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Innovation Analysis Bulletin

10th ANNIVERSARY

A report from Statistics Canada with statistical and analytical updates on:

- **Government science and technology activities**
- **Industrial research and development**
- **Intellectual property commercialization**
- **Advanced technology and innovation**
- **Biotechnology**
- **Information society**
- **Telecommunications and broadcasting**
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In this issue

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Interpreting indicators of the commercial value of intellectual property (p. 15)

Despite some limitations, various indicators for evaluating intellectual property provide useful insights. This article discusses measures of commercial value and their limitations.

Commercializing innovative products: An overview of new statistical indicators (p. 17)

In the fall of 2007, Statistics Canada designed a survey to gather information on how successfully businesses commercialize innovative products. What strategies must businesses use to achieve their ends? How can they attain their business goals? How is commercial success or failure measured? These are some of the challenges that drove the development of a new survey on commercializing innovation.

Tracking use of Radio Frequency Identification tags in Canadian organizations (p. 19)

In 2006, a question on Radio Frequency Identification (RFID) tags was introduced on the Survey of Electronic Commerce and Technology. RFID tags are currently used by organizations for a wide variety of purposes. The concept of RFID tags combines radio frequencies and bar code systems, giving mobility to logistics. The data on RFID tag usage in Canada show the application of this technology is in its infancy. The small number of organizations that use RFID tags can be explained by the newness of the technology and the potentially high costs of investment and implementation. Despite the initial costs, organizations that use RFID benefit in the longer run.

Profiling Internet use among workers in the information and communications technologies sector (p. 22)

Internet use is a key hallmark of an information society. Assessing Internet use today goes beyond access to encompass a cluster of behaviours that reflect the individual's ability to participate productively in an information economy. This study compares the pattern of Internet use of Canadians working in the information and communications technology industries with that of other Canadians.

The story of the Innovation Analysis Bulletin (p. 25)

To mark the 10th anniversary of the *Innovation Analysis Bulletin* in 2008, we are taking a walk down memory lane to discover the story behind the creation of this periodical.

Departure of Frederic Gault (p. 27)

After working for more than 20 years on behalf of science and technology statistics, Dr. Frederic Gault, Director, Science, Innovation and Electronic Information Division, is leaving Statistics Canada.

What's new? (p. 29)

Read about recent releases, updates and new activities in the areas of information and communications technology, and science and technology.

New economy indicators (p. 32)

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Besides the articles to which we refer 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, the questionnaires we have used to collect the information are available for research purposes.

Symbols

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
p	preliminary
r	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
E	use with caution
F	too unreliable to be published

The last decade at Statistics Canada's Science, Innovation and Electronic Information Division

The last decade of the *Innovation Analysis Bulletin* (IAB) tells the story of the evolution of the Science, Innovation and Electronic Information Division (SIEID) and its precursor, the Science and Technology Redesign Project. This evolution brings all of the measurement and analysis activities together in an integrated approach to understanding technological and related organizational change. This includes measurement of research and development resources allocated to the formal generation of knowledge (research and development); the use and commercialization of intellectual property of universities, government laboratories and businesses; the activity of innovation; and the adoption and use of advanced manufacturing technologies, biotechnologies, information and communications technologies (ICTs), knowledge management practices, nanotechnologies, and emerging technologies.

From activities to linkages and impacts

One of the first acts of the Science and Technology Redesign Project, which began in 1996, was to work closely with the Advisory Committee on Science and Technology Statistics to produce a systems-based framework for developing new statistics in a coherent manner. The systems approach was influenced by the earlier work of Herbert Simon and J. Forester; the importance of knowledge creation, transmission and use came from the work of Paul David and Dominique Foray. Clearly stated was the need to link to policy issues by formulating and testing hypotheses and using the formal language of the framework to pose the questions. The first issue of the IAB summarized a paper on this framework: *Science and Technology Activities and Impacts: A Framework for a Statistical Information System*.

The framework looked at actors (governments, businesses, educational institutions and others) engaged in well-measured activities, such as research and development (R&D) performance and technology use in industry, and in evolving activities, such as innovation and the commercialization of intellectual property. However, the framework emphasized measuring linkages between the actors in order to reveal the dynamics of the system. These linkages identified sources of information for firms' innovation activity as well as how intellectual property was commercialized in universities—the subject of another article in the first IAB.

In the same issue, the paper, *Knowledge Flows in Canada as Measured by Bibliometrics*, was summarized. This was a bibliometric analysis of co-publication in Canada to reveal the knowledge flows between the actors and it demonstrated the utility of this kind of analysis for programme evaluation and research. The work also contributed to the creation of the Observatoire des Sciences et des Technologies[1] in Montreal, an organization that is still serving the Canadian research community.

A Dynamic Analysis of the Flows of Canadian Science and Technology Graduates into the Labour Market, a paper on linkages that was also summarized in that first issue, analysed data from the National Graduates Survey to show the industries to which the 1990 bachelor's degree cohort had moved by 1995.

From the beginning, the IAB provided information on technology use in Canada. Initially, this was limited to information and communication technologies (ICTs) and biotechnologies. The work expanded over the years to include surveys of technology use in manufacturing and pioneering work on the measurement of nanotechnologies, which is still evolving. One of the challenges of these lines of enquiry was finding the firms that used or developed the technologies. This was met by a short survey with a large sample, the Survey on Emerging Technologies, which identified firms to survey in greater depth about these technologies. This instrument has been successful and consideration is being given to applying the approach to finding other rare events in the economy.

The first issue of the IAB also reported on two papers on the use of computer communications services: *Canadians Connected* and *Getting Connected or Staying Unplugged: The Growing Use of Computer Communications Services*. These were the first of many reports on the Connectedness project that looked at the use of ICTs and their applications in Canada.

The framework emphasized the importance of the impacts of the activities and linkages, but this was recognized as a challenging undertaking that would require a combination of official statistics, case studies, analysis and expert opinion. Measuring impacts remains an objective for the program and more information is now available to support the analysis.

Involving the experts

The need for expert input into the development of indicators was recognized at the very beginning of the Science and Technology Redesign Project and a series of five workshops was

organized for staff to learn about topics of immediate interest. The first workshop, held in 1997, explored geography looking at local and regional systems of innovation, which are important in a federal country like Canada. One of the unexpected outcomes of the workshop was the recognition that discussion of these issues among academics, practitioners and statisticians was important. The Innovation Systems Research Network (ISRN) came into being as a forum for discussion of regional innovation, with the help of the National Research Council (NRC), the Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC). The ISRN transformed into a research consortium funded by the SSHRC and is now a leading force in the areas of economic geography and innovation.[2]

Three workshops on technologies and practices followed. The first, on ICTs, was held in 1999, when the new Organisation for Economic Co-operation and Development (OECD) definition of the ICT sector was being applied and there was a recognized need, for statistical purposes, to define electronic commerce. The subject of the second, held in 2000, was biotechnology and, again, there was a need at the OECD to define the activity for statistical purposes so that official statistics could be used to make international comparisons. The third, in 2001, built on an OECD forum held in Ottawa in 2000, and looked at knowledge management as a technology. The workshop contributed to an OECD project on knowledge management (OECD, 2003).

A recurring theme in the workshops—alliances, networks and partnerships as part of the innovation process—was the subject of the last workshop in the series. The authors and titles of all the papers from these workshops can be found in *List of Papers Published by Kluwer Academic Publishers,* in the *Economics of Science, Technology and Innovation Series* (2004), available in the SIEID Working Paper series.

The series of five workshops were part of a learning plan of the team and a way of contributing to the international debate. In addition to these workshops, the division supported an Industry Canada conference to review the finding of the 1999 innovation survey. This gave rise to an edited collection of papers, Gault (2003), which still provides a baseline for innovation research in manufacturing in Canada. This was followed by a workshop on innovation and policy in 2003 which resulted in another edited volume, Earl and Gault (2006).

One of the questions of policy relevance about innovation—how much money was made when the new products went to market or new ways were found to get products to market—gave rise to two workshops on commercialization and their reports, *Summary: Meeting on Commercialization Measurement, Indicators, Gaps and Frameworks, Ottawa* and; *Summary: Joint Statistics Canada–University of Windsor Workshop on Intellectual Property Commercialization, Windsor* appear in the SIEID Working Paper Series.

The OECD Blue Sky II Forum: What Indicators for Science and Technology and Innovation Policies in the 21st Century? was held in Ottawa in September 2006. SIEID hosted this most recent workshop with the support of Industry Canada and the U.S. National Science Foundation. It attracted 250 people from 25 countries and featured about 50 papers (OECD, 2006). Selected papers were subsequently edited and, in some cases, combined and published (OECD, 2007) in order to support a broader public discussion, which is still ongoing.

International standards

Work on science, technology and innovation indicators does not take place in isolation. The first question raised by the users of the indicators is how they compare with those of other countries or regions. For the last 50 years, the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) and its predecessors have set the standards for data collection and interpretation. NESTI is best known for the *Frascati Manual* (OECD, 2002), which is now in its sixth edition and deals with research and development. The *Frascati Manual* process has given rise to the Frascati family of manuals that provide guidance on a wide range of statistical measurement, including innovation, patents, human resources, and technological balance of payments, all listed in the current manual.

The NESTI approach was applied to the development of indicators for the information society with the establishment in 1997 of an ad hoc panel chaired by a vice-chair of NESTI. In 1999 the panel became the Working Group in Indicators for the Information Society (WPIIS) and now has at least as complex and policy-relevant an agenda as that of NESTI. WPIIS defined the ICT sector, for statistical purposes, and went on to define ICT products and electronic commerce. Its model surveys provide a means of probing what is done with the ICT infrastructure that has been established over the last decade. These surveys influence Statistics Canada's Canadian Internet Use Survey (CIUS) and Survey of Electronic Commerce and Technology (SECT).

In 2000, when the need for internationally comparable biotechnology statistics from official sources was recognized, NESTI and the Working Party on Biotechnology (WPB) agreed to establish an ad hoc group on biotechnology statistics. While the task was not as straightforward as for ICTs, the group did produce definitions and gather statistics that are now used for international comparison. The group brought its initial tasks to an end in 2004 and worked virtually until NESTI brought it back into being to serve the growing needs of WPB.

In 2007, the Working Party on Nanotechnology was created to examine the policy implications of nanotechnologies. NESTI created an ad hoc group to undertake the very complex task of developing definitions for statistical purposes in consultation with other international organizations.

The ad hoc groups on biotechnology and nanotechnology are chaired by staff from SIEID, as is NESTI. WPIIS was chaired by a member of SIEID from 1997 to 2002 and since then has had a vice-chair from the division. This involvement of SIEID in the development of international standards is paralleled by its divisional learning plan and is reflected in its surveys.

One of the initiatives of both the OECD and SIEID in the area of knowledge management practices did not give rise to an ongoing statistical group or a manual, although it did result in an OECD survey and an edited book of papers from that work (OECD, 2003). It may have been that policy users of the statistics were ready for indicators related to ICTs, biotechnologies and nanotechnologies, but were not ready for indicators of human practices that in themselves are close to technologies. That did not mean that the work had no influence as it appears in the third edition of the *Oslo Manual* (OECD and Eurostat, 2005) which extended the definition of innovation from new or significantly improved processes and products to include new industry structures or use of new practices and the development of new markets, or new approaches to existing markets. The WPIIS has also moved to look at electronic business practices. The work on knowledge management and related business practices has diffused across a number of communities of practice rather than becoming a separate focus with its own working group and manuals, but it is still there influencing international standards.

Outreach

Learning is enhanced by transferring knowledge to others and by understanding and trying to solve their problems. SIEID has undertaken a number of knowledge transfer experiences over the years and has gained a lot from them. Staff has worked with Ethiopia, Hungary, South Africa, Latin America and the Caribbean on ICT indicators and more broadly with China, South Africa and Spain on indicator development. For example, in 2004, 27 Chinese colleagues working on science and technology indicators spent time in Ottawa working with SIEID staff and in Montreal with the UNESCO Institute of Statistics.

Outreach takes different forms. Researchers from outside the statistical office, under very strict conditions, are allowed to gain access to microdata from surveys in order to do analysis. Participants have come mainly from Canadian universities and government departments, but there have also been visitors from the Netherlands and Germany. As a result of the program, a community of researchers and policy analysts is able to work with data from innovation and technology use surveys and to test hypotheses that bear directly on policy issues. Findings have appeared in federal policy documents and have informed work in a number of OECD countries.

Another form of outreach is the case study and the testing of questionnaires by interviewing helpful respondents. *Characteristics of Growth Firms*, in the Working Paper Series, is an example of the findings of a case study. Every new SIEID questionnaire is tested before it is used and this is an opportunity for respondents to learn about the work of the division and to contribute to it.

SIEID staff present the division's work to groups from all over Canada. This has led to financial support for increasing survey samples in some Canadian provinces. It has also led to a wider understanding of the use of science, technology and innovation indicators.

Publications of the division are a key element of outreach and SIEID's principal vehicle is the IAB, which is read around the world, on average, by over 1,000 people each month. The Connectedness Series provides peer-reviewed papers on the information society and much of SIEID's work appears in publications and working papers (see the references at the end of this article).

Where next?

The previous issue of the IAB, released in October 2007, covered many topics that are current policy preoccupations: collaboration in innovation; global supply chains; biotechnologies and nanotechnologies; R&D outsourcing and innovation; selling R&D services domestically and abroad; Internet benefits; and highly qualified personnel (HQP).

These topics were also highlighted in the OECD Blue Sky II Forum in 2006 (OECD, 2007) and they are shaping the work of SIEID, its learning activities, its international participation, and its knowledge sharing.

The common direction is developing better indicators of linkages (collaboration, funding, trade, and supply chain links) to add to existing indicators of activities (R&D performance, intellectual property management, innovation, commercialization, and HQP development and use) and better indicators of outcomes (such as revenue from new products introduced in the last three years, changes in employment levels, or new markets developed). This direction both defines and restricts the work program. While partners are welcomed for all projects, not all proposals from outside are accepted. For a project to be undertaken, it must contribute to the objectives of SIEID.

The difference between work on indicators now and 20 years ago is that markets have changed as emerging economies have become major players; business communications have changed with ICT diffusion; energy and food supplies are being strongly coupled by biofuel policies; food and health care delivery being transformed by biotechnology; and many other areas, including security, are being transformed by nanotechnologies. The ICT infrastructure is enabling supply chain and value chain management across company and geographical boundaries and, in most industrialized countries, all of the technologies just mentioned are contributing to monitoring and managing the therapeutic care of aging populations.

The challenge is to understand the dynamics of change and that means developing and using more indicators of linkage and of outcomes, and engaging in studies of impacts of science, technology and innovation activities. The rich collection of findings from the last decade, chronicled in the IAB, provides a base for this work in the next decade. As the last decade has shown, the most interesting activities cannot be

predicted. However, a knowledgeable, intellectually agile, and a well-connected team, able to learn and produce internationally comparable official statistics, is fundamental to the support of evidence-based policy.

Canada is not alone in addressing these challenges. The OECD has embarked on an organization-wide project to develop its Innovation Strategy, inspired by the Jobs Strategy of the 1990s. The next two years will offer opportunities for growth in understanding and leadership.

Notes

1. http://www.ost.uqam.ca.

2. http://www.utoronto.ca/isrn.

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Fred Gault, former Director, SIEID, Statistics Canada

Statistics Canada's life sciences statistics program: Future directions and challenges

Data collected through Statistics Canada's life sciences statistics program indicate that Canada has a sizable biotechnology sector in comparison with larger countries in Europe. This program regularly provides assistance to other countries, which view Canada as a world leader in the development of biotechnology statistics. This article notes the future directions and challenges facing the program.

Over the past decade Statistics Canada's biotechnology surveys have provided a clear, consistent and comparable picture of the biotechnology sector in Canada. This is unique in the world. Biotechnology, along with information and communications technologies (ICT) and nanotechnology, has been labelled an 'enabling technology.' Such technologies were identified by the federal government in **Mobilizing Science and Technology to Canada's Advantage (2007)** as "underpinning many of the most transformative advances in science and technology". These advances form the foundation for opportunities to build strategic advantages for Canada in a competitive global marketplace. The potential impact of these enabling technologies touches all four of the government's stated priorities: environment, energy, health and life sciences, and ICT.

Two of these enabling technologies—biotechnology and nanotechnology[1]—are also 'emerging' technologies: their scientific foundations are comparatively recent and their impacts have not yet been realized. Emerging technologies share a number of characteristics but, most notably, they have a broad range of potential applications and their incorporation into market production systems is in the earliest stages. Emerging technologies are assumed to follow a path from discovery through incremental improvement to dissemination as they move out of the laboratories and into the factory. However, this path is modified to meet more stringent regulatory obligations that apply to all human health products and to any genetically modified life form that will be released into the environment. These technologies continue to be actively developed in university laboratories but have also begun the shift into the marketplace with new products for the treatment of disease, production of biofuels, and new techniques for environmental remediation for a variety of traditional resource industry activities.

Evolving program

Statistics Canada's life sciences statistics program, based on the Emerging Technologies Survey, has evolved from a biotechnology focus and now provides measures of other science-based activities and their transition to the marketplace for these priority areas, through statistics on biotechnologies, nanotechnologies, bioproducts, and functional foods and natural health products. This evolution enables an understanding of the current state of the sector and its technologies. However, if the surveys are continued over time, we could determine the path of development of emerging technology in Canada and the impacts of government policies on its firms. By providing regular, consistent snapshots of biotechnology and other technologies, Statistics Canada's life sciences surveys are an important means of measuring these impacts over time. The Emerging Technologies Survey provides the capacity to collect similar statistics for bioproduct, functional food and nanotechnology firms as well.

Data have been used in a wide variety of forums by stakeholders in public, private and academic sectors. Researchers from the academic community rely on biotechnology databases and the knowledge of Statistics Canada staff in support of their research.

Monitoring progress

Biotechnology is an important transformative technology, and some biotechnology applications, existing or potential, raise important and legitimate public concerns. This makes policy choices more difficult to make and to sell. Political support is uneven across capitals. Meanwhile, as exemplified by the number of firms participating and the level of investment in research and development (R&D), biotechnology keeps making progress and is diffusing through the economy. This requires monitoring. Biotechnology increases our knowledge of living organisms and allows for the transformation of existing processes. However, and more importantly, it also allows for a substitution of inputs toward the use of biomass, a renewable resource, therefore with a potential to also become sustainable.

With a progressive switch toward more use of biomass, new product and process innovation may have significant substitution effects in the economy. As is often observed, such effects trigger losses in employment and capital in some industrial sectors and the potential for job creation and capital formation in others. These effects require monitoring if countries wish to minimize losses and maximize benefits to their population. An important motive for the monitoring of these changes is the need to minimize the costs associated with this shift.

Other member countries of the Organisation for Economic Co-operation and Development (OECD) are in the process of building biotechnology statistics programs and some data are now available to permit comparisons between countries.

Table 1
Key biotechnology statistics from selected Organisation for Economic Co-operation and Development (OECD) member states, 2003

	Biotechnology revenues	Biotechnology research and development spending	Biotechnology employment
	millions of purchasing power parity dollars		number
Canada	3,842	1,488	11,864
France	2,146	671	8,923
Germany	3,222	1,353	17,277
United Kingdom	5,701	2,007	22,406
United States	51,655	16,834	130,305

Source: OECD, 2006.

Canada's biotechnology sector

Table 1 indicates that Canada has a sizable biotechnology sector in comparison with larger countries in Europe, such as France and Germany. In addition, the Canadian biotechnology sector is comparatively R&D-intensive, with a ratio of sales to R&D that is lower than all but Germany, while the United States and France report higher levels of sales per unit of R&D.

Statistics Canada has been very active on the international scene: for example, chairing the OECD ad hoc groups on biotechnology and nanotechnology statistics; leading in the development of internationally comparable statistics for biotechnology; and developing bioproducts and nanotechnology. The Statistics Canada biotechnology statistics program regularly provides assistance to other countries, which view Canada as a leader in the world in the development of biotechnology statistics.

Historically, Statistics Canada's life sciences statistics program was funded solely through the Canadian Biotechnology Secretariat, a co-ordinating agency that is now defunct. Agriculture and Agrifood Canada continues to support work on bioproducts and functional foods. In order to continue to produce statistics on biotechnology and nanotechnology, Statistics Canada is seeking other funding sources.

Note

1. While ICTs have transformed society and will continue to have profound impacts, both economic and social, as the ever-increasing power of computing systems is combined with more sophisticated software for specialized and general applications, they are sufficiently well developed that they are no longer truly 'emerging'. Biotechnology and nanotechnology, by contrast, are in much earlier stages of development.

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Adapted from the working paper, "Selected Results of the Biotechnology Use and Development Survey 2005", by Charlene Lonmo and Chuck McNiven.

Chuck McNiven, SIEID, Statistics Canada

Biotechnology spinoffs: Transferring knowledge from universities and government labs to the marketplace

When an existing firm decides not to commercially develop a discovery, enterprising entrepreneurs may establish a spinoff organization to pursue the venture. Of the 532 biotechnology firms in Canada in 2005, 179 reported that they were spinoffs from another organization.

Spinoffs are firms that have been established by entrepreneurs and have a strong connection to another organization. These entrepreneurs identify discoveries with economic potential that the originating organization chooses not to pursue. The technology may not be pursued because commercialization is outside the mandate of the organization (in the case of universities, hospitals and government labs) or because it is outside the core competence of the organization (in the case of other firms). The Biotechnology Use and Development Survey (BUDS) 2005 defined spinoffs as "new firms created to transfer and commercialize inventions and technology developed in universities, firms or laboratories".

Human health sector leads

Of the 532 biotechnology (biotech) firms in Canada in 2005, 179 reported that they were spinoffs from another organization (Table 1). The human health sector had the highest number (132) and the highest proportion (43%) of spinoffs, followed by agriculture and food processing. The vast majority of all biotech spinoff firms originated from public research organizations and not from businesses, biotech or otherwise. These trends mirror data from the BUDS 1999[1] when 34% of 358 biotechnology firms were spinoffs, found primarily in the human health sector and originating from public research organizations.

Table 1
Biotechnology spinoffs by originating organization and sector

	All firms	Spin-offs	Public research organizations	Businesses and other organizations	Spin-offs
		number			%
Human health	310	132	114	18	43
Agriculture and food processing	146	36	32	4	25
Environmental/ Natural resources	60	8	4	4	13
Other	16	3	3	0	19
All	532	179	154	26	34

Source: Statistics Canada, Biotechnology Use and Development Survey, 2005.

Spinning out

Spinning out divisions of large corporations as technologies or market conditions change is an established practice (Malecki, 1981). Spinoffs from public research organizations are a more recent phenomenon that seems to have paralleled changes in

intellectual property rights to publicly funded research. Today it is not unusual to have small teams of graduate students or professors establishing small firms to try their hand at commercializing their scientific discoveries—or at least moving a discovery toward the market and selling a more developed idea whose potential can be more easily measured.

Spinoffs

Table 2 shows that biotech spinoffs tended to be newer firms, in operation an average age of 8 years, compared with 17 years for non-spinoff firms. The proportion of Canadian-owned and publicly traded firms did not vary significantly between spinoff and non-spinoff firms.

Table 2
Selected characteristics of biotechnology spinoffs and non-spinoffs

	Spinoffs	Non-spinoffs
	years	
Average age	8	17
	%	
Canadian owned	87	82
Publicly traded	26	24
Reported any revenue	73	87
Reported biotech revenue	59	76
Sought financing in 2005	63	36
Planned to seek financing in 2007	61	37
Rate of collaboration	65	46
Rate of collaboration with foreign partners	42	29
Rate of patenting	84	52
	number	
Average biotech employment	32	22
Average total employment	35	228
	$ millions	
Average biotech revenues	4.3	9.7
Average biotech research and development expenditures	4.3	2.7

Source: Statistics Canada, Biotechnology Use and Development Survey, 2005.

Average biotech employment was not strikingly different. Spinoffs averaged a total of 32 part-time and full-time biotech employees, whereas non-spinoffs reported 22. These figures become more interesting when compared with the total employment of these two groups of firms. For spinoff firms, almost all of their employees were biotech employees (32 out of 35), whereas for non-spinoff firms, only 10% of their employees were biotech employees (22 out of 228). This indicates that spinoff firms are much more focused on biotechnology than non-spinoff firms, with a far greater concentration of effort on biotechnology-related activities. This concentration of employees in biotechnology-related activities in spinoffs was also observed in the 1999 data.

Spinoffs were generally less likely to report biotech revenues—and less likely to report any revenues—than non-spinoff firms. Only 59% of all biotech spinoff firms reported biotech revenues, while 73% reported revenues from some other source. Figures for non-spinoffs showed a similar ratio, with 11% of firms reporting only non-biotech revenues, but the overall proportion of firms with revenues was higher at 87%. Average biotech revenues of spinoff firms were equal to their biotech research and development (R&D) expenditures, whereas non-spinoffs' biotech revenues were more than three times greater than their biotech R&D expenditures.

With average biotech revenues equaling average biotech R&D spending, it is not surprising to see that almost two thirds (63%) of all spinoffs sought financing in 2005 and a similar proportion planned to seek it in 2007. Figures for non-spinoffs were considerably lower, with only 36% seeking funds in 2005 and a similar proportion planning to seek funds in 2007.

Spinoffs differed from non-spinoffs in terms of their rates of collaboration as well. Spinoffs were more likely to collaborate with foreign organizations and more likely to collaborate in general. There was not as large a difference in the proportions collaborating only with Canadian partners (23% of spinoffs versus 17% of non-spinoffs). Finally, the proportion of firms using patents was significantly higher for spinoffs than for non-spinoff firms.

The big picture

Spinoffs tend to be smaller firms, with a concentration of activities related to biotechnology. Many are in a transition period as they shift ideas from public labs to the market. Higher rates of collaboration and patenting may be the result of a need to establish business credibility to counter their lack of years of experience and their tendency to report no revenues. Their average biotech R&D expenditures equaled their average biotech revenues and they were much more likely to be seeking non-revenue funding, perhaps by using patents as valuable assets that can be sold in the market to grant at least some measure of security for those providing funds.

Note

1. For all data from the Biotechnology Use and Development Survey (BUDS) 1999, see Byrd (2002).

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Why don't plants innovate? Findings from the Survey of Innovation 2005

The 2005 Survey of Innovation asked non-innovative manufacturing plants why they did not innovate; that is, why they did not introduce a new or significantly improved product or process to the market during the three-year reference period 2002 to 2004. Lack of market demand was the main response. An examination of respondents' other specified reasons shows that some non-innovators may actually be innovative although they do not perceive themselves to be. Innovative and non-innovative plants perceive success factors, such as developing and seeking new markets, in significantly different ways. Non-innovative plants are not expected to be innovative in the near future.

Based on the *Oslo Manual* guidelines,[1] the Survey of Innovation 2005 defines an 'innovative' plant as one that has introduced a new or significantly improved good or service to the market, or a new or significantly improved process, including a new or significantly improved way of delivering goods or services; a 'non-innovative' plant has made no such introductions. Only innovations occurring during the three-year survey reference period, 2002 to 2004, were considered in this analysis.

About this article

The sample unit for the Survey of Innovation 2005 was the 'statistical establishment,' for which the questionnaire substituted 'plant'. The more familiar latter term is also used in this article.

In the charts, each estimate is graphically illustrated as a horizontal bar. The confidence interval,[2] a horizontal line extending through the end of each bar, shows that the estimate lies within the indicated range of values 95% of the time. Individual estimates with confidence intervals that overlap are not statistically significantly different from each other; those with confidence intervals that do not overlap are statistically significantly different from each other.

More information about the Survey of Innovation is available at http://www.statcan.ca/english/sdds/4218.htm.

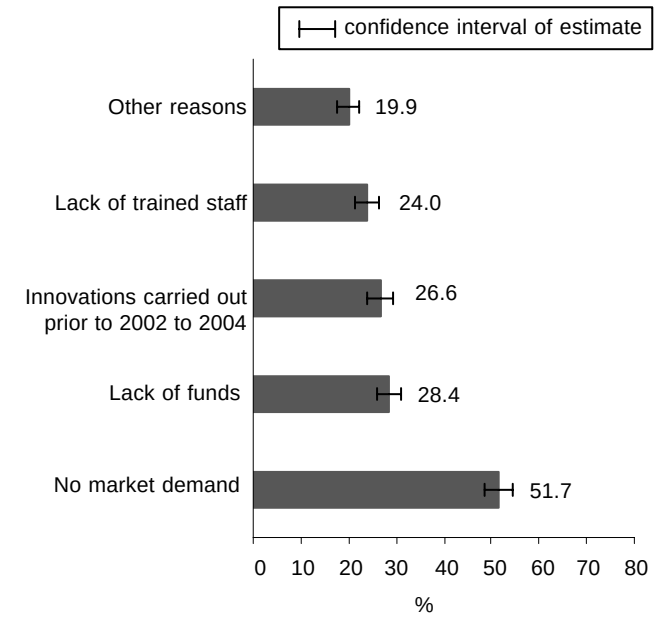
Preliminary results from the 2005 Survey of Innovation are now available. Please contact susan.schaan@statcan.ca for more information.

Lack of market demand is the main reason why plants did not innovate

One-third (35.0%) of manufacturing plants did not innovate from 2002 to 2004. These non-innovators were asked to indicate the reasons why they did not innovate during that period.

Not unexpectedly, lack of market demand was the main reason why plants did not innovate, with half (51.7%) of the non-innovative plants citing this reason (Chart 1). The three other principal reasons, each reported by about one-quarter of non-innovative plants, were lack of funds, having carried out innovations prior to 2002 to 2004, and lack of trained staff.

Chart 1
Non-innovative plants, by reasons for not innovating, 2002 to 2004



Source: Statistics Canada, Survey of Innovation, 2005.

Could some non-innovators actually be innovative?

An examination of the one in five (19.9%) non-innovative plants that specified a reason other than the four main ones for not innovating found that some non-innovators might actually be innovators. Some specified that they did not innovate because they were creating custom products according to customer specifications or orders. Others indicated that they operated as subcontractors in accordance with customer specifications and, as a result, were not innovative. The issue of customization is an interesting one. In the *Oslo Manual*, plants that are engaged in custom production and make items according to a customer's orders are not considered as product innovators unless the items have significantly different attributes from products that the plant has previously made. Given the focus of the

plant's activities on custom work, it could be that innovations in the process, rather than the product, have been overlooked. It is also possible that these plants attributed the innovation to the client or customer who provided the specifications rather than to themselves for having produced it.

A number of plants specifying a reason other than the four main ones for non-innovation indicated that they did not engage in innovation activities at their location but that these activities were carried out in other plants that were part of the larger firm or at the level of the firm itself. This reflects the influence of the sampling strategy on survey responses. The sample unit was the plant and not the firm, and so innovation activities outside the plant would not be taken into account. This is clearly a case where innovation is occurring in the larger firm but is not being captured because of the sampling strategy.

Some plants indicated that they were in 'traditional' industries where technology and operations had changed very little. It would appear that a number of plants that identified themselves as non-innovators might be innovators that do not recognize their own innovations. An emerging literature is looking at the issue of user innovation where the innovation occurring in plants is being carried out by users of technologies and is not limited to technology manufacturers. Capture of this innovation activity is not always recognized in traditional innovation surveys. Also at issue is incremental change, often seen in these traditional industries, as opposed to the "new or significantly improved" changes included in traditional innovation surveys.

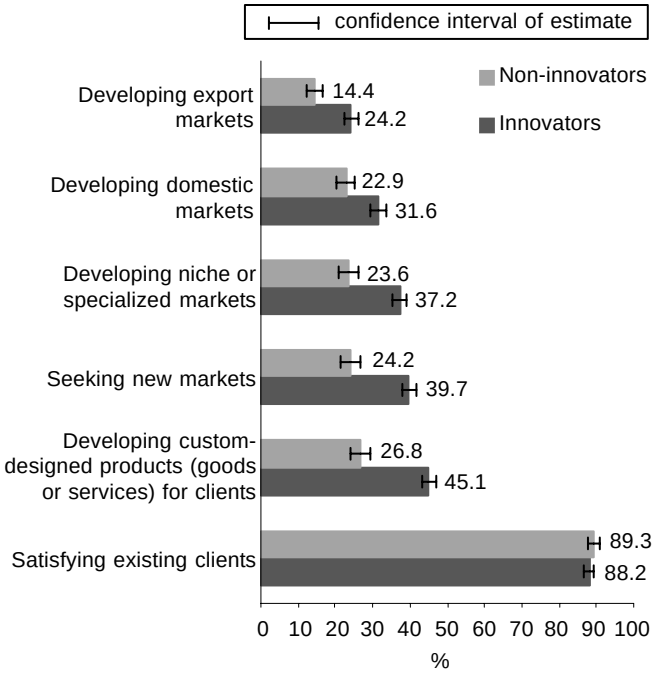
Do perceptions of success factors for innovative and non-innovative plants differ?

Plants were asked to indicate the importance of factors for their success. Of the six market- and product-related success factors offered, satisfying existing clients was rated as highly important by most innovative and non-innovative plants alike (Chart 2). However, for the remaining factors, there was a significant difference between innovators and non-innovators.

Developing new domestic and export markets and seeking new markets were more likely to be success factors of high importance for innovative plants than for non-innovators. This suggests that non-innovators perceive their markets to be stable and, therefore, do not view market expansion as highly important to their success the way innovators do.

Innovators are more likely than non-innovators to indicate that developing niche or specialized markets is a highly important success factor. Further, innovators are more likely to perceive that developing custom-designed products is a highly important success factor. This is an interesting finding as it suggests how important a role innovation plays in allowing specialization and customization of products for plant success and competitiveness in the marketplace. This is consistent with the observed trend in Canada of the transition from traditional manufacturing activities to manufacturing with a higher value-added component. Innovation would appear to play an important role in a plant's capability of making this transition.

Chart 2
Plants rating a high degree of importance to market- and product-related factors for the success for their plant, 2002 to 2004



Source: Statistics Canada, Survey of Innovation, 2005.

Will non-innovators be innovative in the future?

Survey data suggest that non-innovators are not likely to be innovative in the near future as they showed little indication of having carried out innovation activities during the reference period. Only small percentages of non-innovators engaged in activities to develop innovations that were still ongoing at the end of 2004 (13.4%) or were abandoned during the survey reference period (6.5%).

Notes

1. Organisation for Economic Co-operation and Development and Eurostat, 1997, *Oslo Manual*, 2nd edition: *Proposed Guidelines for Collecting and Interpreting Innovation Data*, Paris. These guidelines were adopted for the Survey of Innovation 2005.

2. As the sample drawn for the Survey of Innovation 2005 was only one of many possible samples that could have been drawn using probability sampling methods, a sampling error can be attributed to each estimate. Standard errors combined with imputation rates have been used to provide a guide as to the reliability of percent estimates. The System for Estimating Variance due to Non-response and Imputation program (SEVANI) was used to complete these calculations. For the Survey of Innovation 2005, a 95% confidence interval was used in the probability sample scheme.

Susan Schaan and Frances Anderson, SIEID

The use of patents and the protection of intellectual property in the Canadian manufacturing industry

Using data from the Survey of Innovation 2005, this article will examine the use of patents by Canadian manufacturing plants. Survey findings establish that plants use strategic methods more than patents for intellectual property protection. Patent use varies both by how big the plant is and whether it is innovative or non-innovative. In addition, the use of patents by Canadian manufacturing plants varies by the subsector in which they are classified.

What are patents?

Patents are rights granted to inventors—individuals or firms—so that they can benefit exclusively from their invention. In Canada, patents are generally granted for a period of 20 years from the date of the application. Patents can be used strategically to make a profit through selling or licensing the technology.[1]

In exchange for the exclusive rights granted them when they choose to patent their invention, inventors must pay a fee and describe, in writing, the uniqueness of their invention in clear and specific terms. This description is then available as a document for anyone to read.

In order to patent a technology in Canada, the inventor must show it to be novel and unique. The technology must have utility and it must also require a degree of ingenuity so that it is not obvious to someone who is skilled in the area of the technology.

About this article

The sample unit for the Survey of Innovation 2005 was the 'statistical establishment', for which the questionnaire substituted 'plant'. The more familiar latter term is also used in this article.

In the charts, each estimate is graphically illustrated as a horizontal bar. The confidence interval, a line extending through the end of the bar, shows that the estimate lies within the indicated range of values 95% of the time. Individual estimates with confidence interval values that overlap are not statistically significantly different from each other; those with confidence intervals that do not overlap are statistically significantly different from each other.

Further work based on the Survey of Innovation 2005 will be released in Summer 2008 in a working paper examining the use of different types of intellectual property by innovative firms.

More information about the Survey of Innovation is available at http://www.statcan.ca/english/sdds/4218.htm.

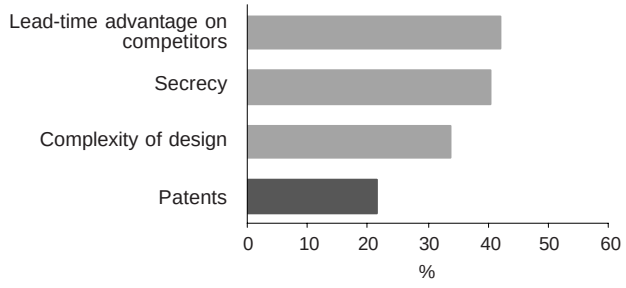
For further information about the Survey of Innovation or this article, please contact mark.uhrbach@statcan.ca.

Overview of intellectual property methods

During the three year period, 2002 to 2004, 3 out of 4 (76.4%) Canadian manufacturing plants used some method to protect their intellectual property (IP). During the three years, 2002 to 2004, about 1 in 5 (21.7%) plants used patents to protect their intellectual property. About 1 in 10 firms (12.2%) applied for a new patent during the three years, 2002 to 2004. In 2004, an average of 6.0% of the total revenue of Canadian manufacturing plants was protected by patents.

Manufacturing plants were more likely to use at least one of three identified strategic methods than to use patents to protect their IP: 42.4% used lead-time advantage over competitors, 40.4% used secrecy, and 33.8% used complexity of design, compared with only 21.7% of plants that used patents (Chart 1).

Chart 1
Use of patents by Canadian manufacturing plants compared to strategic methods of intellectual property protection during the period 2002 to 2004



Source: Statistics Canada, Survey of Innovation, 2005.

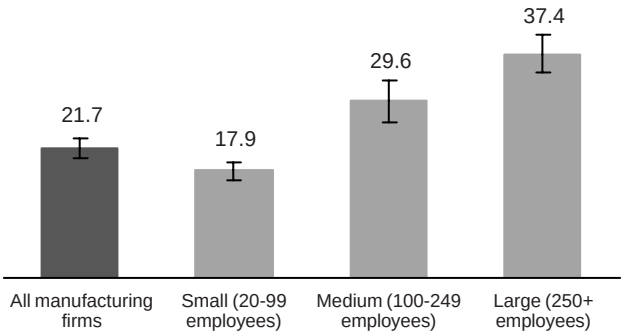
Plants may be less likely to use patents than strategic methods of IP protection for several reasons. The cost and the effort of procuring a patent may be a barrier for some plants. Also, some may feel that they will maintain a strategic or competitive advantage by keeping the new invention secret as opposed to disclosing its description and inner workings through patent documents. Finally, prosecuting another plant for patent infringement through legal means for copying a product or idea may be prohibitive or undesirable.

Patent use by size of plant

The Survey of Innovation 2005 collected data for three sizes of manufacturing plants: large (more than 250 employees), medium-sized (100 to 249 employees) and small (20 to 99 employees). During the reference period, a higher percentage of large plants (37.4%) than of medium-sized (29.4%) or small (17.9%) used patents to protect their intellectual property (Chart 2).

While large plants were more likely than their smaller counterparts to use patents, the data show that a similar share of plants of all sizes used strategic methods to protect intellectual property. During the reference period, about 60% of large, medium-sized and small plants used at least one strategic method to protect their intellectual property.

Chart 2
Percentage of firms protecting intellectual property that used patents during the period 2002 to 2004, by size

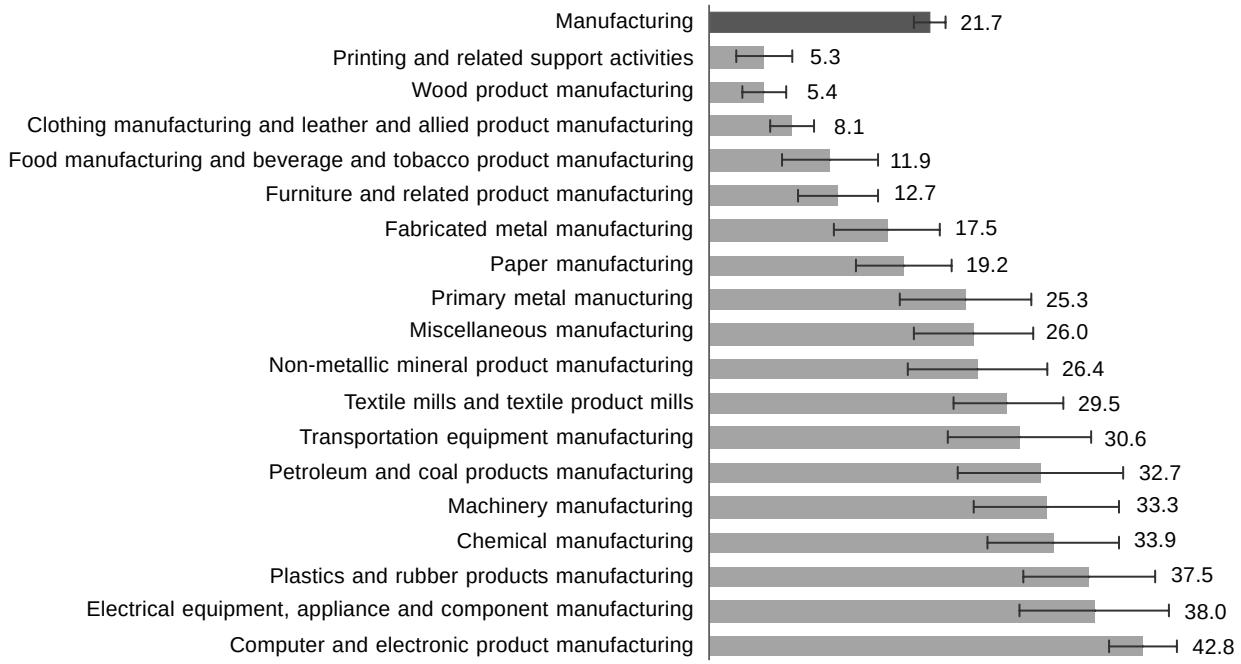


Source: Statistics Canada, Survey of Innovation, 2005.

Patent use by innovators and non-innovators

Innovators were more likely to use patents than non-innovators. More than one-quarter (27.9%) of innovative plants used patents during the reference period, while only one-tenth (10.2%) of non-innovative plants did so.

Chart 3
Percentage of manufacturing firms that used patents to protect intellectual property , by subsector, 2002 to 2004



Source: Statistics Canada, Survey of Innovation, 2005.

Patent use by subsector

By their nature, certain industries will be more likely than others to embrace the use of patents to protect their intellectual property. This may be related to factors such as the degree of competition within an industry and the products or technologies that are produced by these industries.

The data show that among the 18 subsectors in the Manufacturing sector,[2] patent use varies considerably (Chart 3). Three subsectors had among the highest levels of patent use during the reference period: Computer and Electronic Product Manufacturing; Electrical Equipment, Appliance and Component Manufacturing; and Plastics and Rubber Products Manufacturing. At the other end of the spectrum, patent use was lowest among plants in Printing and Related Support Activities, and Wood Product Manufacturing.

Notes

1. Further information on patenting in Canada is available through the Canadian Intellectual Property Office at http://strategis.gc.ca/sc_mrksv/cipo/patents/pt_main-e.html.

2. The 18 Manufacturing subsectors measured are all at the three-digit level of the North American Industrial Classification System (NAICS 2002).

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Interpreting indicators of the commercial value of intellectual property

Despite some limitations, various indicators for evaluating intellectual property provide useful insights. This article discusses measures of commercial value and their limitations.

Measuring the value of intellectual property (IP) is a relatively new and evolving activity. This note briefly reviews the methods of estimating the commercial value of IP, with a more detailed discussion of patents as an indicator of value.

Several aggregate approaches are used to estimate the commercial value of IP, notably the following: production or replacement cost; discounted cash flow; market capitalization minus the replacement cost of physical assets; and production cost plus return on capital used to capitalize research and development (R&D) expenditures. Each serves a useful purpose, but as measures of commercial value, they all have shortcomings: production cost is an input measure; the discounted cash flow method requires assumptions about economic and technological developments in the future; and the market capitalization approach measures more than IP and is subject to frequent and sizable changes.

The indicators approach, however, deals with certain components of intellectual property. The most common metrics currently available from this approach are the following: contribution of new and substantially improved products and processes to a company's sales; licence fees and royalties; and the number of patents held by an organization.

Evaluating the commercial value of patents

Transferability

- Need for additional development for commercialization
- Technological support at the time of technology transfer
- Licence-constraining conditions
- Obligation or co-operation of right holder in response to infringement
- Possibility of a dispute with third parties (legal)

Characteristics of technology

- Characteristics of the invention (base technology or application)
- Degree of technology superiority (if an improvement over an existing one)
- Technological field or industry of application

Duration

- Time structure of patent rights (years remaining in legal protection)
- Probability of emergence of replacement technology.

Some limitations of patents

These indicators provide useful insights, but they also have some limitations. Licence fees and royalties may not fully reflect a patent's commercial potential. For example, IP owners may issue licences royalty-free or at a low fee in the expectation of benefits in the future. Free or discounted-rate licensing encourages adoption of the underlying technology as the industry standard. This can establish the licensor as a technological leader in the long run, or it can induce other firms to develop complementary lines of business, thereby diversifying the underlying technology's applications and increasing its commercialization potential.

Some patents and copyrights may not be commercially viable

IP owners rarely commercialize all the patents and copyrights they hold. Some may not be economically viable under the prevailing market conditions. Changes in buyers' preferences since the technology was patented can reduce its economic feasibility. Technological advances may have rendered it obsolete. The IP owner may have reoriented its business, the patented technology may no longer fit its new strategy, and it may take time to find a licensee who is willing to commercialize it. However, such instances are likely to be few.

Some patents are used as levers of business strategy

Many of the patents and copyrights that are not commercialized contribute to growth in other ways (Table 1). IP has been used as a lever in business strategy for years and as it continues to gain increasing recognition as a valuable asset in the legal system and financial markets, it is becoming a means of raising capital. Some of the patents held by an organization may not have been intended for economic exploitation in the first place; rather, they were acquired to pre-empt competitors from entering that particular field of technology. Other patents can serve as collateral for loans, as backing for securitization

Table 1
How firms use Intellectual Property to create value

Function	Activities	Comments
Revenue generating	Licensing IP out to individual firms for a fee.	This is the preferred method of technology transfer, but 'grant-back' provisions and leakages are of concern. Some countries offer IP owners incentives, such as lower patent renewal fees, to promote technology transfer.
	Participating in a patent pool or exchange. These are often set up in 'patent thickets'—one-stop places for all patents needed to produce a product—where the risk of inadvertent IP infringement is high. These thickets negotiate licence fees favourable to users.	Patent thickets are generally found in information and communications technologies and biotechnologies. Pools function smoothly when participating technologies are complementary, not competitive.
Strategic	Licensing it out without a fee to get the underlying technology established as the industry standard.	This establishes the corporation as technology leader in its industry and positions it for long-term advantage.
	Offering non-exclusive royalty-free licences in order to foster development of complementary product and business lines.	Diversification of applications of a base technology increases its commercialization potential.
	Patenting a technology to pre-empt competitors, form strategic partnerships, and use it as a bargaining chip in business and financial deals.	Pre-emptive patenting is one of the reasons why some patents are not commercialized.
Financial	Attracting venture capital in order to expand business.	Patents and copyrights are said to be among the most important factors in the investment decisions of a venture capitalist.
	Using IP as collateral to borrow money from financial institutions.	Some institutions accept patents and copyrights and insurance policies on IP as sole or additional collateral for loans. This type of activity is in a very early stage.
	Securitizing IP to raise capital. This activity is very limited and usually requires a portfolio of patents to mitigate concerns over piracy, technological obsolescence and litigation over the underlying asset.	IP-backed securitization is beginning to gain some ground in the music and pharmaceutical industries.

Sources: Atuahene-Gima and Patterson 1993; Hamburg, Kiel and NRC 1996; and Kamiyam, Sheehan and Martinez, 2006.

and as a way of attracting risk capital by offering venture capitalists and other investors the prospects of a quick return. The music and pharmaceutical industries are the most likely ones to engage in these activities: the investor's or lender's concern about the risk of piracy and litigation over property rights that characterizes IP in these industries is mitigated by using a portfolio of patents, rather than a single patent, as the security.

Learning about the characteristics of patents

Although measuring the commercialization of IP presents challenges, further insights can be gained by learning more about the characteristics that determine patents' commercial value, notably the technical and exchange features of the underlying technology. For example, an asset is more valuable if it is easily transferable in an exchange, with no or little risk of litigation over property rights. A patent on an emerging technology offers more commercial value than one providing incremental improvement over an existing technology. Similarly, a patent portfolio with a longer-term structure of property rights is more valuable than one with rights about to expire in the near future.

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Commercializing innovative products: An overview of new statistical indicators

In the fall of 2007, Statistics Canada designed a survey to gather information on how successfully businesses commercialize innovative products. What strategies must businesses use to achieve their ends? How can they attain their business goals? How is commercial success or failure measured? These are some of the challenges that drove the development of a new survey on commercializing innovation.

Background

Increasingly, commercialization is proving to be of prime importance, indeed, as much so as production, for any company seeking to acquire a share of the market or merely to sell its products. There is no end to market studies aimed at gathering consumer opinions on the features of this or that new product.

Not only are firms looking for information on the features of competing products, they are primarily interested in winning over consumers, meeting their needs and, eventually, gaining their loyalty. Furthermore, this quest for information is often thought through even before a product is brought to market. Creating and fulfilling a new consumer need requires lengthy preparation. When it comes to commercializing a new product, planning can make all the difference between commercial success and failure.

Measuring commercial success

Commercializing innovation includes all activities that a firm must implement to derive an economic benefit from the launch of a new product. In general, the sale of products, especially innovative ones, requires a certain amount of promotion. Commercial success is measured to assess to what extent innovations are well received in the marketplace.

Commercial success occurs when a firm achieves its goals. Its aim may be to recover development costs, increase revenues, profits, exports or market share, or generate a strong demand for its product. The notion of commercial success may vary according to the characteristics of a given industry, business or product.

This notion of commercial success also depends on the novelty level of the product being marketed. A product said to be "innovative" must be new or improved significantly, and must have been brought to market over the past three years. A firm

who wishes to launch an entirely new product must publicize and promote it. It may also measure product sales. A significantly improved product generally replaces another and its success is linked in some way to the popularity of the product being replaced. In such cases, the issue of commercial success is more difficult to grasp and its measurement is more complex.

Another stumbling block to measuring success is the problem of timing. A statistical survey is a snapshot of circumstances as they stand at a given time or period. Some of the companies surveyed will have been innovative at different times over the past three years. They cannot all be expected to have reached the same stage in their commercialization efforts.

Additionally, different firms and industries have different products. Some have relatively short life cycles and require change very quickly. Development costs are often spread over a large number of units. Computers and cellular phones are good examples of such products. In these cases, one can expect to measure commercial success quite soon. Other products, such as commercial airliners, have relatively long life cycles and may be very costly to develop. Profitability may only be achieved after several years. In the shorter term, commercial success would be measured rather on the basis of the number of orders.

Can commercial success be quantified? The answer is yes, though the process is a difficult one. An initial problem is to obtain relevant data from companies. Their accounting does not always support easy extraction of the required data. A second challenge is related to problems of timing and differences among products, as explained above. For all these reasons, commercial success tends to be measured according to the achievement of objectives rather than quantitatively.

Strategic features

The market is rife with risks and obstacles for which innovative firms must prepare. If a firm neglects to prepare its commercialization efforts, it may jeopardize its chances of establishing its products rapidly in markets that are already highly competitive.

Risk arises, for example, from the uncertainty that the consumer will accept the new product. The firm may mitigate its level of uncertainty to some extent by carrying out pre-commercialization strategies.

Indeed, a widespread strategy is for firms to build consumer interest in a new product even prior to its launch, either through advertising, promotion at business shows and exhibitions, or by creating expectations via the delivery channel (e.g. the Internet, emphasizing personalized service, offering modular products, etc.), in order to generate consumer curiosity. A prime example of this approach is provided by competition among video-game console designers, who conduct communication campaigns even before their products are available. Diehard gamers will be onboard at the outset, while the undecided will be keen to discover the innovation's potential even before testing the game. The same phenomenon may be observed among major aircraft manufacturers and, to a lesser extent, small and medium enterprises.

Other strategies for reducing market uncertainty are market studies, distribution network sharing agreements, implementation of strong customer support networks (sales force), product research agreements with partners who are well established in business channels, etc.

Beyond pre-commercialization strategies, firms also attach considerable importance to their market position. In conducting positioning strategies, a firm will determine how to achieve its market positioning goal.

Possible market positioning goals include aiming to become the market leader for a given product or product line, targeting a specific market niche, creating a new market, taking over competitors' market shares, etc.

Each firm is seeking strategies to prolong its survival in a particular market and commercialize its products under favourable conditions. Commercial strategies can be many, complex or complementary, though, first and foremost, they must meet the firm's specific need to commercialize its products.

Finally, alternative strategies include partnerships with universities, other companies or organizations, holding a leadership position with regard to environmental standards, prices or production costs, offering the shortest delivery time or being first to market, outdoing the competition in terms of exceptional customer service, etc.

It is important for decision makers to have quantitative indicators of innovative performance in Canada, though they must also understand how firms go about achieving, maintaining or improving performance levels. Understanding firms' commercial strategies may fulfil this need.

Organizational features

In order to conduct various strategies, firms must acquire human and financial resources and skills, and they must also protect their investment. Furthermore, they may enter into partnerships to obtain resources or mitigate risks.

Human resources are a company's lifeblood. However, the skills required to commercialize a product differ from those needed to perform technical development. At each stage of the commercialization process, firms require qualified staff to perform research and development, develop new products, conduct market studies and promote products. Companies must also protect their intellectual property rights. To this end, they may hire staff and train and develop resources internally, though they may also call upon other organizations with the skills they seek.

It is not always advisable for a firm to develop internally all its required skills. For example, developing a distribution network throughout North America requires time and resources, and it may be preferable to enter into an agreement with an established network. However, such an agreement also has a cost, that of managing the partner relationship. Through strategic agreements, companies may gain access to specialized skills, financial resources, intellectual property, new markets and distribution networks.

An intellectual property protection strategy is required to safeguard investments in innovation, while allowing the product to move freely to reach the consumer. Patents, copyright and trade secrecy are the primary tools for protecting intellectual property.

Committing human resources to commercialization, establishing partnerships and protecting intellectual property require financial resources. The main source of funding is generally the firm itself. To obtain additional funding, firms use the banking system, venture capital and financial markets, and they may also seek government support. Some businesses are more successful than others in seeking out funding, and it is important to understand why this is so.

Corporate culture is an ill-defined notion that is difficult to grasp. However, it has an impact on a firm's operations that is sometimes greater among small and medium enterprises.

In many cases, firms have been established by an individual or a small group. The entrepreneur's personality and skills then become significant characteristics of the firm. In such cases, the firm is a reflection of its founder or chief executive. This individual takes commercialization initiatives, selects innovative distribution channels, decides on advertising, etc.

The innovation commercialization survey asks direct questions on entrepreneurs' personal characteristics as well as their commercialization training and skills.

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Tracking use of Radio Frequency Identification tags in Canadian organizations

In 2006, a question on Radio Frequency Identification (RFID) tags was introduced on the Survey of Electronic Commerce and Technology. RFID tags are currently used by organizations for a wide variety of purposes. The concept of RFID tags combines radio frequencies and bar code systems, giving mobility to logistics. The data on RFID tag usage in Canada show the application of this technology is in its infancy. The small number of organizations that use RFID tags can be explained by the newness of the technology and the potentially high costs of investment and implementation. Despite the initial costs, organizations that use RFID benefit in the longer run.

Introduction

What do a retailer, a hospital, an international airport, a law firm and a college all have in common? They all may use Radio Frequency Identification (RFID) transponders, or RFID tags, in their unique daily operations.

RFID tags are newly deployed in the Canadian business world, with only an estimated 2% of all private organizations and almost 7% of all public organizations utilizing RFID tag technology (Statistics Canada 2006).

Definition

The Radio Frequency Identification (RFID) tag is a microchip with an antenna. The tag is small enough to attach to any object (e.g., books, clothing, shipping containers, animals) and versatile enough to store information as simple as a unique serial number or as detailed as a full logistics track log. Identification information is transmitted by radio waves between the tag and the reader, which then displays that information.

What is Radio Frequency Identification anyway?

RFID systems consist of three main components: a tag, a reader, and a supportive hardware and software computer system. This automatic identification system is similar to a bar code system; however, it is mobile and more sophisticated through its use of radio frequencies to transmit and receive information and microchips to store a substantial amount of information.

There are two different kinds of RFID tags: a 'read-only' tag is hard-coded with identification information; a 'read-write' tag can have its information changed many times.

An interrogator, or reader, is used to communicate with the RFID tag. The reader sends out a radio signal; the tag picks up the signal and sends it back to the reader with the identification information. For effective information transfer, the distance between the tag and the reader can range from a few centimetres to about 200 metres. The reader can be handheld or fixed at strategic locations, such as an organization's shipping and receiving bay.

Combined with a software and hardware system, RFID tags can assist users in accurately tracking various items through a given environment.

Use of this technology by organizations

Two examples show how RFIDs are currently utilized around the world (Bacheldor, 2007a, 2007b). The first example is from the health care industry. In the United States, the medical staff at a hospital in Pittsburgh, Pennsylvania, use RFID tags to administer the correct medication to patients. RFID tags containing a unique identification number attach to the patient's wristband and medication package. Before the medication is administered to the patient, a nurse must first log in using the RFID-enabled reader to scan his or her badge's tag. Then the reader is used to scan the unique identification numbers from the patient's wristband and medication package. The identification numbers are automatically cross-checked with the hospital's database system, which contains the patient's medical history. The staff is thus able to verify the patient's medical needs at his or her bedside with the use of this RFID technology.

The second example is from the airline industry. In Thailand, the international airport in Bangkok uses RFID tag technology to keep a record of all air freight passing through its cargo terminal. All cargo items in the terminal contain an RFID tag to track their arrival and departure. Readers located at fixed positions in the terminal send a radio signal to the tag as the cargo passes by them. The radio signal is then returned to the reader with identification information such as a description of the cargo and its time of arrival or departure. Read–write RFID tags are used because they can be attached to an item when it arrives and detached before it leaves.

RFID tag technology is being used in many environments and Canadian organizations are gradually exploring its capabilities.

A relatively small percentage of organizations use this technology

In the private sector, approximately 2% of all organizations use RFID tags. The percentage of usage for each industry does not greatly deviate from this total. For all industries surveyed, the proportion of their organizations using RFID tags ranged between a high of 5% in the Utilities sector and a low of less than 1% in the Health Care and Social Assistance sector (Table 1).

Some sectors, such as the Administrative and Support, Waste Management and Remediation Services sector and the Arts, Entertainment and Recreation sector, are more likely than others to benefit from the use of RFID tag technology. Each is a compilation of diverse subsectors, which include Packaging and Labelling Services, Investigation and Security Services, Business Support Services, Waste Management and Remediation Services, Gambling Industries, Heritage Institutions, and Amusement Parks and Arcades.

For the majority of private sectors, however, no more than about 2% of their organizations use RFID tags (Table 1).

Table 1
Organizations in the private sectors that use Radio Frequency Identification tags

	Organizations that use RFID tags
	%
Utilities	5
Forestry, logging and support activities[1]	5
Administration and support, waste management and remediation	5
Transportation and warehousing	4
Arts, entertainment and recreation	3
Manufacturing	3
Retail trade	2
Mining and oil and gas extraction	2
Information and culture industries	2
Educational services	2
Wholesale trade	2
Finance and insurance	2
Construction	1
Real estate and rental and leasing	1
Management of companies and enterprises	1
Professional, scientific and technical services	1
Accommodation and food services	less than 1
Other services (except Public administration)	less than 1
Health care and social assistance	less than 1
Private sector, all organizations	2

1. From NAICS sector 11 (Agriculture, Forestry, Fishing and Hunting), only subsectors 113 (Forestry and Logging) and 11531 (Support activities for Forestry) are included here. Subsectors 111 (Crop Production), 112 (Animal Production) and 114 (Fishing, Hunting and Trapping) are excluded.

Note: Sectors are based on North American Industry Classification System (NAICS) 2002.

Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2006.

In the public sectors—Health Care and Social Assistance, Educational Services and Public Administration—almost 7% of all organizations use RFID tags, although there is wide variability among sectors (Table 2).

Table 2
Organizations in the public sectors that use Radio Frequency Identification tags

	Organizations that use RFID tags
	%
Health Care and Social Assistance	10
Educational Services	6
Public Administration	3
Public sector, all organizations	7

Note: Sectors are based on North American Industry Classification System (NAICS) 2002.
Source: Statistics Canada, Survey of Electronic Commerce and Technology, 2006.

The generally low percentages of usage in the private and public sectors are likely due, in part, to the high costs involved in implementing an RFID system (OECD, 2006). Although some RFID tags may cost less than a dollar it's the required number of tags and readers combined with the computer systems with their specialized hardware and software, and employee training that together contribute to drive up the total cost significantly.

Reasons other than cost may also influence an organization's decision to apply RFID tags. For example, the size of the organization, as determined by number of full time employees, may be a factor: large organizations potentially adopt newer technologies more quickly than medium-sized and small organizations (Uhrbach and van Tol, 2004). Additional reasons include awareness of the technology, pressure from competition or the market to adopt the technology, and the suitability of RFID to operational needs.

Summary

It is clear that the early adoption rates for RFID technology are low in both the private and public sectors. There are many possible reasons for this, including lack of awareness of RFID and its potential applications, and investment and startup costs.

Research and analyses continue to explore the viable application of RFID tags by industry and firm size—in Canada and around the world.

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Profiling Internet use among workers in the information and communications technologies sector

Internet use is a key hallmark of an information society. Assessing Internet use today goes beyond access to encompass a cluster of behaviours that reflect the individual's ability to participate productively in an information economy. This study compares the pattern of Internet use of Canadians working in the information and communications technology industries with that of other Canadians.

While Internet use has increased significantly over the last decade among all socio-economic groups, differences related to the diversity of Internet use have become the focus of recent studies (Montagnier and Vickery, 2007). Measuring individual Internet use has evolved beyond the simple metrics of access or connectivity; it now encompasses online behaviours that reflect the intensity and scope of individuals' use of the Internet as well as their perception of what they can achieve with their Internet skills. Identifying the workplace influence on the personal use of information and communications technologies (ICTs) may help further our understanding of these behaviours.

For instance, many workers in ICT industries have a higher exposure to the Internet in their day-to-day work. Based on findings from the 2005 Canadian Internet Use Survey (CIUS), this article compares the Internet use of ICT sector workers with that of other workers in the economy with respect to propensity to go online for personal, non-business reasons, as well as level of Internet experience and scope of use. As ICT sector workers are likely to be more educated and have higher levels of income (factors associated with higher Internet use), a control group with similar education and income profiles is used for comparison.

Definitions of workers in information and communications technologies and other sectors

The ICT sector is defined as the aggregation of industries primarily engaged in producing goods or services, or supplying technologies, used to electronically capture, transmit and display data and information (see text box). This definition was developed by the Organisation for Economic Co-operation and Development (OECD) as a standard to monitor ICT sector development and to facilitate comparisons across countries and over time. Manufacturing industries in the ICT sector include establishments that manufacture products intended to fulfil information processing and communication functions including transmission and display, or use electronic processing to detect, measure and/or record physical phenomena, or to control a physical process. The products of the ICT services industries are used for information processing and communication by electronic means.[1]

For the purposes of this article, **ICT sector workers** are defined as those individuals employed in the industries that comprise the ICT sector (see text box). It must be emphasized that while workers in ICT industries are more than likely to use ICTs such as the Internet during the course of their work, there are some workers in these industries not employed in ICT-related jobs. Likewise, a portion of workers in non-ICT industries are employed in ICT-related jobs. Thus, an alternative taxonomy could be based on occupation.[2]

Since ICT sector workers have higher levels of education and income than others, workers from another group also known to have high levels of education and income are used for comparison purposes. The Professional, Scientific and Technical Services (PST) group was selected for this purpose (see text box).[3] Again, we have defined **PST sector workers** as individuals employed in the PST sector, although some of them may not be working in these professional capacities. To complete the typology, **other workers** consist of those employed in industries outside the ICT and PST sectors. The analysis also includes people not in the labour force, such as retirees.

Both ICT sector and PST sector workers are more likely to have university education and report higher levels of household income than other Canadians (Table 1). When we controlled for household income, education was found to be the most important factor associated with Internet use in Canada (McKeown, Noce and Czerny, 2007). However, in 2005, the sectors differed in that three-quarters of ICT sector workers were men, compared with just over half of PST sector workers.

Table 1
Selected characteristics of workers, by status of work, 2005

	Workers			
	ICT sector	PST sector	Other sectors	Not in labour force
	years			
Average age	38	40	40	61
	%			
Male	75	55	52	39
University degree	48	45	21	13
Household income > $80,000	52	50	37	10

Source: Statistics Canada, Canadian Internet Use Survey, 2005.

Measures of Internet use

The first indicator examined is the prevalence of Internet use for personal, non-business reasons from any location (including home, work, school, library or other). In 2005, ICT sector workers had overwhelmingly (94%) adopted the Internet for personal use (Table 2). Likewise, PST sector workers also reported using the Internet at a much higher rate (92%) than workers in other sectors (77%) or those not in the labour force (39%).

A large majority (85%) of Internet users working in the ICT sector reported five years' experience or more online. Despite the similar age and income profiles of workers in both sectors, ICT sector workers used the Internet more frequently and also spent more time online than workers in the PST sector. And 68% of ICT sector workers reported using their Internet connection at work for personal, non-business uses. In all of these use attributes, ICT sector workers reported the highest levels. As well, both ICT and PST sector workers reported using their Internet connection at work for personal use more frequently than did workers in other sectors.

Table 2
Selected Internet use attributes of workers, by status of work, 2005

	Workers			
	ICT sector	PST sector	Other sectors	Not in labour force
		% of all people		
Internet use from any location (past year)	94	92	77	39
		% of Internet users		
Experience (5 years +)	85	79	63	52
		% of home Internet users		
Frequency of use (daily)	83	70	64	67
Time (5 hours per week +)	65	50	45	49
High-speed connection	91	88	82	75
		% of all people		
Personal use at work (past year)	68	57	33	...

Source: Statistics Canada, Canadian Internet Use Survey, 2005.

Table 3 shows selected online uses of the Internet from home by workers in these sectors. Out of 20 Internet activities measured by the CIUS, home Internet users working in the ICT sector reported the highest average number of Internet activities (12), followed by workers in the PST sector (10), other sectors (9), and persons not in the labour force (8). E-mail is a ubiquitous online activity and virtually all home Internet users working in the ICT and PST sectors report using the Internet for this reason. Other activities, such as Internet banking, are less common and may be more popular among individuals who have a relatively high level of Internet comfort. Indicatively, nearly four in five home Internet users working in the ICT sector (79%) reported doing banking online.

Table 3
Internet activities of workers, by status of work, 2005

	Workers			
	ICT sector	PST sector	Other sectors	Not in labour force
		Average number of uses		
Types of use from home	12	10	9	8
		% of home Internet users		
E-mail	97	97	91	91
Internet banking	79	73	59	43
Researching community events	57	49	43	36
		% of all people		
Online purchase (e-commerce)	67	53	31	13

Source: Statistics Canada, Canadian Internet Use Survey, 2005.

As a final measure, individuals' participation in electronic commerce may serve to indicate the extent to which Canadians have embraced the digital economy. In 2005, just over one-quarter (28%) of adult Canadians reported making an online purchase from home, work, school, a library or other locations, such as a friend's house or Internet café. However, about two-thirds (67%) of ICT sector workers and over half (53%) of PST sector workers reported making an online purchase in 2005.

From access to impacts

The focus of Internet research has shifted from investigating connectivity and basic use to understanding intensity and diversity of uses as well as the impacts on society. With this shift, there is a need to look at factors relating to the competencies and skills of Internet users, including 'self-efficacy'—their perception of what they can achieve with their skills (Underhill and Ladds, 2007). The more comfortable people are online, the greater their propensity to engage in complex and more intense Internet activities.

This study found that exposure to the Internet (and related ICTs) at work is a factor associated with a higher number of home-based, personal online uses. Those in the ICT sector were shown to have a different pattern of online use. In this descriptive analysis, PST sector workers served as a comparison group to account for the effect of higher income and education levels.

A multivariate analysis could be used to control statistically for factors such as age, income and education, all of which previous studies have found to influence connectivity and basic use (McKeown, Noce and Czerny, 2007).[4] We suggest that the emerging metrics of Internet use incorporate the human capital component of ICT usage (Veenhof, Clermont and Sciadas, 2005; Hargittai, 2002) as more work in the area of digital literacy is needed for understanding Internet use behaviour and impacts.

Canadian Internet Use Survey

The 2005 Canadian Internet Use Survey (CIUS) asked more than 30,000 Canadians aged 18 years and older about their Internet use over a 12-month period, including the number and value of their online orders.

For the purposes of this study, the information and communications technologies (**ICT**) **sector** includes the following four-digit industries as defined by the North American Industry Classification System (NAICS 2002):

- 3333 Commercial and Service Industry Machinery Manufacturing
- 3341 Computer and Peripheral Equipment Manufacturing
- 3342 Communications Equipment Manufacturing
- 3343 Audio and Video Equipment Manufacturing
- 3344 Semiconductor and Other Electronic Component Manufacturing
- 3345 Navigational, Measuring, Medical and Control Instruments Manufacturing
- 3359 Other Electrical Equipment and Component Manufacturing
- 4173 Computer and Communications Equipment and Supplies' Wholesaler-Distributors
- 5112 Software Publishers
- 5171 Wired Telecommunications Carriers
- 5172 Wireless Telecommunications Carriers (except Satellite)
- 5173 Telecommunications Resellers
- 5174 Satellite Telecommunications
- 5175 Cable and Other Program Distribution
- 5179 Other Telecommunications
- 5181 Internet Service Providers, Web Search Portals
- 5182 Data Processing, Hosting, and Related Services
- 5415 Computer Systems Design and Related Services
- 8112 Electronic and Precision Equipment Repair and Maintenance

Although some ICT industries are defined at the five-digit industry level, data from CIUS are available only at the four-digit level. The decision on whether or not to include industries at the four-digit level was based on the value-added contribution of respective six-digit industries in the input-output tables. As the majority of their value-added share comes from non-ICT industries, NAICS 4179 (Other Machinery, Equipment and Supplies Wholesaler-Distributors) and 5324 (Commercial and Industrial Machinery and Equipment Rental and Leasing) are excluded from the sector definition for the purposes of this study.

The Professional, Scientific and Technical Services (**PST**) **sector** (NAICS 54) comprises nine four-digit industries whose establishments are primarily engaged in activities in which human capital is the major input. Note that NAICS 5415 (Computer Systems Design and Related Services) belongs to both the ICT and PST sectors. As this study uses the PST sector as a control group for the purposes of comparison with the ICT sector, industry 5415 is included only in the ICT sector figures reported in this study and not in those of the PST sector. The PST sector definition in this study includes the following four-digit industries:

- 5411 Legal Services
- 5412 Accounting, Tax Preparation, Bookkeeping and Payroll Services
- 5413 Architectural, Engineering and Related Services
- 5414 Specialized Design Services
- 5416 Management, Scientific and Technical Consulting Services
- 5417 Scientific Research and Development Services
- 5418 Advertising and Related Services
- 5419 Other Professional, Scientific and Technical Services

Notes

1. The OECD definition is based on the International Standard Industrial Classification (ISIC Rev3). Statistics Canada employs the North American Industry Classification System (NAICS) for industry data. Figures for the ICT sector are reported based on an established ISIC-NAICS 2002 industry concordance (Statistics Canada, 2003). In 2007, NAICS industry definitions were revised. However, since this study uses results from the 2005 CIUS, the industry classifications used at that time (NAICS, 2002) are retained for the purposes of this analysis.

2. The OECD has analysed the concentration of ICT-skilled employment across industry sectors, including those not classified to the ICT sector. These analyses, for example, make distinctions among three types of ICT competencies by occupation: ICT specialists, and advanced and basic ICT users (see OECD, 2006).

3. In terms of their relative magnitude in the economy, the ICT and PST sectors hold similar shares. In 2005, they accounted for 4.5% and 4.6% shares, respectively, of total economy gross domestic product at basic prices, based on chained (2002) dollars.

4. The implied direction of cause and effect is not entirely clear as those people with a propensity for digital engagement may seek education and work opportunities in the ICT area.

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The story of the Innovation Analysis Bulletin

To mark the 10th anniversary of the *Innovation Analysis Bulletin* in 2008, we are taking a walk down memory lane to discover the story behind the creation of this periodical.

Michael Bordt, currently Assistant Director of the Environment Accounts and Statistics Division of Statistics Canada, can be credited as being the founder of the *Innovation Analysis Bulletin* (IAB). Recently he took a few minutes from his busy schedule to give his thoughts on this periodical.

IAB: Michael, what compelled you to officially create the *Innovation Analysis Bulletin*? Was there any particular discussion or interaction that motivated you to take on this initiative?

MB: Statistics Canada's Science and Technology (S&T) and Information and Communications Technology (ICT) analysts were looking for a way to reach a broader, non-technical audience. This included not only our counterparts in other departments, who were already making use of the working papers and science bulletins, but their bosses, academics and business leaders.

The approach was really put together by all the analysts at the time. I volunteered—or was volunteered—to manage the process.

IAB: What messages did you foresee the document containing and conveying? And has that been accomplished?

MB: The IAB was intended at first as an ongoing summary of the work in Statistics Canada on S&T, innovation, emerging technologies and ICTs. It has certainly accomplished that—and more. Some short analyses and conceptual pieces are done specifically for the IAB. They wouldn't have a home otherwise.

IAB: Volume 1, Number 1, was released in 1999. What was the initial reaction to the publication?

MB: The initial reaction was very quiet. We released July 26, 1999, as an "other releases" item in the Statistics Canada *Daily*. There were no news stories on the articles. The rest of the summer was uneventful until we noticed that the IAB was the number one downloaded publication from the Statistics Canada website for the month of August 1999. We knew somebody was reading it!

IAB: How is the information contained in the IAB being used?

MB: Having one repository for the summaries of findings in these quickly moving fields (S&T, innovation, emerging technologies and ICTs) certainly has a wider distribution of the results of our analysis in these fields. On occasion, I see someone reading a copy of the IAB on the bus. I can't say the IAB is uniquely responsible for this, but when any one of the Science, Innovation and Electronic Information Division (SIEID) staff went to a meeting over the past 10 years, I encouraged them to take a bundle of copies with them to distribute to the unconverted.

IAB: Do you feel there are particular types of articles that readers prefer?

MB: I was always sure they preferred the simpler articles that told interesting stories about the more important results of a study. That kind of article is not easy to write—even some of mine were less than inspiring. As analysts, we're tempted to get in all the results, all the explanations and (we're a statistical agency, aren't we?) all the numbers. I asked one analyst to focus and shorten an article, so he took out most of the words and left the numbers!

It really trains our thinking about our work to decide early on in the writing what the headline will be and to focus the article on making that headline interesting, memorable and well-understood.

IAB: Is there one particular issue or article that stands out in your mind?

MB: I have always liked the summary articles. "We have learned a great deal", in the February 2002 issue, was in response to someone who remarked on all the work we had done to that point and asked, "But what have you learned?" We followed up four years later with "We're still learning!" These articles chronicled the 10th and 20th issues. It's about time for another one.

IAB: As the IAB enters its 10th year of existence, distribution includes over a 1,000 print copies annually and more than 200,000 cumulative downloads for the first 9 volumes issued. Do you think the IAB is getting sufficient circulation?

MB: There is such a high turnover and growth in the audience for the subject matter that it's a challenge just to maintain a steady circulation. The older readers are retiring and the younger ones don't always know about it. Personally, I'm never happy with the status quo. I'm certain that there are always potential readers out there who would benefit from knowing about the IAB.

IAB: Are there any amusing or troubling anecdotes that you can share regarding the IAB?

MB: I can't think of anything troubling other than missing a few publication dates. The first issues were certainly fun. We hired a journalist, Mark Foss, who helped set the style. He would interview us about the analysis project and insert quotes in the article. That style lives on in some of the articles in subsequent issues.

IAB: You are no longer involved with the production of the IAB. Do you miss being involved?

MB: I missed it so much, I started *EnviroStats*. I'm still involved to some degree. I have contributed to a few articles since my departure and I'm always on the lookout for collaboration. For example, I have been talking with the S&T analysts about collecting data on emerging environmental technologies.

IAB: Are you a regular reader of the IAB?

MB: As regular as I can be. I still subscribe to *The Daily* for e-mail notifications on subjects "S&T" and "Communications".

IAB: So, you read all of the articles?

MB: Okay, I admit I skim the first page and jump to the articles of main interest. Eventually, I get around to reading the entire issue.

IAB: Thank you for your time, Michael. We are sure readers of the IAB enjoyed learning of the story behind its existence.

Rad Joseph, SIEID, Statistics Canada

Departure of Frederic Gault

After working for more than 20 years on behalf of science and technology statistics, Dr. Frederic Gault, Director, Science, Innovation and Electronic Information Division, is leaving Statistics Canada.

Following a 15-year career as a lecturer in theoretical physics at Durham University, Dr. Gault joined Statistics Canada in 1984. In 1988, he became chief of Science and Technology Section, which at that time was part of Science, Technology and Capital Stock Division. The notable event of that period was the very first survey of manufacturing technologies (1987). In 1989, Dr. Gault was appointed Director of Services, Science and Technology Division.

The next few years were difficult ones. In the early 1990s, because of budget cutbacks, the staff of Science and Technology Surveys Section was reduced to a total of 8.5 person-years. Despite the cutbacks, the first survey on innovation was conducted (1993), and the Statistics Canada Advisory Committee on Science and Technology Statistics was established.

Then came a period of significant development of the statistical programme in the science and technology and information society fields, development that was undertaken in close cooperation with users. As part of the review of federal science and technology activities, the Statistics Canada Advisory Committee on Science and Technology Statistics served as a task force on the development of science and technology statistics. In the 1994 report, the main recommendation was that Statistics Canada establish an on-going development project to design, plan and implement an extended program of science and technology statistics. The Advisory Committee on Telecommunications was formed shortly thereafter, and its work led to the establishment of the current statistical program on the information society.

Fred Gault has an abiding interest in official statistics on science and technology. It is more than his job, it is a passionate interest. When we initially began our collaboration, there was little funding for data on S&T. Our first, and monumental challenge was to develop a framework for the collection and use of S&T data. This task engaged the Advisory Committee, and particularly a small working group of the Advisory Committee together with Fred Gault, for a considerable period of intensive, often heated, but always creative, work. The intensity of our engagement in this task found us working on Saturdays, early mornings and late evenings. No one protested; the challenge was so very engaging of both our intellects and our interests. The framework we developed continues to guide the work of the SIEID.

Susan A. McDaniel, Chair of the Statistics Canada Expert Advisory Committee on Science and Technology Statistics from 1996 to 2004

In 1996, following two or three years of efforts to obtain funding for such a program, the Science and Technology Redesign Project was launched under Dr. Gault's direction. The project had two major focuses: science and technology statistics and statistics on telecommunications and the information society. During that period, Dr. Gault's team carried out a series of projects in rapid succession:

- Survey of Innovation in the Service Industries (1996)
- Survey of Biotechnology Use (1996 and 1997)
- Project to develop the statistical infrastructure for telecommunications and the information society (1996)
- Household Internet Use Survey (1997)
- Project to develop bibliometric statistics (1997)
- Survey of Advanced Technology in the Canadian Manufacturing Industry (1998)
- Annual Survey of Telecommunications (1998)

In 1999, Science, Innovation and Electronic Information Division was established. This marked the beginning of a phase of consolidation and expansion of the work done in the early years. The well-established statistical programs on R&D and telecommunications were joined by new programs on innovation, electronic commerce, Internet use by individuals, and life sciences as well as new indicators and special projects such as intellectual property in universities and knowledge management.

- Quarterly Survey of Telecommunications (1999)
- Survey of Innovation (1999, 2003, 2005)
- Redesigned biotechnology survey (1999)
- Connectedness Series (1999)
- Innovation Analysis Bulletin (1999)
- Survey of Electronic Commerce and Technology (2000)

This period of growth resulted in the production of a large number of publications and a total of eight books over a 10 year period on subjects as diverse as regional innovation systems, biotechnology, innovation, alliances and partnerships,

knowledge management, the information society, and information and communications technology. The most recent book summarized the proceedings of an OECD international conference (Blue Sky II) held in Ottawa in September 2006.

We would be remiss if we failed to mention Dr. Gault's contribution to Statistics Canada's reputation on the international scene. Appointed vice-chair of the OECD's Working Party of National Experts on Science and Technology Indicators (NESTI) in 1995 and its chair in 2002, Dr. Gault, together with his team, has made Statistics Canada a pioneer and a leader in science and technology statistics. The Working Party's key activities during that period included revising the Frascati Manual and the Oslo Manual and overseeing the work of the Ad hoc Biotechnology Statistics Group.

Fred Gault's leadership and mind have been instrumental in moving the international measurement agenda forward. I have seen this first hand, as the member of the OECD Secretariat who has had the pleasure of riding co-pilot, watching Fred navigate through clear skies and turbulence as the chair of two working parties dedicated to the development of indicators that shed light on the development, diffusion and impact of science and tehnology.

The development of new statistical standards and indicators at the OECD very much depends on the initiative of a member country to be the locomotive that pulls the train. Statistics Canada, especially Fred's division, has performed that role in numerous areas, with Fred acting as the engineer. The list is a long one but perhaps the most memorable is Fred's pioneering work as the first Chair of the OECDs Working Party on Indicators for the Information Society (WPIIS). Emerging from the largest OECD Ministerial meeting ever held in Ottawa in 1998 (October) on e-commerce, Fred led this working party to be the front runner in producing a measurement framework for the Information Society. By 2000, a mere 16 months later, internationally comparable official statistics on e-commerce began to appear—and year after year the group produced a new standard every time it met (an unprecedented pace for international bureaucracies). These were the building blocks of the OECD "Guide to Measuring the Information Society" produced for the World Summit on the Information Society (WSIS) in 2005. This Guide acted as a rallying point for all the world's international organizations interested in measuring the information society—the OECD, UNESCO, UNCTAD, ITU, the World Bank, ECLAC, etc.—to form a partnership to develop a set of core ICT indicators that could be measured world-wide—one of the more tangible outcomes of WSIS. As Fred might say: "It has not been an uninteresting experience". (his use of double negative has also become world famous, especially among interpreters of OECD meetings!)

Andy Wyckoff, Organisation for Economic Co-operation and Development (OECD)

Dr. Gault was also the first chair of the OECD's Working Party on Indicators for the Information Society, a post he held from 1997 to 2002. During that period, the Working Party developed the first recognized definition of the information and communications technology (ICT) sector and a statistical definition of electronic commerce. It also produced the first collection of statistics on the subject, a model survey on ICT use by households and individuals, and a survey on ICT use by businesses. This work led to other international standards and later to the production of the Guide to Measuring the Information Society. The Working Party's accomplishments have helped improve the statistical system in Canada and in the rest of the world.

In addition to his participation in projects carried out in conjunction with the OECD, Dr. Gault worked with colleagues from China, Russia, South Africa and a number of other African countries on the New Partnership for Africa's Development (NEPAD). He also served as a member of several other international committees.

It is important to note that these initiatives were assisted by the establishment of strong partnerships between Science, Innovation and Electronic Information Division, Industry Canada and the many users of our data in federal and provincial government departments, ministries and agencies. In 2007, Dr. Gault received the Partnership Award of the Association of Professional Executives of the Public Service of Canada (APEX).

"If Fred Gault did not exist, we would have to invent him!!" I'm not sure that this expression quite works; but I am certain it describes the value that all of us attach to Fred as a professional, colleague and friend. It has been my good fortune to work with Fred for the last few years, both here in Canada and internationally.

As most people already know, Fred's leadership role at the OECD and in other international fora is almost legendary. I personally benefitted from his extraordinary capacity to manage and advance complex international projects when he took charge of the efforts to develop new statistical systems to measure the e-economy following the OECD Ministerial Conference on Electronic Commerce in 1998. In short order, we had not only developed an excellent survey instrument in Canada, but had developed a scheme for trans-national measurement of e-business for use within the OECD that eventually spread to the wider international community.

What I most admire about Fred was his capacity to convert any meeting into a mini-tutorial on the value and application of statistical information to evidence-based policy and analysis. His wry, iconic sense of humour always made these diversions from routine business hugely entertaining as well as educational.

Fred exemplifies the level of intellect, integrity and professionalism that we all strive to attain as public servants. The Public Service will very much miss him and his immense talents. Some of us, however, will hopefully have the pleasure and privilege of continuing to work with him as he assumes new roles and new challenges in the years ahead.

Richard Simpson, Director General, Electronic Commerce, Industry Canada

We are grateful to Dr. Gault for his many initiatives and for the leadership he has provided. He has made an outstanding contribution to Statistics Canada's success and to the development of the science and technology statistics program. We wish him every success in his future endeavours.

Taking over the position of Director for Science, Innovation and Electronic Information Division is Paula Thomson. The next issue of the Innovation Analysis Bulletin will include an interview with Ms. Thomson.

What's new?

Read about recent releases, updates and new activities in the areas of information and communications technology, and science and technology.

Information and communications technology

Workshop on ICT Measurement for Knowledge Economy, New Delhi, India, November 19-20, 2007

Statistics Canada was invited to participate in a workshop co-sponsored by the OECD and the Indian Department of Information Technology. The steady growth of ICT service activity in the Indian economy has resulted in a need to develop metrics of ICT measurement. SIEID was asked to make presentations on the "Framework for Collection of Statistics in OECD Countries" and on the "Experience in Collecting Internationally comparable ICT Statistics", describing Statistics Canada's experience with model surveys of ICT usage by individuals (CIUS) and by businesses and organizations (SECT). A presentation was also made featuring "The social impacts of ICT" in Canada. The workshop was attended by over 100 government officials, academic researchers, private sector ICT providers and members of various industry associations. For more information, please visit:

http://www.mit.gov.in/default.aspx?id=478.

Digital Ontario Symposium, School of Environmental Design & Rural Development, University of Guelph, March 5-6, 2008

Statistics Canada was invited to participate in Digital Ontario, a symposium that examined governance, leadership, engagement and strategic partnerships for development in a digital age. The Information Society section of SIEID contributed to a plenary session with a presentation on "Internet use in Canada: Overview with a focus on regional connectivity". Other topics covered trends and issues related to the access and use of high speed Internet across the country. The symposium was attended by over 100 academic researchers and government officials from various ministries and provinces. The symposium agenda and selected papers are available at this address:

http://www.uoguelph.ca/snowden/digital_ontario.html.

2008 Statistics Canada Socio-economic Conference. Ottawa, May 5-6, 2008

The Information Society section of SIEID organized two related sessions—"Participation in the Information Society"—which included six research papers on a variety of Internet topics ranging from online privacy and security concerns to gender differences in use patterns. As well as analysts from Statistics Canada and other federal departments, these sessions featured an analysis of Canadian Internet use patterns by Dr. Catherine Middleton—Canada Research Chair in Communications Technology in an Information Society—and an international comparison of Internet use by Mr. Pierre Montagnier—a senior researcher with the OECD's Directorate for Science, Technology and Industry in Paris. For the conference agenda, abstracts and authors, please visit our website:

http://www.statcan.ca/english/conferences/socioeconomic2008/program.htm.

Information Society research and analysis

Studies have been released on Internet use, based on data from the 2005 Canadian Internet Use Survey (CIUS), including:

A paper entitled 'Getting a second opinion: Health information and the Internet' was released in *Health Reports*, Vol. 19, no. 1

http://www.statcan.ca/english/freepub/82-003-XIE/2008001/article/10515-en.htm.

A second paper 'A new benchmark for Internet use: A logistic modeling of factors influencing Internet use in Canada, 2005' will be published in the Government Information Quarterly.

A study of Internet use and social cohesion, based on several sources, is forthcoming in the *Connectedness Series* (Catalogue no. 56F0004MWE).

Telecommunications and broadcasting

Annual Survey of Telecommunications Service Providers

The processing of 2006 data is on-going and the release of data is planned for June of 2008 in *Broadcasting and Telecommunications* (Catalogue no. 56-001-XIE, Vol. 38, no. 1). This will be the final release from this survey in its current form.

In order to avoid duplication, minimize response burden, make more efficient use of resources and promote coherence of the Canadian statistical system, Statistics Canada and the Canadian Radio-television and Telecommunications Commission (CRTC) have agreed to merge and harmonize three surveys of telecommunication services providers—two conducted by Statistics Canada and one by the CRTC. The new survey will meet the market monitoring needs of the CRTC and the needs of the System of National Accounts. It will be conducted for the first time in 2008 for the 2007 reference year and will use the online data collection platform operated by the CRTC. As a result, the current Annual Survey of Telecommunications and

the Annual Survey of Internet Service Providers and Related Services are no longer conducted. Results are expected to be released in Summer 2008.

Quarterly Survey of Telecommunications Service Providers

The collection and processing of data from the redesigned Quarterly Survey of Telecommunications is on-going. The first release of the 2007 Quarterly data is planned for the second quarter of 2008.

Annual Surveys of the Radio, Television and Cable Industries

The 2006 statistics for the cable and other program distribution industry were released on December 7, 2007 in the *Daily* (http://www.statcan.ca/Daily/English/071207/d071207d.htm) and in *Broadcasting and Telecommunications,* Catalogue no. 56-001-XIE, Vol. 37, no. 2 (http://www.statcan.ca/english/freepub/56-001-XIE/56-001-XIE2007002.htm).

The collection and processing of 2007 data for the radio, television and cable industries is on-going. Data for these industries will be released in the Summer and Fall of 2008.

Canadian Internet Use Survey

The 2007 CIUS was conducted in October and November 2007, and findings are scheduled to be released in two phases: Internet use in June and Internet shopping by November.

Survey of Electronic Commerce and Technology

Final results from the 2007 Survey of Electronic Commerce and Technology were released on April 24, 2008.
http://www.statcan.ca/Daily/English/080424/d080424a.htm.

Science and Technology activities

Research and development in Canada

The service bulletin 'Gross Domestic Expenditure on Research and Development, 2007 intentions' (Catalogue no. 88-001-XIE Vol. 31, no. 8) was released on December 20, 2007.
http://www.statcan.ca/english/freepub/88-001-XIE/88-001-XIE2007008.htm.

Industrial research and development

The service bulletin 'Industrial research and development, 2003 to 2007' (Catalogue no. 88-001-XIE Vol. 31, no. 6) was released on November 20, 2007.
http://www.statcan.ca/english/freepub/88-001-XIE/88-001-XIE2007006.htm.

Federal science expenditures

The service bulletin 'Federal government expenditures on scientific activities, 2007/2008 (intentions)' (Catalogue no. 88-001-XIE Vol. 31, no. 7) was released on December 11, 2007.
http://www.statcan.ca/english/freepub/88-001-XIE/2007007/part1.htm.

Higher education sector research and development

The service bulletin 'Estimation of research and development expenditures in the higher education sector, 2005/2006' (Catalogue no. 88-001-XIE Vol. 31, no. 4) was released on August 31, 2007.
http://www.statcan.ca/english/freepub/88-001-XIE/88-001-XIE2007004.htm.

Human resources and intellectual property

No updates to report.

Federal science expenditures and personnel, intellectual property management annex

No updates to report.

Intellectual property commercialization in the higher education sector

No updates to report.

Innovation

Innovation in manufacturing

Tables presenting results from the Survey of Innovation 2005 will be available in the Spring on CANSIM (Tables 358-0062 to 358-0117). Custom requests for non-standard tables are being produced.

Analysis of the micro-data of the Survey of Innovation 2005 by external facilitated access researchers continues. The OECD sponsored project to compare innovation in selected OECD countries is wrapping up with first results to be published soon.

Estimates from the Survey of Innovation 2005 were incorporated into the OECD's Science and Technology Indicators Scoreboard 2007.

Innovation in services

Two working papers based on the Survey of Innovation 2003 have been released. These include: 'Innovators, Non-innovators and Venture Firms: What Is the Nature of Firms in Research and Development Services Industries' by Charlene Lonmo, Catalogue no. 88F0006XIE 2007, no. 007 (http://www.statcan.ca/english/freepub/88F0006XIE/88F0006XIE2007007.htm); and 'Innovative Exporters and

Intellectual Property Regimes in Selected Service Industries: Evidence from the Canadian Survey of Innovation 2003' by Frances Anderson and Ingrid Schenk, Catalogue no. 88F0006XIE 2008, no. 001 (http://www.statcan.ca/english/freepub/88F0006XIE/88F0006XIE2008001.htm).

Innovation in advanced technologies in manufacturing and logging

Data collection for the Survey of Advanced Technology 2007 is complete. This survey of advanced technology use was sent to almost 9,500 manufacturing plants and about 370 logging operations. First results are expected in early Summer 2008 with facilitated access research projects to follow.

A follow-up to the Survey of Advanced Technology 2007 has been carried out. This survey examines plants that modify or create technologies in more detail. First results are expected in Summer 2008.

Innovation in advanced technologies in mining

Lack of funding has resulted in the cancellation of this survey.

Community Innovation

No updates to report.

Commercialization

Data collection for the Survey of Commercialization 2007 is now complete with plans for release of a working paper in Spring 2008.

The 2007 Survey of Business Incubation is in the field. Preliminary results are expected to be available in Spring 2008.

Biotechnology

The 6th ad hoc meeting on Biotechnology Statistics is scheduled for May 2008. The meeting will focus on impacts of biotechnology and methodological issues, following up on initiatives that began at the December 2006 meeting.

A paper entitled 'The Impact of Collaborations on Canadian Biotechnology Firms' was presented at the Statistics Canada Socio-economic Conference in May 2008.

Nanotechnology

At the OECD Working Party Nanotechnology meeting in November 2007 the first meeting of the Statistics and Measurement Working Group was held with Statistics Canada co-chairing with the OECD. The group adopted as a statistical working definition of nanotechnology, the ISO's work in progress definition and began work on developing a statistical program framework. The Working Party Nanotechnology met again in April 2008 and the statistics group presented its framework for international comparable statistics program.

Functional Foods and Natural Health Products

The Functional Food and Natural Health survey, undertaken in partnership with Agriculture and Agri-Food Canada, is currently in progress and data are expected to be released in the Winter of 2008.

Knowledge management practices

Knowledge Transfers between Canadian Business Enterprises and Universities: Does Distance Matter?

This study examines whether the transfer of knowledge flows from universities to enterprises in Canada is hampered by the geographical distance that separates them. The transfer of knowledge flows are measured by the amount of R&D payments from business enterprises to universities that are directly reported in Statistics Canada's survey on Research and Development in Canadian Industry. Data from the 1997 to 2001 surveys were used.

After controlling for unobserved individual heterogeneity, selection bias as well as for other covariates that could affect the extent of industry-university R&D transactions such as absorptive capacity, foreign control, belonging to the same province, past experience with a given university and other firm and university characteristics, it is found that a 10% increase in distance decreases the proportion of total R&D paid to a university by 1.4 percent for enterprises that do not report any codified transfer of knowledge flow, and by half as much for enterprises that report codified knowledge flows.

The authors are Julio M. Rosa, SIEID and Pierre Mohnen, UNU-MERIT, Maastricht University, Netherlands, and CIRANO, Canada.

New economy indicators

We have compiled some of the most important statistics on the new economy. The indicators will be updated, as required, in subsequent issues. For further information on concepts and definitions, please e-mail sieidinfo@statcan.ca.

Table 1a
General economy and population

	2001	2002	2003	2004	2005	2006	2007
Gross Domestic Product (GDP) ($ millions)	1,108,048	1,152,905	1,213,408	1,290,788	1,371,425	1,446,307	1,531,427
GDP implicit price index (2002=100)	98.9	100.0	103.3	106.6	110.2	112.8	116.4
Population (thousands)	31,021	31,373	31,676	31,995	32,312	32,649	32,976

Source: Statistics Canada, 2007, Canadian Economic Observer, Catalogue no. 11-010-XWB, Table 380-0056, Table 051-0001.

Table 1b
Gross domestic expenditures on research and development (GERD)

	2001	2002	2003	2004	2005	2006	2007
GERD ($ millions)	23,132	23,532	24,635	26,480	27,699	28,067	28,984
"Real" GERD ($ millions 2002)	23,389	23,532	23,848	24,841	25,135	24,882	..
GERD/GDP ratio	2.09	2.04	2.03	2.05	2.01	1.94	1.89
"Real" GERD per capita ($ 2002)	753.97	750.07	752.87	776.40	777.88	762.11	..
GERD funding by sector				**% of GERD**			
Federal government	17.7	18.1	18.4	17.6	18.9	18.8	18.8
Provincial governments	4.5	5.0	5.6	5.3	4.9	5.1	5.1
Business enterprise	50.2	51.4	50.2	49.4	48.5	48.0	47.8
Higher education	12.7	14.7	14.6	15.7	15.7	16.2	16.4
Private non-profit	2.3	2.7	2.6	2.8	2.8	2.9	2.9
Foreign	12.6	8.2	8.7	9.4	9.2	9.1	9.0
GERD performance by sector							
Federal government	9.1	9.3	8.5	7.9	8.7	8.2	8.1
Provincial governments	1.2	1.2	1.1	1.1	1.1	1.1	1.1
Business enterprise	61.7	57.5	57.0	56.4	55.4	54.7	54.4
Higher education	27.8	31.7	33.1	34.2	34.4	35.5	36.0
Private non-profit	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Federal performance as a % of federal funding	51.3	51.5	46.0	44.8	46.0	43.6	43.0
"Real" federal performance of research and development ($ millions 2002)	2,126	2,190	2,016	1,954	2,191	2,037	2,009

Source: Statistics Canada, CANSIM Table 358-0001 "Gross domestic expenditures on research and development, by science type and by funder and performer sector, annual".

Table 1c
Information and communications technology (ICT) sector

	2001	2002	2003	2004	2005	2006
ICT sector contribution to GDP[1]						
ICT, manufacturing ($ millions 1997)	11,069	8,619	9,239	9,516	10,261	10,702
% of total ICT sector	20.6	15.9	16.1	16.0	16.5	16.5
ICT, services ($ millions 1997)	42,349	44,982	47,522	49,037	51,325	53,511
% of total ICT sector	78.6	82.9	82.7	82.7	82.3	82.3
Total ICT sector ($ millions 1997)	53,857	54,288	57,482	59,298	62,359	65,019
Total economy GDP ($ millions 1997)	957,258	982,843	1,002,936	1,034,024	1,062,951	1,091,587
ICT as a % of total economy	5.6	5.5	5.7	5.7	5.9	6.0
Total business sector GDP ($ millions 1997)	808,810	831,293	847,701	875,777	902,519	927,564
ICT as a % of business sector	6.7	6.5	6.8	6.8	6.9	7.0

1. Data are in basic prices using chained-Fisher methods of deflation (1997 chained dollars), CANSIM Tables 379-0017 "Gross Domestic Product (GDP) at basic prices, by North American Industry Classification System (NAICS), annual" and 379-0020 "GDP at basic prices, special industry aggregations based on NAICS, annual", www.statcan.ca.

Sources: Statistics Canada, Gross Domestic Product by Industry (National) (Annual and Monthly) (various years).

Table 1d
Information and communications technology (ICT) access and use

	2001	2002	2003	2004	2005	2006	2007
ICT adoption rates (private sector)				**% of enterprises**			
Personal computer	83.9	85.5	87.4	88.6	..	..	..
E-mail	66.0	71.2	73.8	76.6	76.2	77.5	81.1
Internet	70.8	75.7	78.2	81.6	81.6	82.8	86.7
Have a website	28.6	31.5	34.0	36.8	38.3	39.7	41.4
Use the Internet to purchase goods or services	22.4	31.7	37.2	42.5	43.4	44.8	48.5
Use the Internet to sell goods or services	6.7	7.5	7.1	7.4	7.3	8.0	8.2
Value of sales over the Internet ($ millions)	10,389	13,339	18,598	26,438	36,268	46,492	58,235
ICT adoption rates (public sector)							
Personal computer	100.0	99.9	100.0	100.0	..	..	..
E-mail	99.7	99.6	99.8	99.9	99.6	99.9	100.0
Internet	99.7	99.6	100.0	99.9	99.6	99.9	99.9
Have a website	86.2	87.9	92.7	92.4	94.9	94.4	93.2
Use the Internet to purchase goods or services	54.5	65.2	68.2	77.4	82.5	79.5	82.1
Use the Internet to sell goods or services	12.8	14.2	15.9	14.0	15.2	15.9	15.9
Value of sales over the Internet ($ millions current)	354.8	327.2	511.4	1,881.5	2,924.7	3,424.3	4,450.0
ICT adoption rates (individuals aged 18 years and over)				**% of individuals**			
Personal (non-business) Internet use from any location	..	..	..	..	67.9	..	..
Personal (non-business) Internet use from home	..	..	..	..	60.9	..	..
Use the Internet to order or purchase goods or services (% of Internet users)	..	..	..	..	41.1	..	..
Total value of e-commerce orders or purchases ($ billions)	..	..	..	..	7.9	..	..
Average value of e-commerce orders or purchases (dollars per consumer)	..	..	..	..	1,150	..	..

Sources: Statistics Canada, Canadian Internet Use Survey; Survey of Electronic Commerce and Technology.

Table 1e
Telecommunications services indicators

	2001	2002	2003	2004	2005	2006
Teledensity indicators				**per 100 inhabitants**		
Wired access – Voice Grade Equivalent (VGE)	67.9	65.5	64.9	64.1	64.1	64.2
Wireless access (VGE)	34.7	38.1	41.8	46.8	52.5	57.3
Total public switched telephone network (PSTN)(VGE)	102.5	103.6	106.7	110.9	116.6	121.4
				thousands		
Homes with access to cable	11,068.6	11,378.9	11,694.4	11,908.2	12,113.2	12,484.3
Homes with access to Internet by cable	9,339.3	10,046.0	10,685.9	11,124.2	11,517.9	11,968.6
Access indicators						
Total wired access lines (VGE)	21,126.0	20,622.0	20,612.0	20,563.0	20,780.0	21,000.0
Residential access lines (VGE)	12,920.0	12,913.0	12,886.0	12,891.0	12,900.0	12,950.0
Business access lines (VGE)	8,206.0	7,709.0	7,726.0	7,672.0	7,880.0	8,050.0
Total mobile subscribers	10,800.0	11,997.0	13,291.0	15,020.0	17,016.6	18,749.1
Digital cable television subscribers	808.4	1,146.5	1,403.9	1,810.5	2,283.1	2,777.2
Satellite and multipoint distribution system subscribers	1,609.2	2,018.6	2,205.2	2,324.6	2,491.5	2,628.7
High speed Internet by cable subscribers	1,624.0	2,055.0	2,532.0	2,933.0	3,467.0	4,041.0
Investment indicators						
Investments by the telecommunications services industries (NAICS 517) ($ millions current)	10,652.9	9,080.5	6,901.1	8,251.0	7,910.8	7,655.9
Investments by the telecommunications services industries (NAICS 517) ($ millions constant)	10,621.4	9,080.5	7,392.4	9,351.0	9,318.4	9,482.8

Source: Statistics Canada, Telecommunications statistics (various years), CRTC Telecommunications Monitoring report, July 2007.

Table 1f
Characteristics of biotechnology innovative firms

	2001	2002	2003	2004	2005
			number		
Firms	375	..	496	..	532
Total biotechnology employees	11,897	..	11,931	..	13,433
Firms that were successful in raising capital	134	..	178	..	173
Existing patents	4,661	..	5,199	..	3,849
Pending patents	5,921	..	8,670	..	7,038
Products on the market	9,661	..	11,046[E]	..	2,438
Products/processes in pre-market stages	8,359	..	6,021	..	F
			$ millions		
Total biotechnology revenues	3,569	..	3,820	..	4,191
Expenditures on biotechnology research and development	1,337	..	1,487	..	1,703
Export biotechnology revenues	763	..	882	..	792[E]
Import biotechnology expenses	433	..	422[E]	..	689[E]
Amount of capital raised	980	..	1,695	..	1,350

Source: Statistics Canada, Biotechnology Use and Development Survey (various years).

Table 1g
Intellectual property (IP) commercialization

	2001	2002	2003	2004	2005
Federal government					
Number of new patents received	133	142	178	169	108
Royalties on licenses ($ millions)	16.3	15.5	14.9	15.2	17.2
Universities and hospitals					
Number of new patents received	381	..	347	397	374[p]
Income from intellectual property ($ millions)	52.5	..	55.5	51.2	55.1[p]

Sources: Statistics Canada, Federal Science Expenditures and Personnel Survey, and Survey of Intellectual Property Commercialization in the Higher Education Sector (various years).