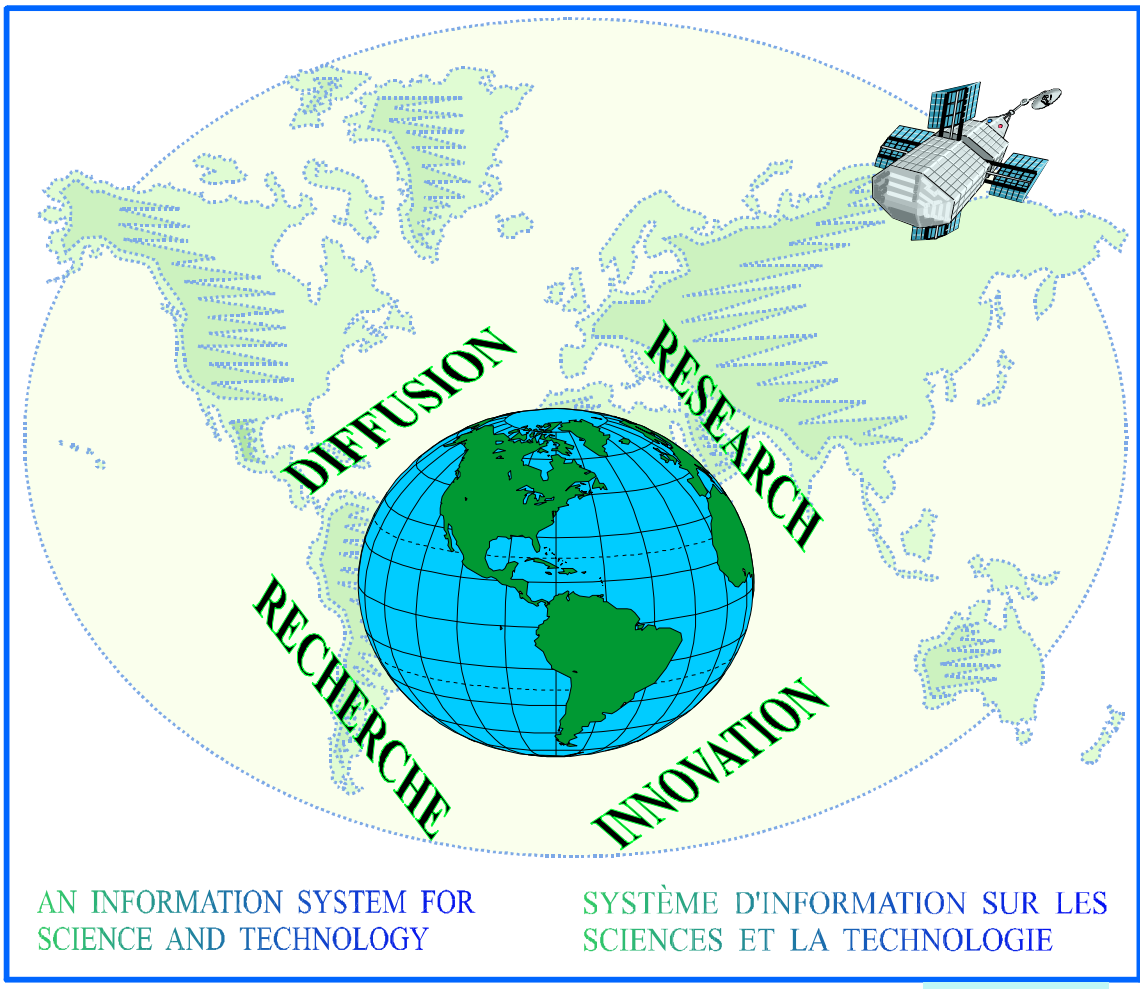
SCIENCE AND TECHNOLOGY

SCIENCES ET TECHNOLOGIE

COMMERCIALIZATION OF INTELLECTUAL PROPERTY IN THE HIGHER EDUCATION SECTOR: A FEASIBILITY STUDY

ST-97-11



AN INFORMATION SYSTEM FOR SCIENCE AND TECHNOLOGY

SYSTÈME D'INFORMATION SUR LES SCIENCES ET LA TECHNOLOGIE

Statistics Canada Statistique Canada

Canada

COMMERCIALIZATION OF INTELLECTUAL PROPERTY IN THE HIGHER EDUCATION SECTOR: A FEASIBILITY STUDY

A Report Prepared by

The Impact Group

Science and Technology Redesign Project
Statistics Canada
October 1997

ST-97-11

Price: $75.00

C O N T E N T S

THE INFORMATION SYSTEM FOR SCIENCE AND TECHNOLOGY PROJECT

The purpose of this project is to develop useful indicators of activity and a framework to tie them together into a coherent picture of science and technology in Canada.

To achieve the purpose, statistical measurements are being developed in five key areas: innovation systems; innovation; government S&T activities; industry; and human resources, including employment and higher education. The work is being done at Statistics Canada, in collaboration with Industry Canada, and with a network of contractors.

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

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

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say how much the federal government spends and where it spends it. The current report, released early in 1997, begins to show what the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information will provide a context for reports of individual departments and agencies on performance measures which focus on outcomes at the level of individual projects.

By the final year of the Project in 1998-99, there will be enough information in place to report on the Canadian system on innovation and show the role of the federal government in that system. As well, there will be new measures in place which will provide a more complete and realistic picture of science and technology activity in Canada.

CONTACTS FOR MORE INFORMATION

S & T Redesign Project

Director Dr. F.D. Gault (613-951-2198)

An Information System for Science and Technology

Chief, Indicators Development
Dr. Frances Anderson (613-951-6307)

Chief, Data Integration Projects
Daood Hamdani (613-951-3490)

Project Development Officer
Antoine Rose (613-951-9919)

Science and Technology Section

Project Leader, Private Sector
M. Boucher (613-951-7683)

Senior Project Officer
D. O'Grady (613-951-9923)

Project Leader, Public Sector
B. Plaus (613-951-6347)

Senior Project Officer
J. Thompson (613-951-2580)

FAX: (613-951-9920)

Working Papers

The Working Papers publish research related to science and technology issues. All papers are subject to internal review. The views expressed in the articles are those of the authors and do not necessarily reflect the views of Statistics Canada.

PREFACE

The paper, **Commercialization of Intellectual Property in the Higher Education Sector: A Feasibility Study**, provides over fifty potential indicators for measuring the transfer of intellectual property from universities to the private sector. The indicators and the paper contribute to the discussion of how to measure the flow of ideas from one sector to another in the Canadian science and technology system and it specifically considers universities as a source of ideas for commercial application. It also prepares the way for a possible pilot survey.

The measurement of the flows of ideas, information and knowledge is part of the Information System for Science and Technology Project at Statistics Canada. The objective of the Project is to develop useful indicators of activity and a framework to tie them together into a coherent picture of science and technology in Canada. Part of tying together indicators of activity is measuring the linkages between the various parts of the system. This paper is one example of possible measurements of knowledge flows. In 1997, there are also surveys of innovation in selected service industries and of the use and planned use of biotechnologies in selected manufacturing and primary industries, as well as analytical projects, which provide some indicators of linkage. For each of the surveys, there are questions about linkages and knowledge flows to tie the activity of innovation, or technology use, to the sources of ideas and technologies.

Linkage is being measured by a bibliometric project which identifies the economic sector and the location of co-authored scholarly publications. The reports from this work, to be released early in 1998, will identify the links between research workers in the universities, in government and in industry. Already released is the most recent study of contracts between funders and performers of R&D in industry which demonstrates the key role of service industries in developing and spreading new ideas. And, about to be released is a paper showing the linkages between industry and public institutions.

The objective of all of this work is to develop new indicators of knowledge and information flows in the Canadian science and technology system.

Commercialization of Intellectual Property in the Higher Education Sector: A Feasibility Study

BACKGROUND

This project was commissioned by Statistics Canada, as part of its *Information System for Science and Technology Project*. The federal government launched its Science and Technology Review in June 1994. Prior to this, an existing Working Group of the Statistics Canada's Advisory Committee on Science and Technology Statistics, undertook to examine the Canadian statistical information system for science and technology, with a view to identifying relevant information and data requirements which would help illuminate policy choices and monitor program initiatives.

The final report of the Working Group concluded, in part, that current statistical information for science and technology in Canada was not consistent with the importance of science and technology to the evolution of Canadian society. The Working Group recommended that Statistics Canada establish an on-going development project to design, plan and implement an extended program of S&T statistics, the concepts and definition of which would be developed in collaboration with competent national and international agencies to ensure that the resulting data would be comparable with those of Canada's trading partners.

The Information System for Science and Technology Project (ISSTP), is a project undertaken by Statistics Canada with the support of Industry Canada to develop a new generation of indicators.

> *'This new generation of indicators is to provide reliable and timely measures of the resources devoted to scientific, technological and innovative activities, the factors affecting these investments, the outputs and impacts of such activities, and more generally contribute to heightened awareness and understanding of the relationship between science, technology, innovation and economic growth, job creation and quality of life.'*
>
> (MOU between Industry Canada and Statistics Canada, March 29, 1996)

ISSTP activities are grouped into seven theme areas:

1. Government Support for S&T Activities
2. S&T and the Service Industries
3. Innovative and Absorptive Capacity of Firms
4. S&T Knowledge Circulation
5. People, Jobs and S&T
6. Regional Innovation
7. Internationalization of S&T

The current project - IP Commercialization in the Higher Education Sector - could contribute valuable information to a number of the ISSTP themes.

In 1996 the Canadian Institute for Advanced Research (CIAR) prepared a report that examined the commercialization of university research in Canada[1], and a follow-up report that included reaction from the university community to the initial report[2]. The follow-up study reported that:

> *'There was general agreement among the university respondents that measures to show progress in commercialization activities and outcomes over time would be desirable.'*

The follow-up study proposed a number of measures that might be included in an information gathering exercise. It also noted that '*Concerns were, however, expressed about the increasing load being placed on universities to produce data for various purposes and at various times ... these measures (should be) requested at the same time as data is being collected for the Maclean's survey'*.

STUDY OBJECTIVES

The purpose of the project is to identify useful indicators related to the commercialization of university intellectual property, which could be developed through a more complete study. Specific project objectives were to determine:

STUDY OBJECTIVES
1. What data currently are collected that would contribute to this kind of study;
2. The willingness of institutions to contribute to such a study;
3. The types of data on university IP and IP commercialization which can be collected, and the appropriate techniques for doing so;
4. Estimates of IP commercialization not captured by institutions;
5. The appropriate frequency of data collection;
6. The preferred method of data collection, analysis and dissemination;
7. The number of universities that required capture 90% of activity by value;
8. A realistic cost and time frame for a complete study; and
9. Other issues that might arise in the course of the discussions.

THE ROLE OF THE HIGHER EDUCATION SECTOR IN INNOVATION

[1]CIAR. The Commercialization of University Research in Canada: A Discussion Paper. Toronto. 1996.

[2]CIAR. The Commercialization of University Research in Canada: A Review and Approach to a Strategy for Industry Canada. Toronto. 1996.

The impetus for this work is a growing recognition that research conducted in the higher education sector makes an important contribution to the economy and society:

> *'...university research has become increasingly important in the technology driven economy of the 1990s. The common perception of a university as merely an institution of advanced education is an anachronism if indeed the perception was ever really grounded in reality. Universities are still in the education business, of course, and this mission continues to be of critical importance. However, universities also make substantial contributions to the economy through research leading to patentable inventions and discoveries, faculty spin-off ventures, technology transfer, software development, and consulting, to name but a few.'*[3]

Though this report focuses on the commercialization of knowledge - intellectual property - developed at universities, readers should always bear in mind that the university's role in innovation is far broader. Of primary importance is the university's role in educating and training young people, so they can become productive members of the labour force. University research is another important source of innovation. Most university research contributes to understanding of knowledge, and becomes freely available through the published literature. Only a small proportion has immediate commercial potential. Therefore, it would be entirely misleading to equate the university's role in innovation with the amount of research that it commercializes.

Statistics Canada data indicate that the university sector performed approximately $2.9 billion of research in 1995[4]:

Funding of Research at Canadian Universities (1995)
($ millions)

Federal	Provincial	PRO	Business Enterprise	University	Private Non-Profit	Foreign	Total
889	345	--	313	1,054	255	20	2,876

[3]Chrisman, James J. Economic Benefits Provided to the Province of Alberta by the Faculty of the University of Calgary. University of Calgary. September 1994.

[4]Science and Technology Data. Industry Canada. Industry and Science Policy Sector. July 1996.

Universities themselves contributed $1,054 million, which was the largest part of funding.[5] The Federal Government supported $889 million of research, largely through the three Granting Councils (MRC, SSHRC, NSERC). Provincial Government sources spent $345 million, and the Business sector spent $313 million. Private Non-Profit organizations financed $255 million of research, and Foreign sources contributed $20 million.

The $2.9 billion of research undertaken at universities compares with a 1995 total of $5.4 billion performed in the private sector, and $1.6 billion in federal laboratories. Canadian R&D expenditures totaled $11.8 billion in the same year. Thus, next to Business Enterprises, the University sector is the one that performs most research.

If it is true that university research provides an important stimulus to the economy, and to improvements in quality of life, what tools do we have for measuring research inputs, processes, linkages or outcomes?

At the national level, existing measurement tools are rather crude. Statistics Canada publishes aggregate income and expenditure data (as above), but with little refinement. For instance, there are no national data to indicate the forms of research funding; such as, the proportion of Business funding for university research that occurs in the form of grants, contributions, contracts, equipment donations, or other sources of in-kind support.

Similarly, there are few if any data that illustrate the processes or linkages through which research conducted at universities is transformed into economic outputs. Nor are there national data that indicate the impact of university research on wealth creation or quality of life.

UNIVERSITY-BASED INNOVATION

The modern university is a complex institution that is rapidly adapting to new opportunities and expectations. It includes traditional academic (e.g. philosophy) and professional (e.g. engineering) departments and schools. But it is also just as likely to provide an institutional base for centres of excellence, teaching and research hospitals, faculty consulting companies, technology transfer offices, for-profit development corporations, research parks, business incubators, venture capital funds, specialized research institutes, sponsored research chairs, and other organizations and institutions whose work contributes to economic or social innovation.

Interviews with university officials point to the many ways that universities, faculty, students, and other university-based entities contribute to social and economic innovation. The modern university will typically:

- Educate, train and re-train highly qualified research personnel (HQP) and business managers;
- Develop and disseminate new knowledge by conducting research and publishing its results;
- Identify and evaluate intellectual property with commercial potential;
- Protect novel discoveries (intellectual property - IP) through patenting;
- Exploit new knowledge by licensing patents and discoveries to industry;
- Solve technical problems of industry and government through contract research;
- Establish, nurture and take equity positions in spin-off and start-up companies;
- Finance technology scale-up and demonstration projects; and,
- Transfer knowledge and know-how through consulting activities.

Many of these activities - education and training, for instance - take place in the normal course of university operations. Others - nurturing of spin-off companies, for example - may be the result of activities and resources specifically devoted by the university.

[5] Note from the editor, Statistics Canada : the self funding of $1,054 million in effect include approximately 70% of general university funds basically composed of government transfers.

It is important to recognize that intellectual property commercialization represents perhaps the smallest of the modern university's influences on innovation. In the long run, teaching and advancement of knowledge through peer-reviewed research exert a much more important influence on society. Commercializeable research represents only a very small portion of all research carried out at the university. In most instances it is a by-product of university research and not an end in itself. Therefore, IP commercialization data should not be considered as the primary measure of innovation that arises in universities. To understand the broad picture, IP commercialization data need to be considered in the context of other measures of university innovation.

UNIVERSITY RESEARCH AND INTELLECTUAL PROPERTY

The vast majority of university research is undertaken for the purpose of making a contribution to the world stock of knowledge, and not for financial gain. Most research is financed by grants. In comparison, a small amount is in the form of research contracts. As such, the results of most research are published in the open literature and are freely available to the scholarly community and the world at large. In most instances, publishing research results prior to applying for intellectual property protection, results in a forfeiting of exclusive rights to the knowledge. A small portion of university research produces 'intellectual property', as understood in law:

> *'Intellectual Property refers to ownership rights given by law to intellectual information such as inventions, literary works, trade names, logos and know-how. In Canada, IP can be legally protected by patents, copyrights, trade marks, industrial designs, integrated circuit topographies and plant breeder rights. IP can also be protected by non-disclosure (trade secrets) but under a different area of law. Intellectual property is also referred to as 'product of the mind', 'intangible assets', or other phrases conveying similar ideas.'*[6]

Once it is granted legal protection, intellectual property can be bought, sold, leased, shared or bartered. This is normally accomplished through the process of licensing. Therefore licensing is one key commercialization indicator. Some institutions barter their IP rights in return for equity in a company, which is often a start-up or university spin-off venture.

Research undertaken on contract to an outside body is generally treated in a different way from research financed by grants. Contract research typically defines the respective IP rights of the funder and performer. In most instances the IP rights are the property of the research funder. Though the performer may retain a right to publish results, a delay is often built into the contract to allow the funder time to exploit the findings. In the final analysis such matters are subject to negotiation between the parties.

While there is a tendency to associate intellectual property with the natural sciences, engineering and medicine, IP can be created in any discipline. For example, books, plays, and musical compositions all represent forms of IP. Even though these may result from research conducted by members of a university with the aid of university facilities, and might even produce significant financial returns (as, for example a textbook), in practice most universities forego their financial interest in these types of IP. So for practical purposes, IP does refer largely to inventions in science, engineering and medicine.

University policies regarding IP vary widely. In general, though, they fall into two categories. Some universities confer ownership in IP to its creator, while others retain ownership themselves. For example, the University of Waterloo's patent policy grants IP ownership to the inventor:

---

[6]Cited in Canadian Institute for Advanced Research. The Commercialization of University Research in Canada: A Discussion Paper. Toronto. 1996. Page 12.

> *'With the exception of contract research ... the University acknowledges that it has no direct equity in the ownership of any invention developed by a member of its faculty, staff or student body (notwithstanding that such invention might be intellectually conceived in the course of University work). Accordingly, the inventor of any such invention is free to publish the details of the invention, and to prosecute patent proceedings with respect to the said invention ...'*[7]

However, inventors at Waterloo are required to:

> *'...at all times keep the University ... fully and promptly informed of all patent applications in Canada or elsewhere.'*[8]

Furthermore, the University retains for itself:

> *'... a non-exclusive, free, irrevocable license ... under all patents arising from the invention, but without the right to commercially exploit, sub-license or sell any product or process which is patented or arises from such patented invention.'*[9]

Other universities take a different position, retaining ownership of an invention and granting exploitation rights to the inventor. Therefore, it is important to distinguish between ownership issues and exploitation issues. Until it is commercialized, IP represents potential value. Only when it is commercialized does it produce actual value. Therefore, from the standpoint of measuring the impact of IP, what matters more than ownership is exploitation.

Many universities require their researchers to provide the university with an 'invention disclosure' when they believe they have made a discovery with commercial potential. University officials - often the technology transfer office or university-owned development foundation - will review the disclosure with the inventor. Officials advise the inventor of different commercialization options open to them under the university's IP policy. One large university we spoke with sees from 100-150 disclosures each year. Typically, they are in the area of medicine/biotechnology, and the remainder in the physical sciences. The university may end up making an initial investment in 10-15% of these through its private development arm. Inventors are free to exploit the inventions that the university declines to support itself.

Much of the IP that results from university research is in the form of computer software. Software is normally protected under copyright legislation, rather than patent legislation. Universities vary in their attitude towards commercializing software IP. As a practical matter, some universities which retain IP ownership forego their rights in software; because it is too difficult to market or because software requires significant additional investment for such items as updating and cross-platform compatibility. Unlike some other inventions, software inventions also becomes obsolete quickly and would require ongoing development and maintenance.

WHY INDICATORS?

---

[7] Source: University of Waterloo.

[8] Ibid.

[9] Ibid.

A legitimate question to pose is about this project is 'Is it worthwhile developing indicators for university research commercialization?'. In our opinion, the answer is yes. Universities play an important role in our national system of innovation. As with many institutions that rely on public funding, there is growing demand for accountability, as expressed in the following exchange at a 1996 meeting of the House of Commons Standing Committee on Industry:

> *... when NSERC gives to the University of Toronto in a partnership of some sort, maybe with a private sector company, and something gets developed that's commercially viable. How does the government get a return, a royalty - a standardized form that they basically all sign by receiving the money, stating that if something is developed, then the government will get a percentage - 1%, 10%, 5%, or whatever the appropriate amount is - so that in effect the government will be getting something back? Why is that not being set up, if it isn't - when we've been at this for two years on the same procedure?*
>
> Hon. Tony Ianno (Liberal - Trinity-Spadina)

> *Can we get a fairly clear and concise answer to that question?*
>
> Hon. Tony Valeri (Liberal - Lincoln)

In the words of the President of the Association of University Technology Managers:

> *'Think about the fact that public benefit is the focus of our business transactions ... and that acting on behalf of the public takes resources. To serve our multiple constituencies well, we must capture a fair return from innovations created with public funds. It is not just our responsibility to seek a fair return on our intellectual property assets, it is irresponsible not to do so.'*
>
> Teri F. Willey, 1996 AUTM President

Commercialization indicators will also help policy makers better understand the processes, outputs and outcomes of university research, and the impact of research and research funding on economic and social development.

A common set of commercialization indicators helps universities to benchmark their own performance against that of similar institutions in Canada and abroad. Knowledge gained can help universities improve their technology transfer and commercialization activities.

Finally, commercialization indicators can help universities and their supporters to communicate the value of the research enterprise. Addressing the House of Commons Standing Committee on Industry, one member had this to say:

> *'One of your greatest challenges is no doubt to communicate the benefit or the results of research. There should be greater cooperation between academics, research centres and businesses to promote research results and to make everyone benefit from them.'*
>
> Hon. Nick Leblanc (BQ - Longueuil)

RECENT COMMERCIALIZATION STUDIES

It appears that the only nation-wide attempt to collect information on university IP commercialization was an exercise undertaken in 1995 by NSERC, as part of the competition held for its Intellectual Property Management program. This

program provides funds to universities to establish or support technology transfer offices. In order to apply for program funds universities were required to provide information on their IP activities. Information was solicited on such items as patents, licences, staffing, research activity, industry contracts and revenues, inventions, software, biological materials, companies and new company formation, and job creation. Though NSERC has coded and compiled the data received, it has not analyzed the information[10].

The major published source of Canadian data is the annual licensing survey conducted by AUTM (Association of University Technology Managers). Data from the most recent AUTM survey[11] indicate some impressive commercialization performance on the part of many universities. Much of this arises because universities are allocating more resources to technology commercialization. In some instances they are spending university funds, and in other cases they are using outside funding sources, such as the federal government's Intellectual Property Management program, provincial funds, or private sources of capital.

Whatever the source of funds, there are more people than ever working to commercialize university technology. In 1995, the latest year for which data are available, 16 Canadian institutions[12] reported the following commercialization resources, transactions and returns:

---

[10]We understand that an official of NSERC is undertaking a private analysis of the data.

[11]All tables in this section are taken from: Association of University Technology Managers Inc. AUTM Licensing Survey FY 1991 - FY 1995.

[12]Including: University of Toronto, Mount Sinai Hospital, University of Waterloo, UTI Inc./University of Calgary, University of British Columbia, University of Alberta, McGill University, Queen=s University, University of Manitoba, Université de Montréal, University of Guelph, Université de Sherbrooke, Simon Fraser University, Concordia University, Carleton University, University of Western Ontario.

Professional FTEs for Technology Transfer and Licensing, FY 1992 - FY 1995							
FY 1995		FY 1994		FY 1993		FY 1992	
FTES - Tech. Transfer	FTEs - Tech. Licensing	FTEs - Tech. Transfer	FTEs - Tech. Licensing	FTEs - Tech. Transfer	FTEs - Tech. Licensing	FTEs – Tech. Transfer	FTEs - Tech. Licensing
60.2	39.3	50.2	39.2	40.5	26	29.1	17.8

Clearly, universities are devoting greater personnel resources to technology transfer and licensing. The following table indicates some of the activity generated by technology transfer and licensing offices:

University Technology Commercialization Activities, 1995									
Royalties Received (million)	Licenses Generating Royalties	Professional FTEs for Licensing	Legal Fees Expended	Legal Fees Reimbursed	Invention Disclosures Received	U.S. Patent Applications Filed	U.S. Patents Issued	Licenses & Options Executed	Total Active Licences & Options
$10.5 m	300	39.3	$2.9 m	$1.3 m	578	290	87	172	769

What these figures do not adequately represent is the increasing volume of technology commercialization at Canadian universities. For example, the number of licenses and options that are generating royalties for the institutions is growing rapidly:

Licences and Options Generating Royalties				
FY 1995	FY 1994	FY 1993	FY 1992	FY 1991
300	242	182	111	109

A great deal of the increase in activity is the result of greater attention to IP commercialization on the part of universities. Some is also the product of increasing awareness and interest in commercializing research by individual researchers. The operation of Centres and Networks of Centres of Excellence on university campuses has probably also contributed to the growing volume of technology being commercialized.

Also growing quickly is the number of invention disclosures that are being registered with the universities, which may be evidence of increasing faculty and student interest in commercializing technology:

Invention Disclosures Received for Fiscal Year				
FY 1995	FY 1994	FY 1993	FY 1992	FY 1991
578	445	393	284	250

Technology licensing revenues accruing to the universities are also growing in line with the expanded commercialization activities:

Gross Royalties Received for Fiscal Year				
FY 1995	FY 1994	FY 1993	FY 1992	FY 1991
$14,385,732	$7,869,748	$6,836,357	$5,191,309	$3,976,950

Readers should bear in mind that revenues from university technology commercialization account for only a tiny portion of university operating costs. No university undertakes technology commercialization because it expects to receive a significant short term net benefit. Indeed, though the AUTM survey does not provide data on university commercialization costs, it is likely the case that Canadian university revenues from technology commercialization only began to exceed costs in 1995. In previous years, it is probable that commercialization expenses were higher than revenues. However, one official with whom we spoke explained that even if his institution lost money commercializing its intellectual property, he would recommend strongly to the University's Board of Directors that it continue to underwrite the activity, because it had a significant positive impact on the community.

Another indicator of universities' commercialization activities is the number of start-up companies formed[13]. In 1995, institutions reported that 31 start-up companies were formed, compared to 29 in 1994. Between 1980 and 1993 universities reported creating a total of 156 start-up companies.

Reports such as the AUTM licensing survey suggest that technology commercialization activities are thriving at our universities. Recent trends are encouraging. However, a word of caution is in order. Total Canadian university revenues recorded by AUTM were under $10 million in 1995 and the number of start-up companies was 31. Compared with the performance of the national economy as a whole, a provincial economy, or even a large municipal economy, we are not dealing with large effects. The level of effort required to develop commercialization indicators for the sector needs to be balanced against the volume of activity being measured.

COMMERCIALIZATION INDICATORS

AUTM provides the best available data on university IP commercialization. However, the AUTM survey only presents a partial picture. In the first instance, it excludes more institutions than it includes. Sixteen (16) institutions (15 universities and one teaching hospital) provided financial data for the 1991-1995 survey, compared with 89 members of the Association of Universities and Colleges of Canada (AUCC). That said, the universities that did participate include most of the country's large research universities.

However, it is important to note that the institution that earned the second-highest royalties in 1995 was a teaching hospital (Mount Sinai). This institution accounted for almost 19% of all reported Canadian royalties in that year[14]. This raises a number of important considerations. Given the significance of the hospital sector[15], commercialization

[13]AUTM defines start-up companies as **A**..companies that were dependent upon licensing the institution=s technology for initiation.@

[14]Year-to-year results do vary. In 1994, Mount Sinai reported only $188,545 of royalty income, compared with $1.95 million in 1995.

[15]University of Toronto, for example, has 11 affiliated teaching hospitals, a number of which conduct significant amounts of research.

surveys should try to capture information from hospitals that are affiliated with universities, and that conduct significant amounts of research. But it will be difficult to know what portion of hospital IP that is commercialized was developed directly through university research affiliations (e.g. faculty cross-appointments with a university) and what portion was commercialized in other ways (e.g. through private non-profit research funding from agencies such as the Canadian Cancer Society).

The Mount Sinai example also shows that IP returns can be volatile and vary significantly from year to year, often depending on the institution's success in exploiting a very small number of developments. Most of the institutions that participated in the AUTM survey do not show this extreme annual variation. Such variation demonstrates the difficulty of comparing individual institutions and of comparing the performance of one institution over time.

A second factor to be kept in mind about the AUTM survey is that it is primarily a survey of licensing activities. Other questions related to technology commercialization are included[16], but the survey is not a commercialization study *per se*, because it does not attempt to capture a full range of commercialization indicators.

In our opinion, a third problem with the AUTM survey is that its wording is difficult and its nomenclature may be open to misinterpretation by survey respondents and users of the data[17]. AUTM is making an ongoing effort to improve its survey methods.

In spite of these concerns, we must acknowledge that the AUTM survey appears to be the only comprehensive university technology commercialization survey that is undertaken in Canada. Participation by institutions is voluntary. AUTM is a professional organization, whose members are individuals rather than institutions. Thus, if a particular institution appears in the survey it is because one or more employees who are members of AUTM have volunteered to provide the data requested.

If a Canadian commercialization study were to be launched, it must account for the prior existence of the AUTM survey, and build on its strengths.

Even if a comprehensive AUTM-type survey of commercialization activities at all universities were to be undertaken, it might not yield a complete picture of the commercialization activity emanating from the universities. That is because not all commercial activities come to the attention of university officials. Universities are large organizations with many researchers. Even with the best of reporting and disclosure systems, some commercialization activity is bound to go unreported. A university with good systems in place might expect to record up to 85% of commercialization activity in its jurisdiction. Institutions that are not so well organized might record less. Also, in the normal course of events universities forego most of their own commercialization rights to discoveries, and cede them to the inventor. Inventors may later succeed in commercializing the technology without the knowledge of the university. Similarly, much faculty consulting activity - possibly an important commercialization indicator - could go unreported to university officials.

---

[16]For example, **A**How many start-up companies were formed ... that were dependent upon the licensing of your institution=s technology for initiation?@

[17]For example, AUTM uses a single number to represent **A**licenses/options ... execute(d)@. Readers have no way of knowing if the data provided (e.g. **A**100 licences executed@) refer to one technology licensed 100 times, or 100 technologies licensed one time.

SELECTING INDICATORS

Before selecting the indicators that best describe university IP commercialization, we need to understand the underlying commercialization process. From discussions with university technology transfer officials, and selected readings, we suggest a number of commercialization themes for which it might, in principle, be worthwhile to develop indicators:

1. **IP Creation**	Indicators that would measure the volume and character of research activity at Canadian universities. Such indicators would provide an overview of the scale of research activities that have the potential to produce IP. These indicators would measure the 'stock of knowledge'. Many of these are now collected by research funding agencies or the universities themselves. Other relevant indicators might measure the impact of training and re-training activities on the nation's stock of highly qualified personnel (HQP).
2. **Identifying IP**	This set of indicators would measure the volume of invention disclosures that researchers bring forward to university technology transfer officials, and the disposition of the disclosures.
3. **Protecting & Managing IP**	These indicators would provide a picture of the nature and volume of the technologies being disclosed, and the size and cost of university IP protection activities.
4. **Exploiting IP**	Once IP has been protected, additional work may need to be done to prove or develop the technology to a stage where it attracts commercial interest. Effort also needs to be devoted to marketing technology. At this stage, funds may flow to universities from licensing activities. Universities sometimes take equity positions in companies in return for contributing IP. This set of indicators is oriented to understanding the nature of IP exploitation at universities.
5. **Faculty IP Transfer**	The transfer of knowledge or know-how by faculty - often through consulting activities - is an important process of technology commercialization. These indicators would provide a picture of the magnitude of faculty consulting activities and their impact on wealth creation and quality of life.
6. **Company Support**	Some universities operate research parks and business incubators designed to promote the growth of start-up and spinoff companies. This set of indicators would characterize support of these activities.
7. **IP Transfer Impacts**	Once IP is transferred to a company, it helps to produce improvements in wealth creation and quality of life. These indicators would provide measures of how university IP helps the economy and society.

Once there is agreement on the important IP commercialization processes, work can begin to select specific indicators. At this point, consideration needs to be given to the following factors:

- The legitimacy of the individual indicators;
- The usefulness of the indicators to different information users;

- The degree to which the indicator measuring system describes the true situation;
- The uses to which the information will be put; and,
- The cost of acquiring information - in time and money - against its value.

Appendix 1 contains a list of over 50 possible indicators of university IP commercialization. Universities and other potential users of commercialization information need to work together to create a balanced information collection system.

BARRIERS TO DATA COLLECTION

There appears to be general but cautious consensus among university officials interviewed in the course of this study, that a national project to develop university research commercialization indicators is worth pursuing. But there are significant barriers that need to be overcome before a project can be launched.

Universities are under constant pressure to provide information to various public agencies. The cost to them - in time and often, in money - is not negligible. Costs could mount, particularly if they were asked to do a historical analysis of activity. Some institutions might need to be compensated financially in order to participate in something more than a basic information gathering activity.

Care also needs to be taken to avoid duplication of effort, wherever possible. Many universities already participate in the AUTM survey. In our opinion, however, that survey has conceptual and methodological weaknesses. Still, the larger universities are already providing data that meets AUTM's information requirements. Any new initiative should use the AUTM work as a springboard to a more comprehensive information gathering exercise.

The lack of a standardized, off-the-shelf computer database for recording and analyzing commercialization data presents another barrier. It is likely that no two universities presently collect the same data in the same format. Some have custom-built databases, which may or may not cover all indicators of interest. Others may rely on paper-based systems, which are inherently less flexible and more limiting.

Beyond some basic data that all universities are likely to collect (or could easily do so) there is no agreement on which of many possible indicators are either practical or desirable. It could be that a national indicators project should be launched in stages. Simpler data would be collected initially, and more complex data would be collected in subsequent years. Agreeing on precisely what indicators are worth tracking is another issue that needs to be dealt with. Appendix 1 of this study provides a list of innovation themes and possible indicators that would be candidates for a comprehensive survey. We believe that the university and government communities need to reach consensus on the makeup and timing of any eventual indicators project.

Confidentiality concerns also need to be taken into account, particularly with respect to contract research activities funded at universities. Though the volume of contract research is small in comparison with grant research, many believe that contract research - and faculty consulting - are important commercialization indicators. A code of practice may need to be developed so that participants could collect and provide information that might be considered valuable, but commercially sensitive. Similarly, if measures of the impact of (contract) research on industry are adopted - for example sales, employment or exports resulting - confidentiality issues need to be addressed. It might be that universities will ultimately want to include some forms of data collection as a condition of research contracts.

In our opinion, given good will and a common purpose, none of these barriers is insurmountable. However a process will need to be established wherein the views and requirements of all parties are taken fully into account.

CONCLUSIONS

We have reached the following conclusions about the feasibility of establishing a national university IP commercialization indicator system.

1. Interest is High

Though universities are very aware of and concerned about the barriers to collecting information on IP commercialization, they do agree that a national indicators system can be valuable. Commercialization indicators can help universities to demonstrate accountability and to communicate the impact of their work to the community at large. They can help them compare their commercialization activities with those at different institutions. They can help improve commercialization activities at individual institutions. And, they can provide policy makers with the information they need to make decisions about support for research.

2. Cooperation is Key

Further work in this area cannot proceed before a partnership is established between Statistics Canada and the university community. Any national indicators program needs to be a cooperative venture. As such, universities need to be equal partners in determining the nature and scope of any program that is ultimately developed. Statistics Canada will need to consult with the community determine which organization(s) should be invited to represent the university community in discussions and any detailed work that follows. Some possibilities include the Association of Universities and Colleges of Canada (AUCC), Canadian Association of University Research Administrators (CAURA), Canadian University Intellectual Property Group (CUIPG), or AUTM Canada, which represents the Canadian members of AUTM[18]. Because of their central role, the national Granting Councils must also be partners in the indicators project.

3. Resource Requirements Must be Addressed

Data cannot be collected without spending resources; either time or money. A comprehensive indicators project could impose costs which some universities might consider to be beyond their current capabilities to absorb. However, it will be difficult for universities to estimate their costs until such time as the scope of a national indicators project is defined. The option of providing resources to the community to defray some costs, needs to be considered.

4. Technical Matters Require Further Work

There are many technical matters that need to be addressed before a national program can be instituted. These include issues related to confidentiality, indicator selection, and database development, to name just three. It appears to us that a written survey is the most effective research tool, but this should be confirmed in further discussions with university representatives. A system of technical review will need to be established.

5. Phasing is a Consideration

It may be desirable to launch a pilot indicators project initially, that would collect a set of baseline data. More complicated or detailed data collection could be introduced at a later stage. This implies a phased approach to data collection.

6. Recognition of Existing Systems

Current indicator activities - in particular the AUTM survey - need to be taken account of before any new initiative is launched. Wherever possible, new initiatives should build on current information gathering activities.

[18] Note from the editor, Statistics Canada : the Canadian Association of University Officers (CAUBO) should be included in this list as a key provider of statistical data on universities.

7. Critical Mass

From discussions with officials at NSERC, it would appear that the participation of the top 15 or so university research grant recipients would provide sufficient data to capture information about 90% of the university commercialization activity in the country. Most of the top 15 universities that receive NSERC grants also receive grants from MRC, though their relative ranking may change on each list.

8. Cost

Cost projections are difficult to arrive at at this time, because many considerations still need to be finalized. We estimate that a budget in the order of $50,000 might be required to develop an indicators **plan** and **methodology**. Following this, a more detailed determination of costs will be possible for the implementation phase.

9. Time Frame

We expect that an indicators plan and methodology can be established in approximately six months from the launch of a project. It may take a further three months of discussions with the community before the work can begin. Realistically, a full-scale indicators project will probably not be possible before Spring 1998.

RECOMMENDATIONS

We recommend that Statistics Canada:

1. Circulate This Report and Seek Comment

This report should be distributed to the organizations who were consulted during its preparation, and to other universities and stakeholder organizations. Written comments should be invited. On the basis of the comments received, Statistics Canada should determine whether or not to proceed to the next phase of work.

2. Establish a Management Committee

If Statistics Canada decides to proceed with this project, it should invite representative university organizations and other stakeholders to nominate individuals to join a Management Committee, that will oversee further work. The Management Committee should establish detailed terms of reference for an indicators project, including a project timetable and budget. Statistics Canada should set aside sufficient funds to finance the activities of a Working Group.

3. Establish a Working Group

The Management Committee should appoint a Working Group to resolve the detailed technical and administrative requirements of a national indicators project, and issue a report for consideration by the Management Committee.

4. Solicit Comments and Advice

After review by the Management Committee, the Working Group's report should be circulated widely to universities and stakeholder groups, and written comments should be solicited. The Management Committee should review the comments and recommend what further measures, if any, should be undertaken to initiate a national indicators project.

***

Appendix 1
Sample Commercialization Indicators

Innovation Theme	Sample Indicator
Creating IP	
Nature and extent of university research*	Volume of research ($, # of projects, fields, etc.) Distribution among universities Type of research (grant, contribution, contract, etc.) Research quality (bibliometric data)
Training/re-training of HQP and Managers*	Enrolment, graduation and employment data (FT/PT)
Identifying IP	
Identifying inventions	# of invention discoveries reported # of invention discoveries reviewed by university or agent # of invention discoveries declined for investment
Protecting and Managing IP	
Identifying & evaluating intellectual property	# of invention discoveries accepted for investment # of technology transfer personnel $ of technology transfer expenditures Field of discovery (cf. NSERC/MRC categories) Field of application (cf. SIC code)

Protecting intellectual property	# of discoveries with patent applications
	# of patent applications per discovery
	# of patents granted
	# of software copyrights registered
	$ invested to protect new IP
	$ invested to protect old IP

IP Exploitation by Institution	

Demonstrating/developing intellectual property	# of prototype, demonstration or scale-up projects
	$ investment in prototypes, demonstration or scale-up
	# of market studies
	$ investment in market studies

Exploiting intellectual property	# of university-owned commercialization companies
	$ spent to market inventions
	# of technologies licensed
	# of licenses/options awarded
	$ of royalty income
	$ from licensing fees
	$ from equity investments
	Type of company licensing IP (e.g. SME, Canadian, etc.)
	Country in which IP is being commercialized

Innovation Theme	Sample Indicator
IP Transfer by Faculty	

Transferring intellectual property	# of faculty engaged in consulting
	# of consulting projects completed
	$ of faculty consulting income
	$ of research contracted back to institution
	Impact of faculty consulting (sales, exports, jobs, etc.)
	Biological material exchanges

Support of Technology-based Companies	

Research Parks and Business Incubators	Presence of a research park or business incubator
	$ spent on park or incubator activities
	# employees devoted to park or incubator activities
	# of tenant companies
	# of employees/employee growth at tenant companies
	$ sales/sales growth at tenant companies

Impacts of IP Commercialization	
New company formation	# of start-up companies created (from IP) # of university spin-off companies created (from IP) $ of outside investment leveraged into new companies New company growth (sales, employment, exports, etc.)

Returns from equity investments	# of companies with university equity investment
	Type of equity investment (IP, cash, etc.)
	Type of equity received (shares, warrants, debentures, etc.)
	$ returns from dividends
	$ returns from equity disposition

Job creation	# of jobs created through IP commercialization
Exports	$ of export revenues earned through IP commercialization

* Not recommended for an IP commercialization study

Appendix 2
Organizations and Individuals Consulted

Association of University Technology Managers (US)
Mr. Dan Massing
Chair, Statistics Committee
SUNY Research Foundation
(716) 645-3811

Association of University Technology Managers (Canada)
Ms. Natalie E. Dakers
Vice President, Canada
University-Industry Liaison Office
IRC Room 331 - 2194 Health Sciences Mall
Vancouver, BC
V6T 1Z3

Association of Universities and Colleges of Canada
Dr. Robert Davidson
Director, Research and Policy Analysis
A.U.C.C.
350 Albert Street, Suite 600
Ottawa, ON K1R 1B1
(613) 563-1236 x 202 Tel.
(613) 563-9745 Fax
RDAVIDSO@AUCC.CA

G-10 Vice Presidents Research
Dr. Carolyn Hansson
Vice-President Research
University of Waterloo
chansson@nh3adm.uwaterloo.ca
(519) 888-4889

Dr. Pierre Bélanger
Vice-Principal (Research) & Dean
Graduate Studies
Faculty of Graduate Studies & Research
McGill University
853 Sherbrooke St. W.
Dawson Hall, Room 308
Montréal, QC H3A 2T6
Tel: 514-398-3991
Fax: 514-398-8257
pbelange@fgsr.lan.mcgill.ca

Dr. Maurice St-Jacques
Vice-recteur à la recherche et à la planification
Rectorat
Université de Montréal
H-625, C.P. 6128, Succursale Centre ville
Montréal, QC H3C 3J7
Tel: 514-343-7270
Fax: 514-343-5750
STJACQUM@ERE.UMONTREAL.CA

Dr. Denis Gagnon
Vice-recteur
Vice-rectorat à la recherche
Pavillon des Sciences de l'éducation, local 1454
Université Laval
Québec, QU
G1K 7P4
(418) 656-2599 (Tel)
(418) 656-2401 (Fax)
Denis.Gagnon@vrr.ulaval.ca

Dr. G. E. Gerber
Vice-President Research and International Affairs
McMaster University
Gilmour Hall, Room 112
1280 Main Street West
Hamilton ON
L8S 4M1
email: gerberg@mcmaster.ca
office_phone: 27270

Dr. Suzanne Fortier
Vice-Principal (Research)
Queen's University
Phone: (613) 545-6933
Fax: (613) 545-6934
e-mail: fortiers@post.queensu.ca

Dr. W.A. Bridger
Vice-President (Research)
The University of Western Ontario,
Stevenson-Lawson Bldg. Rm. 117
London ON
N6A 5B8
Tel: (519) 661-3851
Fax: (519) 661-3139
bridger@julian.uwo.ca

Dr. Bernard H. Bressler
Old Admin Bldg, Rm. 209
2329 West Mall
Vancouver, BC
V6T 1Z4
(604) 822-4813
email: vpr@unixg.ubc.ca

Dr. Roger S. Smith
Acting Vice-President (Research and External Affairs)
University of Alberta
Tel: (403) 492-5353
e-mail: roger.smith@ualberta.ca

Industry Canada
Yuri Daschko
Director
University Research Policy
235 Queen Street
Ottawa ON
K1A 0H5

Ms. Sue Milne
Analyst
University Research Policy
235 Queen Street
Ottawa ON
K1A 0H5

Natural Sciences and Engineering Research Council
Mr. Paul Latour
Director
University Industry Projects Division
Constitution Square, Tower II
350 Albert Street
Ottawa, ON K1A 1H5

Mr. Leo Derikx
Director General
Research Partnerships Directorate
Constitution Square, Tower II
350 Albert Street
Ottawa, ON K1A 1H5

Social Sciences and Humanities Research Council
Mr. Robert Hanson
Director, Evaluation and Statistics
350 Albert Street
PO Box: PO Box 1610, Station B
Ottawa, Ontario
K1P 6G4
(613) 992-5148

Medical Research Council
Dr Francis S. Rolleston
Director, Innovation Teams
Holland Cross, Tower B
1600 Scott Street, 5th Floor
Ottawa, ON
K1A 0W9
(613) 954-1801

University of Alberta
Dr. James W. Murray
Director and Associate Vice-President
Research/Industry Relations
Industry Liaison Office
222 Campus Tower
8625 - 112 Street
Edmonton AB
T6G 2E1
jim.murray@ualberta.ca

University of Calgary
Dr. James J. Chrisman
Acting Associate Dean
Research and Ph.D. Program
2500 University Drive N.W.
Calgary AB
T2N 1N4
chrisman@acs.ucalgary.ca

Ms. Elan Nutting
Marketing Assistant
University Technologies International Inc.
Ste. 204, 609 - 14 Street N.W.
Calgary AB
T2N 2A1
(403) 270-7027 ext. 213
(403) 270-23844
nuttinge@uti.ca

Dr. Emlyn L. Jessop
Director, Research Services
University of Calgary
2500 University Drive N.W.
Calgary, AB T2N 1N4
Tel: (403) 220-3380
Fax: (403) 289-0693

University of British Columbia
Mr. Angus Livingstone
Associate Director
University-Industry Liaison Office
IRC Room 331 - 2194 Health Sciences Mall
Vancouver BC
V6T 1Z3

Mr. David P. Jones
Technology Transfer Manager - Prototype
Development Program
University-Industry Liaison Office
IRC Room 331 - 2194 Health Sciences Mall
Vancouver BC
V6T 1Z3

Ms. Natalie E. Dakers
Technology Transfer Manager - Life Sciences
University-Industry Liaison Office
IRC Room 331 - 2194 Health Sciences Mall
Vancouver BC
V6T 1Z3

University of Toronto
Dr. Peter Munsche
Associate Vice President, Research
27 King's College Circle
Toronto ON
M5S 1A1
(416) 978-6063
(416) 978-5821 (Fax)
peter.munsche@utoronto.ca

Mr. Edward J. Kenny
President
Innovations Foundation
525 University Avenue, Ste. 925
Toronto ON
M5G 2L3
e.kenney@utoronto.ca

Western Vice Presidents Research

Dr. Bernard H. Bressler
Vice President Research
The University of British Columbia
Old Admin Bldg, Rm. 209
2329 West Mall
Vancouver, BC
V6T 1Z4
(604) 822-4813
email: vpr@unixg.ubc.ca

Dr. Alex McAuley
Associate Vice-President, Research
Office of Research Administration
University of Victoria
P.O. Box 1700
Victoria, BC V8W 2Y2
Tel: 604-721-7973
Fax: 604-721-8960
AMCA@UVVM.UVIC.CA

Dr. Cooper Langford
Vice President Research
University of Calgary
2500 University Drive NW
Calgary, Alberta
T2N 1N4
(403) 220-5465

Dr. Andy Khan
Vice President Research
Athabasca University
1 University Drive (Box 10,000)
Athabasca AB
T9S 1A1
1(800) 788-9041 or (403) 675-6100

Dr. Terrence P. Hogan
Vice-President (Research & External Programs)
206 Administration Building
Winnipeg, MB R3T 2N2
Phone: (204) 474-9404
Fax: (204) 275-1160
E-mail: Dr. T.P. Hogan

Dr. Katherine Schultz
Associate VP (Research & Graduate Studies)
Office of the Vice-President (Academic)
University of Winnipeg
515 Portage Avenue
Winnipeg, MB R3B 2E9
Tel: 204-786-9797
Fax: 204-783-8910
schultz-k@c-h.uwinnipeg.ca

Dr. Larry Symes
Associate Vice President, Research and
Graduate Studies
University of Regina
3737 Wascana Parkway
Regina SK
S4S 0A2
(306) 585-5207

Dr. Dennis Johnson
Vice President Research
University of Saskatchewan
(306) 966-8513

Dr. Bruce P. Clayman
Vice-President Research
Simon Fraser University
3200 Strand Hall
Burnaby, BC V5A 1S6
Tel: 604-291-4152
Fax: 604-291-4860

How to Order Publications

These and other Statistics Canada publications may be purchased from local authorized agents and other community bookstores, through the local Statistics Canada offices, or by mail order to:

Marketing Division, Sales and Service
Statistics Canada
Ottawa, Ontario
K1A 0T6
1(613)951-7277

National toll free order line: 1-800-267-6677
Fax number: 1-(613)951-1584
Toronto Credit Card only (973-8018)

CATALOGUED PUBLICATIONS

Statistical Publication

88-202-XPB Industrial Research and Development, 1997 Intentions (with 1996 preliminary estimates and 1995 actual expenditures)

88-204-XPB Federal Scientific Activities, 1997-98 (annual)

88-001-XPB Science Statistics (monthly)

Volume 20

No. 1 The Provincial Research Organizations, 1994

No. 2 Software Research and Development (R&D) in Canadian Industry, 1993

No. 3 Research and Development Personnel in Canada, 1983 to 1993

No. 4 Federal Government Expenditures on Scientific Activities, 1996-97

No. 5 Industrial Research and Development, 1991 to 1996

No. 6 Total Spending on Research and Development in Canada, 1971 to 1996

No. 7 Estimation of Research and Development Expenditures in the Higher Education Sector, 1994-95

No. 8 Distribution of Federal Expenditures on Science and Technology, by Province and Territories, 1994-95

No. 9 The Provincial Distribution of R&D in Canada, 1979 to 1994

No. 10 Federal Government Personnel Engaged in Scientific and Technological (S&T) Activities, 1987-88 to 1996-97[e]

No. 11 Research and Development (R&D) for Pollution Abatement and Control in Canadian Industry, 1990, 1991 and 1993

No. 12 Biotechnology Research and Development (R&D) in Canadian Industry, 1989 and 1993

No. 13 Research and Development (R&D) Expenditures of Private Non-Profit (PNP) Organizations, 1995

Volume 21

No. 1 Scientific and Technological (S&T) Activities of Provincial Governments, 1987-88 to 1995-96

No. 2 The Effect of Country of Control on Industrial Research and Development (R&D) Performance in Canada, 1993

No. 3 The Provincial Research Organizations, 1995

No. 4 Federal Government Expenditures on Scientific Activities, 1997-98

No. 5 Industrial Research and Development, 1993 to 1997

No. 6 Software Research and Development (R&D) in Canadian Industry, 1995

No. 7 Distribution of Federal Expenditures on Science and Technology, by Province and Territories, 1995-96

No. 8 Total Spending on Research and Development in Canada, 1986 to 1997[e], and Provinces, 1986 to 1995

No. 9 Estimation of Research and Development Expenditures in the Higher Education Sector, 1995-1996

WORKING PAPERS - 1996 AND 1997

These working papers are available from the Science and Technology Section of Statistics Canada, please contact:

Science and Technology Section
Science and Technology Redesign Project
Statistics Canada
Ottawa, Ontario
K1A 0T6

Tel: (613) 951-6347

ST-96-01 Estimation of Research and Development Expenditures in the Higher Education Sector, 1993-94, December 1995
Price: $75.00

ST-96-02E Federal Science Expenditures and Personnel, 1993-94 to 1995-96, January 1996
Price: $75.00

ST-96-03 Federal Government Expenditures and Personnel on Activities in the Natural and Social Sciences, 1986-87 to 1995-96, March 1996
Price: $75.00

ST-96-04 Scientific and Technological Activities of Provincial Governments, 1988-89 to 1994-95, March 1996
Price: $75.00

ST-96-05 Methodology for Estimation of Higher Education Personnel, June 1996
Price: $75.00

ST-96-06 Estimates of Research and Development Personnel in Canada, 1979 to 1993, June 1996
Price: $75.00

ST-96-07 Estimation of Research and Development Expenditures in the Higher Education Sector, 1994-95, October 1996
Price: $75.00

ST-96-08 Estimates of Canadian Research and Development Expenditures (GERD), National 1963 to 1996, and by province 1979 to 1994, November 1996
Price: $100.00

ST-96-08 Appendix #1

National Series of GERD, 1963 to 1996, November 1996
Price: $100.00

ST-96-08 Appendix #2
Estimates of Canadian Research and Development Expenditures in the Natural Sciences, Canada 1985 to 1996 and by Province, 1985 to 1994, November 1996
Price: $100.00

ST-97-01 A Compendium of Science and Technology Statistics, February 1997
Price: $75.00

ST-97-02 Provincial Distribution of Federal Expenditures and Personnel on Science and Technology, 1994-95, February 1997
Price: $75.00

ST-97-03 Scientific and Technological Activities of Provincial Governments, 1989-90 to 1995-96, March 1997
Price: $75.00

ST-97-04 Federal Government Expenditures and Personnel on Activities in the Natural and Social Sciences, 1987-88 to 1996-97[e], March 1997
Price: $75.00

ST-97-05 Transfers of Funds for Research and Development in Canadian Industry, 1993
March 1997
Price: $75.00

ST-97-06 Estimation of Research and Development Expenditures in the Higher Education Sector, 1995-96, August 1997
Price: $75.00

ST-97-07 Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1986 to 1997, and by Province, 1986 to 1995, August 1997
Price: $75.00

ST-97-08 Federal Government Expenditures and Personnel on Activities in the Natural and Social Sciences, 1988-89 to 1997-98[e], July 1997
Price: $75.00

ST-97-09 R&D Tax Treatment in Canada: A Provincial Comparison, September 1997
Price: $75.00

ST-97-10 Provincial Distribution of Federal Expenditures and Personnel on Science and Technology, 1987-88 to 1995-96, October 1997