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Summary: Joint Statistics Canada - University of Windsor Workshop on Intellectual Property Commercialization Indicators, Windsor

November 2004

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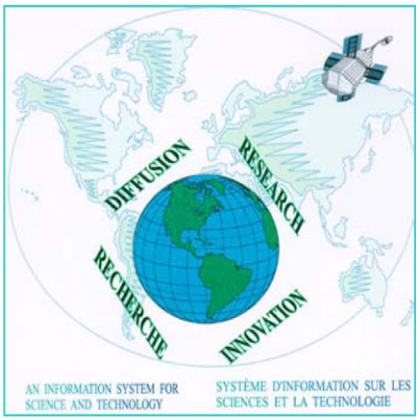

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Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
…	not applicable
0	true zero or a value rounded to zero
0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{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

NOTE: Due to rounding, components may not add to totals

The science and innovation information program

The purpose of this program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors**: are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities**: include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages**: are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes**: are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts**: are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and 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 picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that 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 only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators 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 has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical Information System,** Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193.

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Acknowledgements

This summary is the result of the efforts of both the workshop's organisers and participants. While not everyone can be recognised, the authors would like to thank Kim Livingstone, University of Windsor, and Louise Earl and Carol Poirier, Statistics Canada for their efforts in organising the workshop. Also, the workshop would not have succeeded without the valuable insights of the presenters and discussants who are named throughout the report. The workshop's insights will be used to assist Statistics Canada in developing indicators to measure commercialization activities.

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

The publication of this report was made possible by the contribution of many people including Louise Earl, Michael Bordt, and Claire Racine-Lebel.

Preface

The workshop summarised in this report is the latest in a series of foresight exercises Science, Innovation and Electronic Information Division (SIEID) has undertaken that assist in the production of indicators in support of evidence-based policy.

Previous workshops have looked at the adoption, development and use of new and emerging technologies such as information and communication technologies and biotechnology. Technology adoption and development is just one aspect of knowledge transfer. Other aspects include the roles of networks, alliances and partnerships for which a research workshop was held. The innovation system, geographic concentration of innovative activity and the management of knowledge in today's economy have all been explored, furthering our research on the impact of innovation.

Innovation, the introduction of new or significantly improved products or processes to the marketplace, has been the topic of research workshops in this series. This latest workshop looked beyond innovation to commercialization. It is through innovation that new products are introduced to the market, new production processes are developed and introduced, and organisational changes made. Through the adoption of new technologies and practices, industries can increase their production capabilities, improve their productivity, and expand their lines of new goods and services. Commercialization is the process of extracting economic value out of new products, processes, and knowledge.

Developing intellectual property through research and development is the starting point of the commercialization process for the public sector. Surveying the commercialization of intellectual property in the higher education sector as well as for federal science-based departments started in 1998. Many of the activities surrounding commercialization in the public sector such as protection of intellectual property, licensing and spinning-off new companies are well understood while other activities such as university-industry linkages and private sector commercialization processes are less well known. The purpose of the workshop was to explore gaps in the knowledge of commercialization and to help policy-makers, analysts and statisticians create frameworks for the development of indicators.

1. Introduction

Of the seven research workshops conducted as part of the foresight function of the Science, Innovation and Electronic Information Division (SIEID) at Statistics Canada, this was the first to be co-sponsored by a university, the University of Windsor. It was also the first to take place outside of Ottawa.

The University of Windsor location provided an opportunity to hear from people involved in producing intellectual property that could be commercialized, and from firms that were the recipients of the knowledge generated in universities. Legal experts advised on the problems of managing intellectual property and on how to better inform academics and their private sector partners, about what the protection mechanisms for intellectual property could or could not do.

The workshop placed the performance of commercialization in the context of recent federal policies and history. The policy most directly relevant to the discussion was the intention on the part of universities collectively through the Association of Universities and Colleges (AUCC) along with the federal government, by Industry Canada, to triple the value of commercialization of university-generated intellectual property by 2010, and to double the expenditure on the performance of research and development (R&D), in return for a federal contribution towards the overhead costs of R&D. As the production, transmission and use of intellectual property are complex and changing, with economic and social outcomes, they are subjects for academic research. Presentations were made on the concerns of stakeholders, on frameworks for analyzing the process of commercialization, and on the conditions needed for commercialization.

Analysis, and the monitoring of the progress towards the AUCC /government targets for commercialization, require measurements of the activity using agreed-upon definitions and standards for measurement so that the results could be comparable over time and across institutions and regions. There was a presentation on existing measures in the surveys of Statistics Canada designed to encourage discussion on conceptual frameworks and indicators.

2. Stage Setting

On behalf of the University of Windsor, the President, Dr. Ross Paul, welcomed participants to Windsor and to the University. Dr. Fred Gault thanked Dr. Paul for the support given to the Workshop and welcomed participants on behalf of Statistics Canada.

Dr. Susan McDaniel, Vice-President Research of the University of Windsor presented the objectives of the Workshop. They were to present and discuss intellectual property (IP) commercialization with particular reference to current policy initiatives, the current state of academic research; how university researchers transfer their new knowledge to industry receptors noting knowledge exchange models that work within the context of developing statistical indicators required to inform public debate. Finally, the workshop intended to arrive at recommendations that will assist in guiding the data development program within Statistics Canada.

3. Context and Targets

3.1 Historical Context

(Tom Brzustowski, Natural Sciences and Engineering Council of Canada)

Dr.Tom Brzustowski, President of the Natural Sciences and Engineering Council of Canada, took the workshop back to the work of the Expert Panel on Commercialization of the Prime Minister's Advisory Council on Science and Technology (ACST) and the report of its findings (Fortier 1999). The report drew upon expert papers commissioned by the Panel and on consultations in 1998-99. Following the report, there were more consultations on its findings and the results were presented to the Minister of Industry in November 1999. There was no immediate response from the government.

Universities reacted against the definition of innovation in the report and the recommendation on university policies on intellectual property. The view at the time was that some changes in wording of the report would have been sufficient to address the criticism, while retaining the substance of the report, and its recommendations in respect of research-based innovation. However there were no revisions and no follow-up on the part of the government.

This did not stop some government agencies from implementing some of the recommendations. For example, the Natural Science and Engineering Research Council (NSERC) moved to support the training of commercialization officers, to require that federally funded potential IP be disclosed to the institution, to broaden the range of its partnership programs and to add the 'benefit to Canada' clause to its agreements. None of this was intended to supersede the intellectual property ownership policy of the universities.

The *Fortier Report* also dealt with measurement of intellectual property activities in the universities and made specific recommendations in Appendix 4. Most of these recommendations were adopted by Statistics Canada, with the exception of the recommendation that the results for individual universities be published. Under the Statistics Act, this could not be done without the written permission of the universities.

Five years later, the question could be asked whether the *Fortier Report* addressed the right problem. The Report focused on the commercialization of basic research leading to what has been called 'research-based innovations'. It did not address project research in partnership with industry, or the advanced training of highly qualified personnel (HQP). In partnerships, the university participants provide knowledge, which may lead to new products or processes, brought to market by the industry partner, not by the university. Innovation in industry, especially in large firms, is initiated by the R&D department which needs the intelligent and highly qualified people produced by the universities. More broadly, in small and medium-sized firms, the highly qualified people play a key role in integrating knowledge from clients, competitors, and other sources to create new products and processes for the market. Research-based innovation, originating in universities, is a comparatively small component of the innovation system.

Brzustowski presented a systems view of innovation and commercialization where the actors were the universities, governments and the private sector. Each actor had a multiplicity of roles. Governments were sources of research funds, promoters of commercialization and innovation, regulators, and collectors and distributors of revenues. Businesses were involved in bringing new products (goods and services) to market and in developing new processes to produce products, new or old, and deliver them to the market. They were also involved in funding commercialization through the provision of seed capital, venture capital, and other forms of higher risk financing, as well as the lower risk financing from banks and pension funds. At least as important as profit-making to businesses are the management practices and organizational structures that are needed to make a business succeed and grow, and these come from a variety of sources including venture capital firms and management consultants. The universities are there to do first class research, develop highly qualified personnel, and to contribute to the community through partnerships and the provision of knowledge that may or may not be commercialized.

The NSERC model describes the linkages and feedback loops which make the system work and the outcomes related to wealth creation through new valued added activity, leading to economic and social impacts. NSERC has had successes as a result of its role in the system and these are documented in *Research Means Business* (NSERC 2004) which describes 134 firms that began with an NSERC grant for basic research a decade or more ago.

Brzustowski ended with a reference to the Bayh-Dole Act in the U.S. which gives universities ownership of IP created in research sponsored by grants from the U.S. government in return for the obligation to commercialize it. In Canada ownership resides in the universities, but in some the institution owns IP while in others the inventor does. Ownership is specified in university policies or in collective agreements and while both options work in Canada, the recommendation of Brzustowski is for university ownership.

The presentation placed the commercialization debate in context. In the discussion, the question arose of the place of social science in commercialization and of the priorities for the allocation of public resources. Was health care more important than support for commercialization, for example? This allowed a refinement of the discussion to tradable knowledge, tacit or codified, which may or may not be subject to commercialization. This excluded non-tradable services and emphasized the creation of wealth, rather than savings. On the subject of social sciences, the importance of a balanced emphasis on both the sciences and engineering and the social science and humanities was noted.

The point was raised that up to 98% of firms in Canada are small or medium-sized enterprises and that they needed support from established and larger firms. This came close to a discussion of economic clusters which has been the subject of a five-year research program in Canada funded by the Social Science and Humanities Research Council (SSHRC). Time constraints precluded its development but there are references in Wolfe (2003).

3.2 The AUCC - Federal Government Agreement

Michelle Gauthier, Association of Canadian Colleges and Universities

Dr. Gauthier introduced the *Framework of Agreed Principles on Federally Funded University Research* (AUCC 2002) in which the federal government acknowledged its responsibility for providing the necessary levels of investment in university research and the AUCC agreed to produce a periodic public report to demonstrate the collective progress made by universities in relation to research, knowledge transfer and innovation.

The report, planned for October 2005, will highlight the essential role of federal and other investments in universities, and document both the collective accomplishments of AUCC members and the provision of necessary support by the federal government. It will also inform key stakeholders of the collective progress of the universities in meeting the targets of tripling of the value of commercialization and of doubling the expenditure on R&D in universities.

A point emphasized was that the reporting would be for universities collectively, not the progress of individual universities. This is consistent with the practice of Statistics Canada which publishes aggregate results from its Survey of Intellectual Property Commercialization in the Higher Education Sector (Read 2003) and is contrary to the recommendation in the *Fortier Report* that the results for individual universities be released.

In addressing the tripling target, AUCC sought a feasible, reliable and credible measure of a collective outcome that takes account of the different strategies of commercialization and respects the decision-making of individual institutions. It settles on a base year of 1999 with data from the Statistics Canada survey. The measure was the total income from commercialization of university intellectual property which includes royalties from licensing, equity liquidated by institutions, dividends paid to institutions, and reimbursements of patent costs. As this measure was $23.4 million in 1999; the 2010 target becomes $70.2 million.

However there are objectives beyond the targets. The commitment to basic research remains, while there is recognition of the importance of deriving economic and social value from the activity. There is also the role of the federal government in facilitating industry, university and government partnerships in support of commercialization.

While all of this is a Canadian activity, and part of the Innovation Strategy, other countries are engaged in the commercialization of intellectual property from their universities and there is a need expressed for international comparisons of the activity. The AUCC wants recognition of the contribution of the universities to innovative and competitive companies and a move towards economic impact assessment broader than revenue from the commercialization of intellectual property. The presentation ended with a description of the benefits of university research and knowledge transfer.

3.3 Discussion

In discussion, the importance of industry in moving knowledge from the university to the market place was a recurring theme. This included contractual links with the universities, the spinning-off of new firms, the licensing of intellectual property, or the building of new models of collaboration which emphasized the flow of knowledge as a broader objective than commercialization. An example of such a new model was the University of Windsor/DaimlerChrysler Automotive Research and Development Centre (ARDC) which supports both the university, and industry, in what each does well and draws synergistic benefits from the collaboration. The need of small and medium-sized enterprises (SMEs) for access to relevant research was reiterated.

At the end of the session, business was well established as an actor in the innovation system, whether as a major player in Windsor like DaimlerChrysler, or as an SME seeking new knowledge from the university, or as a firm providing financial support, management advice, human resource supply, or brokering of trade and collaboration. The transfer of knowledge to business was only part of the process in the value chain as it was the business that took the risk involved in converting the knowledge to new products or processes that would allow it to succeed or fail in the market.

The university is also an actor in the system but not just as a source of intellectual property available for license, but also as a source of highly qualified people who provide industry with the capacity to absorb new knowledge and to convert it into value added in production. The university is also a source of academic researchers who could partner in joint projects with industry, adding value through knowledge transfer.

Government, as the third player in the system acts as a provider of research overheads and as a source of research funds. More on the role of government came out in subsequent presentations and discussion.

4. Policies, Indicators and Gaps

4.1 Commercialization and Innovation Policy

(Tim Angus, Industry Canada)

Workshop participants were reminded of the recent initiatives of the federal government. The federal budget in 2004 provided: $75 million over five years for new initiatives to accelerate commercialization of research from universities, hospitals and federal laboratories; $5 million a year was added to the budget of the Industrial Research Assistance Program (IRAP); and $270 million for increased venture capital funding through the Business Development Bank of Canada (BDBC). In addition, the last Speech from the Throne (October 5, 2004) indicated the intention of the government to allocate at least $1 billion from the sale of Petro-Canada to the development and commercialization of environmental technologies.

The Prime Minister has asked the Minister of Industry to study commercialization in Canada with a view to recommending a long-term strategy. The Prime Minister has also announced a comprehensive assessment of federal support for R&D and as part of this, 178 initiatives were found that supported commercialization and which accounted for $3.2 billion of expenditure in a single fiscal year. Industry Canada is also working with other departments and agencies to develop a Strategic Framework for Commercialization.

The process of commercialization is complex and understanding it for policy purposes requires more than surveys, although they do provide important contextual information and some insights into organizational structure and management practices. The need is for a set of indicators that support international comparisons as the government is concerned about the competitiveness of the Canadian economy in a world where just about every industrialized economy has targets for better performance over the next decade and Canada is in danger of losing its position as the leading source of merchandise imports by the United States (U.S.) to China.

Some indicators were reviewed. These showed that Canada has fewer highly qualified personnel (HQP) in its labour force than the U.S., that business managers are less well educated, and that there is a shortage of experienced venture capitalists. This raised a question of the relative importance of business skills compared with science and technology skills and whether indicators should be developed to illuminate this.

Looking at financing, a shortage of 'investor ready' firms was identified by the private sector, leading to a question about the characteristics of an investor ready firm, and whether they should be captured in data collection.

Turning to the business environment, the Organisation for Economic Co-operation and Development (OECD) has shown that the regulations governing foreign direct investment (FDI) in Canada are among the most restrictive in the OECD, and more restrictive than those of the U.S. or Mexico, Canada's North America Free Trade Agreement (NAFTA) partners. This raises questions about the costs and benefits of FDI in Canada. Is it a source of knowledge as well as financing or is it detrimental to the Canadian economy? This question is being posed when China is bidding for a firm in the Canadian resource sector and a Russian firm has bid for a Canadian steel producer.

As for knowledge generation through R&D, Canada is a middle ranking OECD country, with a policy target of being among the top five by 2010 (Industry Canada 2001). Are there indicators that can answer the question of how this radical change can take place? R&D performance is a challenge; Canada is second to the U.S. in exploiting new market opportunities by starting up new businesses. What does this show however? Do these firms survive or die? This leads to a question of what the characteristics are of new firms that do survive and which ones grow from small to medium size. This last question is the subject of an IRAP study being done in conjunction with Statistics Canada (Statistics Canada 2004)

Looking at patenting activity in the U.S., for each US$10 million spent on R&D performance, Canada comes behind the U.S. and Japan in the number of U.S. patents issued. This raises questions about whether a patent is an indicator of commercialization, and about where commercialization may take place. Is there any substance in the suggestion that Canadian intellectual property is being commercialized in other countries, and especially in the U.S.? More indicators are needed to understand these patterns.

In firms, commercialization activities are a subset of innovation activities, and innovation surveys, such as the 1999 Innovation Survey of Statistics Canada (Gault 2003), can identify the barriers to innovation. Some of these barriers also apply to commercialization and a next step may be to differentiate the two types of barriers in the next survey of innovation in 2005. One of the many interesting findings from the 1999 Survey of Innovation was that, while Canadian firms have a higher propensity to innovate than those in selected European countries, they derive less revenue from the sale of new products. This raises questions about why Canadian firms are not gaining as much as their European equivalents, and whether the percentage of sales due to new products is the best measure of commercialization.

The presentation ended with an invitation to participants to address the need for new indicators of firm performance which could be incorporated into the next innovation survey for the year 2005.

4.2 Indicators and Gaps

(Michael Bordt and Sharonne Katz, presented by Michael Bordt, SIEID, Statistics Canada)

This presentation introduced conceptual frameworks for addressing the subject of commercialization and, with a broad framework, the statistics that are available, leading to the question of what should be measured to provide additional useful indicators.

A problem in discussing commercialization is that a definition that supports measurement and consistent comparison of results is missing. This differs from data collection on research and development (OECD 2002) and on innovation (OECD/EuroStat 1997), each of which have internationally accepted manuals which provide definitions and guidance for the collection and interpretations of statistics. For there to be a public policy debate, an accepted definition is needed, and participants in the workshop were invited to contribute to the development of an appropriate definition.

4.2.1 Three overlapping perspectives

Several approaches to commercialization link it specifically to research. Alan Cornford (2004) uses a linear model to examine the linkages between public research, private sector research, the steps required to bring a product to market, and then the evolution of the firm.

Statistics Canada uses a systems approach to classify data on related activities (R&D, invention and IP management, innovation, adoption of technologies and practices), linkages (alliances, networks and partnerships), and outcomes (productivity, market share, skill levels,...) of the actors in the system (governments, business, and higher education) (Statistics Canada, 1998). In the specific area of IP management in government laboratories and universities

commercialization is clearer than in business. In business, commercialization includes almost all activities. In universities and federal laboratories, it involves licenses and spin-off firms and related activities (invention, disclosure, patents, IP policies, and resources devoted to technology transfer). When discussing universities and federal laboratories, we talk about the ***commercialization of research***.

Another approach to commercialization focuses on the introduction of new products and the contribution they make to productivity and national competitiveness. Innovation surveys can be used to analyze some of the aspects of commercialization since they include information on the inputs, barriers and outcomes related to innovation. One of the outcomes is the proportion of sales due to new and improved products which we can call the ***commercialization of innovation***. In Canada, this proportion averages about 26% for innovative manufacturing firms.

Yet other implied frameworks see commercialization as all activities that contribute to productivity and national competitiveness. This would subsume three schools of thought that are generally analyzed separately: knowledge generation, innovation and productivity. This could be described as the ***system of commercialization*** within which we could try to rationalize the contribution of knowledge generation and innovation.

4.2.2 What do and don't we know?

This broader perspective can be used to illustrate some of the gaps in understanding commercialization.

- We know that only a portion of ideas for innovation come from R&D departments. For the manufacturing sector, 53% of respondents indicated that their R&D staff were a source of innovative ideas. This implies the need to look beyond research as a source of ideas for innovation.

- We know that only about 26% of manufacturing revenues are due to new and improved products. This implies the need to look beyond innovation to understand commercialization.

Some other gaps in our knowledge are implied by the broad approach:

- Universities and federal laboratories conducted about a combined $8.5 billion in R&D in 2001. Total royalties from licensing their technologies were about $64 million. To better understand the commercialization of research, we would need more detailed measures of the nature of R&D performed and other benefits of that research such as training, collaboration, community service, and royalty-free licenses.

- Although the licenses are worth $64 million to the universities and federal laboratories, we have no measure of their importance to the economy. A given license may have a key role in an important product. We also have little data on the licensing between companies.

- Work with NRC-IRAP on business growth has shown that not only do R&D, innovation, alliances, IP protection, access to funding and finding a market niche have an influence but so do access to business advice, funding for business development and "adaptability". The latter three characteristics may be important characteristics of commercialization success as well.

- Biotechnology companies cite access to funding as the prime barrier to commercialization. Although many sources of funding are available to technology companies, not all of these sources are successfully exploited. We have little information on funding across the economy.

- There are some research results that link innovation with productivity (e.g., Baldwin 2004) but they are not sufficient to understand the importance of innovation to the economy as a whole. Furthermore, we have no commercialization equivalent to the innovation surveys that help us understand the inputs, barriers and outcomes of the phenomenon.

- All this does not take into account the human side of commercialization. We could for example look at the "appliedness" of doctorates; the capacity for commercialization in management; and the international mobility of entrepreneurial Canadians.

4.2.3 How can we fill the gaps?

If we wish to address these data gaps, we could:

augment existing surveys,

link existing data and

conduct new surveys.

Surveys that may be amenable to augmentation are surveys of R&D, innovation surveys and IP management surveys. R&D surveys, for example could provide more detail on the proportion of R&D that is intended to be commercialized. Innovation surveys could include a module that would ask for inputs, barriers and outcomes of the commercialization of innovation (i.e., revenues due to innovations). The university and federal IP management surveys could also better focus on the proportions of research intended for commercialization as well as a more comprehensive assessment of benefits of the research.

Linking innovation surveys with multiple years of tax data would provide new insights into the relationship between innovation and productivity.

New surveys could be conducted on private sector licensing and productivity-related management practices. A licensing survey would not only help assess the benefits of publicly-funded research but would also provide insights into IP flows between companies, regions and countries. A survey of management practices would help understand management capacity for commercialization and perhaps provide approaches to measuring entrepreneurship and adaptability.

4.2.4 How does it all fit together?

It has been suggested that the issue of commercialization, productivity and competitiveness is sufficiently complex that it might be better analyzed and benchmarked in terms of a "satellite account". Satellite accounts are used in national accounting to map and benchmark activities that are related to, but not contained within the System of National Accounts. Statistics Canada has developed, for example, satellite accounts to track the generation of wastes from economic activity.

In the case of the present topic, commercialization, productivity and competitiveness are not products that flow out of the economy but rather a characteristic of the economic system. To understand that characteristic, it would be necessary to systematically measure the stocks and track the flows of not only the dollars and goods through the economy but also the people and knowledge.

Furthermore, such a "competitiveness account" would have to take a new perspective on organizations, beyond the basic inputs and outputs, income and expenditures. Universities train graduates and, together with government laboratories, produce public knowledge. Companies use knowledge from universities and other sources to innovate and create competitive advantage. Government programs create the linkages that facilitate this transfer. Developing a set of accounts that brings this together would require not only existing data and our current understanding of competitiveness but would also require new data and new research.

4.3 Challenges of IP Commercialization in Universities

(Paul Fox, University Counsel, University of Windsor)

A policy to increase the amount of commercialization in universities may lead to a reduction of the free exchange of knowledge, an increase in secrecy in universities and a shift in priorities from basic to more applied research. Universities are moving from being the source of basic research to a being a source for invention which may be protected by intellectual property instruments and then commercialized through technology transfer or industrial liaison offices.

Technology transfer offices are a relatively recent phenomenon in universities and they pose challenges in a community where resources are scarce. For technology transfer offices to work, they must be staffed by quality people who are expensive and who occupy space which could be provided to academics who do research. The combination of skills required for technology transfer suggest that a new profession is emerging which combines experience of industry and of the university, with the ability to move knowledge out of the university.

If there is a technology transfer office, its staff will seek intellectual property to commercialize, but academics are caught in the publish or perish culture of the university and spending time on patenting may impact on the likelihood of tenure. If there is pressure, the disclosure and the patent application may be made prematurely, reducing the ability for defending it if it is contested. A solution to this would be for universities to recognize that a record in technology transfer should carry as much merit as publication in peer reviewed journals.

Even if a university is a good environment for technology transfer, there is a potential for conflict of interest. If the academic has an interest in the commercialization of intellectual property, a decision must be made as to when the use of university facilities, other staff and students, should be paid for, and when are they being used legitimately for non-commercial research.

Ownership of IP is also an issue, as mentioned in the presentation by Tom Brzustowski. Collaboration clouds the role of other participants and may limit the ability of the principle researcher to commercialize the result. If the IP is owned by the university, commercialization may be easier, but how is the revenue to be shared between the inventor and the institution? There are also concerns about the payment of indirect costs for a project that leads to commercial outcomes.

The Association of University Technology Managers (AUTM) has suggested that a technology transfer office should anticipate being in place for at least ten years before there are any net revenues. That requires a substantial initial investment upfront on the part of the university. However, if universities are to be players in technology transfer, there may be little choice to making these investments.

4.4 Discussion

During the discussion, the role of social scientists in the creation of and transfer of intellectual property was raised. The point was made that many social scientists want to study or measure factors related to commercialization with a view to improving the processes and to create social value. As well, not all of the products and processes developed are derived from the natural sciences and engineering, some are the result of social science, especially the development and application of business practices.

Measuring the contribution of retired researchers was raised. There may be means for tracking the work of existing staff as the knowledge is developed and commercialized, but a retired researcher, who will have acquired the knowledge through years of research in universities, may be commercializing it outside the university and the country, unknown to those who accumulate such statistics. Similarly, questions arose about how the ideas and work of students are protected and who could claim the benefits as universities head down the path of commercialization of intellectual property. It was indicated that the concept of full-fledged commercialization activities ran counter to the concept of public stewardship of knowledge. Also, a university's main output is its' students and they are developed through codified knowledge.

Looking at the range of statistics available on R&D, invention, innovation, diffusion of technologies and practices, and the development of human resources for science and technology the time might be right for the development of a ‘satellite account’ at Statistics Canada to bring all of this information together, including impacts, linkages and outcomes.

Looking at the Industry Portfolio, it appeared that there was no coherence of policy activities related to commercialization across the departments and agencies and that this impeded progress.

Participants were asked to review the material presented in the session and to contact either Industry Canada or Statistics Canada on matters of policy, definition and measurement.

5. Producers and Users of Intellectual Property

5.1 Researchers Producing Intellectual Property

A panel consisting of
Dr. Jerry Sokolowski, NSERC-Ford Industrial Research Chair in Light Metals Casting; University of Windsor
Dr. Douglas Stephan, NSERC-NOVA Industrial Research Chair in Polymerization Catalysis, University of Windsor,
Dr. Roman Maev NSERC Industrial Research Chair in Applied Solid State Physics and Material Characterization, University of Windsor
each discussed their successful commercialization activities. For these researchers, university-industry collaborations are viewed as unique processes which benefit all parties. In some cases, the researchers and their students have the opportunity to work closely with industry which allows them to exchange knowledge and expertise and to develop a better understanding of needs. In other cases, industry is supporting basic research waiting for the "eureka", the serendipitous discovery which will be of great benefit, while in other instances the researchers are learning how to apply their new knowledge as well as their expertise to solve industry problems which are not directly related to their fields of study. The collaborative work generates excitement as laboratory processes are turned into production line outputs allowing researchers and their students to realize their work and see its impacts on the economy, human health, and the environment.

Commercialization processes in universities are evolving. Researchers entering the process today are receiving better institutional support than was available as little as five years ago. Technology transfer offices can be viewed as a means for assisting researchers interested in commercialization as well as impediments to commercialization as bureaucratic paperwork is encountered. Emphasis was placed upon the individual relationship that researchers establish with their industrial collaborators. The technology transfer offices should not interfere nor hamper this relationship. It was noted that the researchers all were relieved and happy to discover that their industrial partners had treated them fairly. Commercialization is stressful and time-consuming, it can absorb hours of valuable time which might be better applied to research especially for some researchers who are not interested in the paperwork. For these researchers, having a technology transfer office to handle the patenting applications, marketing and to some extent acting as an industrial liaison is a boon.

For all the researchers, international connections through the research community as well as through industrial collaborators were of paramount importance to technology transfer. The keys to commercialization were a strong understanding of industries' needs developed by listening to clients, the expert knowledge of highly qualified personnel developed within the universities, good knowledge of the technology and a strong awareness of the international context.

5.2 Users of Intellectual Property

A panel of receptors of university-based intellectual property provided insights into their activities and needs.

Dominique Baulier, Research & Development Director, Valiant Machine & Tool, presented the keys to his success with university-based intellectual property. First and foremost is an identification of needs: what type of research is required and has any related work already been patented? The second step is intensive benchmarking. Patenting is expensive. Businesses which use patents establish policies or work procedures to handle this form of intellectual property protection. For instance, a policy could be to patent only when it will protect core business. It is important for the business to know that it can detect infringements and then ensure that it can take remedial action if patent infringements are detected. For this reason, some businesses will not patent in countries that do not uphold patent protection. Prior to embarking upon patenting, it is important to do some "pre-patenting investigation". Many patents are poorly written, which makes it strategic to find deficiencies in patents held by other businesses especially competitors and turn around these patents for competitive advantage. Some businesses, especially large businesses, are becoming experts in using patents to block the work of their competition.

John L. Mann, Director of Engineering and Regulatory Affairs, DaimlerChrysler Canada Inc., emphasized the win-win situation of university-industry research collaboration which makes both partners stronger. Through university-industry collaboration national wealth rather than income is being generated. Basic research is the prerogative of academia and it is essential that universities are not turned into industry. For university-industry collaborations to work, it is important for all involved to understand each others needs. Relationships are built on people and their interactions. Patents play an important role, but being first is the key to the success in industry. This makes finding applications for basic research imperative. Industry needs to be fast in order to grow, but industry also understands that research takes time. Therefore, looking for creative applications of knowledge generated in other fields of study is important for both researchers and industry.

5.3 Discussion

Following the panels a number of points were raised in the discussion. One strongly made point was that universities should not become businesses as they are not necessarily good at it. They should do what they are good at and that is the production of knowledge. Again the University of Windsor/DaimlerChrysler collaboration was raised as an example of how researchers and industry user of knowledge have worked very successfully together to mutual advantage. The principal means of transferring IP was through students and relationships. Networks were valuable. In business, it was important to be first, be fast, and then to grow quickly.

Another suggestion was that researchers should not invent and get involved in legal issues as it took away from their job which was the creation of new knowledge. In the business context, this led to a discussion of the tactical use of patents. Tactical patents where not necessarily of monetary value, but they supported legal challenges to other firms entering the field which allowed the firm to gain additional advantage through tactical use of the legal system.

Some comments were directed at the federal government and the fact that it does not appear to function in a coherent manner when negotiating abroad and fails to make good use of the knowledge stored in universities.

6. Academic Research: What are we learning?

There were three presenters and the discussion points are incorporated into the summaries.

6.1 Concerns of Stakeholders about IP and Commercialization

(Myra J. Tawfik, Faculty of Law, University of Windsor)

The presentation resulted from a survey, funded by the Law Foundation of Ontario, and conducted with two senior law students, Jacquelyn Chan and Telly Lebedev. The survey set out to determine whether the Windsor-Essex county community, which includes the University of Windsor, generated or used IP and if so, whether there was a need to develop the public legal education resources to assist the community in addressing its IP issues.

Dealing with IP is complex as there are different instruments and legal mechanisms for its protection: patents for inventions; copyright for text, music and software; trademarks for means of identifying products; and registration for integrated circuits and for seeds. It was also noted that SMEs in particular, and some industries more than others use trade secrets to protect their IP. However the first step is to identify the IP, and then to protect it, and only then does the question arise as to whether to commercialize it or not.

The Windsor-Essex County community divided into four distinct categories:

1. those (individuals or institutions) who understood IP and were satisfied with the legal resources available to them;
2. those who understood IP and were not satisfied;
3. those who have a basic knowledge of IP, and were not satisfied; and,
4. those who had no knowledge of IP protection, although they deal with IP daily.

The University was in the second category while SMEs fell in categories 3 or 4.

The survey raised some of the ethical issues noted by Paul Fox. How does an academic community move from a culture of knowledge creation and dissemination to one that seeks to appropriate and commodify knowledge. This is a debate that needs to take place.

For those who wish to deal with IP protection there is no specialized legal practice in Windsor to support them. Within the University, there is a dichotomy between the copyright community, mainly those from the social sciences and humanities who see themselves as consumers of copyright protected material for teaching and research, and the patent community, mainly from the natural science and engineering, who see themselves as creators of IP. Addressing the needs of both requires quite different resources and it may be clear why the *Fortier Report* excluded copyright issues in respect of books and journal articles. Publishing books and journal articles, even if they generated revenue was seen by the Fortier Expert Panel as part of the work of the university, not to be tampered with.

However, there is a sense that the University may be ready to commit resources to providing advice to academics on IP protection and commercialization. If this is done, it is an opportunity to work collectively towards developing meaningful policies that integrate commercialization activities with the mission of the University as a publicly funding agency of higher learning.

6.2 Analytic Frameworks for University-Industry Collaboration

(Hans Schuetze, Faculty of Education, University of British Columbia)

Dr. Schuetze looked at the changing policy environment for university-industry collaboration, the changing norms and structures of science, and functions, norms and structures of universities.

The presentation began with a review of models of higher education with public and private institutions operating as either for-profit or as non-profit enterprises. Harvard was an example of a private non-profit university and most Canadian universities fell in the public non-profit category. The point was made that Canadian universities were experiencing less public funding while deriving more from the market. This move to the market had implications for the functions of the universities as teaching, research and community service activities moved from education to on-line courses at a market rate, from basic research with accessible results to applied research with restricted access, and from continuing education as a service to more market-driven continuing education.

Norms were also changing from recognition and reputation gained in and through observing the norms of science to the protection of private knowledge and related monetary gain. Public knowledge is being replaced by publicly disclosed but privately owned knowledge.

The conceptual frameworks for analyzing this included higher education theory, organization theory and innovation systems theory. A comparison was made between universities in Canada, public non-profit institutions, and the firm, a private for profit institution. This illustrated the move toward the profit motive and a culture of competition from the goals of generating and disseminating knowledge and a culture of collegiality in support of the public good.

While the neo-Marxists saw commercialization of formerly public functions of the state as part of a neo-liberal agenda, the neo-institutionalists saw advantage in public-private partnerships and viewed technology transfer and commercialization as an institutionalization of what had gone on before between individual academics and private firms.

Having established commercialization of IP as a part of a current trend, the issue of measurement was addressed. At present, the inputs to IP generation can be measured, the research grants and contracts, the institutional research budgets, the number of research personnel and the number of technology transfer staff. The outputs of commercialization can also be measured. The IP by type and field, licenses, contracts for research services, and the revenues from licenses and contracts, the number of spin-off firms and the university equity in them, and the number of personnel in the spin-off firms.

What was not measured was the consulting activities of faculty or the contribution to private sector innovation by research in the public domain or by university graduates. As well, there was no measure of the 'entrepreneurial culture' which was increasingly evident in the universities.

6.3 Framework Conditions for Commercialization

(Rejean Landry, Nabil Amara, Imad Rherrad and Malek Saihi, presented by Rejean Landry, Faculty of Commerce, Universite Laval)

The research presented by Dr. Landry posed four questions.

1. What is the extent of patenting and spin-off creation in natural science and engineering in Canadian universities?
2. Are there differences between the disciplines with regard to patenting and spin-off creation?
3. What are the determinants of patenting and spin-off creation?
4. What are the policy and managerial implications of the results for the development of effective interventions?

The survey went to individual researchers which made the work different from surveys of institutions. It looked at three micro-determinants: science/technology push; market pull; and, coordination.

The assumption with science/technology push is that the research gives rise to commercial applications. The indicators are publications, IP, field of research, years of experience, and funding for research.

With market pull, the assumption is that users driven by the market take results from the university to commercialize. The indicators have to reflect the contextual factors in which firms and universities operate.

For the co-ordination approach, there is an asymmetry of knowledge as users cannot evaluate the research and there is exclusion as the tacit knowledge of the researcher cannot be transferred to all users. Addressing this requires the building of linkages and measuring the linkages provides the indicators.

The data came from a telephone survey of a representative sample of 1,554 researchers in 25 fields funded by NSERC and 81% participated. The analysis used appropriate econometric techniques.

The findings were that research champions should be the targets of commercialization interventions. The champions were distinguished from other researchers by more publications, more years of experience, working in larger research units, and being in engineering and life sciences. The recommendations where that technology transfer offices should develop policies for champions and not necessarily deal with other researchers in the same manner.

Improving the likelihood of commercialization requires attention to the following seven activities.

1. More radical research, in hope of a breakthrough
2. Increased linkages with researchers and users building social capital
3. Bigger research units
4. More scientific publications
5. More funding, including both university money and partnership or grant money
6. Importance of protecting IP
7. More consultancy as a way of building a client community

7. What was learned from the workshop?

Tom Brzustowski chaired the final session on summarizing what was learned in the workshop. There were three presenters and are summarized here, with some discussion points added stimulated by the presentation.

7.1 Michelle Gauthier

Working definitions of commercialization activities are important. It was clear from the workshop that commercialization of IP from universities is quite different from what is done in business. Understanding the need for information and the context for that need, locally and globally was important.

While it was clear from the workshop that some of the prerequisites for success are in commercialization, implementing the technology transfer is quite another matter and there was room for more facilitation and knowledge sharing. This leads to the key role of the technology transfer offices and, at the federal level, the importance of an accurate and appropriate approach to understanding and reporting on commercialization.

Commercialization is important as it leads to wealth creation, but there is much to learn and more bridges to be built. The workshop contributed to this.

7.2 Susan McDaniel

Technology transfer and commercialization are transformative processes. More effort must be placed on creating a common language and defining the terminology so that it is both inclusive and distinct. Knowledge transfer is happening whenever there are open exchanges and discussions and the key is to develop active listening skills.

It is important to return to first principles and understand the role of the university in commercialization and technology transfer. University and industry should not be viewed as competing spheres. University-industry collaborations are looking for solutions to problems. These solutions benefit everyone and illuminating the problems is part of good and open dialogue. Interaction between researchers and users extends human knowledge, one of the goals of universities and adds value.

7.3 Fred Gault

Commercialization has different meanings in the university and in business. Statistics Canada is measuring commercialization through the Survey of Intellectual Property Commercialization in the Higher Education Sector. This is just a subset of commercialization activities but it is important for that survey to work well and to address the needs of universities, the AUCC and the federal government as progress is made towards the targets. The dialogue begun at the workshop will contribute to defining and measuring commercialization in other sectors of the economy.

The flow of knowledge from the university to business depends in part on the size of the business. It is easier for a large firm to find and use knowledge and intellectual property as it will have the absorptive capacity needed to assess the knowledge and to convert it into value. However, 98% of firms in Canada are small or medium-sized and they lack absorptive capacity. Work on linkages with the universities to firms must address both the capacity to transmit knowledge and capacity to assess and absorb it.

The federal government sees commercialization, in all sectors, as a means of improving the productivity of the country and making it competitive with its principal trading partner, the U.S. There is also the 'accountability' question of what the government gets in return for research grants and contracts to universities. Of course, part of the answer to that, emphasized at the Workshop, is highly qualified graduates, freely available research results, and community involvement, as well as revenue from commercialization.

The university is linked to both governments and to business in many ways, and part of the reason for discussions like those at the Workshop was to find best practices for dealing with intellectual property, and not just in the natural sciences and engineering. It was also important to move knowledge about management practices from the business and management schools out to business.

With all of the actors in the system being linked together and with each having policies and practices to deal with the flow of knowledge for commercial use, the question does arise as to whether all of those policies are reinforcing or not. That is an important question which indicators could help to address.

As a final point, the building of value is a matter of urgency, given some of the global competitors, such as China. If Canadian institutions do not move quickly to make the system work better, Canada will no longer be a player of significance.

7.4 Summary

(Tom Brzustowski and Participants)

The sense of urgency is an important message to take away and this was supported by an example from China.

Definitions are important, and a rules-based approach, but there should not be too many rules and there was a need for common sense.

Universities are not the only players in commercialization. There are the Community Colleges and they were expected to play a significant role in converting knowledge to value.

Countries are different. One example is Finland and how it functions as a club. This raised the question of how to change the culture of Canada so that the different components of the system would work together more easily for the common good. In Finland, it took a major economic collapse to change the culture.

The Workshop engaged mainly the university and other players and it should be followed by another workshop with a business focus, hosted by an industry association. The findings of the two would be complementary.

Again the need to better understand commercialization by businesses was reiterated suggesting that measurement work on intellectual property should be extended to the private sector.

8. Next Steps

The immediate need is for the AUCC, Industry Canada, and Statistics Canada to publish the concepts and definitions underpinning the indicators that will be used to track progress towards the targets agreed by the AUCC and Industry Canada. The AUCC is planning to release a report in October 2005 and the AUCC, Industry Canada and Statistics Canada will continue to work together on using, reviewing and producing these indicators.

The results of the discussion on universities will support parallel work on measuring and interpreting commercialization of intellectual property from federal laboratories. The indicators used for the universities, hospitals, and the federal government, will be available for application to any public institution.

Statistics Canada will convene a working group to address indicator production and to discuss the measurement of commercialization in the private sector.

The policy issues concerning the role of public institutions in the creation of knowledge and the commercialization of intellectual property are matters for on-going discussion within those institutions.

Commercialization in the private sector is a much broader concept as it involves not just intellectual policy management, but the financing needed to move knowledge to market, and the business practices that support this. Private sector commercialization also goes beyond the deriving of value from intellectual property protected by an intellectual property instrument such as a patent or a copyright. It includes the translation of ideas, from whatever source, into new knowledge which enables the firm to derive value by selling new products or by selling more effectively.

Indicators of the activity of commercialization and of the activity of innovation overlap substantially. This is particularly true if innovation includes not just the introduction of new products to the market and new processes to produce or deliver products to market, but also the development of new markets and the organizational structures and practices to support the creation value through new or more effective market offerings. Commercialization activities will also take place in firms that do not innovate, but which need to raise funds and to acquire skills to bring existing products to market, using existing production and delivery processes.

The OECD and Eurostat are in the process of revising the OECD/Eurostat Oslo Manual that deals with the measurement and interpretation of information on innovation and it is expected to be available in late 2005. The manual is expected to broaden the definition of innovation and Statistics Canada will continue its involvement in this process.

In the first quarter of 2005, discussions will be held on the content of the next survey on innovation in Canadian industry. This is an opportunity to identify activities related to commercialization and to develop indicators of these activities in support of evidence-based policy. However, it will be up to the policy community to agree upon the issues that are to be illuminated by the indicators.

As commercialization on knowledge in the private sector is a principal concern of business, a business-led forum on the subject would advance discussion of what indicators are of use to business, to small and medium-sized firms and to large firms. Statistics Canada would be willing to support such a private sector initiative.

Finally, the suggestion came out the Workshop that Statistics Canada develop a satellite account to bring together all of the information that now exists around technological and organizational change and the economic and social consequences of those changes. This will be brought to the Statistics Canada Advisory Committee on Science and Technology Statistics for further discussion.

Participants in the Workshop, and readers of this document are encouraged to contact the authors if they wish to know more about any of the initiatives noted in this section or if they wish to contribute.

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