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

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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

Blue Sky II Forum – What indicators for science, technology and innovation policies in the 21st century?

'Blue Sky' is a synonym for thinking creatively, without limiting horizons, about developing new indicators to respond to changing policy and user needs in the areas of science, technology and innovation (STI). The first Blue Sky Forum was organized by the OECD and held in Paris in 1996. It helped set the agenda for developing STI indicators over the past decade. The intent of Blue Sky II was to review progress made while looking towards developing policy-relevant STI indicators for today's global economy. Statistics Canada, the OECD, the U.S. National Science Foundation and Industry Canada partnered to host this landmark conference.

Held in Ottawa, Canada, on September 25-27, 2006, the Blue Sky II Forum examined new areas for indicator development and set a broad agenda for future work on science, technology and innovation (STI) indicators. Emphasis was placed on indicators of outcomes and impacts in order to support monitoring, benchmarking, foresight, and evaluation activities, applied to policies and programs, and their economic and social impacts. As expected, the Forum provided ideas and guidance for indicators work in both OECD-member and non-member countries, as well as for other international organizations.

Four broad topics

The Forum brought public policy researchers, economists, social scientists and statisticians, together with policy makers, government officials and other stakeholders with an interest in science, technology and innovation indicators.

Four broad topics were covered:

- New uses of existing STI indicators;
- New uses of existing non-STI indicators for the purpose of STI policy making;
- Completely new STI indicators and;
- A synthesis of findings leading to an agenda for the next decade of work for STI indicators.

The Forum included plenary sessions featuring invited guest speakers who are leading authorities in their fields. Concurrent workshops provided participants with an opportunity to listen to presentations and exchange information on more specific themes selected through a call for papers.

This special Blue Sky II edition of the IAB includes summary articles of selected workshops and plenary sessions, written by the session Chairs. Additional information, including papers presented at the Forum, is available at:

http://www.statcan.ca/english/conferences/sciencetech2005/index.htm

SIEID contribution

Specific contributions by SIEID staff included the following:

- **New directions for understanding innovation –** Frances Anderson and Susan Schaan, Statistics Canada, and Ingrid Schenk, Industry Canada
- **Science, technology and innovation for sustainable development** – Michael Bordt, Johanne Boivin and Julio Miguel Rosa, Statistics Canada
- **Towards understanding the impacts of science, technology and innovation activities** – Heidi Ertl and colleagues, Statistics Canada
- **Towards a nanotechnology statistical framework** – Kevin Fitzgibbons, Office of the National Science Advisor, and Chuck McNiven, Statistics Canada
- **Biotechnology impact indicators: From measures of activities, linkages and outcomes to impact indicators**, Antoine Rose and Chuck McNiven, Statistics Canada

Blue Sky II – STI Indicators at the OECD: Lessons learned

The third plenary session of the Blue Sky II Forum attempted to draw the "lessons learned" since the first Blue Sky a decade earlier. The panel, chaired by John Dryden, Deputy Director for Science, Technology and Industry at the OECD, brought together five speakers uniquely qualified to provide pertinent insights into indicator development at the OECD with a historical yet forward-looking perspective.

Benoit Godin, researcher at the *INRS Urbanisation, Culture et Société*, Canada is an authority on the history of S&T indictors. Drawing upon the history of the relationship between indicators and science policy, he identified three basic conditions for constructing a new generation of indicators: to reconsider the conceptual frameworks used to collect and analyze statistics; to think about what national systems really mean for statistics, instead of focusing on international comparisons and standardizing methodologies; and to depart from the economic approach. Although these ideas are extreme and provocative, he put forward three suggestions for the future. First, noting that the field of science and innovation studies and the conceptual policy frameworks that drive indicator development have fully endorsed the productivity issue, he suggested reversing the dominance of economic over social issues. Second, he advocated the need for new data sources, which, despite the immense difficulties involved, would move from economic measures to multidimensional measures of science, including social, cultural, health and environmental measures. His third suggestion was to get new ideas – in other words, look for ideas from a more diverse range of disciplines and approaches.

Giorgio Sirilli, researcher at the National Research Council of Italy has a long experience of S&T indicators, having chaired the Group of National Experts on Science and Technology Indicators (NESTI) at the OECD, and now serving on its bureau. He knows first-hand the process of development of indicators and their use for S&T policy. He first addressed the proposal of Dr. John Marburger, the Science Adviser to the U.S. President, for a "science of science policy". He applauded the effort to render the S&T endeavour more rational and transparent, but cautioned against over optimism in applying the natural sciences paradigm to social science and in asking more of the latter than it can deliver. He also pointed out that indicators work is a "heavy ship", with long lead-times, high investment and high momentum, so rather than trying to address the short-term perceived needs of policy makers, he suggested working with them to take a longer term view of the policy needs – and consequent needs for indicators. He made two final points: underlining the care needed in constructing and interpreting composite indicators, and expressing support for the development and exploitation of micro data sets.

Luis Sanz Menendez, from the Ministry of Education & Science, Spain, is a vice chair of the Committee for Scientific and Technological Policy (CSTP), the parent body of NESTI. For him, the "dependence" of the indicators production process on policy needs was a fact, from the beginnings of the Frascati Manual, at least. Indicators can increase the portfolio of available "solutions" to help policy makers cope with problems, but sometimes in an independent way. He discussed how the producers of indicators could easily adapt their output to address the needs of policy makers or analysts – micro data on research organisations or surveys of research careers, for example – in order to shed light on future directions for indicator development. He warned against reading international comparisons too literally, which could be damaging for indicator development. He also pointed out that OECD indicator projects were often not of interest to less developed countries, because their national policy making structures are not always able to absorb the knowledge and their consequences. Finally, he felt that we should work harder to interact with national policy making institutions to develop their capability to use indicators at all phases of the policy making process. This would generate feedback and positive pressure for indicator producers.

Ward Ziarko, of the Federal Science Policy Office, Belgium, is also a vice chair of the CSTP, where he is responsible for following closely the activities of NESTI. He addressed three issues: the main policy questions debated by CSTP since the first Blue Sky Forum; their influence on policy making in a research funding agency; and the consequences on data production. He selected from among the policy issues debated over the past decade: services, new and converging technologies, human resources in science and technology (HRST) and mobility, and the 3% R&D intensity target, which seems to have monopolized policy debate in the EU. At the OECD, he noted the emergence of "National system of innovation" approaches as a tool for analysis and industry-science links or public private partnerships. In future, CSTP would put high on the agenda work on changing business patterns, for example, open innovation, and internationalization of research. He also noted that research policies had evolved. Technology push programs, once the core activities of industry research funding agencies, had given way to collaborative research programs and opening up of financing mechanisms, as well as a broader range of activities encompassing all aspects of innovation and knowledge transfer mechanisms, and broader target groups, such as SMEs, low-tech sectors in the economy

and non-technological activities. He identified diverse consequences for data. Well known indicators (e.g. R&D-intensity) may lose some explanatory power but innovation surveys could become more important. As business patterns change, other indicators such as patents and bibliometrics – already widely used for evaluation purposes – could be used for studying industry-science links. Measuring these links (and their effectiveness) is a major challenge.

Andrew Wyckoff is Head of the Information, Computer and Communication Policy (ICCP) Division of the OECD and formerly Head of the Economic Analysis and Statistics Division. He is thus one of those responsible for making things work from an institutional standpoint. First, "Blue Sky" meetings should take place more frequently in order to mix different stakeholders together and exchange ideas. This is done with academia, but there is a need to add business (where most R&D is performed) and civil society. Such gatherings (and, indeed, NESTI) prove that interaction between statisticians and policy makers can be effective. He welcomed the call by Dr. Marburger for a better understanding and analysis of systems of innovation and the need to elevate science policy so that it approaches economic policy. This implies a huge future work agenda. He noted that the population of policy users had shifted from the S&T community steeped in endogenous growth theory and evolutionary economics, to those whose starting point was neo-classical economics and who would like to see S&T indicators cast in the familiar context of productivity analysis and growth accounting models. It is a tremendous opportunity for S&T indicators to be a fundamental part of economic policy making akin to labour, trade or monetary policy. How might we move forward? We should "tweak" existing data to make it more useful and use data from other fields to improve our understanding of innovation. For example, the OECD's analytic databases (e.g. the STAN family) combine existing data sets creatively to make something new and powerful. In addition, increased computing power now makes analysis of micro data sets possible, provided we can overcome the problem of access. Finally we "need a locomotive for the train" – this could mean "lead countries" with innovative work that has been proven in the field or those who are willing to set the pace in a wider OECD effort. In addition to the locomotive, we need an engineer and people who can keep it moving.

John Dryden, *Deputy Director, Directorate for Science, Technology and Industry, OECD*

Blue Sky II – Understanding the impacts of innovation

Innovation is commonly regarded as a key driver of economic growth. But precisely how innovation affects economic growth and firm behaviour is not easily explained. What are the conditions under which innovation becomes effective in enhancing growth and productivity? These important questions were addressed during one of the sessions at the Blue Sky II Forum. As Chair of that session, Dirk Pilat summarizes the highlights of the papers and subsequent discussion.

Papers presented in the session

New directions for understanding innovation (Frances Anderson and Susan Schaan, Statistics Canada, and Ingrid Schenk, Industry Canada, Canada)

Organizational forms and innovative performance (Anthony Arundel, Maastricht Economic Research Institute on Innovation and Technology, and Edward Lorenz, University of Nice Sophia-Antipolis, France)

What is missing in the analysis of input-output relationships of innovation processes? (Svein Olav Nas, NIFU STEP, Mark Knell and Johan Hauknes, Norwegian Social Science Research Institute, Centre of Innovation Research, Norway)

Where science, technology and innovation indicators hit the road and roadblocks (Susan McDaniel, University of Windsor, Canada)

Innovation is commonly regarded as a key driver of economic growth and many OECD-member countries have made innovation a priority in their recent government policies. But precisely how innovation affects economic growth and the behaviour of firms is not easily explained. What are the conditions under which innovation becomes effective in enhancing growth and productivity? Answers to such questions are not straightforward. Session C1 of the Blue Sky II Forum focused on understanding the impacts of innovation and provided some interesting thoughts on the topic. Two

thoughts in particular stood out; the importance of organisational factors for innovation, and the need to do better in using and linking firm-level (micro) data to understand the role of innovation in firms.

The importance of organisational factors

The paper by Arundel, *et al.* (2006) used data from the Community Innovation Survey and a European survey on Working Conditions to examine the link between different types of innovation and organisational factors for 15 EU countries. The paper found that in countries where work is organised to support high levels of discretion in solving complex problems, for example the Netherlands, Denmark and Sweden, firms tend to be more active in terms of in-house innovation. In countries where learning by workers is more constrained and little discretion is left to the employee, for example Portugal and Spain, firms tend to do less in-house innovation, but primarily rely on their suppliers. The paper thus shows a close link between how people work and learn and the way firms innovate.

This finding is closely aligned with studies on the impact of information and communications technologies (ICT). Such studies typically find that the greatest benefits from ICT are realised when ICT investment is combined with other organisational changes, such as new strategies, new business processes and practices, and new organisational structures (OECD, 2004). The common element among these practices is that they involve a greater degree of responsibility of individual workers regarding the content of their work and, to some extent, a greater proximity between management and labour.

Organisational factors are often difficult to measure and are also difficult to influence with policy. However, ignoring these factors may limit our understanding of innovation and, in-turn, its policy development. The recent revision of the OECD's Oslo Manual, notably the expansion of the definition of innovation to include organisational innovation, may help improve our understanding of such "soft" factors in the innovation process.

Better use of micro data

The paper by Arundel, *et al.* (2006) is only one example of the many papers presented at the Blue Sky II Forum which used micro data in a creative way to gain a deeper understanding of innovation. Many of these studies show that turning innovation into stronger business performance is not straightforward. It typically requires complementary investments and changes, including human capital and organisational changes. Moreover, innovation may be part of a process of search and experimentation, where some firms succeed and grow, while others fail and disappear. The importance of these complementary factors suggests that analysis of innovation can not be isolated from analysis of other firm-level phenomena, such as firm entry and exit, investment in training and organisational factors. However, such analysis can only occur when existing firm-level data are used more effectively and different statistical surveys are linked. To make further progress in this area, a few steps seem particularly important.

First, it will be important to improve the ability to link data from different surveys. Examining the interaction between innovation and other firm-level factors requires that other firm-level sources (*e.g.* surveys of ICT use, surveys of organisational factors, or data on entry and exit) are analysed in combination with innovation surveys. Engaging in such analysis thus requires that national statistical offices are able to link these surveys.

Second, cross-country studies can be particularly helpful in understanding differences in innovation performance. However, such studies are still relatively scarce, partly because of confidentiality restrictions on the firm-level data. Some studies have recently engaged in international comparisons (Mohnen, *et al.*, 2006). Understanding the reasons for the cross-country differences in innovation performance reported in such studies would benefit from further work, and could lead to helpful insights for policy. An effort along these lines is currently underway by the OECD's National Experts on Science and Technology Indicators (NESTI), but more could be done.

***Dirk Pilat**, Directorate for Science, Technology and Industry, OECD.*

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Blue Sky II – Non-technological innovation

The 2005 revisions to the Oslo Manual introduced two new types of innovation: marketing and organisational innovation. The implementation of the Oslo guidelines for these new types of innovation in innovation surveys is not straightforward, leaving room for varying interpretation of the definitions and data. However, work on the Fourth Community Innovation Survey, as well as other innovation surveys, has demonstrated that the application of the new guidelines can lead to quality data and meaningful results. As Chair of this session, August Goetzfried summarizes the highlights of the papers and subsequent discussion.

Papers presented in the session

The determinants and effects of non-technological innovations (Tobias Schmidt and Christian Rammer, Center for European Economic Research, Germany)

Just how innovative are New Zealand firms? Quantifying and relating organisational and marketing innovation to traditional STI indicators (Richard Fabling, New Zealand Ministry of Economic Development, New Zealand)

Design as source and enabler of innovation – New and improved indicators (Ray Lambert, UK Department of Trade and Industry, Office of Science and Innovation, United Kingdom)

Better by design? Capturing the role of design in innovation (Meric S. Gertler and Tara Vinodrai, University of Toronto, Canada)

Industrial reflexity: An institutional approach to measure innovativeness of organisations (Manfred F. Moldaschl, Chemnitz University of Technology, The Institute for Human Resource Management, and Center for Innovation Research, Munich, Germany)

The many aspects of design

This session focused on the many aspects of design within technological or non-technological innovation. Design was regarded as an innovation input measure. The papers emphasised that the role of design needs to be better captured within the Oslo and Frascati guidelines, since it can be an important source and enabler of innovation; higher design intensity by firms tends to be related to stronger economic performance. In the 2005 Oslo Manual, design is recorded under product or marketing innovation, depending on the functional changes of the products concerned.

Survey instruments

When looking at the survey instruments to be used in this respect, it is important to note that innovation surveys or the Community Innovation Survey should not be overloaded with too many questions on design. A multi-source approach using a range of official statistics can be used to better understand the role of design in innovation. This implies the measurement of the economic structure, the employment or other characteristics of firms, which can be used to construct relevant design indicators.

Competitive environment drives the firms

The session also looked to some research and analytic results of innovation surveys, including the Community Innovation Survey. Based on these results it seems that the competitive environment of the firm is the main force which drives technological and non-technological innovation. Non-technological innovation is often paired with technological product and process innovation. If both types of innovations are combined, the effect on the firms' performance is markedly higher. In addition, marketing innovation alone is positively correlated with innovation output. When the analysis was based on business panel data, much more insight could be provided. In particular, different results were observed when looking at contemporaneous data or effects observed with a time lag (e.g. on R&D input related to innovation output measures).

Institutional reflexivity

A new approach for measuring the preparedness of companies or other institutions to innovate was also presented: Institutional reflexivity could be seen in the wider sense of measuring organisational innovation or business practices.

***August Goetzfried**, European Commission (Eurostat)*

Blue Sky II – Multidisciplinary science, technology and innovation

At the heart of wanting relevant and useful indicators is the desire to craft policies – both public and private – that improve human well being. In the realm of science, technology and innovation (STI), the 1990s have reminded us of the power that "general purpose technologies" (GPT) such as information and communications technologies (ICTs), have on economies and societies. This power is arguably just beginning to be felt, as was discussed during this session chaired by Andrew Wyckoff.

Papers presented in the session

A framework to measure the impact of investments in health research (Alan Bernstein, Canadian Institutes of Health Research, Canada)

Towards a nanotechnology statistical framework (Kevin Fitzgibbons, Office of the National Science Advisor, and Chuck McNiven, Statistics Canada, Canada)

Indicators for benchmarking biotechnology innovation policies (Thomas Reiss and Iciar Dominguez-Lacasa, Department of emerging technologies at Fraunhofer ISI, Germany)

Biotechnology impact indicators: From measures of activities, linkages and outcomes to impact indicators (Antoine Rose and Chuck McNiven, Statistics Canada)

Inherent in GPTs is that they draw from a variety of scientific and technological fields and have an impact that cuts across all facets of society and sectors of the economy. As a consequence, understanding and tracking their impacts requires a multidisciplinary approach. Session A2 of the Blue Sky II Forum gave rise to four papers which focused on different aspects of "life sciences" – health care, biotechnology and nanotechnology, which many consider to be the next wave of GPTs. Each paper approached the question of how to measure impacts differently and collectively began to assemble a "tool box" of methods that can be developed.

What impact? On whom?

As "impact indicators" become the focus, a number of common problems emerge that should be considered in future research agendas. The breadth of GPTs requires that "impacts" be measured on a broad basis as well, but then this calls into question causality. Can we really attribute that R&D funding for a new health treatment to gains in longevity or labour productivity when in fact a host of other factors probably had an impact as well? It also requires defining the appropriate populations ("stakeholders") to observe in order to measure impacts and what weights are these different groups assigned? Should they be considered equal – which is frequently the default – or are some more important than others? Many agree that social impacts are actually more important than economic impacts, but drawing the distinction between one or the other can be difficult and in many cases the political imperative is to show economic effects.

An important element to consider when looking at the economic impacts of GPTs is how to compare apples to apples over time? This often requires adjustments for what can be significant *quality* changes in products (e.g. bioengineered drugs) over time. It further suggests that statistical techniques developed for constructing hedonic price adjustments for products like housing, motor vehicles and computers be extended to new areas like communications and health treatments.

Be careful what you measure

As the focus turns to indicators that describe impacts, practitioners need to be aware of the power these indicators can have on what is being measured. As one participant characterised it: "you become what you measure." This is sage advice and should be heeded because if the objective is defined by some measure like research and development normalised by gross domestic product (R&D intensity) then it could have perverse effects as activities are reclassified to fit the measure and activities that are perhaps important to improving welfare, but not purely "R&D," fall out of favour. For this reason it is best not to measure impacts by a single measure or a composite index but rather assemble a suite or mosaic of measures.

Participants agreed that the best way to advance work in this area would be to borrow from analogous work already developed (e.g., measuring nanotechnology can take advantage of work undertaken to measure biotechnology which benefited from work done to measure electronic commerce which grew out of work on advanced manufacturing surveys). This underscores the importance of working together internationally to share experiences, exchange lessons learned and pool scarce resources to collectively develop guidelines and best practices.

***Andrew Wyckoff**, Directorate for Science, Technology and Industry, OECD*

Blue Sky II – Specialized surveys: developing countries, remote regions, and special topics

This session dealt with various subject areas, including sustainable development, specialized R&D surveys, the driving factor behind productivity growth in Tanzania, and measurement issues related to R&D expenditures in the South African service sector. Session Chair Ki-Wan Kim provides a summary of the papers and discussion below.

Papers presented in the session

Science, technology and innovation for sustainable development (Michael Bordt, Johanne Boivin and Julio Miguel Rosa, Statistics Canada, Canada)

What drives productivity growth in Tanzania: Technology or institutions? (Pierre Mohnen, Maastricht University and UNU-MERIT, Micheline Goedhuys and Norbert Janz, University of Antwerp and UNU-MERIT, UNU-MERIT)

*Specialized R&D surveys: Design and application (*Peter S. Mortensen and Carter Bloch, University of Aarhus, Denmark)

Measuring SERVERD: Pie in the sky or substantive activity? (Michael Kahn, Human Sciences Research Council, South Africa)

Measuring R&D in developing countries

The case of South Africa demonstrates that the measurement of R&D activities in developing countries may need to take into account the context and specific situation in each country. For example, the measurement of R&D expenditure in the South African service sector required in-depth interviews with respondents in order to capture the details of R&D activities that were sometimes invisible even to insiders of the enterprise. However, this does not mean that the work towards harmonized data at the international level should not be pursued: The consideration of country-specific constraints and situations should be compatible with ongoing efforts to improve international comparability and harmonization among R&D surveys.

The paper by Pierre Mohnen, *et al.* showed that other data sources – such as the Investment Climate Survey – could also be used to better understand the impacts of technological innovations and institutional factors on the socio-economic development of a country, as well as which factors facilitate or hamper innovation and development. This paper explored the possibility of using existing data and conducting more refined econometric analyses, by considering a number of factors that may influence the innovation activities of companies.

Specialized surveys for remote regions

The paper by Peter Mortensen, *et al.* shows that great needs for special surveys do exist in order to meet policy demands (e.g. the ICT sector, biotechnology, etc.). Like the cases of Denmark and Canada, there have been a number of activities in this direction and the experiences with specialized surveys in OECD-member countries need to be gathered and evaluated in order to develop a set of methodological guidelines towards increased international collaboration.

Denmark's experience with a specialized survey on R&D activities in Greenland shows that this kind of activity has a promising future for some of the OECD-member countries (also see the two-tier innovation survey in Italy), but perhaps not for all the countries. NESTI may contribute to active collaboration between member countries who are interested in specialized surveys.

Indicators for sustainable development

There was a wide consensus among session participants that sustainable development (SD) will be one of the most important policy issues in the near future. Therefore, the needs to refine the methodologies for measurement of SD and to design and standardize classifications related to SD are expected to increase.

The paper by Michael Bordt was a review of existing classifications related to SD and will serve as a good starting point for future work. However, the paper also underlined that many issues must be addressed, before OECD-member countries can arrive at an acceptable consensus, not only methodologically but also theoretically. There were diverging opinions about whether it would be desirable to confine the measurement of SD to the research activities related to environmental protection.

A comment from Luc Soete (UNU-INTECH and MERIT) raised the issue that more efforts are required to link the concept of SD with the general discussion on innovation and economic prosperity, which seems to be of great interest to many developing countries.

***Ki-Wan Kim**, Korea Institute of Science and Technology Evaluation and Planning (KISTEP)*

Blue Sky II – Blue skies above, everyone's in love, up a lazy river…with or without a paddle?

A parallel session on new indicators for S&T policies brought together contributions by Sylvan Katz, Hiroyuki Tomizawa and Takayuki Hayashi, and Monica Salazar, with Pierre Mohnen following as the discussant. In essence, the three contributions addressed the common theme that 'size counts', as reflected below by the session Chair, Michael Kahn.

Papers presented in the session

Indicators for complex innovation systems: A scale-independent view (J. Sylvan Katz, SPRU University of Sussex, United Kingdom)

Constructing a multi-level Scientometric Indicators System (Hiroyuki Tomizawa and Takayuki Hayashi, National Institute of Science and Technology Policy (NISTEP), Japan)

Innovation systems' based indicators: Relationships between innovation, human capital, and information and communication technologies (Monica Salazar, Simon Fraser University, British Columbia, Canada)

Macro level computations require care

The paper by Sylvan Katz provided arguments to show that one must take care when computing indicators at the macro level where the underlying components of such ratios are scale dependent. If the numerator and denominator are scale dependent, then the ratio must also be scale dependent. Accordingly, if one does not correct for scale dependence the meaning of such indicators will be distorted, which carries serious implications for any resulting policy. He provided data to show how a scale independent GERD-GDP ratio would lead to quite different country or regional level tables.

Problems of information management

The paper by Tomizawa and Hayashi focused on the meso and micro levels in seeking to measure the publications outputs of Japanese research institutions, both public and private. The authors reported how difficult it is to obtain clean and reliable data because of inconsistencies in databases at the institutional level. Their motivation for drilling down to the micro level is to seek a relationship between R&D inputs and publication outputs. Preliminary findings demonstrate the importance of institutional clustering and size factors. Essentially the problem they deal with is one of information management. The problem of dataset incompleteness is not unique to Japan, and occurs in South Africa, and probably elsewhere, so their suggestion for replication of the work in other countries is timely.

Obtaining a deeper understanding

Monica Salazar made an appeal to go back to the Oslo Manual fundamentals when seeking to reveal the linkages and collaborations around firms and to bear in mind that such interactions are also size dependent. As she states: 'We need to refine indicators that measure firms' capacities to innovate, and the impact that economic, social and cultural conditions and the environment have upon these capabilities.' Indeed it is difficult for firms to provide the data that innovation surveys seek, and this becomes a strain for smaller firms in particular. Ultimately, to obtain a deeper understanding of the factors determining and influencing innovation one would have to go to the firm level and conduct in-depth interviews. Among other important aspects would be the human resource practices of the firms. What Salazar refers to as 'local communities' are seen as important for sustaining innovation capability. (This latter point may be supported by the Mohnen-Goedhuys-Janz study on Tanzania that attests to the importance of industry associations as a factor toward innovation.)

Thus, these three contributions range from the macro level down to the level of the firm, hence the reference to 'size counts.'

Econometric perspective

Pierre Mohnen then provided some additional insights from an econometric perspective. He reminded participants that GERD is driven by many more factors than just GDP, so that introducing a scale factor is a first order model. Ultimately one must construct a model by identifying the relevant variables. This becomes complex under globalization as BERD straddles jurisdictions. The finer the variables are cut, the greater the problem of consistency becomes. This would also apply to journal counts. Finally insofar as innovation surveys are concerned one must obtain more information on non-innovating firms and what it is that keeps them buoyant.

Two main messages

What are the take home messages from this session? First that size counts. Second that drilling down to the micro level becomes an essential part of survey methodology. One must understand what is happening at the local level before moving to the global level. By drilling down to the firm level one might be able to develop a checklist or typology of attributes contributing to innovation. However that could well be akin to the holy grail of innovation theory.

In fact the session captured much of the debate on size that characterized the three-day discussion at the Forum. Arguably, the size issue was one of the major themes to emerge from Blue Sky II.

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Blue Sky II Forum: What has been learned and what happens next?

A panel discussion concluded The Blue Sky II Forum. Speakers consisted of Enrico Giovannini, the Chief Statistician of the OECD; Luc Soete, the Director of UNU-MERIT; and Jan van Steen, Senior Policy Officer from the Netherlands Ministry of Education, Culture and Science. Fred Gault of Statistics Canada chaired the two-hours of presentation and discussion. This text is a condensed version of his summary.

Throughout the three day Forum, there were a number of recurring which have been grouped into three areas – high-level issues; cross-cutting issues; and specific issues

High-level issues

The capacity to tell the story

The policy community needs accessible, relevant, timely, reliable and accurate information in the form of science, technology and innovation (STI) indicators to support the telling of the story about what happens when STI activities are undertaken.

Moving from activity to impact measures

Telling the story requires more than the fact that the activity of R&D or of innovation took place. Indicators describing the short term outcomes and the longer term impacts are needed and this has implications for the analytical programmes of the OECD.

The need for co-ordination, focus and synthesis

The OECD has a role in support of improving the science of science policy and telling a compelling STI story. It is to co-ordinate and focus STI related activities taking place across the OECD, and in other international organizations, and to synthesize the results so that they are accessible to the policy community.

Moving from the macro to the micro

Another recurring theme of the Forum was the importance of analyzing micro data in addition to doing more macro analysis using OECD data bases such as the Structural Analysis Statistics (STAN) data bases, and the need to facilitate access to micro data holdings for institutions that hold such data.

The science of science policy

There was a need to understand better the processes involved in science policy and the need for, and use of, STI indicators in its support.

Cross-cutting issues

Human resource measures

A more comprehensive picture of the institutions involved in the education, training, life-long learning facilitation and mobility of STI people is needed, along with the characteristics of the people in the STI system. The human resource indicators should be an integral part of all STI analysis and this is a matter of co-ordination, focus and synthesis.

Classification and guidelines

The revisions of international classifications and guidelines have a direct bearing on the understanding of the STI system and require on-going OECD involvement from the STI perspective.

Firm characteristics

Dealing with a number of policy issues, including a response to the effects of globalization, requires agreed upon measures of size, location, and the location and characteristics of (foreign) affiliates of the firm.

Sustainability

Indicators of the sustainability of STI activities should be developed over the next decade.

Specific issues

Participants in the Forum saw the need for OECD work in a number of areas over the next decade. Each of the issues listed below presupposes the issues already raised.

- Globalization of R&D
- Capitalization of R&D in the System of National Accounts
- Existing innovation variables to be made more internationally comparable
- Open innovation, democratization of innovation, and the implications for intellectual property
- A forum, such as a website, for the exchange of information on new field tested questions on innovation
- Measures of the diffusion of knowledge, technology and practices
- Measures of linkages, including bibliometrics, contracts, collaboration, commercialization, characteristics of value chains, flows of people and capital investment
- Measures of outcomes of all STI activities
- Information on the impacts of STI activities
- Co-ordination of STI related data bases in international organizations outside of the OECD
- Analysis of micro data in addition to macro data
- Development of modeling techniques in addition to econometrics
- Promotion of access to micro data in organizations that collect statistics and for the linking of data sets to enhance analysis and reduce respondent burden
- Promotion of the use of administrative data
- Inclusion of questions on framework conditions in STI surveys and case studies
- Transfer of knowledge of STI indicator development to developing countries and supporting the building of the capacity to develop and to use STI indicators in support of STI policy.

Future Blue Sky

Following the adjournment of the Blue Sky Forum until 2016, the next steps include reporting on the findings of the Forum to the OECD Committee for Scientific and Technological Policy (CSTP) at its meeting in Korea in October 2006 and then the formulation of projects for the consideration of the OECD Working Party of National Experts on Science and Technology (NESTI), as part of its programme of work, when it meets in Paris in June 2007.

***Fred Gault**, Science, Innovation and Electronic Information Division, Statistics Canada.*

NRC-IRAP and growth of firms – Results of a client performance study

Companies funded to conduct research by the National Research Council - Industrial Research Assistance Program (NRC-IRAP) British Columbia Region performed better on most accounts than similar companies overall. This article presents results of a pilot study conducted on companies who were clients of the NRC-IRAP British Columbia Region between 1987 and 1998. All clients spent more than double on R&D on average than non-clients in 2002. All clients averaged nine R&D personnel per client, whereas non-clients averaged five R&D personnel.

Background

NRC-IRAP provides a range of both technical and business-oriented advisory services, along with financial support, to growth-oriented small and medium enterprises. At present, the assessments of the impacts of the program are summaries of anecdotal information on NRC-IRAP client firms. This study compares the performance of the program's client firms with similar non-client firms, and determines whether the clients spend more on R&D and are more likely to increase R&D spending over time; whether they grow faster; are more likely to export; and whether they raise more equity investment than similar non-client firms.

This article describes a pilot study conducted on companies who were clients of the NRC-IRAP British Columbia Region between 1987 and 1998. Growth indicators were produced for the period 1998 to 2002.

Findings will enable NRC-IRAP to engage in evidence-based assessment of their disbursement of public funds, report on the effectiveness of the program, and make decisions regarding program amendment in light of measured outcomes. Similar future studies may be carried out in order to provide regular benchmarking measures to assess the impacts of program changes, and monitor the long-term impacts.

Results presented below constitute only a small part of the whole analysis. More detailed breakdown were performed and provided insight by firm age and industry.

Results

Large firms have been excluded from the following analysis. There were few large clients and excluding them allows us to present more detail on small and medium clients. In the following descriptions “all clients” actually refers to “all small and medium clients” and “non-clients” is “small and medium non-clients”.

Revenue growth

Revenues of all clients grew more quickly than revenues of non-clients. All clients increased revenues by 43% over the period whereas non-clients increased revenues by 38%. Small clients (fewer than 100 employees) increased revenues by 45% and non-clients increased revenues by 37%.

Employment growth

In terms of employment growth, clients edged non-client firms slightly, both grew on average about 11% between 1998 and 2002. Small clients grew in employment by 14% over the period while small non-clients grew an average of 11%.

Payroll growth

All clients increased payroll by 22% over the period whereas non-clients increased payroll by 30%. Small clients increased payroll by 40% whereas small non-clients increased payroll by 33%.

Shareholder equity and growth

Shareholder equity in 2002 averaged $5.1 million per client in 2002 and only $880 thousand per non client. Small clients averaged $1.7 million in shareholder equity in 2002 whereas small non-clients averaged only $608 thousand.

Shareholder equity for all clients grew by 168% between 1998 and 2002 whereas shareholder equity for small non-clients grew by only 40%. For small clients, shareholder equity increased by 135% and, for small non-clients by only 19%.

R&D expenditures

All clients spent more than double on R&D on average than non-clients in 2002. Research and development expenditures for all clients averaged $906 thousand in 2002 whereas expenditures for non-clients averaged $414 thousand. For small clients, the average R&D expenditure was $449 thousand. Small non-clients spent on average $272 thousand.

R&D personnel

All clients averaged 9 R&D personnel per client whereas non-clients averaged 5 R&D personnel. Small clients averaged 6 R&D personnel in 2002 and small non-clients averaged 4 R&D personnel.

Exports

Clients averaged $3.0 million in exports in 2002 whereas non-clients averaged $4.4 million overall. Small clients averaged $1.5 million in exports and small non-clients averaged $2.0 million.

Summary

Initial results show generally superior performance of clients over non-clients especially in terms of average shareholder equity, equity growth, R&D expenditures for small clients and revenue growth. The lower average exports of small clients compared with small non-clients should be investigated further. NRC-IRAP expects to extend the pilot to a national scale.

***Michael Bordt**, Statistics Canada; **Denise Guillemette**, NRC-IRAP; **Julia Rylands**, NRC-IRAP*

Commercializing the results of research in Canadian universities and hospitals: an update for 2004

Canadian universities and affiliated research hospitals have made great strides in commercializing inventions. Since 1998, Statistics Canada has conducted the Survey of Intellectual Property Commercialization in the Higher Education Sector to track progress in this area. This article highlights some of the changes between 2003 and 2004, as well as presents the 2004 regional results.

Major increases between 2003 and 2004

In recent years, the Government of Canada has made substantial new investment in university research. Between 2003 and 2004, total sponsored research funding rose from $4.3 billion to $5.0 billion. During this period, many indicators of the outcomes of university research also increased.

Numbers way up

Between 2003 and 2004, the number of inventions reported or disclosed by researchers to universities and hospitals increased from 1,133 to 1,432 (26%). The number of patents issued to these institutions also increased from 347 to 397 (14%) while the total number of patents held rose from 3,047 to 3,827 (26%).

Table 1 Survey of Intellectual Property (IP) Commercialization in the Higher Education Sector, 2003 and 2004

	Unit of measure	2003	2004	% change
Institutions in survey	number	121	119	-2
Institutions actively managing IP	number	87	91	5
Inventions disclosed	number	1,133	1,432	26
Inventions protected	number	527	629	19
Patent applications	number	1,252	1,264	1
Patents issued	number	347	397	14
Total patents held	number	3,047	3,827	26
New licenses and options	number	422	494	17
Active licenses and options	number	1,756	2,022	15
Income from IP	$ thousands	55,525	51,210	-8
Sponsored research	$ millions	4,282	5,048	18

Source: Statistics Canada, Survey of Intellectual Property Commercialization in the Higher Education Sector.

Patents are typically licensed to other parties, such as to other institutions and companies. New licenses and options rose from 422 to 494 (17%) while total active licenses and options rose from 1,756 to 2,022 (15%).

More spin-offs

In each of the reference years (2003 and 2004), Canadian universities and hospitals created 50 spin-off companies to commercialize their technologies, for a total of 968 created to date. The spin-offs cover a wide range of industries, for example, research and development, computer systems design, engineering and medical devices manufacturing. At the end of 2004, the institutions held $49.9 million in equity in publicly traded spin-off companies. In addition, the institutions also helped their spin-offs to raise $56.4 million in venture capital and other forms of investment.

Income down

Income from intellectual property (IP) (running royalties, milestone payments, etc.) decreased from $55.5 million to $51.2 million (-8%). However, this was offset by an increase in cash dividends received by institutions plus equity holdings, options and warrants cashed in by institutions. The latter increased from $3.0 million to $9.0 million between 2003 and 2004.

Wide variation across regions

Research funding varies widely from institution to institution and from region to region. For example, the 18 universities and hospitals in the Atlantic region, which are mainly small, received $227 million in research funding in 2004. This compares to 37 institutions in Ontario that received $1.9 billion in research funding in the same year.

Regional differences in IP commercialization can be examined in proportion to research funding. Universities and hospitals in British Columbia received 10% of total research funding but accounted for a higher proportion of five major indicators of IP commercialization: 17% of inventions disclosed, 20% of inventions protected, 17% of new licenses and options, 17% of total licenses and options and 23% of spin-off companies created to date.

Prairie institutions obtained 18% of sponsored research funding and accounted for 21% of inventions disclosed, 26% of patents issued and 24% of total active licenses and options. However, they had a lower share of six major indicators of IP commercialization: income from IP (17%), inventions pro-

Table 2 Regional differences in IP commercialization, 2003, Part 1

				Inventions		Patents		
	Institutions	**Sponsored research**	**Income from IP**	**Disclosed**	**Protected**	**Applications filed**	**Issued**	**Total held**
	number	*$ millions*	*$ thousands*	*number*				
Atlantic	18	227	554	71	26	x	x	x
Quebec	29	1,577	x	244	181	387	106	1,027
Ontario	37	1,864	11,418	567	230	398	87	1,013
Prairies	20	885	8,670	302	65	170	102	634
BC	15	495	x	248	127	x	x	x
Total	**119**	**5,048**	**51,210**	**1,432**	**629**	**1,264**	**397**	**3,827**
	Percent of national total							
Atlantic	15	4	1	5	4	x	x	x
Quebec	24	31	x	17	29	31	27	27
Ontario	31	37	22	40	37	31	22	26
Prairies	17	18	17	21	10	13	26	17
BC	13	10	x	17	20	x	x	x
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Statistics Canada, Survey of Intellectual Property Commercialization in the Higher Education Sector.

tected (10%), patent applications filed (13%), total patents held (17%), new licenses and options (14%) and spin-off companies created to date (17%).

Ontario institutions received 37% of total research funding and accounted for an equal or higher proportion of three of eight indicators of IP commercialization: 40% of inventions disclosed, 37% of inventions protected and 49% of new licenses and options. However, they accounted for a lower proportion of the following five indicators: 22% of income from IP, 31% of patent applications filed, 22% of patents issued, 26% of total patents held, 33% of total active licenses and options and 36% of spin-off companies created to date.

Quebec institutions obtained 31% of sponsored research funding and accounted for 31% of patent applications filed. However, on all other published indicators, they had a lower result: 17% of inventions disclosed, 29% of inventions protected, 27% of patents issued, 27% of total patents held, 18% of new licenses and options, 24% of total active licenses and options and 17% of spin-off companies created to date.

In recent years, Atlantic institutions have become more active in IP commercialization. Atlantic institutions obtained 4% of sponsored research funding and accounted for 5% of inventions disclosed, 4% of inventions protected and 7% of spin-off companies created to date. However, they lagged in both new and total licenses and options (2%), as well as income from IP (1%).

Other indicators that may play a role in IP commercialization outcomes are expenditures on IP management and the value of research contracts. (Table 2, Parts 1 and 2)

Preliminary results from the 2004 Survey of Intellectual Property Commercialization in the Higher Education Sector were released on January 27, 2006. This article includes revised estimates. The complete working paper with the revised estimates was released on October 4, 2006.

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Table 2 Regional differences in IP commercialization, 2003, Part 2

	Licenses and options		Spin-off companies created to date	Other indicators of note		
	New	**Total active**		**Expenditures on IP management**	**Research contracts**	**Inventions declined**
	number			*$ thousands*	*$ millions*	*number*
Atlantic	12	36	65	1,743	73	30
Quebec	89	496	165	9,196	153	40
Ontario	240	678	344	12,133	469	122
Prairies	71	477	170	5,492	145	53
BC	82	335	224	8,363	101	110
Total	**494**	**2,022**	**968**	**36,927**	**941**	**355**
	Percent of national total					
Atlantic	2	2	7	5	8	9
Quebec	18	24	17	25	16	11
Ontario	49	33	36	33	50	34
Prairies	14	24	17	15	15	15
BC	17	17	23	22	11	31
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Statistics Canada, Survey of Intellectual Property Commercialization in the Higher Education Sector.

The functional foods and nutraceuticals industry in Canada

Results from the Functional Foods and Nutraceuticals Survey (2005) indicate that there were 389 firms in Canada engaged in activities related to either functional foods, nutraceuticals or both during 2004/05. This article takes a closer look at a group of firms which generates $29 billion in revenues and employs over 50,000 persons.

Defining functional foods and nutraceuticals (FFN)

For the purposes of the survey, functional foods are foods which "have demonstrated physiological benefits and/or reduced risk of chronic disease beyond basic nutritional function", while nutraceuticals are defined as "product(s) isolated or purified from foods and sold in medicinal forms such as powders, tablets and capsules and demonstrated to have physiological benefit or provide protection against chronic disease".

The largest group of firms was engaged in nutraceutical–related activities only, followed by functional foods only and finally firms that report both functional food and nutraceutical-related activities (see Table 1).

Reported sales

Firms with functional food or nutraceutical-related activities reported about $2.9 billion in sales from these products. This accounted for 10% of revenues from all sources for these firms. About half of this figure was reported by firms with only nutraceutical-related activities where nutraceutical revenue accounted for over half of revenue from all sources.

Related R&D

Firms with functional food or nutraceutical-related activities were actively involved in related R&D. These firms spent $74 million in 2004 on R&D that was specifically directed to functional foods or nutraceuticals. This accounted for almost half of the total funds spent on R&D by these firms, indicating that firms see these products and processes as important to their longer term competitiveness. Across the board, firms with functional food only, nutraceutical only and both functional food and nutraceutical-related activities reported a significant component of R&D directed towards functional foods and nutraceuticals.

Interestingly, the proportion of funds focused on functional foods and nutraceuticals R&D was lowest for nutraceutical only firms, which, as noted above, reported the highest concentration of revenues from functional foods or nutraceuticals. This would seem to indicate that most of the products in the nutraceuticals categories are already on the market and generating revenues.

Table 1 Selected business measures for firms with functional food and/or nutraceutical-related activities, 2004

	Number of firms	FFN revenues	FFN revenue as % of total	FFN R&D	FFN R&D as % of total
		millions	*%*	*millions*	*%*
All firms	**389**	**2,887**	**10**	**75**	**46**
Functional foods only	118	824	5	21	46
Nutraceuticals only	174	1,620	57	30	39
Both functional foods and nutraceuticals	97	443	7	24	57

Note: The figure for FFN revenues for firms with both functional food and nutraceutical-related activities is an estimate that should be used with caution.

Source: Statistics Canada, Functional Foods and Nutraceuticals Survey, 2005.

Employment

Overall, functional food and nutraceutical firms employed over fifty-thousand individuals in 2004/05 (see Table 2). One quarter of these were engaged in nutraceutical or functional food-related activities.

There were almost 13,000 employees with functional foods or nutraceutical-related responsibilities in Canada in 2004. About one half work in firms that were engaged in nutraceuticals-related activities only. One third worked in firms engaged in functional food only-related activities while the remaining sixth worked in firms with both functional foods and nutraceutical activities.

Table 2 Selected employment measures for firms with functional food and/or nutraceutical-related activities, 2004

	Number of firms	All employees	Average number of employees per firm	FFN employees	FFN employees as % of total
		thousands		*thousands*	*%*
All	**389**	**52**	**133**	**13**	**25**
Functional foods only	118	34	288	4	12
Nutraceuticals only	174	13	77	6	49
Both functional foods and nutraceuticals	97	44	44	2	55

Source: Statistics Canada, Functional Foods and Nutraceuticals Survey, 2005.

Firm size

Firms that reported only functional foods-related activities tended to be the largest, with an average of 233 employees. These firms also reported the lowest degree of concentration in functional foods and nutraceuticals. Only 12% of their employees and 5% of their revenues came from functional foods.

Firms with activities related to nutraceuticals only were on average smaller than those with functional foods firms, with a higher proportion of their employees dedicated to nutraceuticals-related to activities.

Firms with both functional foods and nutraceutical-related activities were on average the smallest of all, with 44 employees per firm, of whom over half had functional food or nutraceutical-related responsibilities. Whereas actual revenue from functional foods or nutraceuticals was comparatively low the degree of focus on functional foods or nutraceuticals in R&D was quite high, both in terms of an absolute value and as a proportion of all R&D spending. This may indicate that these firms are at an earlier stage of development with fewer functional foods or nutraceuticals on the market.

Expanding product line

The Functional Foods and Nutraceuticals Survey provides a picture of a group of firms from many industries. These firms are engaged in developing products to benefit human health, directly from natural sources, to be ingested as a food or a supplement. The survey shows that these firms have significant sales of products and are also continuing to research and develop new and improved functional food and nutraceutical products.

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Defining bioproducts: a daunting challenge

Bioproducts play an important role in the search for solutions to declining reserves of oil, increasing costs of oil extraction, increasing oil prices and increasing greenhouse gas (GHG) concentration. They also offer opportunities for rural economic development and diversification for farmers. This article summarizes ongoing work towards improving our understanding of the bioproduct concepts and their definitions.

New and old processes

Bioproducts are not only new products; the bioproducts activity sector encompasses both new and old processes to develop products from renewable resources. However, as noted by Traoré (2003), a rigorous definition of what constitutes a bioproduct does not have consensus among stakeholders which could have an impact on the interpretation of data.

Evolution of the definition

An early definition of a bioproduct came about after Agriculture and Agri-Food Canada (AAFC) completed a background paper entitled "Discussion Framework: Developing Bio-based Industries in Canada" (Crawford, 2000). Quoting from that paper: *the term bioproducts is used to describe a commercial or industrial product (other than food and feed) that is generated from biomass. These products include biopower (heat and electricity), biofuels (ethanol and biodiesel), industrial biochemicals and a broad range of other bioproducts like agri-fibre panels, textiles made from flax and hemp, and bioplastics made from corn starch*. The paper also defined the term biomass as *describing any organic carbon-based materials that are available on a renewable or recurring basis and which can be used in place of fossil-fuel sources to develop value-added products, such as power, heating, industrial chemicals and consumer goods. Biomass sources are from agriculture (plant, animal), marine, forestry and even municipal waste streams.*

In 2001, these two definitions were combined, giving rise to *a third definition for a bioproduct: a commercial or industrial product (other than food and feed) made with biological or renewable domestic agricultural (plant, animal), marine or forestry materials, such as bio-energy (heating and electricity), bio-fuels (ethanol and bio-diesel), bio-chemicals, fiberboard, textiles and bio-plastics, other* (Biotechnology Use and Development Survey, 2001).

The definition further evolved in 2004 with Statistics Canada's Bioproducts Development Survey, the first of its kind. It specified that a bioproduct was *a commercial or industrial product (other than food, feed and medicines) made with biological or renewable agricultural (plant, animal), marine or forestry materials.* To complement the definition, a list of bioproduct categories was provided in the questionnaire (Table 1). According to Rose (2000), by combining a list of products with a definition, the interpretation of the definition would not be left to the respondent.

Table 1 List of bioproducts categories, Bioproducts Development Survey

1. Bio-fuels (methane, ethanol, bio-diesel)
2. Bio-energy (heating and electricity)
3. Bio-sensors
4. Biocatalysts
5. Bio-chemicals (bio-solvants, bio-adhesives, biosurfactants, bio-lubricants, fine-chemicals, etc.)
6. Bio-plastics
7. Bio-pesticides/bio-fungicides/bio-herbicides
8. Fibre composites

In 2005, a pre-contact survey on emerging technologies was conducted to identify firms involved in various sectors. Although there was no bioproduct definition provided, an extended list of bioproduct categories was specified (Table 2).

Table 2 List of bioproducts categories, Survey on emerging technologies, 2005

1. Bio-fuels ethanol, bio-diesel
2. Bio-energy heating and electricity
3. Bio-chemicals/bio-pharmaceuticals
4. Bio-plastics/ bio-adhesives
5. Bio-lubricants/ bio-solvants
6. Biocatalysts
7. Bio-sensors
8. Bio-pesticides/bio-fungicides
9. Fiberboard /agri-fiber panels
10. Textiles from hemp and flax
11. Cosmetics

Textiles from hemp and flax and cosmetics have been added to the list of bioproducts which allows for the identification of a greater number of firms involved in this activity sector.

How do other organizations define bioproducts

Industry Canada (IC) does not have a definition for bioproducts; however it does specify that bioproducts firms *include firms that produce fuels, chemicals, materials and speciality products using biological feedstocks and bioprocesses* (IC, 2002). The Agricultural Policy Framework (AAFC, 2003) provides a much broader definition of a bioproduct: *a product developed from living organisms and their constituent parts that may replace or augment products derived from non-renewable resources.*

Industry associations can have their own bioproduct definition as well. For example, BC Bioproducts Association includes functional food and nutraceuticals (FFN) and food supplements entering into feed as bioproducts. BIOCAP Canada Foundation and Pollution Probe share the same definition, which is close to the one used in Statistics Canada's Biotechnology Use and Development Survey; *bioproducts refer to commercial, industrial and environmental products, but not to the feed and fiber we traditionally derive from microbial and plant species*. Finally, Goodfellow Agricola Consultants Inc. is a group with relevant experience and extensive knowledge in the areas of bioproducts and biotechnology. It defines bioproducts as *non-food, non-feed agricultural and marine products, and non-timber, non-pulp forestry products that are used in a variety of commercial/industrial applications.*

The United States Department of Agriculture (USDA) uses the term *biobased product* rather than bioproduct and it is defined by the Farm Security and Rural Investment Act of 2002 (FSRIA). According to this Act, a biobased product is *a product determined by the Secretary of Agriculture to be a commercial or industrial product (other than food or feed) that is composed in whole or in significant part, of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials.*

Considerations

The most recent definition of a bioproduct, accompanied by a list of bioproducts categories in the Bioproducts Development Survey, is a substantial improvement but still incomplete. The definition does not consider the novel or innovative aspect of the product. Since many bioproducts are not new products (for example: paper, plywood, etc.), the innovative aspect in the definition needs to be considered.

The notion of a bioproduct is often based on the origin of the product rather than the fundamental difference from products obtained from fossil-based feedstocks (Archambault *et al.*, 2004). For instance, the chemical structure of methanol is exactly the same whether it is produced from natural gas or from syngas, while the latter is derived from biomass. The issue of capturing not only new products derived from biomass, but also capturing new ways of producing existing products needs to be addressed.

The issue of including bioprocesses in the list of bioproducts also merits consideration. A bioprocess seems to be a link between biotechnology and bioproducts rather than a bioproduct *per se*. In fact, a bioprocess is defined by the Canadian Biotechnology Secreteriat (CBSec) *as any process that uses complete living cells or their components (e.g. enzymes, chloroplasts) to effect desired physical or chemical changes*. Therefore, bioprocesses may have to be dealt with separately from bioproducts.

Bioproducts activities

The term *bioproducts industry* is often used to describe a group of firms involved in bioproduct-related activities. However, it is used inappropriately. The conventional industry concept is well established in the North American Industry Classification System (NAICS). Bioproduct activities occur in various sectors of the economy similar to biotechnology. As noted in a report submitted to the British Columbia Bioproducts Working Group (Faculty of Forestry, UBC, 2005), bioproducts activities require, as input, different feedstocks which belong to various industries (e.g. agriculture industry, forest industry, etc.); the final products that are created at the end of the process also belong to various industries (e.g. chemical industry, car industry, etc.). Thus, the only overarching characteristic of bioproducts is that they are derived from biomass.

In addition, most of the bioproduct activities account for one-quarter of the total revenues of all firms involved in such activities in Canada in 2003, which indicates that bioproducts are just one part of a firm's business activities (Sparling *et al.*, 2006). Therefore, it is difficult to attribute the term industry to the group of firms that are engaged in bioproduct-related activities.

Summary

The primary criterion to define the term bioproduct is the use of biomass as the input to develop/produce bioproducts. This is a necessary but not sufficient requirement to determine a comprehensive and accurate definition of a bioproduct. It also has to be an industrial or commercial product other than food, feed and medicines (to exclude health and pharmaceutical products). Finally, the focus should be on traditional products from alternative resources and on non-traditional products in order to capture the novelty or innovative aspect of a bioproduct.

The bioproduct model, like many other new concepts, is evolving. The definitions of bioproduct and biomass will certainly continue to evolve over time and will require some flexibility to allow for revisions. These definitions are fundamental to the success of the Bioproducts Development Survey. The precision of the definition should reflect the intent to measure the innovative aspect of the bioproducts sector

(e.g. traditional forest products such as lumber, paper and plywood should be excluded from the definition).

***Johanne Boivin**, Agriculture and Agri-Food Canada*

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Canadian firms connect with government on-line

Over the past six years, the Government of Canada[1] has worked toward providing services online for corporations, clients and citizens alike. By 2005, the initiative had resulted in 130 of the most commonly used services being available online to complement more traditional means of delivery. This article provides highlights from Statistics Canada's 2005 Survey of Electronic Commerce and Technology (SECT) which investigated federal and provincial government online services.

Services available

Government services available online range from handling simple requests for information to managing complex transactions online in real time. Firms may use the Internet to register a business with a government agency or to apply for grants from the federal government. For many organizations in Canada dealing with various levels of government online has become an everyday reality.

In many cases, having the ability to interact with various levels of government online is more efficient for both parties instead of directly dealing with an individual or navigating a phone network. Online services are available 24 hours a day, 365 days a year instead of only operating during office hours.

In 2005, the Survey of Electronic Commerce and Technology asked firms about their interaction with local, provincial or federal government on-line. Specifically, firms that used the Internet were asked if they had obtained information, completed taxation forms or applied for grants and benefits online.

When referring to firms, this article refers to private firms and those that have indicated they use the Internet only, except where noted.

1. The Government Online (GOL) Initiative was a project undertaken by the federal government in order to make the Government of Canada more accessible on the Internet to Canadian individuals and businesses. However, the SECT asked respondents not only if they had dealt with the federal government, but also provincial and municipal firms that may have implemented programs of their own to become accessible online.

Canadian Government Online (GOL)

Although the survey asks about interaction with any level of government online including federal, provincial, and municipal, it is expected that the majority of interaction takes place with the federal government.

This is a result of a major initiative by the Canadian federal government that began in 1999 to make the most commonly used services available online to users. Traditional methods have not been abandoned but instead have been complemented by the online presence of over 130 services from 34 different agencies and departments.

Online portal used for basic services most often

The results from the survey indicate that the greatest percentage of private firms use the Internet to obtain information and documents from government web sites. In 2005, 65% of firms that used the Internet obtained information or documents through this online channel. Large firms were most likely to take advantage of using the Internet to obtain information and documents. Just over 80% of large firms that had the Internet in 2005 used it to do so. At the other end of the spectrum, 62% of small firms in Canada obtained information this way. It is expected that this will remain the most common way for Canadian firms to interact with their government online. There are very few barriers to doing so, as security concerns are not an issue and the need for technological knowledge is minimal.

Almost one-third of firms return tax forms online

Data from the survey indicate that in 2005, 32% of firms completed or returned tax forms online. These forms may include such things as Goods and Services Tax remittances, employment taxation information (T4) or year-end income taxes (T2). The majority of these dealings involve interaction with the federal government.

In Canada, remitting such information to the government over the Internet is done solely on a voluntary basis. This is in contrast to such countries as Holland where use of online transactions with the government has been pushed by legislation. For example, firms in Holland must submit their Value Added Tax declaration online. This causes the percentage of firms using the Internet to submit taxes to rise considerably.

Interestingly, there seems to be little difference in the percentage of small firms and large firms that choose to provide tax information to the government online. While 30% of small firms supplied tax information online in 2005, the percentage of large firms doing so, was 31%. The parity between large and small firms in this instance may be a result of many factors so it would be unwise to speculate on the reasoning for this similarity. Regardless, any barrier that may exist to remitting taxes online does not seem to be one that affects only small firms.

Two industry sectors stood out as heavy users of tax remittance services offered online by the government. Over 41% of firms in the Professional, Scientific and Technical services sector did so, while about 37% of firms in the Manufacturing sector engaged in this activity. Interestingly, in both sectors the percentage of small firms that remitted taxes online was higher than the percentage of large firms that did so.

Applying for grants online limited to a few industries

One of the questions on the 2005 edition of SECT asked firms if they had used an online method to apply for grants or benefits from any level of government. Overall, less than one in twenty firms had done so.

As expected, those that used this service were concentrated in a few sectors. Those sectors that were most likely to interact with the government online for this reason included the Educational Services sector at 22% and Information and Cultural Industries at 12%. The only other sectors that had over 10% of firms applying for grants or benefits online were Private Health Care and Social Assistance and the Arts, Entertainment and Recreation sector.

This concentration in a few industries can be expected to continue. Applying for grants or benefits is an activity that only applies to a certain percentage of firms in any situation, be it online or through traditional methods.

Large firms were more likely than small ones to apply for grants or benefits online. This could be a result of having more resources in place in order to draft proposals and submit requests.

Public firms embrace online practices

In previous years of conducting the SECT, it has been documented that public firms are the most likely to use many technologies and stay on the cutting edge. This appears to be the same in their interactions with online government services. Public firms had a higher proportion of firms using each of the three types of interaction with government online than their private counterparts. In 2005, 89% of public firms used the Internet to obtain documents or information, 36% used the Internet to remit tax information, and 40% of firms applied for grants or benefits online.

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Are Internet users tuning out traditional media?

Over the past decade, Internet content has evolved to the point where it now represents a significant source of information and entertainment for many people. The Internet has changed the way that many individuals and organizations gather information, and has undoubtedly had some influence on their use of traditional media. While few Canadians had Internet access and went online to gather news information in the mid-1990's, today many use the Internet to access online newspapers, reports, discussion forums and even blogs. In 2005 for example, about 62% of home Internet users - or 38% of Canadian adults overall - went online to view news or sports information (Statistics Canada, 2006).

Internet vs. television

The widespread use of the Internet has attracted the attention of those working in traditional media, such as television, radio and print. While they must now compete with this new source of information, some have also begun to view the Internet as a growth opportunity (Media Audit, 2004).

Television has long dominated the entertainment landscape in Canada. Yet as the Internet evolved, particularly through increased bandwidth and greater diversity of content, visions of a battleground between traditional television and the Internet began to emerge. While television is sometimes viewed as a passive form of entertainment[1], Internet use tends to be more interactive - users can both receive and send information, and can more easily tailor their experience to suit their own interests. In addition, there is the theory that time spent on the Internet must necessarily take away from time previously allocated to other activities - sometimes referred to as the 'time displacement' model (Robinson, et. al., 2000). Evidence abounds that some Internet users have in fact cut back on their television viewing since starting to use the Internet (Kraut, et. al., 2005; Dryburgh, 2001).

Media patterns and the Internet

Data from Statistics Canada's *2005 General Social Survey on time use* provide a detailed snapshot of the media consumption patterns of Canadians. This survey asked respondents to report all of their activities[2] over a 24-hour period. Initial findings show that during the course of the day, Canadians

Table 1 Average time spent by Internet users and non-users accessing various media over a 24-hour period, 2005

Activity	Internet non-users[1]		Moderate Internet users[1]				Heavy Internet users[1]			
	Time	Adj. Time[2]	Time	Diff.	Adj. Time[2]	Adj. Diff.	Time	Diff.	Adj. Time[2]	Adj. Diff.
	time in minutes									
Watching TV	125.8	125.2	112.2	-13.5**	120.2	-5.0	124.3	-1.5	120.6	-4.6
Reading books	13.0	12.8	16.3	3.3*	17.2	4.4**	15.8	2.8	17.0	4.2*
Reading magazines	1.6	1.6	1.4	-0.2	1.7	0.1	2.2	0.6	2.5	0.9
Reading newspapers	7.8	7.5	7.8	-0.1	9.4	1.8**	6.7	-1.2	8.2	0.7
All media activity	150.7	149.6	139.8	-10.9**	150.8	1.2	152.9	2.2	152.1	2.5

* Difference from non-users is statistically significant at the 95% confidence level ($p < .05$).
** Difference from non-users is statistically significant at the 99% confidence level ($p < .01$).

1. Internet non-users are defined as individuals who did not use the Internet for personal use for an episode of at least 5 minutes during the 24-hour diary period captured in the 2005 General Social Survey on time use. Moderate users are defined as those spending 5 minutes to 1 hour on the Internet for personal use, and heavy users are defined as those spending more than 1 hour on the Internet for personal use. Figures refer to personal use of the Internet only and do not include use for school or work-related purposes.
2. Adjusted figures control for age, sex, number of children aged 14 and under in respondent's household, day of week (weekday or weekend), education and time spent at location of work.

Source: Veenhof, 2006.

1. Interactive forms of television are becoming increasingly common. These include 'reality' programs involving audience participation, those incorporating viewer feedback by phone or Internet, interactive weather and video game channels, and even sports programs allowing viewers to choose from a variety of different camera angles, for example.

2. In the diary study, respondents were instructed not to report activities that lasted less than 5 minutes.

spend approximately two-and-a-half hours consuming traditional media, with television taking up a very large share of that time (Table 1). While moderate[3] Internet users spent an average of nearly 14 minutes less time watching television during the day than those who did not use the Internet, once respondents of similar social and demographic backgrounds were compared, the difference in time spent watching television was no longer statistically significant (see adjusted figures under the column, 'Adj. Diff.').

Most interestingly, heavier Internet users - those spending more than one hour on the Internet for personal use during the day - did not differ significantly in their television viewing time from Internet non-users, both before and after adjusting for differences in social and demographic characteristics. This finding is particularly revealing when one considers that the average heavy Internet user dedicated two-and-a-half hours to using the Internet for leisure during the day, yet still found nearly the same amount of time to spend watching television. Although the survey is not longitudinal in nature and therefore cannot be used to assess whether Internet users cut their television viewing over a period of time, the lack of significant differences in television viewing between Internet users and non-users questions the extent to which Internet users might consider the Internet as a 'replacement' for television, or rather simply another form of information and entertainment.

Internet users are also avid consumers of other media. Although much Internet content is text-based, Internet users appear to remain interested in textual material in traditional formats. Internet users tend to spend slightly more time during the day reading books than non-users of the Internet (Table 1), and in the longer term, also tend to read books and magazines with greater frequency (Table 2). These findings echo those of earlier research which found that Internet users tend to be drawn to printed materials (Cole and Robinson 2002; Pronovost, 2002). Although non-users were less likely than Internet users to read books and magazines frequently, they were equally likely to be regular newspaper readers.

Table 2 Frequency of media use for leisure, Internet users and non-users, 2005

Activity	Internet non-users[1]	Moderate Internet users[1]	Heavy Internet users[1]
		% of individuals	
Individuals performing activity on a regular or semi-regular basis:			
Listen to music on CDs, cassettes, DVDs, records (at least once a week)	73.4	80.3*	82.9**
Watch a video (VHS or DVD) (at least once a month)	61.9	66.6	72.6**
Read a magazine as a leisure activity (at least once a month)	69.9	78.4**	75.7*
Read a newspaper as a leisure activity (at least 3 times a week)	65.2	65.4	63.3
Read a book as a leisure activity (at least 1 book a month)	38.6	44.1*	48.2**
Attend movie or drive-in (at least once every month)	18.8	25.8**	29.0**
Use library services as a leisure activity (at least once every month)	14.8	21.2**	18.9
Individuals stating they never performed the activity during the year 2005:			
Listen to music on CDs, cassettes, DVDs, records	17.4	10.1**	9.5**
Watch a video (VHS or DVD)	22.9	14.2**	12.0**
Read a magazine as a leisure activity	23.1	13.8**	16.5**
Read a newspaper as a leisure activity	13.5	11.2	13.6
Read a book as a leisure activity	34.9	25.2**	25.8**
Attend movie or drive-in	40.9	28.1**	29.4**
Use library services as a leisure activity	72.6	63.6**	67.6

* Difference from non-users is statistically significant at the 95% confidence level ($p < .05$).
** Difference from non-users is statistically significant at the 99% confidence level ($p < .01$).

Source: Veenhof, 2006.

3. For the purposes of this study, moderate Internet users are defined as those respondents who spent between five minutes and one hour on the Internet during the day for personal use; heavy users are described as those spending more than one hour on the Internet for personal use during the diary day.

Internet users and other activities

In terms of other leisure activities, Internet users were more likely to attend movies or watch rented or purchased videos at home on a regular basis. And despite the fact that about one-half (51%) of heavy Internet users stated that they listen to music that they downloaded on their computer at least once a week, they were also more likely than non-users of the Internet to listen to music in traditional formats (e.g. CDs, DVDs, cassettes and records).

What is perhaps most interesting in Table 2 is the number of people who say they never use certain media: non-users of the Internet were more likely than Internet users to say that in the year 2005, they never read books or magazines, or watched films. The data illustrate that Internet users look to many sources for information. Recent reports suggest this is true not only with respect to media use but also concerning the use of other information and communications technologies (ICTs). The concept of 'media multiplexity' describes how intensive users of one type of technology - such as the Internet - are also likely to communicate frequently using other technologies, such as the telephone (Sciadas, 2006; Boase, et. al., 2006).

Active communicators and consumers

The findings presented here suggest that Internet users are active communicators and consumers of other media. Even heavy Internet users, averaging two-and-a-half hours per day on the Internet for personal use, spent an equal amount of time with traditional media. Based on the amount of time they dedicate to various sources, it is entirely possible that Internet users continue to value the use of other media and technologies as distinct experiences.

Some of the data in this article first appeared in Statistics Canada's Connectedness Series, August 2, 2006, (Veenhof, 2006)

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Accessing SIEID micro data: how it's done

A recurring theme at the Blue Sky II Forum, held in Ottawa in September 2006, was the importance of analysing micro data and the need to facilitate access to micro data holdings for research purposes, both at the OECD and in member countries. Analysis based on econometric modeling and on the use of micro-simulation models could, it was argued, greatly contribute to telling the story of what is happening in the science, technology and innovation (STI) system.

Facilitated access at Statistics Canada

Canada is one of the OECD-member countries that has made considerable progress on this front. The first access to SIEID micro data by external researchers was undertaken in 1996 with the analysis of micro data from the Survey of Innovation 1996. A program of facilitated access to micro data is now in place, whereby external researchers are sworn in as 'deemed employees' of Statistics Canada and enter into a contractual arrangement with the department to conduct approved research projects. Before approval is granted, the research projects are reviewed at several levels to ensure the feasibility of the project. In addition, there is a fee associated with the use of micro data through the facilitated access program, and researchers must consent to personal screening in order to obtain the necessary security clearance.

Numerous projects and publications

Since 1996, research has been carried out by Canadian and international researchers using SIEID micro data from various surveys, including innovation, biotechnology and advanced technologies. See below for a list of selected publications based on this work, along with recently approved research projects currently underway.

Different sources of financial support

Financial support to carry out the facilitated access research projects comes from different sources, most notably from funding provided by the Policy Research Initiative (PRI). PRI funding for a number of facilitated access projects has been provided under the terms of the Memorandum of Understanding (MOU) between Statistics Canada and Industry Canada since fiscal year 2001-2002. Industry Canada has also supported several research projects by both government and academic researchers to work on policy relevant issues. In recent years, university researchers have applied for and received funds to carry out research projects using SIEID micro data from the Social Science and Humanities Research Council (SSHRC). In several cases, graduate students involved in these research projects have based their thesis work on the analysis of SIEID micro data.

Readers should note that in addition to micro data for the surveys of innovation, biotechnology and advanced technology, micro data for the Survey of Electronic Commerce and Technology (SECT) are also available through the facilitated access program.

For more information on the SIEID Facilitated Access Program, please contact Frances Anderson at 613-951-6307; frances.anderson@statcan.ca

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Current projects

Acharya, Ram, Surendra Gera, and Wulong Gu, "Knowledge spillovers and R&D co-operation: evidence from Canadian firms"

Bérubé, Charles and Pierre Mohnen, "Impact of direct and indirect support of innovation"

Chamberlin, Tyler and Jérôme Doutriaux, "The impact of the supply chain on innovation in the forest sector: Evidence from the Survey of Innovation 2005"

Landry, Réjean, Nabil Amara and Namatié Traoré, "Innovation through absorptive capacity building: Evidence from select service industries in Canada"

Schmidt, Tobias, "The antecedents of firms' motives for R&D cooperation: Evidence from Canadian manufacturing firms"

Tang, Jianmin and Henrique do Livramento, "Offshoring, outsourcing and productivity performance: Plant-level evidence from Canadian manufacturing"

Size and persistence of R&D performance in Canadian firms

Data from the Research and Development in Canadian Industry Survey reveal that between 1994 and 2002, 31,190 enterprises undertook research and development (R&D) activities for at least one year. However, only 5% (1,699) can be considered persistent R&D performers, appearing on the R&D in Canadian Industry database for nine years. It appears that the size of the R&D expenditure groups that firms belong to influences their level of persistence in R&D performance. This article investigates that premise.

Survey results show that firms which began R&D in the largest expenditure group of $10 million or more in 1994 (see Table 1 and Chart 1), showed greater propensity to persist with their R&D programs, than those at the lowest expenditure group. For example, while 31.6% of those in the highest R&D spending group (spending $10 million and over) reported performing R&D in all nine years, only 2.6% of the lowest spending group (spending less than $100,000) reported undertaking R&D for that long[1]. This pattern could be the result of different approaches of these firms to R&D. The firms and enterprises in the largest R&D expenditure category might approach R&D as a program rather than as a short term project (which appears to be the approach taken by firms in the smallest expenditure groups).

The proportion of firms in all but the smallest expenditure group in the survey (see Chart 2) increased over the study period. For example, the proportion of firms in the largest R&D expenditure group increased from 0.9% in 1994 to 1.7%. However, the share of firms in the smallest R&D expenditure group participating in the survey declined from 58.9% in 1994 to 52.4% in 2002, after reaching a high of 60.1% in 1996.

Gauging the strength of R&D programs

Expenditure on R&D is an important parameter in gauging the strength of a firm's R&D program. Although firms spending less than $100, 000 form the largest single group of R&D performers, firms spending $1 million and over on R&D accounted for 86% of the total expenditure on R&D from 1994-2002. Overall, average annual R&D spending by all firms present in 1994 and who continued to perform R&D increased from $576,000 in 1994 to $1,683,000 in 2001, before falling to $1,559,000 in 2002. This drop was mainly due to a significant fall in expenditure by firms in the $10 million or more R&D expenditure group which coincided with market reversals in the dot com and the telecommunication equipment sectors. Despite this fall, this amount was still an increase of 271% over 1994 spending.

In line with the traditional model of high spending, long-term R&D programs, the highest average R&D spending per firm was reported by firms with R&D expenditures of $10 million or more in 1994 and R&D activities in all nine years. The second highest average R&D expenditure reported by the 15 firms with R&D expenditures over 10 million, was reported by firms that participated for only one year. This observation appears contradictory to the above-mentioned thesis which links high expenditure with long term R&D programs. It may be that these firms were re-identified as new administrative records due to mergers and acquisitions.

The total expenditure of firms spending less than $100,000 in 1994 fluctuated over the study period, ultimately ending up at a higher level ($266 million) than the reference year ($238 million). Although 80% of firms who spent less than $100,000 in 1994 were not reporting in 2002, of those that

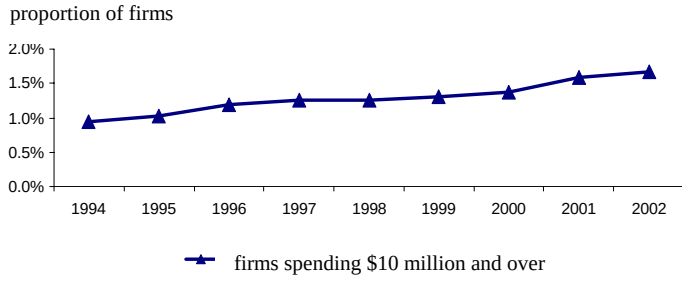
Table 1 Firms present in RDCI survey by R&D expenditure group, 1994 to 2002

	1994	1995	1996	1997	1998	1999	2000	2001	2002
R&D Expenditure Group	*number of firms*								
$10,000,000 or more	104	110	117	121	123	130	149	192	205
$1,000,000 to 9,999,999	653	706	700	691	700	760	855	991	966
$500,000 to $999,999	605	594	431	442	469	521	671	766	734
$200,000 to 499,999	1,443	1,467	1,214	1,161	1,283	1,433	1,576	1,833	1,754
$100,000 to $199,999	1,766	1,670	1,454	1,483	1,565	1,625	1,885	2,115	2,182
Less than $100,000	6,561	6,224	5,889	5,751	5,644	5,498	5,713	6,190	6,431
Total	**11,132**	**10,771**	**9,805**	**9,649**	**9,784**	**9,967**	**10,849**	**12,087**	**12,272**

Source: Statistics Canada, RDCI Survey.

1. Related findings were made by Grégoire and Charron (1996).

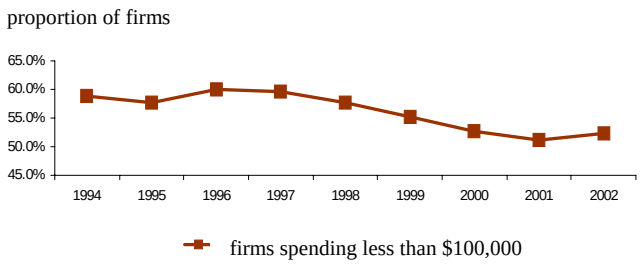
Chart 1 Proportion of firms in the largest R&D expenditure group in the RDCI Survey



persisted up to 2002, 39% were in higher spending categories (including 43 or 3%) who were spending more than a million dollars and 18% (239) spending between $100,000 and $199,999 on R&D). It would appear that some of these firms switched from a short-term project-oriented approach to a longer term R&D program approach.

The average spending per year by firms that spent less than $1 million on R&D (the four smaller expenditure categories) in 1994 exceeded the boundaries of their various size categories in 2002 by a significant amount. These are firms that were present in 1994 and persisted in 2002. For example, firms that spent under $100,000 in 1994 were spending more than $200,000 in 2002. On the other hand, although R&D spending per firm almost doubled in these categories, firms in the two highest spending groups who spent over a million dollars stayed within the limits of their size categories.

Chart 2 Proportion of firms in the smallest R&D expenditure group in the RDCI Survey



The total expenditure of firms who reported spending $10 million or more in 1994, and continued to perform R&D in 2002, peaked in 2001 (almost $6.2 billion). However, 2002 witnessed a fall in their expenditure to $4.9 billion, which was still above the expenditure level of these firms in 1994 (almost $4.5 billion). Only one year, 1996 ($4.4 billion) had a lower level of R&D spending than in 1994.

Higher expenditure = greater persistence

In a nutshell, firms spending $10 million or more on R&D in 1994 persisted longer than those in the smaller expenditure groups. These firms also account for a substantial percentage of the money expended on R&D. This could be related to the long term program approach to R&D taken by these firms. In 2002, a significant decline in the expenditure of the firms spending $10 million or more in R&D and market downturn in the dot com and the telecommunication equipment sectors precipitated a fall in the average annual expenditure on R&D by all firms. It remains to be seen whether or not this fall reflects a change pattern in spending by the largest spending R&D firms.

The premise of this work is based on previous research by Grégoire and Charron (1996) and The Impact Group (2005).

This article was adapted by Horatio Sam-Aggrey from the working paper ***Size and Persistence of R&D Performance in Canadian Firms*** *authored by Fred Gault and Robert Schellings, SIEID, released on August 18, 2006.*

References

Gault, F., and R. Schellings (2006), *Size and Persistence of R&D Performance in Canadian Firms*, Statistics Canada.

Grégoire, P., and C. Charron (1996), *Compendium 1996 Indicateurs de l'activité Scientifique et Technologique au Québec*, Bureau de la statistique du Québec, Octobre 1996, pp. 50-66.

The Impact Group (2005), *The Demographics of Industrial Research in Canada 1994-2000*, Toronto, January.

What's new?

Recent and upcoming events in information society and innovation analysis:

Information society

A new study entitled *The Internet: Is It Changing the Way Canadians Spend Their Time?* (author: Ben Veenhof) was released on August 2, 2006 in *The Daily*. This was followed by the release of *Our Lives in Digital Times* (author: George Sciadas) on November 10, 2006. Both studies examine the outcomes and impacts of information and communications technology (ICT) and are available at www.statcan.ca. Choose 'Publications' and 'Free internet publications', then 'Communications', and 'Connectedness Series' (Catalogue No. 56F0004MIE).

Telecommunications

Annual survey of telecommunications service providers

Selected statistics on telecommunications services industries for 2004 were made available June 27, 2006 in *Service Bulletin, Broadcasting and Telecommunications*, Vol. 36, no. 1 (56-001-XIE, free). The collection of 2005 statistics is on going.

Quarterly survey of telecommunications service providers

Selected statistics on telecommunications services industries for the first quarter of 2006 were released September 13, 2006 in *The Daily***.** Selected statistics for the second quarter were released November 27.

Broadcasting

Annual surveys of the radio, television and cable industries

Selected statistics on the television industry for 2005 were released on July 13, 2006 in *The Daily*. More detailed data were made available in *Service Bulletin, Broadcasting and Telecommunications*, Vol. 36, no. 2 (56-001-XIE, free).

Selected statistics on the radio industry for 2005 were released on August 14, 2006 in *The Daily*. More detailed data were made available in *Service Bulletin, Broadcasting and Telecommunications*, Vol. 36, no. 3 (56-001-XIE, free).

Statistics for the cable and satellite television industry for 2005 were released on November 2, 2006 in *The Daily* (CANSIM table 353-0003).

The publication *Broadcasting and Telecommunications Service Bulletin*, Vol. 36, no. 4 (56-001-XIE, free) will soon be available.

Canadian Internet Use Survey

First results from the *Canadian Internet Use Survey* were released on August 15, 2006 in *The Daily*. This was followed by selected statistics *on E-commerce: Shopping on the Internet*, released on November 1, 2006. Available on CANSIM: tables 358-0135 to 358-0138.

Survey of Electronic Commerce and Technology

The *2006 Survey of Electronic Commerce and Technology* was mailed out in November 2006. Results expected in April 2007.

Science and innovation

S&T activities

Research and development in Canada

The service bulletin Total spending on research and development in Canada, 1990 to 2006, and provinces,1990 to 2004, (88-001 Vol. 30, no. 7) was released on September 18, 2006 in The Daily. In addition, a working paper titled Estimates of Canadian Research and Development Expenditure (GERD), Canada, 1995 to 2006, and by Province 1995 to 2004**,** (Cat. No. 88F0006-XIE no. 009) was released the same day. Data on CANSIM table 385-0001 and on Summary tables were also updated.

Industrial research and development

The service bulletin *Industrial Research and Development, 2002 to 2006*, (88-001 Vol. 30, no. 4) was released on August 14, 2006. Data on CANSIM table 385-0024 and Summary tables were updated the same day.

Federal science expenditures

The service bulletin *Federal government expenditures on scientific activities, 2006/2007***,** (88-001 Vol. 30, no. 6), was released on September 7, 2006.

Higher Education Sector R&D

The service bulletin Estimation of research and development expenditures in the higher education sector, 2004/2005**,** (88-001 Vol. 30, no. 5) was released on August 17, 2006.

Other

A working paper titled Scientific and Technological Activities of Provincial Governments and Provincial Research Organizations, 2000/2001 to 2004/2005**,** (Cat. No. 88F0006-XIE no. 004) was released on July 13, 2006.

A working paper titled *Size and Persistence of R&D Performance in Canadian Firms, 1994 to 2002,* (Cat. No. 88F0006-XIE no. 008) was released on August 18, 2006.

A working paper titled Are small businesses positioning themselves for growth? A comparative look at the use of selected management practices by firm size, (Cat. No. 88F0006-XIE no. 010) was released on October 2, 2006.

Human resources and intellectual property

Federal intellectual property management

Federal science expenditures and personnel, intellectual property management annex

No updates to report.

The higher education sector

Intellectual property commercialization in the higher education sector

A working paper *Commercialization of intellectual property in the higher education sector, 2004* was released on October 4, 2006 (88F0006XIE200611, *free*). Preliminary data for 2005 were released on November 7, 2006, CANSIM table 358-0025.

Innovation

A presentation on "Measuring Offshoring with Surveys: Canada" was made by Frances Anderson and Susan Schaan at the *Statistics Canada Workshop on Measuring Offshoring and Its Impacts* held on June 7-8, 2006 in Ottawa.

A paper was presented at the OECD Blue Sky Conference on "New Directions for Understanding Innovation" by Frances Anderson, Charlene Lonmo, Susan Schaan and Ingrid Schenk.

Innovation in manufacturing

The production of tables for the *Survey of Innovation 2005* is continuing. They will be made available through CANSIM.

Innovation in services

A special SIEID project is underway to improve understanding of firms in NAICS industry group 5417: Scientific Research and Experimental Development Services.

Innovation in advanced technologies

Questionnaire design for the *Survey of Advanced Technology 2006* has been completed and activities are underway in preparation for an April 2007 mail out.

Community Innovation

No updates to report.

Commercialization

The working papers *Conceptualizing and Measuring Business Incubation*, no.6 Catalogue No. 88F0006XIE2006006 (free) and *Characteristics of Business Incubation in Canada, 2005*, no. 7 Catalogue no. 88F0006XIE2006007 (free) were released on July 24, 2006 in *The Daily*.

Biotechnology

Data for the *Bioproducts Development and Production Survey, 2006* will be collected in winter 2007. Results are expected in spring 2007.

Technological Change

No updates to report.

Knowledge management practices

No updates to report.

In brief

In this section, we highlight articles of interest that have recently appeared in Statistics Canada's *The Daily* and elsewhere.

Are small businesses positioning themselves for growth? A comparative look at the use of selected management practices by firm size

It is well-known that small firms are managed differently from large firms, and this paper provides further evidence in support of this idea while suggesting that some small firms are adopting management behaviours of larger firms. Could these small firms be positioning themselves for growth or using organisational innovation as a tool for survival or adopting some formal organization practices early? In 2004, the Survey of Electronic Commerce and Technology provided a list of eight management practices that according to interviews with small and medium-sized firms indicated potential firm growth. The management practices listed were organisational structures; employee feedback surveys; mentoring or coaching programs; and written strategies for marketing; managing growth; commercialisation of intellectual property; succession management; and risk management. This was released on October 2, 2006 in *The Daily*.

Louise Earl, SIEID, Statistics Canada.

Survey of Intellectual Property Commercialization in the Higher Education Sector, 2004

Universities and their affiliated research hospitals make an important contribution to innovation in Canada's economy. Besides generating new knowledge and training highly qualified graduates, some of the technology they produce is patented and licensed to companies for incorporation into commercial products. This is the fifth survey of intellectual property commercialization in the higher education sector. This was released on October 4, 2006 in *The Daily*.

Cathy Read, SIEID, Statistics Canada.

The Internet: Is it changing the way Canadians spend their time?

This study aims to develop a better understanding of the social impacts associated with Internet use in Canada. Although much work has been accomplished on the penetration and use of the Internet, this study uses data from the General Social Survey, Cycle 19: Time Use to better understand how personal use of the Internet fits in the day-to-day lives of Canadians.

The survey provides a time-diary account of respondent activities over a 24-hour period, enabling detailed comparisons among heavy Internet users, moderate users, and non-Internet users and

their time allocation decisions. Heavy Internet users spent more time alone during the diary day than non-Internet users, even when compared to people of the same social and demographic background. Although they spent less time with family and friends, many heavy Internet users participated in online activities involving social interaction, such as email or chatting with others. This was released on August 2, 2006 in *The Daily*.

Ben Veenhof, SIEID, Statistics Canada.

Survey of Research and Development in Canadian Industry Intended to Directly Benefit Developing Countries, 2004

Commercial research and development (R&D) performers in Canada devoted a mere 0.4% of their total R&D spending to developing countries, according to estimates based on data from the 2004 Survey of Research and Development in Canadian Industry Intended to Directly Benefit Developing Countries.

Just 2.7% of commercial enterprises in Canada carried out R&D to benefit developing countries in 2004.

The survey also showed that more than 70% of commercial R&D performers are exporters of goods and services and that nearly 5% of the exports are intended for developing countries. This was released on July 19, 2006 in *The Daily*.

Julio Miguel Rosa, SIEID, Statistics Canada.

Conceptualizing and measuring business incubation

This paper conceptualizes business incubation and translates theoretical ideas into measurable metrics.

Specifically, it explains and develops the concept, discusses the influence of major economic and technological events on its evolution, identifies different models and explains how business incubators create value. It then explains how these concepts have been implemented in Statistics Canada's first survey of business incubators. This was released on July 24, 2006 in *The Daily*.

Daood Hamdani, SIEID, Statistics Canada.

Characteristics of business incubation in Canada, 2005

This paper highlights business incubators in Canada. A business incubator is a business unit that specializes in providing space, services, advice and support designed to assist new and growing businesses to become established and profitable. The survey covered information on business incubator affiliation; infrastructure; sources of funding; policies; clients and activities; services; impact; management; and barriers. This was released on July 24, 2006 in *The Daily*.

Michael Bordt, EASD, Daood Hamdani, Rad Joseph, SIEID, Statistics Canada.

Competition, firm turnover and productivity growth

This paper investigates the extent to which productivity growth is the result of firm turnover as output is shifted from one firm to another, driven by the competitive process. Turnover occurs as some firms gain market share and others lose it. Some of the resulting turnover is due to entry and exit. Another part arises from growth and decline in incumbent continuing firms. This paper proposes a method for measuring the impact of firm turnover on productivity growth and shows that it is far more important than many previous empirical studies have concluded. It argues that firm turnover associated with competition is the main source of aggregate labour productivity growth in Canadian manufacturing industries. This was released on September 25, 2006 in *The Daily*.

John R. Baldwin and Wulong Gu, Analytical Studies Branch, Statistics Canada.

Survey of Canadian Attitudes toward Learning, 2006

Data from the first-ever Survey of Canadian Attitudes toward Learning, released today, provide a barometer of opinions, perceptions and beliefs about lifelong learning among Canadians. The survey was sponsored by the Canadian Council on Learning, and asked more than 5,000 adults about four aspects of learning throughout the lifespan: early childhood learning, structured learning (elementary, secondary and postsecondary), work-related learning, and health and learning.

The survey showed that the vast majority of Canadian adults feel there is a strong relationship between education and success in life.

Over 80% of adult Canadians believe that it is not just formal education that is critical to success, but it is also learning during each specific stage from birth to age five, and through the elementary, secondary and postsecondary levels. This was released on October 10, 2006 in The Daily.

Christine Hinchley, Culture, Tourism and the Centre for Education Statistics, Statistics 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 contact the editor.

Table 1 New economy indicators, 2000 to 2005	Units	2000	2001	2002	2003	2004	2005
General economy and population[1]							
GDP	$ millions	1,076,577	1,108,048	1,152,905	1,213,408	1,290,788	1,371,425
GDP implicit price index	1997=100	105.5	106.7	107.8	111.3	114.7	118.3
Population	thousands	30,689	31,021	31,373	31,676	31,989	32,299
Gross domestic expenditures on R&D (GERD)[2]	$ millions	20,580	23,169	23,539	234,337	26,003	27,174
"Real" GERD	$ millions 1997	19,507	21,714	21,836	21,866	22,670	22,970
GERD/GDP ratio	ratio	1.91	2.09	2.04	2.01	2.01	1.98
"Real" GERD/capita	$ 1997	635.64	699.98	696.01	690.31	708.70	711.18
GERD funding by sector							
Federal government	% of GERD	17.7	18.1	18.1	18.6	17.9	18.3
Provincial governments	% of GERD	4.5	5.0	5.0	5.7	5.4	5.6
Business enterprise	% of GERD	44.8	50.3	51.3	49.5	49.0	47.9
Higher education	% of GERD	14.0	12.6	14.7	14.7	15.9	16.6
Private non-profit	% of GERD	2.2	2.3	2.7	2.6	2.8	2.9
Foreign	% of GERD	17.4	12.6	8.2	8.7	9.0	8.7
GERD performance by sector							
Federal government	% of GERD	10.1	9.1	9.3	8.6	8.0	8.0
Provincial governments	% of GERD	1.2	1.3	1.3	1.3	1.3	1.2
Business enterprise	% of GERD	60.2	61.6	57.4	56.3	55.5	53.9
Higher education	% of GERD	28.1	27.7	31.7	33.5	34.8	36.4
Private non-profit	% of GERD	0.3	0.3	0.3	0.4	0.4	0.4
Federal performance as a % of federal funding	% of federal	58.4	51.3	51.5	46.0	44.6	43.4
"Real" federal performance of R&D	$ millions 1997	1,972	1,971	2,032	1,872	1,816	1,828
Information and communications technologies (ICT)							
ICT sector contribution to GDP - basic prices[3]							
ICT, manufacturing	$ millions	17,070	11,069	8,619	9,239	9,516	10.261
% of total ICT	% of total ICT	30.9	20.6	15.9	16.1	16.0	16.5
ICT, services	$ millions	38,316	42,349	44,982	47,522	49,037	51,325
% of total ICT	% of total ICT	69.4	78.6	82.9	82.7	82.7	82.3
Total ICT	$ millions	55,176	53,857	54,288	57,482	59,298	62,359
Total economy[4]	$ millions	943,738	957,258	982,843	1,002,936	1,034,024	1,062,951
ICT % of total economy	%	5.8	5.6	5.5	5.7	5.7	5.9
Total business sector	$ millions	798,412	808,810	831,293	847,701	875,777	902,519
ICT % of business sector	%	6.9	6.7	6.5	6.8	6.8	6.9
ICT adoption rates (private sector)							
Personal Computer	% of enterprises	81.4	83.9	85.5	87.4	88.6	n/a
E-Mail	% of enterprises	60.4	66.0	71.2	73.8	76.6	76.2
Internet	% of enterprises	63.4	70.8	75.7	78.2	81.6	81.6
Have a website	% of enterprises	25.7	28.6	31.5	34.0	36.8	38.3
Use the Internet to purchase goods or services	% of enterprises	18.2	22.4	31.7	37.2	42.5	43.4
Use the Internet to sell goods or services	% of enterprises	6.4	6.7	7.5	7.1	7.4	7.3
Value of sales over the Internet	$ millions	7,246	10,389	13,339	18,598	26,438	36,268

1. Source: Statistics Canada, 2003, *Canadian Economic Observer*, Cat. No. 11-010-XIB, June 2004, Ottawa, Canada.
2. Source: Statistics Canada, 2003, *Science Statistics*, Cat. No. 88-001-XIE, various issues, Ottawa, Canada.
3. Source: Statistics Canada, 2006, CANSIM Tables 379-0017 "Gross Domestic Product (GDP) at basic prices, by North American Industry Classification System (NAICS), annual" and 379-0020 "Gross Domestic Product (GDP) at basic prices, special industry aggregations based on North American Industry Classification System (NAICS), annual". www.statcan.ca, Ottawa, Canada.
4. The "total economy" is in chained-Fisher methods of deflation and therefore does not match GDP.

Table 1 New economy indicators, 2000 to 2005	Units	2000	2001	2002	2003	2004	2005
Information and communications technologies (ICT) (continued)							
ICT adoption rates (public sector)							
Personal Computer	% of enterprises	100.0	100.0	99.9	100.0	100.0	n/a
e-mail	% of enterprises	99.0	99.7	99.6	99.8	99.9	99.6
Internet	% of enterprises	99.2	99.7	99.6	100.0	99.9	99.6
Have a Web site	% of enterprises	72.6	86.2	87.9	92.7	92.4	94.9
Use the Internet to purchase goods or services	% of enterprises	49.1	54.5	65.2	68.2	77.4	82.5
Use the Internet to sell goods or services	% of enterprises	8.6	12.8	14.2	15.9	14.0	15.2
Value of sales over the Internet	$ millions current	111.5	354.8	327.2	511.4	1,881.5	2,924.7
ICT adoption rates (individuals aged 18 years and over)							
Personal (non-business) Internet use from any location	% of individuals	..	..	..	..	..	67.9
Personal (non-business) Internet use from home	% of individuals	..	..	..	..	..	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
Teledensity indicators							
Wired access (Voice Grade Equivalent - VGE)	per 100 inhabitants	28.3	67.1	64.7	63.4	60.7	58.6
Wireless access (VGE)	per 100 inhabitants	28.4	34.3	37.9	41.8	46.5	51.4
Total public switched telephone network (PSTN) (VGE)	per 100 inhabitants	94.7	101.4	102.6	105.2	107.2	110.0
Homes with access to cable	thousands	10,892.4	11,068.6	11,378.9	11,694.4	11,908.2	12,119.0
Homes with access to Internet by cable	thousands	7,609.7	9,339.3	10,046.0	10,685.9	11,124.2	11,504.8
Access indicators							
Total wired access lines (VGE)	thousands	20,347.0	20,805.1	20,300.8	20,067.6	19,470.5	18,976.1
Residential access lines (VGE)	thousands	12,871.7	12,854.2	12,752.1	12,648.2	12,488.1	11,947.9
Business access lines (VGE)	thousands	7,475.3	7,950.9	7,548.7	7,419.3	6,982.4	7,028.1
Total mobile subscribers	thousands	8,726.6	10,648.8	11,872.0	13,227.9	14,912.5	16,663.8
Digital cable television subscribers	thousands	387.2	808.4	1,150.1	1,382.4	1,843.5	..
Satellite and MDS subscribers	thousands	967.1	1,609.2	2,018.6	2,205.2	2,324.6	..
High speed Internet by cable subscribers	thousands	786.3	1,384.8	1,874.8	2,363.3	2,837.8	..
Investment indicators							
Investments by the telecommunications services industries (NAICS 517)	$ millions (current)	9,517.8	10,652.9	7,310.4	6,181.0	6,984.3	7,365.9
Investments by the telecommunications services industries (NAICS 517)	$ millions (constant)	9,866.2	11,146.5	7,586.8	6,947.3	8,124.0	8,796.7
Characteristics of biotechnology innovative firms[5]							
Number of firms	number	..	375	..	496	..	..
Total biotechnology employees	number	..	11,897	..	11,931	..	..
Total biotechnology revenues	$ millions	..	3,569	..	3,820	..	..
Expenditures on biotechnology R&D	$ millions	..	1,337	..	1,487	..	..
Export biotechnology revenues	$ millions	..	763	..	882	..	..
Import biotechnology expenses	$ millions	..	433	..	422[E]	..	..
Amount of capital raised	$ millions	..	980	..	1,695	..	..
Number of firms that were successful in raising capital	number	..	134	..	178	..	..
Number of existing patents	number	..	4,661	..	5,199	..	..
Number of pending patents	number	..	5,921	..	8,670	..	..
Number of products on the market	number	..	9,661	..	11,046[E]	..	..
Number of products/processes in pre-market stages	number	..	8,359	..	6,021	..	..
Intellectual property commercialization[6]							
Federal government							
New patents received	number	..	110[r]	133[r]	142[r]	178[p]	169[p]
Royalties on licenses	$ thousands	..	15,669[r]	16,284[r]	15,508[r]	15,063[p]	15.154[p]
Universities and hospitals							
New patents received	number	..	381	..	347	397	374p
Income from intellectual property	$ thousands	..	52,510	..	55,525	51,210	55,127p

5. Source: Statistics Canada, 2003, *Features of Canadian biotech innovative firms: Results from the Biotechnology Use and Development Survey – 2001*, Science, Innovation and Electronic Information Division Working Paper Series, Cat. No. 88F0006XIE2003005, Ottawa, Canada.
6. Sources: Statistics Canada, Federal Science Expenditures and Personnel Survey, and Survey of Intellectual Property Commercialization in the Higher Education Sector (various years).