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# Summary: Meeting on Commercialization Measurement, Indicators, Gaps and Frameworks, Ottawa

December 2004

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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 meeting's organisers and participants. While not everyone can be recognised, the authors would like to thank Marc Nadeau, Carol Poirier and Mary-Ann Clarke-Wilkinson for their efforts in organising the workshop. The meeting day assistance of Ginette McConnell, Danielle Bélisle and Charlene Lonmo is also gratefully acknowledged. The meeting would not have succeeded with the valuable insights of the presenters and discussants who are named throughout the report. The meeting'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 the participants who kindly reviewed the text, and Claire Racine-Lebel.

## Preface

The meeting summarised in this report resulted from a workshop on commercialization which was part of 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 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 meeting 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

On December 13th, 2004, Science, Innovation and Electronic Information Division, Statistics Canada, hosted an expert meeting on commercialization. The purpose of the meeting was to identify indicators that can be used in support of evidence-based commercialization policy, and a conceptual framework to tie them together. Participants of the meeting included representatives from federal policy departments, private sector interest groups and public sector associations and councils. The meeting took a more immediate view of the challenge to measure commercialization and asked what has to be done in the short term to answer questions related to policies of the government.

## 1.1 Background

Statistics Canada sees a growing interest in the measurement of commercialization for a variety of purposes and it anticipates more use of existing measures and a demand for new measures as related policies develop. If the indicators are to provide a coherent picture of commercialization activities, conceptual frameworks have to be developed into which the indicators fit. The longer term objective is to make the indicators and frameworks understandable and applicable for public and private sector policy analysts, for practitioners of commercialization activities and for official statisticians.

# 2. Commercialization in the Public Sector

In the introductory material provided by Statistics Canada, it was suggested that commercialization in the public sector refers to the transfer of intellectual property (IP) to the private sector through the licensing of protected IP (patent, copyright, trademark,…), or through the creation of spin-off firms, or a combination of both. The act of transferring the IP in return for money is the commercialization. There is no explicit reference to the introduction of new products to the market or of new processes to produce or deliver products (goods or services).

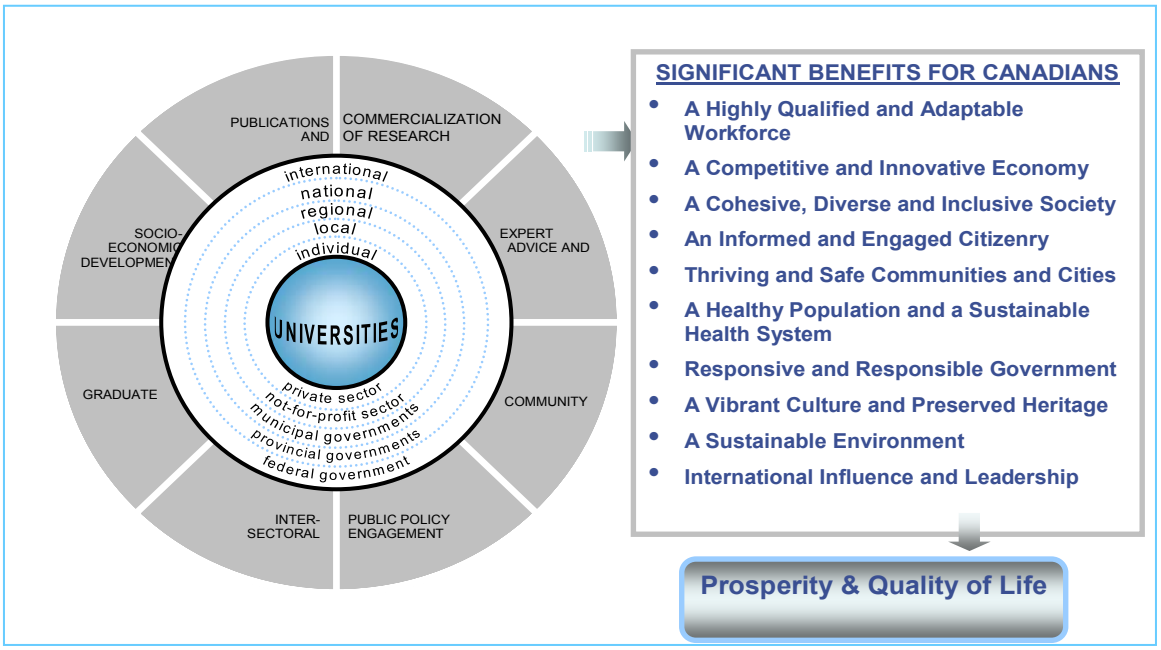
The meeting began with a review of the Association of Universities and Colleges of Canada's (AUCC) agreement with the federal government in which the goal of tripling commercialization by 2010 is set. The indicators to be used to demonstrate progress are in place. Michelle Gauthier, Director, Research and Policy Analysis Branch, AUCC, framed her comments in terms of AUCC's involvement in commercialization policy and measurement, including past public documents, the Framework of Agreed Principles with the Federal Government[1] and the tripling target for the commercialization of university research by 2010. She then elaborated on the current efforts of the AUCC to push the measurement of commercialization to a broader discussion of the economic and social benefits of research, innovation and knowledge transfer, of which commercialization is an aspect. She spoke about the types of measures that the AUCC is looking for within this broader framework, and in particular the key gaps within it.

1. www.aucc.ca/publications/media/2002/index_e.html

For the AUCC, commercialization of intellectual property is one part of knowledge transfer. Knowledge transfer activities includes the development of highly qualified personnel for industry, provision of expert advice and consulting services, diffusing knowledge into the public domain through conferences and papers and developing collaborative partnerships in the pursuit of new knowledge. The end result of university research may not be a commercialization activity such as new patents, licenses or spin-offs but rather the production for the labour force of highly qualified personnel capable of performing all activities from basic research through to product development and marketing to turn new knowledge into goods and services.

AUCC challenged Statistics Canada to survey organisations involved in commercialization in both the private and public sectors to better understand the relationships between the actors. It is important to understand the production of highly qualified personnel, and Canada's universities and colleges have provided a large proportion of the national labour force with post-secondary education, but it is equally important to understand how these personnel are applying their knowledge, their type of work and their networks. The impact of collaborations and understanding better linkages need to be studied to determine where the greatest gains are seen. Where does value-added occur? How can universities and colleges help businesses get the most out of their investments in highly qualified personnel, public research, collaborative or joint research, and technology transfer through such vehicles as licenses? How can this collaborative work improve productivity and economic competitiveness? What is the value of international research relationships? How can tracking the commercialization of new Canadian knowledge outside of the country or foreign knowledge within Canada be done? AUCC stressed the importance of framing commercialization, research, innovation and knowledge transfer in terms of their long term economic and social benefits (Figure 1).

**Figure 1. The AUCC's vision of university research and knowledge transfer**



The next topic was commercialization from government departments and this was led by Susan Stanford, Director General, Commercialization Branch of the National Research Council (NRC). There are no goals comparable to those for the universities for commercialization of intellectual property developed in federal laboratories, but there is government support for commercialization suggesting both that is important, and that it should be measured. The presentation began with a definition of the commercialization dilemma. According to Ms Stanford, for purposes of the presentation "commercialization is the process to take products and services to market in a way that generates revenues and profit".

Commercialization is not a linear process, but rather "iterative". It was noted that language is an issue particularly when viewed from public and private sector perspectives. It goes beyond technology transfer to a view of maximizing the commercial return of technological innovations. According to the NRC, there is a "need to foster small and medium technology company growth". Canada is considered to have a strong science and technology base and educational system to support scientific and technological advances. Small firms involved in research and development (R&D) dedicate a higher proportion of their revenues to R&D expenditures than larger firms. It is important that small and medium-sized enterprises maximize their investments in technology and R&D by gaining market successes as this will improve innovative capacity. The key question is why is Canada not gaining in personal wealth when public investments in R&D, highly qualified personnel and a science and technology educational infrastructure are strong? A proposed framework to explore the answers to this question focuses on linking inputs with outputs within a life-cycle.

The Goldsmith framework which develops an integrated life-cycle approach that highlights technology, market and business disciplines at each stage of the process (see Figure 2) was presented. While each of these three disciplines is required at each stage of the life-cycle, the development of technology into marketable applications can be identified within the Goldsmith framework. The first or "Concept Phase" is characterized by intensive R&D investment. At this stage technology concepts are developed, but have not yet realized economic impact. The "Development Phase" of the Goldsmith framework is also R&D intensive, but additional factors such as technology bundling, market assessments and potentials applications of the technology are developed — technology is "adapted" to target applications. This activity requires and integrates additional business and market knowledge and expertise, and could through licensing realize nominal economic value. The third stage or "Market Entry Phase" requires a balance of technology, business and market knowledge to support technology adoption by private sector firms, or to create a new company. The final stage which is not part of the original Goldsmith framework is the "Market Expansion Phase". Here firms and motivations for incremental technology development are typically market and client driven — not curiosity or technology driven. Economic impact is achieved through repeatable sales of the original technology concept in multiple markets, and the integration of the original technology concept into multiple applications. The Goldsmith framework was designed for new product introduction and new company creation which is most often reflective of emerging and disruptive technologies. These emerging and disruptive technologies account for a very small percentage of total innovation where the majority of innovations involve adopting or adapting technologies.

Canada is considered a small company economy and therefore focus should be directed to all phases of the life-cycle framework with emphasis on growth. Also presented were a series of "Survival Performance Metrics" (Figure 3). These metrics show the impact of business decisions which can include technology adoption further down the life-cycle.

## 2.1 Discussion of public sector commercialization indicators

Andrew Maxwell, Canadian Innovation Centre, commented that the largest impact in the area of creating new knowledge-based industries, facilitated by governments' investment in universities, is the talent to help develop such businesses and not just intellectual property transfer. Measuring patents and licensing revenues could inhibit knowledge transfer and run counter to the goal of training highly qualified personnel. It is very important that measures of highly qualified personnel are improved which includes finding ways to measure university alumni activities. This idea of measuring and tracking talent was furthered by Michelle Gauthier who emphasized the need to expand the base of indicators to include university - industry collaborations and measures of relationships between universities and the private sector as well as the not-for-profit sector. She also noted that faculty renewal is underway and with it is coming cultural change in universities as new faculty members bring more entrepreneurial and collaborative spirit towards their research.

Pierre Therrien, Industry Canada, noted that it would be interesting to have some measures of the contributions of the universities to the private sector, beyond the development of highly qualified personnel. Only a very small percentage of firms used universities as sources of innovation. Is there a stronger relationship between small firms and universities than between large firms and universities? Why does it appear that universities are not used as a source of knowledge by industry? It was further noted by Lorne Heslop, Agriculture and AgriFood Canada, that there is pressure to measure outcomes of increased government investment in R&D by universities which requires an understanding of the ability of industry to absorb new technology prior to transfer.

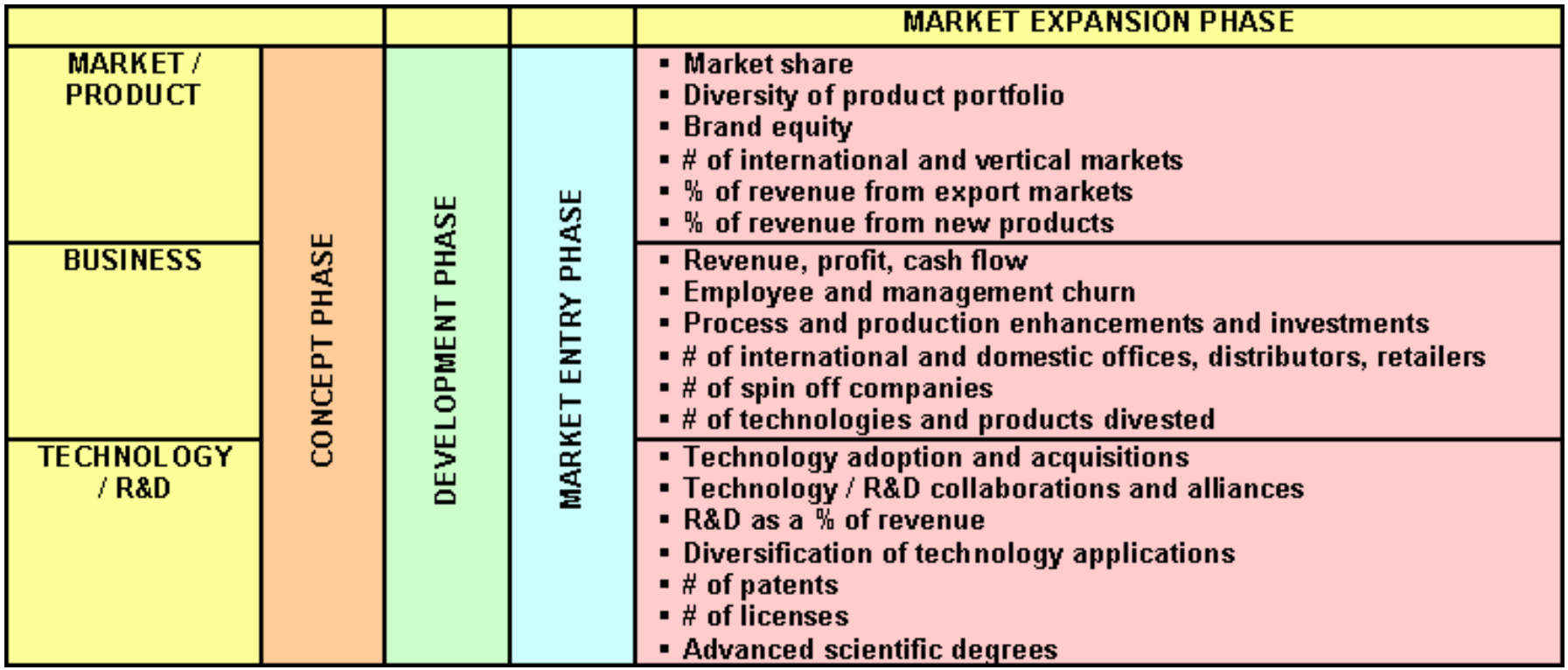
Bill Reimer, Canadian Innovation Centre, suggested that Canada lags in its ability to create value-added. Metrics are required to understand the pull-side of knowledge or technology transfer. What is currently measured are licences of unique technologies, but often the end product requires a suite of technologies and someone to put the suite together. The market needs can only be met by the convergence of technologies and with appropriate market knowledge. Andrew Maxwell pursued this idea by noting that starting with a technology innovation and hoping that people will buy it is not a way to increase the chance of success. The role of the universities is to find the best private sector partner or partners. The commercialization process will occur in the private sector by established firms or through start-ups. The challenges of company creation are enormous and needs to have a different-level of public-private sector engagement. Attention must be paid to the capitalisation of small companies due to the costs of bringing a product to market.

**Figure 2**
**Commercialization Life-Cycle Framework**

| | CONCEPT PHASE | DEVELOPMENT PHASE | MARKET ENTRY PHASE | MARKET EXPANSION PHASE |
|---|---|---|---|---|
| MARKET | Initial market and opportunity assessment<br>Lead customer identification and engagement | Develop Marketing plan including segmentation, channel and customer relationship strategies | Implement promotion plan<br>Perform competitive market intelligence | Target vertical and adjacent markets and increase market penetration<br>Enhance partnership delivery channel and CRM |
| BUSINESS | Identify financial, physical & HR requirements | Secure required financing<br>Establish management team, financial and business plans<br>Determine break-even point | Manage financing, skills and production needs<br>Adjust strategic and business plans to respond to market opportunities | Diversify internal and outsourced skills required to meet ROI objectives<br>Establish international partnerships |
| TECHNICAL | Determine features and performance requirements<br>Perform competitive technology intelligence – Patent search | Move development into prototyping, testing and production phase<br>Source raw materials and establish Q&A systems | Establish manufacturing facilities and product technical support | Determine incremental product development cycle<br>Continuously assess competitive product functionality and emerging technologies for adoption |

Source: Based on Dr. Randy Goldsmith, Oklahoma Technology Commercialization Centre with modifications by Acorn Growth Companies.

**Figure 3**
**Survival Performance Metrics**




Source: Susan Stanford, National Research Council

Turning the discussion back to indicators, Ron Freedman, Impact Group, suggested better measurement of universities' infrastructure that support commercialization such as incubators and showing tenancy rates of industrial parks. It would also be good to highlight additions to intellectual property equity on an annual basis.

Susan Stanford took the opportunity provided to develop some new themes in response to the discussion. Marketing products or new technologies requires three to 100 times the investment of the initial product development, this investment can stall companies growth or willingness to undertake more R&D. The high failure rate of small companies is also an issue and emphasis should be placed on assisting companies to grow from small to medium-sized or large. The best practices of companies need to be shared through the life-cycle of business creation, market development and technology adoption. She also made the point that public sector commercialization can go beyond technology transfer. The example was the establishment of new firms to enable the commercialization of new platform technologies that could not be accommodated by existing firms.

Michelle Gauthier then responded to some of the discussion items that concerned universities, in particular receptor capacity of industry which has been an on-going issue. The universities are curious to know whether trained researchers who have moved into management place more value on research and development than managers who are not trained researchers. Are former researchers less risk-averse? The concern about how to measure incubators and partnerships was underscored as well as how to draw the line between what can be shared and what cannot be shared. Finally, the question of ownership of intellectual property rights was considered. Some universities give sole rights to the researchers and therefore can not measure the payback for the research which is a measurement issue. Other universities share royalties which allows some measurement.

## 3. Conceptual Frameworks and Private Sector Organizations

Businesses are preoccupied with markets. To survive in markets they must innovate, and that means bringing new products to market, putting new processes in place to produce to deliver products, old or new. The new processes may be technological, organizational, or a combination of the two. The market can refer to the existing market served by the firm, and the need to keep or expand market share, or to the development of totally new markets. In business, commercialization is part of innovation and it includes how the business finances its activities, manages them, and builds its vision for the future.

George Schoenhofer, Industry Canada, presented a policy department's perspective for a conceptual framework for commercialization, with emphasis on the private sector. The brief presentation illustrated the complexity of the situation from a policy and a measurement perspective. The presentation started with a contrasting view of commercialization: "All of the innovation activities involved in turning knowledge into new goods, services or technologies that are sold in the market." Industry Canada is also considering the Goldsmith framework shown in Figure 2 and emphasized that strong sustainable firms are the core to successful commercialization. Again linkages in Canada and abroad among: customers, suppliers, universities and colleges, governments, competitors, investors and communities were emphasized.

While there is a wealth of indicators available, these metrics need to be reviewed to determine how they can be best used to link commercialization to economic outcomes; to compare the impact of commercialization versus technology adoption; to determine the most important drivers of commercialization; and to measure the type and strength of relationships between firms, and between firms and academia/government. It would also be of interest to look at regional, sectoral and international differences in commercialization activities with particular reference to percentage of sales from new products over time.

Michael Bordt, Statistics Canada, presented a conceptual framework for commercialization in the economy designed to provoke a discussion of how useful conceptual frameworks are for organizing the discussion and for indicating gaps in knowledge and the need for more indicators. It was quickly noted that commercialization is not rigorously defined as evidenced by the different definitions used in the three preceding presentations. Also, an established international framework for measurement has not yet been developed.

There are aspects of commercialization that touch upon knowledge generation, knowledge transfer, knowledge management, innovation and productivity. At present there is no statistical framework connecting all these elements. One could envision a "system of commercialization" that encompasses all these but this would require much more conceptual development.

From the measurement perspective, it would impose considerable burden on firms if they were to provide all of the information called for by the Goldsmith framework, which was only one of many approaches to this problem.

Within the complex all-encompassing concept of commercialization are two perspectives that are reasonably well understood and amenable to measurement: the commercialization of innovation and the commercialization of research.

Commercialization of innovation is already measured by surveys of innovation as revenues from new or significantly improved products or processes. Improvements to this measure would be to better understand the inputs, barriers and outputs of commercialization. Current research only hints at how innovation contributes to commercialization, productivity and competitiveness. Data of this nature would be valuable in improving this understanding.

Commercialization of research would measure inputs, activities and outcomes beginning with R&D and ending with a successful product. In the public sector, we only trace the process as far as the license or spin-offs from universities and federal laboratories. However, present surveys do not cover the private sector. Therefore while data on R&D performance are available, no information on the importance of public sector intellectual property, the extent of commercialization of R&D, the degree of inter-business licensing, the management of intellectual property or financing commercialization activities is collected.

Suggestions for bridging these data gaps include augmenting existing surveys through including questions on commercial applications and objectives of R&D. It would be possible to add a commercialization module to innovation surveys with questions that could be answered by the Chief Executive Officer. The development of a linked database containing innovation data and longitudinal tax data for growth measures could be explored. A similar linked database containing innovation and production data for productivity measures could be developed. It is also possible to develop new sources such as a survey of licensing in the private sector that would cover all sources of intellectual property, to whom it was licensed as well as the importance of public sector intellectual property. To understand firms' activities, a survey of management practices including management capacity, sources of business advice, and measures of entrepreneurship, linkages, strategic decision-making and adaptability could be developed.

The discussion was directed towards an appropriate scope and definition of commercialization, a list of short-term priorities for data collection and analysis and if investigation of development of a commercialization account should begin.

### 3.1 Discussion of Conceptual Frameworks and Private Sector Organizations

Jayson Myers, Canadian Manufacturers and Exporters opened the discussion by encouraging analysts not to get overwhelmed by the complexity of the subject. He recommended going back to basic principles by looking at commercialization from the point of view of the customer. Understanding the receptor capacity of industry as well as how business invests in R&D is important. However, a better understanding of business innovation is also required. The types of companies involved in innovation particularly by size and life-cycle stage would be of interest as applying knowledge for an established company is different to how a new company or start-up works. Indicators would require a time element so that survival rates could be calculated. Other important private sector indicators are rates of investment in new technology, licensing, intellectual property creation, absorption of highly qualified personnel (as well as their development). There needs to be a way to link between outputs of one part of the system, for instance highly qualified personnel as outputs of universities, to inputs in other parts of the system such as how highly qualified personnel apply their skills. Tracking knowledge transfer should be simple and it is instrumental to understanding linkages and flows. This type of information is also useful to business which implies that business should wish to participate in its collection.

Diane Isabelle, National Research Council, recommended that all indicators should be aligned with a Canadian strategy, therefore developing a Canadian commercialization strategy and focus are the starting points. It is known that R&D investment by industry is low and slipping, particularly R&D investment by large firms. This slippage is putting increased pressure on the already fragile public sector R&D performance. The fact that Canada is good at starting companies but not so good at making them grow was reiterated. This suggests that instead of an inverted triangle, Canada has a funnel with no bulk in the middle rather like the Eiffel Tower. Therefore, receptor capacity of Canadian firms for new technologies is limited as small firms may not be able to harvest the technologies and large firms may not want to invest in developing technologies. Analysis of receptor capacity in Canada is required. Barriers facing Canadian firms include awareness of the availability of technologies, access to new technologies, the ability to develop the technologies and an infrastructure gap between the public and private sector which

includes not only facilities but also financing. In addition, there are barriers in terms of awareness and use of linkages and networks by industry. Finally there is a cultural divide between the public and private sectors which needs to be bridged as the public sector needs to work better with the private sector.

Michelle Gauthier amplified the point that the public sector needs to be better engaged in understanding R&D in industry. She further emphasized the engagement of universities with the private sector and how this continues to grow. Someshwar Rao, Industry Canada, noted that there is a per capita gross domestic product (GDP) gap which is caused by an innovation gap. Investments are made in R&D, human and venture capital but the returns are lagging. This leads to the question of why Canada is not getting a good return on innovation. Why are innovations being under-exploited? How can knowledge transfer from the public sector to the private sector be increased? How can better returns on R&D investments be achieved? Measurements are required to support the development a commercialization strategy.

Ron Freedman suggested that commercialization is an invented concept and that it is little more than re-branding of innovation. This makes developing a commercialization framework very difficult. However, commercialization is looking at a sub-set of the former Innovation Strategy as it is focussed on how ideas are turned into goods and services. The real issues are whether or not the government is getting value for its investment in the science and technology infrastructure and university research. Also, are there barriers related to the economy of scale issues which the government could relieve which would ensure a better return for commercialization activities. It is important to note that there has been a structural problem with industrial R&D as the number of firms conducting R&D has been declining since 1994 and now the firms still involved in R&D are spending less. Mr. Freedman recommended that the focus of research on commercialization should be restricted to the companies involved in R&D.

Andrew Maxwell reminded the group that only about one innovation out of about three thousand ideas makes it to market. This implies a yield problem in which speed to market is the key. Understanding the path to market by looking at models as real processes would enable analysts to look at yields at different stages. It is as important to learn from market failures as it is to learn from market successes. What were the causes of the failures and how could future failures be prevented are the questions to ask. The sharing of experiences would assist in developing market channel strategies.

Denys Cooper brought to the table some of the issues that the United Kingdom (UK) and Sweden are currently facing in developing metrics about spin-offs. The UK is encouraging university researchers to do more product development prior to spinning-off companies as there are now too many early stage companies with far too little venture capital available to grow the companies. The issue of intellectual property ownership is also contentious in the UK which is trying to establish guidelines for ownership between universities and the researchers. In Sweden there are researchers concentrating on gazelles, small firms that have experienced rapid growth over a short time period. The emphasis is on understanding where the growth firms are, which industrial sectors as well as their physical location.

In Canada, attention must be paid to tracking foreign direct investment in R&D as this is part of companies looking for efficiencies. Are large multi-nationals using small Canadian subsidiaries for new product development with intentions to commercialize elsewhere? When studying R&D firms, especially small companies, it will be important to study subsidiaries separately particularly to understand growth. Denise Guillemette, National Research Council, further developed the idea of understanding firm growth within a performance framework which would allow analysts to discover inefficiencies in the system. Some of the weaknesses highlighted to date are a lack of non-technical support and business advice. There is also a lack of pressure factors that stimulate innovation and commercialization such as more demanding customers and more quality investment proposals. Venture capitalists believe that they are lacking high quality investment opportunities suggesting that some sort of brokering between the firms with innovations and the financiers is required. Turning to highly qualified personnel, while tracking the socio-economic characteristics of science and technology graduates with masters and doctorates is important, so too! is developing quality management and business talent. This will assist in developing more sophisticated clients for goods and services of other firms.

Phaedra Kaptien-Russell, Finance Canada, returned the discussion to the question of the poor industrial R&D performance in Canada. Return on investment will vary by sector, however, international comparability will occur and metrics must be in place to do this type of analysis well. A better understanding of the bottlenecks or barriers to return on investment for R&D in both the private and public sectors is required as this will help both sectors to better determine the most-effective ways of realising return on investment.

Josy Parrotta-Marck, Industry Canada, suggested that Canada should look to the American model of encouraging development of the medium-sized firms rather than the small firms. Science-based firms are not hungry enough in Canada. Bill Reimer, Canadian Innovation Centre, commented that his centre has been actively involved in commercialization for thirty years, although until recently it was called innovation. Canada needs to understand outputs of innovation, such as the number of jobs created up-stream. The number of patents produced can be an input into the products created elsewhere, it is important to make the linkages and then measure the outputs rather than inputs and outcomes. The government should also investigate the development of innovation and commercialization tax credits.

Craig Wilson, International Trade, agreed with Denise Guillemette's assessment that business development requires specialised set of skills. Australia is actively providing business development assistance and the UK is leveraging private sector R&D. Jayson Myers suggested that businesses measure successes by the bottom-line and that innovation is high-risk. It is important to know where the customers are, and they may not be within Canada. Knowledge generated by Canadian universities, public laboratories and small companies is often commercialized outside of Canada. This requires a more global view of knowledge flows and linkages for measurement purposes. The structure of the businesses must be understood. Lorne Heslop, Agriculture and AgriFood Canada, furthered this theme by reiterating that it is important to measure outputs and to understand how the private sector is taking up R&D to bring new products to market. Also the processes are important, what is being done with patents and by the highly qualified personnel. Christine Apold, Office of the National Science Advisor, suggested that not enough is known about the socio-economic and demographic characteristics of science and technology graduates and this thought was echoed by Denys Cooper.

George Schoenhofer returned to a framework approach to developing metrics while indicating that stories should be told with the indicators already available. The first activity is to get a better picture of linkages and relationships by concentrating on what is happening within firms, and then between firms. Developing quality indicators of management practices to assess management abilities is important particularly to understanding firms that fail. More research and funding for the research is required to better understand commercialization activities in Canada.

## 4. Summary of discussion

Fred Gault, Statistics Canada, summarized the discussion as follows. The purpose of the meeting was to gain new insights into what commercialization indicators and measurements are required and where there are data gaps. There are a number of issues emerging. For R&D in Canada it is necessary to look at the number of firms performing R&D as well as their expenditures. Indicators for understanding commercialization of intellectual property in the higher education sector are in place and well-understood. It may be necessary to undertake a complementary survey of commercialization activities including licensing and patenting within private sector organisations. It remains to be determined if commercialization is a sub-set of innovation or a broader concept.

Technology adoption is extremely important particularly as part of knowledge transfer. Human resources play a vital role in knowledge transfer as well as knowledge generation. They are important components in relationships and linkages between firms and between firms and public sector organisations. The Survey of Earned Doctorates covers some aspects of human resource characteristics and knowledge flow and more use of this survey and the National Graduates Survey could be considered.

Size of firms is an issue, how small, medium and large firms act within the system needs to be understood. The relationship between the supply and demand of investment capital should be explored, perhaps with use of data developed under the Mackay initiative. This leads to understanding barriers in the value, supply and marketing chains and understanding both upstream purchasing of inputs and downstream development of outputs.

It would be helpful to have a better understanding of the commercialization objectives of government in order to guide the development of internationally comparable indicators. The Organisation for Economic Co-operation and Development (OECD) is planning a conference on new indicators in 2006 to set the agenda for the next decade, and this could be a forum for the discussion of commercialization indicators, as well as an opportunity to influence the agenda.

## 5. Conclusion

Participants in the Workshop were given the opportunity to review this document. It will provide input to a discussion of the Statistics Canada Advisory Committee on Science and Technology Statistics on April 7 and 8, 2005.

Some of the issues arising from the meeting are the following.

Public Sector

Statistics Canada will continue to work with the AUCC and Industry Canada on the measurement of the commercialization of intellectual property from the universities and the development of indicators which show the linkages of the universities with the private sector and with other public institutions. The question is whether the university survey should be done annually, rather than occasionally.

The work on measuring the management of intellectual property from departments and agencies of the federal government will continue, and will take advantage of the experience gained in measuring intellectual property activities in universities and hospitals.

As human resources are key to all economic activity, including commercialization, there is a case for developing indicators from the Survey of Earned Doctorates and the National Graduate Survey, in conjunction with likely users of the indicators.

Private Sector

Statistics Canada has experience in measuring a number of activities that relate to commercialization, such as R&D, innovation and the diffusion of practices and technologies. This could be turned to an examination of activities related to bringing products to market, including financing, market development, and the use of management practices and organizational structures.

There is also experience, as a result of working with Industrial Research Assistance Program (IRAP), of measuring the characteristics of small and medium-sized firms that have undergone rapid growth and it is clear that commercialization activities differ significantly with size of firm.

More use could be made of the surveys of the supply and use of business financing, especially for small and medium sized firms. Questions on changes in management structures and practices could be incorporated into innovation surveys to link these activities to the delivery of products to the market.

More radically, a survey of commercialization activities could be launched, if it was clear that the public good gained would outweigh the burden on business.

Economy Wide

Commercialization involves all sectors of the economy and gaining some understanding of the activity requires knowledge of the linkages between the actors in the system. These include contracts, joint ventures, staffing, and alliances, networks and partnerships that are needed for survival in a global economy.

While measuring and understanding linkages is important to having a coherent picture of commercialization, the public interest in accountability requires attention to the outcomes of commercialization. The universities have targets for commercialization as it is understood in that context, but not for the consequences of the activity for the institution and the public it serves. Firms, on the other hand, have to make money and that can be measured, but the link to commercialization activities requires additional measures of market share, exports, and the introduction of new products or processes. The Appendix provides a partial list of indicators for discussion. It does not provide a framework as it was clear from the meeting that there was no agreed framework for commercialization indicators and this is a matter for future work.

## Appendix 1: Summary of Commercialization Indicators Available

All references to Statistics Canada's products can be found on the Internet at www.statcan.ca.

For questionnaires and survey methodology please see http://www.statcan.ca/english/concepts/index.htm and select Survey information or Questionnaires. The survey title and four-digit reference numbers are provided to assist in locating the materials. You can List by subject *science and technology*, or search by survey name in the Alphabetical list. Alternatively you can enter the four-digit survey identifier in the place shown in bold in the following URL using for example, the Survey of Innovation, http://www.statcan.ca/english/sdds/**4218**.htm.

To obtain catalogued products, please go to http://www.statcan.ca/english/services/ and follow the links (Free or For sale and then Science and technology). It is also possible to search for items using the title or the unique catalogue number. For example, type in **Estimation of research and development expenditures in the higher education sector, 2002-2003** or 88F0006XIE2004019 to link to this product.

Public Sector Indicators

1 Technology use, adoption and change indicators

Survey of Electronic Commerce and Technology, 2004 (4225) concentrates on information communication technology with specific questions on technological change included in 2000 and 2002 and licensing from public sector sources questions were included in 2003 and have been analysed. Please see:

**Public Sector Technology Transfer in Canada, 2003** (88F0006XIE2004018)

**An historical comparison of technological change 1998-2000 and 2000-2002, in the private and public sectors** (88F0006XIE2004001)

**Technological change in the public sector, 2000-2002** (88F0006XIE2004008)

**Innovation and change in the public sector, a seeming oxymoron** (88F0006XIE2002001)

**Large public and private sector organizations and their use of ICTs** (88-003-X20003002)

For more information on information communication technology adoption, contact Bryan Van Tol at (613) 951-6663. Please contact Louise Earl for information on technological change and licensing at (613) 951-2880.

## 2 Higher education sector

### 2.1 Commercialization indicators

Indicators for commercialization of intellectual property by the higher education sector such as licenses, patents, spin-offs and sources of funding are available from the Survey of Intellectual Property Commercialization by the Higher Education Sector.

**Survey of intellectual property commercialization in the higher education sector, 2001** (88F0006XIE2003012).

For more information, please contact Cathy Read at (613) 951-3838.

The Association for University Technology Managers also produces some information that may be of interest, please see www.autm.net .

### 2.2 Research and development indicators

Indicators on research and development expenditures, number of researchers, sources of funds by the higher education sector are available in:

**Estimation of research and development expenditures in the higher education sector, 2002-2003** (88F0006XIE2004019)

For more information, please contact Janet Thompson at (613) 951-2580.

## 3 Federal science-based departments and agencies

### 3.1 Research and development indicators

*Federal Science Expenditures and Personnel (4212)*

Indicators on federal science expenditures and personnel in federal natural and social science departments include expenditures on research and development and related scientific activities by source of funds, number of personnel and socio-economic objective.

Data are published in **Science Statistics** (88-001-XIE, fee product).

For more information please contact Lloyd Lizotte at (613) 951-2188.

### 3.2 Commercialization indicators

Indicators for commercialization activities by federal natural science-based departments and agencies including intellectual property management infrastructure and expenditures, barriers to commercialization, patents, licenses, royalties and spin-offs are available from the Intellectual Property Management Survey of Federal Science-Based Departments and Agencies (annex to 4212).

**Commercialization in Canadian federal science-based departments and agencies, 2002-3** (88-003X2004002)

For more information please contact Michael Bordt at (613) 951-8585.

Private Sector Indicators

4 Technology use, adoption and development indicators

4.1 Indicators on technology adoption are available from the following surveys:

*Survey of Advanced Manufacturing Technology, 1998 (8083)*

Selected article:

**Patterns of advanced manufacturing technology (AMT) use in Canadian manufacturing: 1998 AMT Survey results** (88F0017M2001012)

For more information contact Fred Gault at (613) 951-2198

*Biotechnology Use and Development Survey, 2003 (4226)*

Recent articles include:

**Trends in Canadian biotechnology activity: 1997 to 2001** (88F0006XIE2004017)

**Bioproduct development: An intrinsic part of Canadian biotechnology firms** (88-003XIE 2004001 and 88F0006XIE2003013)

**Features of Canadian biotech innovative firms: results from the Biotechnology Use and Development Survey - 2001** (88F0006XIE2003005)

For more information contact Antoine Rose at (613) 951-9919

*Survey of Electronic Commerce and Technology (4225)*

This survey concentrates on information communication technology with specific questions on technological change included in 2000 and 2002; a question on the percentage of sales from new products in 2002, and licensing questions were included to 2003.

Selected articles:

**Broadband Internet: Removing the speed limit for Canadian firms** (11-612-M2004016)

**Innovative firms: A look at small firms** (88F0006XIE2004010)

**Firms getting connected: Who is using E-commerce now?** (88-003-X-2004001)

**Starting the new century: Technological change in the Canadian private sector, 2000-2002** (88F0006XIE2004001)

**Information and communication technology use: Are small firms catching up?** (11-612-M2004009)

For more information on information communication technology adoption, contact Bryan Van Tol at (613) 951-6663. Please contact Louise Earl for information on technological change at (613) 951-2880.

*Compendium of information communication technology indicators*

**Beyond the information highway: Networked Canada** is a compendium of statistical data and analysis on information communication technology which includes a large number of industry and use indicators (56-504-XIE).

For more information please contact Heidi Ertl at (613) 951-1891.

5 Research and development indicators

Indicators on research and development in Canadian industry including expenditures, personnel, type of research, and sources of funds are available from the Research and Development in Canadian Industry Survey (4201).

The indicators are published in the following reports:

**Industrial research and development – Intentions** (88-202-XIE, Fee product)

**Science statistics** (88-001-XIE Fee product)

**Estimates of Canadian research and development expenditures, Canada, 1993 to 2004 and by province, 1993 to 2002** (88F0006X2004020, free)

For more information, please contact Janet Thompson at (613) 951-2580.

Supplementary research and development indicators for Canadian private non-profit organisations are also produced regularly.

# 6 Innovation indicators

Indicators on innovation activities by Canadian business have been collected irregularly since 1993. Indicators that are of interest are percentage of sales from new products, methods of protecting intellectual property, cooperative and collaborative arrangement, amongst others.

*Survey of Innovation in the Manufacturing Sector and Selected Natural Resource Sector, 1999 (4218)*

For an overview of survey methodology please see:

**Survey of Innovation 1999, methodological framework: Decisions taken and lessons learned** (88F0006X2002012)

Detailed statistical tables are available for free as catalogue 88F0006X2002016.

**Understanding Innovation in Canadian Industry**, edited by Fred Gault (McGill-Queen's University Press, Montreal and Kingston, 2003) contains a collection of articles which are based on the data collected by the Survey of Innovation in the Manufacturing Sector and Selected Natural Resource Sector, 1999.

*Survey of Innovation Selected Service Industries, 2003 (4218)*

Detailed statistical tables are available as a for fee CD-ROM product catalogue 88-524-XCB.

Analytical products are under development and will be available on the Statistics Canada web-site shortly.

For more information please contact Frances Anderson at (613) 951-6307.

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