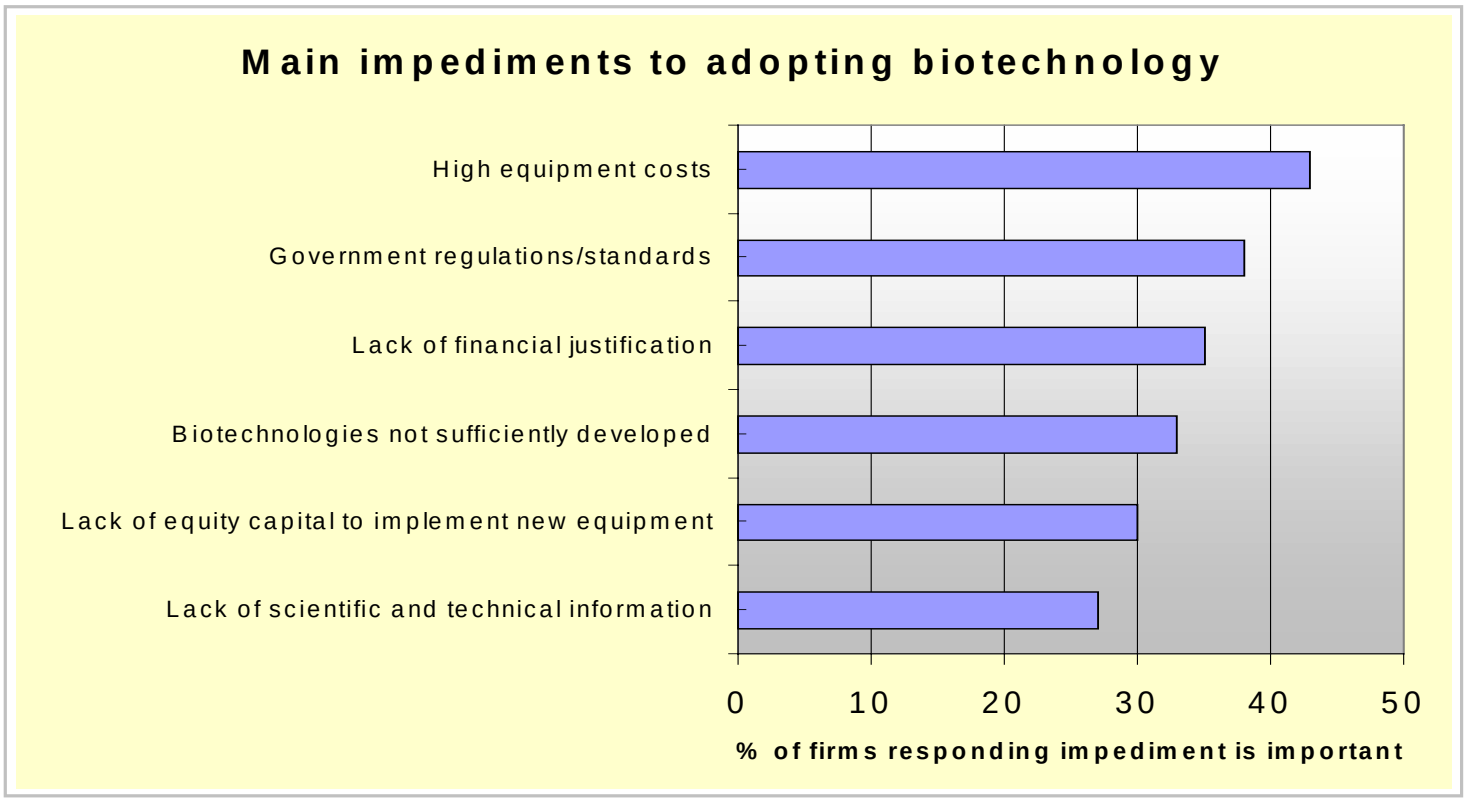
The reasons for the lack of interest vary by sector. Mining firms, for example, most often cite a lack of appropriate biotechnologies, a lack of information and skill shortages. In the wood, pulp and paper sector, high equipment costs are a key obstacle. Both the crude petroleum and petroleum refining sectors cite government regulation as an impediment to adopting new biotechnologies.

Biotechnology users quoted the major impediments to adopting biotechnology as high equipment costs, government regulations or standards, lack of financial justification, insufficient development of biotechnology and a lack of equity capital to implement new biotechnology acquisitions.

Not all sectors view government regulation negatively. Comparing resource industries with manufacturers, the manufacturers were less likely to see regulation as an important impediment. Since resource firms are major users of environmental biotechnology, environmental regulations may be perceived by firms to restrict the take up of biotechnology. On the other hand, food-producing firms and large pharmaceutical firms do not see regulation as an important impediment. It's possible that these two sectors view regulation as a necessary part of business.

The papers discussed in this article are available free of charge on the Statistics Canada web site. Please see instructions on page 2 for details on downloading our research papers for ***Diffusion of Biotechnologies in Canada*** *(1999, by Antony Arundel, MERIT) and working papers for* ***Biotechnology Use by Canadian Industry*** *(1998 by Antoine Rose)*

Further information, contact Antoine Rose, Statistics Canada, Life Sciences Unit, (613) 951-9919. Antoine.Rose@statcan.ca.



What's new?

Recent and upcoming events in innovation analysis

Science and Innovation

S&T Activities

Federal and provincial S&T

Federal science expenditures

Status: A service bulletin, Science Statistics, Cat. No. 88-001, Vol. 23, No. 5, was released in October 1999. An annual publication**, Federal Scientific Activities**, Cat. No. 88-204 was released in December 1999.

University R&D expenditure estimates and personnel

Status: A service bulletin, Science Statistics, Cat. No. 88-001, Vol. 23, No. 7, was released in November 1999.

Gross expenditures on research and development (GERD)

Status: A service bulletin, Science Statistics, Cat. No. 88-001, Vol. 23, No. 6, was released in November 1999.

R&D personnel in Canada

Status: A service bulletin will be released in the spring of 2000.

Contact: Bert Plaus (613) 951-6347,
Bert.Plaus@statcan.ca

or: Janet Thompson (613) 951-2580
Janet.Thompson@statcan.ca

Industrial R&D

Research and development in Canadian Industry

R&D in Canadian industry

Status: A service bulletin, Science Statistics, Cat. No. 88-001, Vol. 23 No. 3 was released in June 1999.

Contact: Don O'Grady (613) 951-9923
Don.O'grady@statcan.ca

Private non-profit organizations

R&D expenditures in private non-profit organizations

Status: A service bulletin, Science Statistics, Vol. 23, No. 8 was released in November 1999.

Contact: Robert Schellings (613) 951-6679
Robert.Schellings@statcan.ca

Human Resources and Intellectual Property

The higher education sector

Intellectual Property Commercialization in the Higher Education Sector

Status: The 1999 survey is in the field. A working paper will be released in early 2000.

Federal government research establishments

Intellectual Property Management

Status: The survey is in the field.

Human resources in science and technology

Science and Technology Workers: Deployment in the Canadian Economy

Status: A working paper, An analysis of science and technology workers: deployment in the Canadian economy, was released in June 1999. To download a copy, please see instructions on page 2 for *Downloadable Research papers (free).* Three further reports from this work (*The Work Force in the Computer Services Industry*, *The Work Force in the Telecommunication Carriers Industry* and *The Work Force in the Communication and Electronic Equipment Industry*, each subtitled *A Skill Base in Transition: 1986 to 1996*) will be available in early 2000.

Contact: Michael Bordt (613) 951-8585
Michael.Bordt@statcan.ca

Advanced Technologies

Innovation and advanced technologies and practices in the construction and related industry

Status: The availability of data from the 1999 survey was announced in the Oct. 26, 1999 edition of The Daily.

Advanced technologies in natural resource industries

Status: The survey is still under development.

Contact: Frances Anderson (613) 951-6307
Frances.Anderson@statcan.ca

Advanced technology in Canadian manufacturing

Status: Data from the 1999 survey are available.

Contact: Brenda Hutchinson (613) 951-3497
Brenda.Hutchinson@statcan.ca

Innovation

Innovation in manufacturing

Status: Data from the 1999 survey will be available early in the year 2000.

Contact: Brian Nemes (613) 951-2530
Brian.Nemes@statcan.ca

Innovation in services

Status: A paper titled *Barriers to Innovation in Services Industries in Canada* by Pierre Mohnen and Julio Rosa will soon be released as a working paper.

Contact: Daood Hamdani (613) 951-3490
Daood.Hamdani@statcan.ca

Biotechnology

Biotechnology in industry

Status: A revised questionnaire will be in the field in March, 2000.

Contact: Antoine Rose (613) 951-9919
Antoine.Rose@statcan.ca

Connectedness

Contact: George Sciadas (613) 951-6389
George.Sciadas@statcan.ca

Telecommunications

Annual survey of telecommunications services

Status: The survey is ongoing.

Quarterly telecommunications statistics

Status: Results from the new quarterly survey have been released.

Contact: Haig McCarrell (613) 951-5948
Haig.McCarrell@statcan.ca

Broadcasting

Annual surveys of cable, radio and television

Status: An annex has been developed that addresses the provision of Internet services by cable companies. The survey is currently in the field.

Contact: Daniel April (613) 951-3177
Daniel.April@statcan.ca

Household Internet Use

Annual household Internet use survey

Status: The survey was conducted during the third week of November. The questionnaire has been updated to address household e-commerce.

Contact: Jonathan Ellison (613) 951-5882
Jonathan.Ellison@statcan.ca

Business E-commerce

Annual survey of information and communication technologies and electronic commerce, 1999

Status: The questionnaire is currently in the field. A sample questionnaire is available on the Statistics Canada Web site. Follow instructions on page 2 for *Downloadable Research papers (free)*.

Contact: Cathy Bakker (613) 951-2929
Cathy.Bakker@statcan.ca

International Activities

OECD

At the OECD, working groups are being framed to begin the next revision of the Frascati Manual, which provides guidelines for data collection on R&D. This will be discussed at the next Meeting of National Experts on S&T Indicators (NESTI) in June 2000.

Discussion papers are being prepared on definitions of electronic commerce, on the electronic content sector and on data to be collected for the Information Communication Technology Sector. These will be discussed at the next meeting of the Working Party on Indicators for the Information Economy (WPIIS) in April 2000, and some will be discussed at a Eurostat meeting in January 2000.