Final Report

ISSUES WITH RESPECT TO COMMERCIALIZING CANADIAN UNIVERSITY RESEARCH

Prepared for:

Expert Panel on Commercialization of University Research
of the
Advisory Council on Science and Technology

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1. Introduction

1.1 Purpose of Document

This is a background document for the Expert Panel on Commercialization of University Research (hereafter referred to as "the Panel") of the Advisory Council on Science and Technology (ACST). In it we:

- Identify key Canadian stakeholders in the process of commercializing university research;
- Discuss the main issues that arise among these different stakeholder groups with respect to commercialization;
- Identify issues and problems on which there is general consensus; and
- Discuss issues about which there is disagreement or controversy, and why.

1.2 Methodology

This work was done in two related but separate stages. The first stage was done for the Association of Universities and Colleges of Canada (not the Panel), with respect to issues around the management of university intellectual property (IP). That work (AUCC, 1998a) and the draft proceedings of the AUCC Symposium at which it was tabled (AUCC, 1998b) formed the background to the present study for the Panel. Here we analyze a broader set of issues including those relevant to industry and the investment community, but still related to the factors and issues that foster or inhibit the commercialization of university research. The work for the Panel was done through a literature review of published and unpublished papers relevant to the topic, plus interviews with experts and interested parties across Canada. These parties include respondents from the academic, industry, and investment communities. (We did not attempt to deal with the legal aspects of commercialization.) The list of documents reviewed is found in Appendix A and the list of people interviewed is in Appendix B. A summary of the key issues or recommendations in each of the documents has been submitted separately to the ACST secretariat.

2. Major Stakeholders

2.1 Introduction

This chapter simply lists the key organizations involved or interested in the commercialization of university research. As can be seen, there are many stakeholders and each has a particular set of goals, pressures, and views. Key individuals interviewed for this study are listed in Appendix B. Other key individuals are listed in Appendix 1 of *AUCC 1998 b*. The opinions expressed, issues raised or recommendations made by organizations and individuals are presented in subsequent chapters of this document. Several individuals and organizations will also be writing directly to the Expert Panel or request meetings with members.

2.2 Faculty Members and Students (the Researchers)

Researchers and students are the creators, the inventors who generate the IP. Another small group of researchers studies the research process, including research evaluation, research funding policies, innovation systems, ethics in research and conflicts, etc. Few academic researchers in Canada work directly on the study of commercialization of university research.

Faculty members are often represented by associations or unions. The national association is the *Canadian Association of University Teachers*. Students are also grouped into associations. *The Canadian Graduate Council* is a national association of graduate students. ,

2.3 Universities and Affiliated Research Hospitals and Institutes

Through the researchers they employ and support with infrastructure, these institutions generate the research results with potential for commercialization. Institutions must have policies and systems in place to ensure that potentially valuable results are identified, protected and transferred. In universities, the Vice-President (Research) or equivalent is generally responsible for the development and implementation of IP policies. In smaller institutions, the Office of Research Services will have one employee responsible for the administration of research grants and contracts as well as for IP management. In larger universities, this responsibility is delegated to various types of university-industry liaison offices (UILOs) (see Section 2.4).

Deans and Department Chairs have line responsibilities with respect to hiring, promotion and tenure, and thus can have a strong influence on commercialization of university research.

The national association of universities is the *Association of Universities and Colleges of Canada.* Regional and provincial associations include the *Association of Atlantic Universities*, the *Council of Nova Scotia University Presidents*, the *Conférence des recteurs et principaux des universités du Québec*, the *Council of Ontario Universities,* the *Council of Western Canadian University Presidents* and the *University Presidents' Council of British Columbia.*

2.4 Offices of Technology Transfer, University-Industry Liaison Offices, Business Development Offices and Arm's Length University Corporations

Throughout this report, these administrative entities will be called university-industry liaison offices or UILOs. Responsibilities related to IP management in universities are summarized in *AUCC 1998b*, page 9.

Not all UILOs are involved in all aspects of IP management. All have administrative roles with respect to contracts or university-industry grants. In some universities, the university-industry liaison office also has the responsibility for all the other aspects of IP management. In a growing number of universities, these activities are farmed out to arm's-length companies (which may serve one or several universities, which may or may not be "for profit" and in which the university may or may not have equity). Finally, in other cases, some of the tasks may be assigned under contract to other sector-specific agents such as liaison and transfer centres or technology transfer companies (*AUCC, 1998b*).

Ten large universities have created the Canadian University Intellectual Property Group (CUIPG). Sixteen Canadian universities belong to the US-based Association of University Technology Managers (AUTM), which conducts regular surveys of the intellectual property management activities of its members.

2.5 Research Organizations Mainly Involving University Faculty Members and Students

The *Networks of Centres of Excellence (NCE)*, *Ontario Centres of Excellence* and a number of Québec *Centres de liaison et de transfert* fall in this category, with most research falling into the pre-competitive category. These organizations have their own technology transfer or business development function.

2.6 Academies, Scientific and Professional Associations

Scientific societies and professional associations represent the interest of their discipline or membership. The *Royal Society* and the *Canadian Academy of Engineering* conduct studies, hold conferences and occasionally publish discussion papers or reports on research policies and research funding policies.

2.7 Granting Agencies

Federal granting councils, the *Medical Research Council (MRC)*, the *Natural Sciences and Engineering Research Council (NSERC)* and the *Social Sciences and Humanities Research Council (SSHRC),* are the single largest funders of university research in Canada. They contribute to funding the direct costs of research programs and projects, but do not support the indirect costs. All councils have a wide range of programs, from scholarships and fellowships, to researchers in training, to senior researchers supported through research grants for ongoing research activities. Some programs support research partnerships with the private sector and other users of research results. Together with Industry Canada, the three councils administer the NCE Program. The policies and programs of the three councils have a strong influence on the behaviour of universities and researchers.

Provincial granting agencies, such as the *British Columbia Health Research Foundation*, the *Alberta Heritage Fund for Medical Research*, the *Fonds de recherche en santé du Québec* (FRSQ) and the *Fonds FCAR* in Québec offer comparable and complementary programs in BC, Québec, and Alberta. Other provincial programs are briefly mentioned in section 2.8.

Private not-for-profit granting agencies, such as the *National Cancer Institute* and other charitable foundations (mainly in the biomedical area) are also involved in research funding in universities and hospitals.

2.8 Existing Companies, Industry Associations, and Think Tanks

Existing companies are a major vehicle for the commercialization of research results generated in partnership with or by universities. This is not a monolithic block. Not only are there large, medium and small firms, but there are research-intensive and non-research-intensive firms in each of the three categories. Some companies have internal research and development (R&D) arms and others do most R&D through contracting and/or joint ventures. There are also enormous sectoral variations.

Some existing companies are significant:

- funders of university research;
- research partners of university scientists;
- performers of research and generators of knowledge and intellectual property;
- receptors of university knowledge, students, and IP (the latter most often through licensing arrangements).

They work in partnership with universities, work with researchers in the identification of research ideas, provide support for the research in the form of grants or contracts, adopt research results generated in universities or elsewhere, add value to them and create new processes or products, etc.

Major industry associations include *CATA* (the Canadian Advanced Technology Association), *PMAC* (Pharmaceutical Manufacturers Association of Canada) and the *Canadian Chemical Producers Association*.

There are many industry research organizations including *PAPRICAN* (Pulp and Paper Research Institute of Canada), *Forintek*, *Feric*, the *Industrial Research and Development Institute*, the *BC Advanced Systems Institute*, the *National Optics Institute* and *PRECARN*. These typically receive part of their funding from governments and part from industry, and have strong university links. *C-HEF* (the Corporate-Higher Education Forum) is an association dedicated to fostering understanding and collaboration between Canada's business and academic communities. Formed in 1983, its members are chief executives of corporations and universities who share their knowledge and experience to anticipate needs and act on opportunities that strengthen their institutions and Canadian society as a whole. The *Conference Board of Canada* is a private sector think tank which focuses a significant proportion of its efforts on human resources and innovation issues, including intellectual property management and commercialization of university research. Its members are mostly medium and large-size companies.

2.9 Start-up Companies

Start-ups are new companies created specifically to develop IP or technologies generated at universities, research hospitals, networks of centres of excellence, etc. The creation of start-up companies is a major commercialization vehicle.

2.10 Financial Institutions, Venture and Seed Capital Companies, Angel Investors and Other Individuals

Investors provide the capital required for successful commercialization and expect a return (usually large) on the investment. Angel investors and early venture capital ("seed") companies play a key role in the funding of the development of early technologies to the point when they can be transferred to a new or an existing company. Financial institutions and venture capital companies may take over the financing at that point.

2.11 Provincial governments

Provincial governments are the major funders of university operations and provide the basic research infrastructure. Some provincial governments, mainly through their ministries of Education or Higher Education, Health, and Agriculture, also have programs in direct support of university research.

Through their industry or economic development or science and technology ministries, and through arms' length agencies such as Science Councils or Economic Development Councils, provincial governments promote university-industry interface and encourage their universities to enter into partnership with the private sector and to commercialize research.

Provincial governments put in place policies and programs in support of economic development and job creation. Economic diversification and transition to a knowledge-based economy are major priorities in most provinces. Through tax measures, investment, subsidies, and other vehicles, they encourage the creation of new businesses and the expansion of existing ones. Provincial government tax measures to encourage industrial R&D are described in *AUCC 1998c.*

The Minister of Health in Québec appointed a committee to look at intellectual property and commercialization issues in research hospitals and affiliated institutes. The Committee, chaired by the President of FRSQ, submitted its report to the Minister in March 1998, but it remains unpublished to date. The Ontario Minister of Energy, Science and Technology has just appointed a task force to advise on commercialization issues, including legal aspects. In 1996, the Alberta Government, through the Alberta Science and Research Authority, conducted a study of commercialization (ASRA, 1996) which identified financing and management as the two largest barriers. The Alberta Government has taken the conclusions of this report into account in developing sectoral strategies aimed at facilitating the transition to a knowledge-based economy.

2.12 Federal Government

The federal government is the major funder of university research, through the granting councils (see 2.7). The federal government puts in place policies and programs in support of economic development and job creation. Economic diversification and transition to a knowledge-based economy are major priorities of the federal government. Through tax

measures, investment, subsidies, the regulatory regime, its own research laboratories (in line departments and the *National Research Council*), and regional development agencies (e.g., *Western Economic Diversification*, the *Atlantic Canada Opportunities Agency*), it fosters the creation of new business and the expansion of new ones.

The *Industrial Research Assistance Program* of the National Research Council (NRC), through subsidies to small firms and through a comprehensive network of advisors, is a major player in nurturing young companies and fostering university-industry partnerships (from the industry side). By providing financial support and technical advice, IRAP helps small and medium-sized Canadian firms create and adopt innovative technologies. IRAP can also help firms access expertise in the business end of innovation, such as marketing, financing, and production through the Canadian Technology Network. NRC also plays a major role in the development of regional innovation systems (involving local universities), especially in cities where it has research laboratories. Laboratories of other federal departments play a similar role.

Commercialization of intellectual property in government laboratories is a priority of federal science-based departments and agencies. They share experiences and best practices through the *Federal Partners in Technology Transfer*.

Industry Canada is very interested in the commercialization of university and government research, as exemplified by the creation of the expert panel. Industry Canada also has a *University Advisory Group*, which formed a subgroup on commercialization and a *Council of Science and Technology Advisors* (composed of one member of the Advisory Committee or Council of each science-based federal government and agency) which provides advice on federal research.

3. Issues of Policy and Practices

3.1 Mandate and Goals

3.1.1 Commercialization and the university mandate

There is general consensus among those working in this area[1] that commercialization is (and should be) embedded in the mandate of universities. While there is consensus on this, this seldom translates into concrete plans or strategic goals. However, there has been a significant increase over the past two decades in commercialization interest and activity within the university sector, with heightened interest in the last three years or so.

> *"The environment has changed a lot in the past two or three years. It wasn't quite heretical when we started but it wasn't common at all. Now there's a much more user-friendly approach, university staff are more knowledgeable."*

Within this general consensus that commercialization is a legitimate activity—and especially at the operational level where day-to-day decisions are made—there is a significant amount of variation in the "culture" that drives the process; i.e., there are policies and mechanisms in place to ensure that responsibilities are spelled out, but these policies do not always actively promote commercialization and not all faculty members agree with them.

First, the university community quite rightly feels that teaching and research are their primary mandates, and qualms about the effect of "commercial thinking" are common. Most of these concerns in some way relate to two perceived dangers: (1) restricted ability to carry out fundamental curiosity-based inquiry (all research will become "applied"); or (2) restricted ability (or desire) on the part of scientists to disseminate the results (academic freedom under attack). Some academics believe it is self-evident that increasing university-industry-government collaboration is bad for the universities and that this trend must be actively resisted (e.g., Polster, 1998). Any university or program that fosters commercialization must deal with these fears in a realistic manner. For example, a program that increases funding to university-industry work at the expense of basic research is bound to fail, not only because of the resistance it will face but because it will cut off the life blood of commercialization—the background supply of fundamental research results.

Second, universities are complex collegial organizations with the responsibility for the implementation of policies and the delivery of programs clearly residing in departments and faculties. The policies and goals of the "university" are not always reflected in the traditions and practices of discipline departments.

And third, irrespective of formal policy, there is a large variation in the practical support that universities provide to industry and the investment community. Some, for instance, are known to be virtually impossible to deal with, while others proactively seek out ways to be helpful and are regarded as very entrepreneurial in spirit. More than one industry and investment

[1] That is, among people actively interested in the commercialization process. As will be seen further on, not all faculty members agree that this is an appropriate goal for universities.

community respondent reported that he had never been proactively approached by any university with a commercialization idea.

> *"Why do universities NEVER call the investment community? Why do investors have to knock their doors down, and sometimes not even be allowed in the door?"*
>
> *"Some UILOs are good or excellent. But we've made little headway with [two large universities]; no one can work with them."*

Overall, the lack of a strong and consistent university culture of commercialization with clear goals (see 3.1.2) is one of the most serious barriers that exist.

3.1.2 Goals of universities in carrying out commercialization—Benefits to Canada

There is consensus (universities, investors and industry) that "benefits to Canada" should be the primary goal of commercialization of university research results[2], but there is no consensus on what this means.

In stating that their goal is to generate benefits to Canada, most universities hope that local and regional benefits (both social and economic) will accrue; of particular interest is the creation of local jobs for graduates and the diversification of the economy. This may occur through the creation of local companies, through licences to local companies, or, if licences are granted to companies in other regions or even countries, through creating some activity in the region (fabrication, R&D, etc.).

A small number of universities disagree with this, arguing that we live in the wider world, and that benefits to Canada should be interpreted to mean that Canada will obtain revenues from the invention (through royalties to the university and the inventors, for example) and that Canadians will benefit from the technology.

In addition, there is no denying that other goals (all consistent with benefits to Canada) are first and foremost in the mind of members of the university community, and these differ throughout the university:

- the UILO may want to generate licensing revenues, to partly off-set the costs of its operation;
- deans and department heads want overhead reimbursement to help foster more research;
- researchers want the opportunity go obtain more research funding under contracts to the firms (start-ups or existing ones); and
- researchers want to share in the financial benefits that may accrue to the university.

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[2] This is the goal of commercialization per se, but the goals of commercialization or intellectual property management policies are often narrower: the protection of the rights of the institution, its students and its staff, the management of potential conflicts, and consistency in sharing costs and benefits between the institution and the inventors/creators.

As a result, some universities in practice use commercialization mainly as a tool to obtain licensing and/or royalty revenues to help support their UILO and/or their research programs. This is considered a "will o' the wisp" by industry, and may not necessarily result in maximum returns to Canada, or the most assistance to Canadian firms. This situation is more common when UILOs are expected to be self-supporting.

It is not surprising that stakeholders from outside the university are confused about university goals and the meaning of "benefits to Canada".

> *"There are great inconsistencies among universities as to what they say their goals are, and even more inconsistency as to their actions versus their goals. Many university policies and actions[3] directly inhibit commercialization. And without clear criteria for what 'good for Canada' means it's impossible to work towards a common goal."*

Since much of the discussion about benefits to Canada started when the Networks of Centres of Excellence included a "benefit to Canada" requirement in the award agreement, it would be wise for the federal government, through the Expert Panel, to reflect on this issue: what is the best way to get the better "bang for the buck"? What is the proper balance between:

- promoting a national approach to conducting R&D and commercializing its results, leading to Canada capturing all or most of relatively small benefits; or

- promoting international R&D partnerships, leading to situations where Canada captures what may be a relatively smaller share of larger total benefits.

3.1.3 Goals of industry and investment organizations that make use of university technologies

If the goals of universities are fuzzy, those of industry and investment organizations are crystal clear: they seek to make profits. University research that cannot be translated into increased profits is simply not of interest, at least for immediate consideration. Although this seems like an obvious point, industry and investors report that the implications of this goal are still difficult to get across to many universities and government agencies. For example, industry and investors must be very rigorous in focusing only on the most promising inventions with the best-defined and largest possible markets. This tends to be contrary to the more "egalitarian" way in which UILOs deal with disclosures—e.g., one university officer reported that he was unable to simply dismiss disclosures that were obviously unsuitable for commercialization, since he needed to show that the UILO treated all inventions seriously. Another example is with respect to timing. In some fields like software or telecommunications, a six month delay in commercialization is tantamount to making the invention worthless. This runs contrary to the more leisurely timeframe of universities, the resources available for quick action, and even to the scientific philosophy that the worth of ideas is not closely tied to their age.

It should also be noted that most firms do not regard universities as the major sources of innovative ideas. Although large, sophisticated firms may well have watching briefs on

[3] See section 3.3.5, on the reward system for examples of policies and practices that may inhibit commercialization.

university research, most SMEs obtain the bulk of new ideas from other sources such as customers, competitors, trade fairs, technical publications, etc. (Holbrook & Hughes, 1997; and Centre for Policy Studies in Education, UBC, 1998) Further, an SME with sales of $50 million or more that is looking for growth of, say, 15% per annum may well find that doing so through mergers and acquisitions is a safer, lower cost, and much faster route than attempting to do so through application of technology. The board of such a company is unlikely to approve a technology development project. Thus there is a relatively small "window of opportunity" in terms of the types of firms that universities can expect to attract for technology exploitation. Identifying the right partners is far from easy.

Finally, firms that use university IP do not primarily wish to create Canadian economic development—they wish to make profits for themselves. Thus the goal of many start-up companies is to eventually be bought by a much larger concern—possibly a foreign or multinational firm—with consequent benefits for the shareowners. A number of respondents pointed out that this can cause problems for government if it has invested in the company: sometimes the capital assets and human resources stay in Canada in such a case; sometimes they don't. No easy solution was proposed, and many other respondents believe that none is either possible or warranted: such actions are common world-wide in the high technology sectors[4].

3.1.4 Technology transfer is more than licensing

A common misunderstanding is that all firms look for patentable or copyright IP to turn into new products. This is certainly common in some fields such as biotechnology, and firms and investors in these fields seek dealings with universities in which the IP is strongly protected, can be licensed, and, ideally, owned by the firms (more on the latter topic further on). During the research stage it is highly beneficial for firms and investors to work in some form of partnership in order to help set the research agenda, identify promising results, and allow trust and understanding to develop. If the IP is transferred to a large firm, there may be little or no need for ongoing interaction with the universities during the development phase.

However, this is only one situation among many. In other fields, patenting and licensing of IP is rare—most commercialization comes in the form of either process improvements (e.g., in manufacturing) or new products that rely on secrecy during development and a "jump" on the competition (e.g., in software or some areas of telecommunications). In such cases industry looks for access to university expertise in the form of the latest research and thinking of professors, students, and postdoctoral fellows, ideally in the form of joint research projects but sometimes through short-term contract research or consulting. The students involved are frequently hired by the firms involved after graduation. In some cases access to facilities and equipment is also sought, although often industry is better-equipped with production-scale equipment than are universities. The investment community is less commonly involved.

In either case it is useful to first having some definition of the market that will eventually be served; i.e., by using a "sell-design-build"[5] or "market pull" concept Of course, this is impossible with most basic university research, which almost by definition is in the "design-

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[4] Some countries have regulations with respect to company ownership, investment sources, or moving capital outside the country. It was outside our mandate to investigate the pros and cons of such policies.

[5] This is the terminology of Teknekron.

build-sell" or "technology push" category. As a result, industry and investors often find themselves at odds with universities that come to them with excellent ideas that have no market. The challenge is to marry the two concepts. Both have merits and drawbacks: strictly market pull models have guaranteed users but may ignore new platform technologies; pure technology push ideas work at the boundary of current thinking, but may be impossible to sell[6].

3.1.5 Differing goals of different stakeholders

Each of the major stakeholder groups in Section 2 has different goals within the commercialization process.

Furthermore, because commercialization is a process of interactions among individuals, successful commercialization requires intimate knowledge of, and attention to, these differing goals at the individual level. For example, the participation of the scientist is normally vital if a start-up company is to succeed, yet few professors desire to become industrialists, and the time required to create a new company restricts the ability to carry out and publish research. Similar problems exist for most of the other stakeholders and must be accounted for. In turn this implies that close relationships must be developed among the stakeholders.

3.2 Issues Regarding IP

3.2.1 IP policies

There are four IP policy issues that may affect the commercialization process: (1) whether the university or the inventor initially owns the IP; (2) how revenues are shared; (3) the confusing situation at research hospitals; and (4) whether universities are willing to sell the IP outright to industry and investors during commercialization.

Initial IP ownership. There is no consensus as to whether **initial** IP ownership vested with the institution or the inventor is better within the commercialization process. Those who favour university ownership at all institutions believe that:

- It makes sense for benefits from publicly-funded research to belong to a public institution;
- Benefits to society are more likely if the university owns the IP (e.g., inventors can't simply sell it to the highest non-Canadian bidder);
- There is more incentive for beginning the commercialization process;
- It is easier to protect the rights of all scientists and students involved, as well as the university;
- It reduces the ability of industry to "play one university against another" during negotiations;
- It reduces the time and effort needed to strike a deal with industry and investors;
- It allows the university to try again if the first attempt fails; and

[6] One respondent familiar with an industry-driven research institute noted that, notwithstanding the vital importance of market-driven activities, fully 60% of their work was, in fact, "technology push" from partner universities.

- It is easier to keep track of commercialization activity, and thus measure progress according to plan (if a plan exists).

Those who favour inventor-owned IP, or a diversity of approaches among institutions, believe that:

- Inventor-owned policies encourage more entrepreneurial thinking among faculty and students[7];
- Such policies encourage creation of start-up companies, which are usually locally-based and have the potential to generate significant future Canadian benefits;
- Such policies may reduce the bottleneck that arises when overworked UILOs cannot cope with the demand; and
- There is strength in diversity and merit in having universities experimenting with various approaches.

There are simply no hard data available to decide between these two approaches. Even industry and the investment community have no strong opinions. What all parties do agree on is that human factors are more important than policies—the good will, effort, and expertise of the individuals involved are crucial. So is trust among them, which is best developed through long-term relationships.

On the university side, this means either having a competent UILO (if the institution owns the IP), or researchers who are competent to make deals with industry (where inventors own the IP). Both situations have human resource (HR) implications which will be further discussed in Section 5. On the industry and investor side, it means understanding the pressures universities and scientists face, and finding ways to work within their mandates.

In sum, initial ownership appears to be less an issue than what happen after—i.e., sharing of future benefits and transfer of ownership versus licensing.

Revenue sharing among the institutions and inventors. Different institutions have somewhat different policies as to how net revenues from commercialization are shared among the institution, the inventor, relevant departments, etc. This is not a major hindrance to commercialization (except that inventors need to be properly rewarded and UILOs properly funded, from these or other sources), but it does cause unnecessary delays and frustrations during negotiations if universities do not have their act together. Agreements should be worked out in advance of contacting investors.

One of the problems cited by our industrial respondents is that university policies do not necessarily apply to contract research, where, for example, accommodations can be made on issues of ownership and sharing of future benefits. As a result, industrial partners, especially those with less experience of partnerships with universities, often have no idea what to expect when they embark into partnerships. They consult the university policies found on the institution web site to get an idea of what to expect and find out that these policies do not apply in their case. They advocate a more consistent approach and best practices.

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[7] Of course, as noted earlier some researchers believe this is inherently evil!

Research hospitals. The lack of consistency in initial IP ownership and revenue sharing is especially acute at research hospitals. Some researchers are regular faculty members, others are hospital or research centre employees and others are in temporary "soft-money" positions that create little loyalty to the institution (or indeed Canada). Not all hospitals have IP management policies and it is not always clear whether the university policy applies if it differs. The recent study in Québec (see Section 2.11) has not yet been made public, although the Minister has sent it to universities and hospitals for comments. It is no secret that the report recommends more consistency in policies and practices and more sharing of resources.

Selling IP outright to industry and investors. Most universities are unwilling or highly reluctant to sell their IP outright, instead preferring to provide exclusive or non-exclusive licences depending on the technology and project. Universities say they wish to avoid future problems if the scientist wishes to pursue further research, teaching, or inventions based on the IP. Also, if the company owning the IP fails the university sometimes wishes to try to commercialize it elsewhere.

> *"Venture capitalists want to own the technology. They prefer to have the faculty member give up all rights, including research and teaching on the IP."*

Industry and investors in many sectors often wish to own the IP outright. They point out that research and teaching can always be done on ideas found in published patents; university-created improvements to the IP owned by industry can still be patented by the universities; and if a company fails it's usually for good reasons, including that the technology failed or there was no market for it. Thus they believe there are no really good reasons for universities to retain the IP (other than habit), while there are good reasons for being willing to divest it. The reasons cited are that it's easier to initially attract firms and (especially) investors if clear ownership of the IP is assigned to industry, and that high-technology industry-owned IP is often later traded or sold as part of normal business operations (e.g., in return for complementary IP from a competitor).

> *"Why do universities insist on owning the IP and all improvements? Why charge for the IP when it's known that this causes some investors to back off?"*

Although many feel that worrying about outright ownership is a red herring (in that exclusive licences provide essentially similar protection), it does reduce the ability to attract investments and dispose of the IP in future. There is a lack of hard data on the impacts of universities holding versus divesting ownership of IP. However, respondents from both sides are often very defensive of their point of view. This is probably an area where blanket policies would not make sense, but there is definitely room for sharing of examples of best practices among institutions: when is it best to license and when is it best to sell?

Although industry and investors are becoming more understanding of the universities' wish to obtain revenues from their IP, there are still many who are not willing to pay much for university intellectual property (see section 4.2.4 for a discussion of how to put a price on the IP).

3.2.2 IP identification

It is unclear to what degree there are excellent university ideas that are unknown to industry and inventors. Many universities claim that their faculty members are becoming quite good at

disclosing inventions to the UILO, and that they have more disclosures than they can handle. This, of course, could well be from lack of sufficient HR and resources. Industry and investors are uncertain as to how much undiscovered IP there is, and believe that universities are far less proactive at "walking the halls" to find interesting ideas than they should be; further, some universities actively prohibit investors from doing it themselves. All parties agree that the ability to identify valuable IP in a timely manner is crucial to the process. At universities where IP is inventor-owned, the universities usually have little or no idea how much is being commercialized so it is very difficult to say how much activity there is.

3.3 Commercialization Practices

3.3.1 Administrative structures

There has been a proliferation of UILOs and business development offices at major Canadian universities. Recently there has been a trend to create commercialization entities at arm's length from the universities. These may be for-profit or not-for-profit. The jury is still out as to the benefits of these arm's-length corporations. On the one hand, they make it easier for universities to add value to the early stage of promising IP (since they can focus on "big winners" that can attract investment) and to manage any equity they may take during commercialization (an increasingly common practice). On the other hand, there has not been enough time for universities, industry, or investors to understand the implications of dealing with them rather than directly with the universities.

To further complicate matters, some commercialization is done using the offices of other types of university-based or university-related research organizations such as networks created by the Networks of Centres of Excellence Program or the Ontario Centres of Excellence program, or autonomous industry-led consortia such as PRECARN, PAPRICAN, the Industrial Research and Development Institute, etc. The degree to which the universities and the UILOs are involved varies, depending on the project. Generally, however, industry believes that using sector experts (who may be in industry or centre of excellence organizations) during the commercialization process greatly assists in identifying useful IP, identifying possible users and markets, finding investors, and carrying out the development process.

> *"There's a need for more links with sector experts. But the universities don't come to us."*

During the commercialization process there are sometimes conflicts among the various parties involved, especially in cases of joint research carried out at multiple universities, or where the institutions have different or inconsistent ownership or revenue sharing policies.

3.3.2 Adding value

There is strong agreement that most university IP needs a great deal of added value before it is market-ready. Conceptually the steps in the chain of commercialization are carrying out research, followed by initial development, bench scale-up, prototyping (piloting), and scale-up to full production. Two problems associated with this are the lack of "pre-seed" funding for the bench scale and prototyping stages, and the problem of picking the right IP to concentrate effort on.

"Pre-seed" funding is discussed in Section 4. A related problem is that it's difficult to select the most promising inventions for investment. The industry and investment community complains that universities sometimes do so without first consulting them as to whether there will be a market for the result—and reiterate that an invention is worthless if it can't be sold. For both industry and universities, the costs per project are not negligible and the risks are high— the total costs of adding value and doing due diligence are quite high for any given portfolio of projects.

One more aspect of adding value should be mentioned: "bundling" innovations to form platform technologies[8] is preferred in order to secure investor interest, provide more secure IP protection, and gain higher benefits. This implies the need for joint research programs across institutions (with IP agreements in place before research begins), and the need to find appropriate complementary IP from all sources[9]. The latter includes finding technology from appropriate non-partners and non-Canadians. In some fields, trying to base a start-up (or even a patent) solely on the research of one university, or even a group of Canadian universities, will not succeed:

> *"Trying to commercialize 'Canadian-only' technology is like using a popgun against thunder."*

In some cases putting together one strong initiative requires making hard decisions about critical mass and which technologies (and research groups) are most likely to succeed.

> *"It's better to have one strong [initiative in this field] than seven weak ones."*

Overall, there are still many unanswered questions with respect to adding value, such as what constitutes best practice, whether arm's length companies or angels should be involved, at what point the universities should let go, whether research parks or incubators should be used, how research results should be bundled, how non-Canadian innovations should be included in patents and start-ups, etc.

3.3.3 Pathways to commercialization

Overview. The right pathway is not a matter of using a "cookbook" approach to commercialization. Each project, sector, and partner requires a unique approach. However, there are some general best practices that are discussed below.

The need for business development support. Effective commercialization is more than the transfer of a piece of paper from the universities to the firm, with funding added at a distance by anonymous investors. It is very much a people business dependent on both expertise and trust. Furthermore, it is a process that ideally takes into account the long-term synergistic relationships between all players:

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[8] Platform technologies are derived from fundamental breakthroughs in understanding. They can form the underlying basis for numerous different applications, possibly in a number of different markets. This distinguishes them from more incremental innovations which can only be commercialized in one or two products or processes.

[9] Including sources outside the region or province. Respondents often complain that universities and provincial ministries are too parochial: they wish to deal with local research transferred to local companies for use in local markets.

*"People are realizing that business works not just by attending to the needs of the customer, but the **success** of the customer. You have to try to make your customer successful."*

The industry and, increasingly, the investment community agree that commercialization in many cases is better thought of as business development—the formal or informal technology transfer of university IP to a company (existing or new) is the first step. Other factors (depending on the project) include availability of:

- Highly skilled scientists—but university professors have time and interest constraints;
- Highly skilled entrepreneurs and business managers—but scientists are usually poor at this, and bringing in outside expertise can be very expensive (also see Section 4);
- People and mechanisms able to put the technology together with firms and investors, identify markets, do due diligence, etc.;
- Infrastructure such as real estate, equipment, staff support, etc.—but funding is usually scarce; and
- Initial and follow-on capital.

Funding issues are discussed further in section 4 and human resource issues in section 5.

Licensing, versus start-ups, versus "know-how". Each of these is a legitimate route for commercialization. The following factors[10] are generally taken into account in deciding which route to take:

- Where the innovation is narrow, small, short-term, or incremental to existing technology, and there is already an existing Canadian receptor, it makes sense to license it.
- Where there are broader, long-term, platform technologies[11] for which there is an existing Canadian capability (or where capability can reasonably be developed during the course of a joint research program), it makes sense to license the IP if appropriate agreements can be made. This route requires skilled UILO licensing personnel and the inventor usually must be involved. Lack of industrial receptor capacity and of knowledge-based industry (especially in the resource sectors) is still a major problem, even in the more industrially developed regions of the country. This makes it very hard to move ideas stemming from basic research to many existing companies.
- Where Canadian capability does not exist, the option may be to spin-off platform technologies into a new venture if the researcher is fully committed, there are skilled entrepreneurial staff and owners, a sound business plan can be developed (including sound

[10] The list is heavily adapted from a detailed flow chart originally developed by David Shindler, President, Milestone Medica Corporation.

[11] Platform technologies are derived from fundamental breakthroughs in understanding. They can form the underlying basis for numerous different applications, possibly in a number of different markets. This distinguishes them from more incremental innovations which can only be commercialized in one or two products or processes.

marketing, management, and capitalization) and if incubator support is available[12]. Start-ups are good vehicles as they can lead to future research contracts and potential licenses, job creation, exports, and attraction of capital to the area and the sector. However, they are very risky and require ongoing support[13]. Some start-up firms are based on a single technology, with the corresponding vulnerability . There are few federal or provincial programs that support the R&D efforts of start-up companies. For instance, most of NSERC's Research Partnership programs encourage joint efforts with existing companies and the National Research Council's Industrial Assistance Research Program supports existing companies but not start-ups.

- Where none of the above conditions apply, it may be better to look for offshore licensing opportunities, with some Canadian content (such as manufacturing or R&D) built in somehow if possible.

- Where it is inappropriate to patent or copyright the technology (as for manufacturing processes), the IP is best transferred through the "know-how" of skilled individuals (including students) working in joint research projects.

3.3.4 Partnerships, consortia, and other similar mechanisms

Many of the problems mentioned above can be at least partially alleviated by using partnership models. Many respondents commented favourably on networks of centres of excellence models for creating both licensing and start-up opportunities, and consortium models are useful for "know-how" types of technology transfer. Most problems associated with these models can be reduced by engaging in long-term relationships (to build trust), creating participation of all partners early on in the research process (to ensure relevance of the research and other activities), and by agreeing on how revenues should be shared before the commercialization process begins. Such agreements should be based on existing policies and reflect best practices.

3.3.5 Reward systems

A significant problem is that the metric for measuring success at commercialization is poorly-defined for inventors and universities

Everything depends on individuals. At the end of the day, commercialization depends not on the actions of institutions, firms, or programs, but on the actions of individual people. Every individual working within the system must be valued for what he or she does, and personally get something out of it. Thus any program or incentive designed to foster commercialization must first ensure that the people doing the "grunt work" are adequately recognized and rewarded.

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[12] The jury is still out on the true impact of incubator and multi-tenant facilities. Some have been very successful in obtaining tenants and creating full-fledged companies, others have sat nearly empty for years. This may be a function of not yet having achieved critical mass or of not providing sufficient support—there is a tendency for newer incubators to provide access to mentoring in addition to the usual infrastructure support. If used, they should have exit policies that provide for when and why companies should eventually leave (generally when they have either succeeded or failed) to ensure there is a good flow-through of new start-ups.

[13] Many individuals believe that even failed start-ups are valuable in that the people involved learn a great deal about entrepreneurship that can be applied in future ventures.

Reward system for researchers. Few universities have tenure and promotion policies that reward researchers who identify the IP potential of their research results and become involved in its exploitation through dissemination beyond academic vehicles. Although inventors may reap additional personal or research funds through commercialization, this is usually not enough.

Measures of success for universities. Universities also need to be rewarded for success at commercialization. Although they will gain revenues from the process, it is insufficient to measure success by their licensing revenues, or number of start-ups. One must assess the benefits to society through a more inclusive metric. This should include measures such as: number of partnership and contracting agreements made, amount of consulting by faculty members, amount of royalty and licensing returns to the university, sales revenues or cost savings to industry, number of start-up companies, amount of industrial research funding attracted to the university, capital investments made in companies that use the IP (both initial and follow-on investment rounds), value of university equity shares, technology transfer from movement of human capital, impacts on the local economy such as job creation, and history of the companies involved (including second generation start-ups or spin-outs, sales to larger corporations, etc.)

Note that not all measures are equally important to all stakeholders, and it may be that one or two relatively simple measures are highly correlated with the remainder. Many venture capitalists, for example, argue that simply measuring the incremental capital value of the companies involved would capture most aspects mentioned above, and that maximizing this value would be the easiest way of maximizing returns to Canada. Some additionally argue that this would happen if universities simply focused on maximizing their own revenues; i.e., acting more like an ordinary investor in S&T. This contention, while appealing in its simplicity, is unproven.

Much remains to be done (in Canada and elsewhere) in the development of appropriate indicators to measure successful knowledge flows, and there are few hard facts available on the success universities have had to date if all the measures above are used—a proper study of best practices would require a retrospective review of past commercialization activities. Without a proper idea of what impacts are considered valuable, it is difficult for universities or government to work towards them.

Although there is consensus that good simple measures are required, all agree that this is a very difficult topic and few have concrete suggestions to make.

3.3.6 Conflicts of interest

Although conflicts of interest between commercialization and the teaching and research mandates of universities are unavoidable, few respondents believe that this is a critical problem as long as there are explicit mechanisms for managing conflicts and everything is in the open. In fact, conflicts were seen by many as a necessary (if unwanted) corollary of commercialization. For this reason, university administrators must be alert and deal quickly and effectively with problems as soon as they arise. In fact, to prevent problems from happening, universities should ensure that staff and students are all well informed of their obligations and their rights.

There must be clear policies for faculty members involved in transfer activities, for students who are involved, for faculty members having equity in start-up companies, for partnerships, or when clinical trials are involved. There must also be a clear mechanism for reviewing and resolving potential conflict situations, and for protecting the institution against liability. Although university policies discuss the interests of faculty members, the rights of students are not always clearly stated (Canadian Graduate Council, 1994).

One of the unintended effects of more aggressive technology transfer is a recent tendency for some researchers to shut out collaborators. They choose to work alone (even without graduate students) to ensure that they keep sole control of the intellectual property. We are told that this phenomenon is not widespread. Nevertheless, it is important for university officials and granting agencies to monitor this type of behaviour. Indeed, if this problem were to expand, it could undermine research programs that require collaboration and partnerships.

3.3.7 The social sciences and humanities

There is currently a great deal of interest in commercializing medical technologies and biotechnology because of the possibility of large "windfall" profits, as well as the inherent social benefits. The natural sciences and engineering fields are also active and have well-developed methods for technology transfer, although these are often of the "know-how" variety and proceed without patenting or copyright.

The social sciences and humanities, however, are seriously under-represented in commercialization. The most prevalent means of knowledge dissemination (outside the traditional academic vehicles) is the transfer and exchange of knowledge and know-how in joint research projects. University-industry liaison offices tend to devote few resources to the area and potential research collaborators must find their own contacts and develop their own networks. This is likely to change with the increasing interest in research in new learning materials (e.g., multimedia), and commercializing the results. Some stakeholders—from all sectors—expressed disappointment at the fact that the Expert Panel's mandate was restricted to commercialization. Knowledge and know-how transfer from social sciences and humanities research is important and should be facilitated. There is an increasing number of joint research projects with public and private organizations. The benefits to society of this research are generally social rather than economic (new policies, improvements in health systems, new teaching methods, etc.) and there are still few, if any, indicators to measure these benefits.

3.4 Suggestions and recommendations

There is general consensus that commercialization is (and should be) embedded in the mandate of universities, and that the primary goal of commercialization is (and should be) to generate benefits for Canada. However, there is a lack of a strong and consistent university culture of commercialization. Also, industry and investors do not take seriously enough the universities' concerns about the impacts of commercial activities on research and teaching, or their problems with conflicts of interest. And universities are not making researchers comfortable enough with these activities.

- Universities should send clearer messages to faculties and students about the importance of commercialization and the nature of its goals. At the same time, there need to be strong and consistent messages stating that the first option of researchers and students is always to

publish their results even if they are of commercial value. Only if researchers decide to engage in commercialization do restrictions apply.

- "Benefits to Canada" should mean national social and economic benefits for Canadian society. This appears simple, but the jury is still out on what process (say licensing to a foreign company or a start-up) is best in what situation. Examples of best practices would be useful.

- Universities should continue to review their promotion and tenure policies and the application of these policies throughout the institution so that they reflect contributions made in commercialization.

There are problems with policies: some are not clear, some inhibit commercialization, and some are not applied consistently within institutions. There is a lack of harmonization between policies of universities and affiliated hospitals.

- There appears to be no need of uniform policies, but universities should work together at developing best practices that foster commercialization, and should ensure that their actions reflect these policies. Universities and affiliated hospitals should harmonize their policies.

- Universities, industry, and investors need to find best practices with respect to selling IP outright to industry—most likely universities should be willing to do this more often, and industry should be willing to pay for it more often.

Industry and investors often find themselves at odds with universities that come to them with excellent ideas that have no market.

- There is consensus that early identification of industrial partners and building of partnerships (granting councils have excellent programs to foster this type of interaction) are the most effective means of technology transfer, when the receptor capacity exists.

- Additional expertise is required inside UILOs to identify promising intellectual property. UILOs need staff with entrepreneurship, business, and marketing experience.

There is a proliferation of technology transfer offices, university-liaison offices, technology companies, etc. There is collaboration in some regions, but there is room for more sharing among institutions, not only universities, hospitals and centres of excellence, but also federal government laboratories.

- Institutions in a given city, region or province should get together and develop strategies and plans for sharing technology transfer resources.

The federal government should provide the granting councils with additional funding to facilitate expansion of programs such as the NSERC Intellectual Property Management Program (which provides grants in support of the operations of UILOs).

- Such programs should include incentives for sharing and partnership among institutions (as the NSERC Program indeed does).

- Provincial governments should also foster inter-institutional or regional partnerships through support programs.

There is consensus that there is a critical and difficult step during which value must be added to the intellectual property before commercialization can occur. This involves adding technical value, bundling technologies, accessing capital, "guided entrepreneurship", mentoring, incubator support, etc. There is a lack of "pre-seed" capital for bench scale development, prototyping, and demonstrations, especially in the NSERC fields. Few federal government programs[14] address this gap. On the other hand, there is no unanimity as to whether or not there should be direct government support at this stage (beyond small granting council programs on the university side of the equation and IRAP on the industry side). The venture capital and seed capital supply is much improved recently.

Suggestions include:

- Better financial support through programs such as NSERC's Intellectual Property Management Program.

- Better advice, nurturing and financial support through programs such as IRAP, and better integration of IRAP into the process.

- More discussion on ways to bundle technologies and work with research organizations across the country and outside Canada.

- Development of best practices.

(See also sections 4 on funding, and 5 on human resources.)

There is increasing recognition that "commercialization" is more than patenting IP and selling new products. A better definition of the term includes all ways in which university research and technology can benefit industry; this includes process improvements, application of "know-how", development of entrepreneurship, access to highly-skilled people, sharing of infrastructure, and hiring of students. Further, there is much more realization that commercialization does not end at "the gap" between universities and the private sector, since companies (whether an existing firm or a start-up company) still have a long way to go before making a profit. Yet, all stakeholders pay too little attention to the fact that commercialization is the last and extremely complex step in the transfer process. Again, there is no unanimity as to whether or not there should be direct government support at this stage (beyond tax measures).

- Integrated business development that takes into account all aspects of commercialization (including processes, "know-how", entrepreneurship, students, etc.) is required with support from all stakeholders.

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[14] NSERC's Intellectual Property Management Program and NSERC Technology Partnership Program are the two programs specifically addressing this gap. Other granting council programs support the university research side of things whereas IRAP subsidizes the research and development costs of existing firms after the transfer.

There is lack of trust among universities, industry, and investors, as well as a lack of knowledge of the pressures and constraints facing each sector. All parties accuse the others of not understanding them. Each tends to underestimate the efforts, costs, and risks taken by the others. Many SMEs don't even consider universities as sources of innovation.

- Long-term relationships are necessary for trust to be built, and there are not enough research partnerships that would develop them. This is a slow process which takes time to build. Research partnerships of the granting councils and some provinces are good vehicles to foster such relationships.

- The AUCC could take a leading role in helping build this trust, by increasing its interaction with private sector associations and the investment community and by having working groups tackling specific issues.

- Government goals and expectations should be realistic. Only a sub-set of Canadian firms can realistically make use of university technologies (start-ups and R&D-intensive firms).

The social sciences and humanities are routinely ignored or given little attention.

- Changing culture takes time and incentives. SSHRC should be given additional funding to foster partnerships between researchers and users of research results, recognizing that, in these areas, effective application of research results (and benefits to Canada) is often through better policies, programs and organizations than through commercialization.

Commercialization performance needs to be measured better.

- The universities, industry, and investors should work with the federal government (e.g., through Statistics Canada) to see whether it is possible to develop a simple system of better performance measures for commercialization. However, very careful thought needs to be given to this. The point is not to collect reams of data that are impossible to interpret while introducing a huge workload and cost for all parties—this would defeat the purpose for industry and investors, who already complain about red tape and record-keeping.

4. Issues of Funding and Investment

4.1 University Funding Issues

There is consensus on two issues: (1) Support for basic research is important; and (2) resources devoted to IP management are far too low. These two messages came through loud and clear at the November 26, 1998 AUCC Symposium on Intellectual Property Management (*AUCC, 1998c)*:

> *"The fast growing level activity is putting pressure on UILOs."*
>
> *"The pipeline must be fed and research funding must grow."*

The key issue of basic research funding and the need for a strong research infrastructure has constantly been raised by the federal granting councils, the AUCC, and scientific societies, most recently in their 1998 presentations to the House of Commons Committee on Finance (see, for example, the AUCC web site, www.aucc.ca). This is also a major conclusion of the Québec Conseil de la science et de la technologie (*Conseil de la science et de la technologie, 1998a),* one of the key findings of the 1998 Ontario Innovation Summits (*Ontario, Ministry of Energy, Science and Technology 1998a*). This message was also heard clearly in our interviews with individuals from the venture capital community: investors need the constant flow of new ideas and research results with potential for commercialization.

The pressures on university UILOs is also a major concern of all stakeholders: nothing will happen if all promising inventions are stuck in a bottleneck.

> *"There are limits to the amount of funds that universities can invest in UILOs. Universities do not receive much funding to compensate research overhead, since the federal granting councils do not provide for indirect costs and most provinces provide little if any compensation." (AUCC, 1998c.)*
>
> *"At all four summit meetings, the funding of technology transfer activities, particularly within the universities, was raised as a major issue. The overall view was that universities had a strong desire to increase their technology transfer activities, but limited resources to do so." (Ontario, 1998a).*

In advice to the Québec government on how to foster and nurture innovative firms (*Conseil de la science et de la technologie, 1998b)*, the Conseil de la science et de la technologie also raises the lack of resources for technology transfer as a major stumbling block.

The draft report of the Sub-group of Industry Canada's University Advisory Group also focuses on the issue and recommends that there be Federal support for a tri-council program to provide block grants for research commercialization to universities through their UILOs. The major weakness are identified at the two crucial gaps:

- the lack of human and financial resources for education and intelligence activities to identify potentially valuable research results and encourage researchers to disclose and protect them; and

- the lack of human and potential resources to protect the intellectual property and add value to it.

UILOs estimate that a viable technology transfer operation would require between 1% and 2% of sponsored research funding. Where should that money come from?

There is a consensus that all stakeholders who will eventually benefit from commercialization should chip in: universities, provincial governments (two, Alberta and British Columbia, already have programs of support, and at least two more, Ontario and Québec, have received advice along these lines), the federal government, investors and industrial partners. At the federal level, we hear suggestions for two complementary mechanisms: block grants from the granting councils for the operations of UILOs, and IRAP support at the "value added" gap.

There is, however, no consensus on who exactly should be involved at what point, especially when the time comes to add value to potentially promising IP. Indeed, several stakeholders are convinced that there should be much stronger collaboration between UILOs within the university system and with organizations such as the Ontario Centres of Excellence and venture capital groups (*Ontario, 1998a*). The need for collaboration and sharing of IP management resources between universities and research hospitals is also a major concern. This brings us to the human resources issue (see chapter 5).

4.2 Development Funding Issues

4.2.1 Venture and seed capital

There is a general consensus that venture capital (say, $2 million and up), and seed capital (say, from $1-3 million)[15] are much easier to find now than in the recent past. A number of private and labour-sponsored venture capital funds (LSVCFs) are now active. The LSVCFs represent a good way for the general public to support high-risk ventures since small investments can be bought in fund shares, rather than the large investments ($250k and up) typically required in "traditional" venture funds. However, only some LSVCFs specialize in making S&T investments, and most of those that do focus almost exclusively on life sciences, medical, and biotechnologies[16]. Furthermore, much of the venture capital is now tied up in current investments and follow-on capital has become hard to find. The investment community believes this problem should solve itself once initial public offerings (IPOs) raise more capital.

With respect to improving technology bundling, one respondent suggested some kind of incentive to attract research and financial investment from outside Canada.

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[15] The definitions are rather fluid, nor is it easy to distinguish between them on the basis of the type of activities being funded. However, many respondents refer to them as separate entities.

[16] Only in the life sciences can you build a company on the science and develop capital value; in other fields usually a lot of time and effort on non-scientific issues needs to be done.

4.2.2 "Pre-seed" capital

Observers in all sectors generally agree that a gap exists in "pre-seed" funding for bench scale and prototype and demonstration development (possibly including identification of a suitable industrial partner, market analysis, technical options, patenting strategy, etc.). These two steps are crucial for developing an idea to the point where angels, companies, or investors are interested, and might typically cost in the range of $20k to $1 million, depending on sector and project. At the larger end of this range, various seed and venture capitalists may be interested, but at the smaller end the funding and human resources are often hard to find. This is especially true in the NSERC fields, as even angels tend to be less interested; it is, perhaps, not so difficult to find pre-seed capital in the life sciences. It is not the size of the investment that is difficult so much as the risk involved.

Many respondents reported that none of the current government funding programs supported this stage of value-added activities. The universities also have very little funding available and therefore focus only on "big winners" or relatively easy projects. Technology Partnerships Canada does support this type of work, but was considered unusable by many respondents in the investment and industry communities—the loans are repayable, and they usually are not given for the early stages of high-risk or highly-innovative ventures. The Technology Partnerships program of NSERC focuses in this niche and has high levels of satisfaction among users, but was seen by some of our industry and investor respondents to be overly-complicated, slow, and focused too much on university rather than industry concerns[17].

It was suggested by some investors and industry respondents that IRAP might have an expanded role here. A number of industry-led organizations, and some networks of centres of excellence, have set up in internal pre-seed funds, and a few examples were found of commercial enterprises working in this area, but there is still need for far more effort.

4.2.3 Investment and tax issues

Most respondents in industry and the investment community found the SR&ED tax credits program to be a good one and among the best in the world, and a few believed that no changes were necessary. However, the high level of effort required for firms to understand and comply with its regulations (e.g., is beta testing eligible?), and some recent problems with inconsistent (or retroactive) application of rules were cited barriers to its effectiveness, especially for SMEs (CATA, 1998)[18]. Another problem cited by some of our respondents is that these tax credits cannot presently be used if a firm has a negative cash flow (which, of course, is the case for start-ups as well as many more established high-tech firms from time to time); an example was

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[17] The NSERC Technology Partnership Program is intended to "advance university research discoveries so that they can be transferred, for commercialization, by small- and medium-sized enterprises (SMEs); grants focus essentially on applied work aimed at demonstrating the technical or economic feasibility of a technology to SMEs and/or at advancing the work so that it is ready for transfer." However, many of our respondents knew little or nothing about the TPP, or confused it with Technology Partnerships Canada. Better program visibility was recommended in a recent evaluation report (Ontario Centre for Environmental Technology Advancement, 1998), as were means to address complexity and timeliness.

[18] The CATA criticisms resulted in Revenue Canada agreeing to revise its SR&ED administrative procedures (Re$earch Money, 1998).

cited of a firm that had $70 million in credits that it could not use[19]. One possible change suggested was to allow the credits to be used for job creation in these situations.

Another problem cited was recent changes to tax write-downs for investors in LSVCFs—the total investment amount eligible was recently lowered from $5,000 to $3,500, and the write-down correspondingly reduced. This was seen to reduce the incentive to invest in S&T ventures by the general public—changes to this policy are expected but at this time their exact nature is unknown.

A more pervasive tax problem is mentioned again and again, though: the high levels of tax on capital gains and personal incomes[20]. Report after report and respondent after respondent cites these taxes as causing serious problems. It is safe to say that there is almost unanimous agreement among industry and investors that lowering these taxes would do more to encourage commercialization of university technology, and ensuring the success of those ventures, than anything else.

First, it is difficult to find investment capital for S&T ventures because the capital gains tax does not take into account the highly-risky nature of the investments (i.e., investors believe that this tax should be lower for S&T investments than for "safer" ones). Second, it is hard to recruit and retain highly-skilled people (HQP) in either technical or management positions, especially for start-up firms a year or two after their creation. To attract a senior CEO from the US to a Canadian biotech start-up[21], for example, requires salaries of roughly $400k Canadian to be competitive after taxes. Since this is a difficult amount to find for a new firm, often equity is offered. Equity, though, is less attractive than it might be because of the high capital gains tax. And of course the entire situation is worsened by the low exchange rate of the Canadian dollar.

> *"Keeping people here is a huge problem. We're losing people every day to the US—there comes a point where the tax differential is so huge."*

In a related problem, governments often encourage firms to become more knowledge-intensive, for example by introducing more technology into their operations and products. This is particularly true in the resource industries. However, it is not very attractive for most firms to be the first to try out new, risky technologies (be "early adopters") since no credit is given for the risk levels involved.

Solutions offered for these problems include lowering the two taxes in question, offering tax holidays for the first year or two of S&T start-ups (for either the corporation or senior management or both), offering accelerated write-offs for capital investments made in high-risk projects (e.g., equipment and machine costs), and offering incentives for early adopters.

Whether this is reality or perception goes far beyond the scope of this study, but the federal government is quick to point out that all is not black and white in this area. Tax treatment of employee stock options in Canada compares relatively well to that of the United States in some

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[19] It was further noted that such a situation can make the firm ripe for take-over—a buyer with a positive cash flow would buy not only the firm, but also its tax credits for immediate use.

[20] Corporate income tax levels are usually not considered to be a great problem.

[21] And recruiting abroad is often necessary because of the lack of entrepreneurial HQP in Canada.

areas (shorter holding periods and better transferability options, for example), whereas US policies are more advantageous in others (e. g., the tax applies when the benefit is disposed of, whereas in Canada it applies when the option is exercised)[22]. As for capital gain, there is a small business exemption of $500,000 in Canada, and a 50% exclusion in the US (for up to $10 million, but with many restrictions). Beyond that, the two systems are comparable, with a capital gain reduction in Canada and not in the US. All in all, everything comes back to the personal tax rates. The Department of Finance notes that:

> *"However, higher tax burdens in a particular jurisdiction cannot be viewed in isolation from the level of expenditures and the fiscal position of the government. The level of taxation is largely determined by the demand for government services, which reflects citizens' values."*

4.2.4 Valuing the technology

There is disagreement between universities and investors as to how and when technology should be valued for negotiation purposes. It is very difficult to put a price on technology, especially at an early stage. Universities wish to protect themselves against making a deal that does not reflect the full value of the technology if it later turns out to be a "big winner", and they also wish investors and industry to acknowledge the huge, long-term research investments that the universities have made, only a fraction of which result in commercializable technology. Thus universities tend to wish to place a firm (and high) value on the technology early on.

From the industry and investment community perspective, on the other hand, universities and researchers are seen to have highly-unrealistic ideas of the value of their undeveloped technology, or what appropriate license fees or royalty rates are. Further, we are told that universities and governments do not understand either the huge efforts and costs associated with adding value or commercialization, the length of time it takes[23], or the risks involved. They make the point that:

> *"Technology has no value unless someone is willing to buy it."*

Thus many firms and investors prefer to set a return rate early on, but wait until later in the commercialization process (e.g., when follow-on financing is required) to set a value on the technology. Although industry and investors are becoming more understanding of the universities' wish to obtain revenues from their IP, there are still many who are blunt about not wishing to pay anything at all for university intellectual property. This occur especially when they have contributed to the research through a grant or contract, even if this grant or contract represents only a small fraction of the time and money researchers, universities and funding agencies have invested over the years. Firms argue 1) that they have already contributed to the

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[22] Source: Department of Finance.

[23] Even in engineering fields, it typically takes about 2-3 years to develop and prototype and identify markets, another 1-2 years to find application-specific seed money and deal with regulatory bodies, then another 1-2 years before the first sale, and perhaps 3-6 years of market development before the product achieves commercial success. There is a typical lag of 6-9 years before a given product breaks even on its investment. To build a business around a new idea might take, say, 8-10 people working for 4-5 years to get it off the ground, then sales effort for another 3 years, and sales will need to be, say, $6-10m/yr to break even.

research; 2) that prior knowledge results from publicly-funded research; and 3) that the prior research costs pale in comparison with the development costs and the risks[24].

This can be a serious problem that either consumes a lot of time or prohibits a deal entirely. One solution is to have an initial agreement with a modest up-front payment to the university, with re-negotiations later if the value is seen to be higher than anticipated. But this requires mutual trust from all partners, and currently such trust is in short supply.

Long-term partnerships that involve industry and investors early on are more likely to produce trust and are to be encouraged—parties that are in the business "for the long haul" will have incentives to treat each other fairly. Such partnerships may become more common as the investment community develops more business support and mentoring mechanisms.

4.3 Suggestions and recommendations

Funding for basic research is too low (consensus).

- The federal government should increase funding for granting councils.

Canadians are overtaxed (consensus).

- There is unanimous agreement that the Canadian personal and capital gains tax structure makes it very difficult to find high-risk capital, attract "early adopters", or recruit and/or retain highly-skilled entrepreneurs to run start-ups. The weak Canadian dollar also inhibits recruiting. This is one of the greatest bottlenecks to commercialization.

There is a lack of financial resources in UILOs (consensus).

- Other provincial governments should follow the lead of Alberta and British Columbia and provide earmarked support for university technology transfer activities.
- The federal government should provide the granting councils with additional funding to support UILOs through block grants to universities.
- Industry or investment sources should contribute.
- UILOs should make more use of industry sector expertise, such as that in industrial research institutes and consortia.

There is a gap in federal support programs (there is consensus on this, but not on the point at which government intervention should stop).

- The federal government should fill the gap, by ensuring that there is no void between the point at which granting council support stops and IRAP support begins. It could do that by providing the granting councils with additional funding, expanding programs such as the NSERC Intellectual Property Management Program, ensuring that IRAP has the necessary

[24] This predictably infuriates the universities, who feel it is essentially a slap in the face and implies their work has no value. Industry, for their part, are often "just plain perplexed" as to why the universities wish to be paid for their IP.

resources and flexibility to take over, or encouraging more joint granting councils-IRAP programs.

5. Human Resources and Related Issues

5.1 The Problem

There is a consensus among stakeholders that the lack of human resources with the right skill mix is a major barrier to successful commercialization. Universities, companies (especially small and young ones), the financial sector, and governments all have difficulties attracting and retaining individuals with the right qualifications and experience. Individuals in the private sector find that UILOs are not effective and poorly organized to the lack of human resources. Many directors of UILOs agree with this analysis.

There is no consensus as to who should do what; i.e., which functions should be within universities (and where they should be within the university), which should be in technology or R&D companies and other specialized firms, which should be with investors, and which should be with existing or start-up companies. However, most agree that there is room for several models and there is no need for uniformity: some models that work well in some areas (regional and sectoral) would not in others. We were often reminded that commercialization is the tip of the iceberg. Commercialization is the last step in a long process that involves knowledge generation and exchange.

There is recognition that a variety of skills are needed for effective technology transfer; i.e., these jobs require specialists, not generalists. Professionals, not amateurs are needed. Individuals engaged in "intelligence" who scout the labs to see what research has potential for development do not need the same skills as licensing agents. Professionals who assess the value of technology do not need the same skills as patent agents. Managers who build up teams to start companies do not need the same skills as R&D managers in large corporations. Most of these jobs have one thing in common, though: brokerage, negotiations and match-making require good communication skills.

The needs are there, but they are ill-defined. Solutions are not evident. In this chapter, we will synthesize the major concerns we heard and the means suggested to help solve the problems in the medium to longer term.

5.2 Human Resources in Universities

There is consensus that some functions are the responsibility of universities and the expertise to manage these functions should reside there:

- fostering a culture within the institution so that researchers and other key players in the university community (such as deans and heads of departments) promote research partnerships, the application of research results, and technology transfer; this culture must be tied to the reward system for all individuals involved;
- educating researchers to recognize potentially valuable IP and disclose it early to the institution;
- administrative functions with respect to contracts, university-industry grants, and agreements with technology transfer companies.

Within large institutions, some or all of the above functions may be decentralized at the faculty level, given the need for sector specialists. Faculties of medicine will often have their own business development officer.

Functions other than those above are seen by some stakeholders as best performed by agents of the university, technology transfer companies, R&D companies, or early venture capital companies acting as agents. These functions include:

- assessing technology and risk;
- protecting inventions and adding value to them;
- finding partners and investors; and
- proceeding with commercialization.

The path used for commercialization is not the same for intellectual property generated through ongoing partnerships between researchers and existing companies (market pull) as it is for university research that leads to potentially valuable IP (technology push). In the first instance, the receptor will undertake to add value to the IP (sometimes contracting the researchers) and proceed with commercialization. The university needs personnel with negotiating skills and licensing skills. In the second case, requirements are much more complex as a receptor company has to be found, or investors have to be found to further develop the invention. In a growing number of universities, these activities are farmed out to arm's-length companies (which may serve one or several universities, which may or may not be "for profit" and in which the university may or may not have equity). Finally, in other cases some of the tasks may be assigned under contract to other sector-specific agents such as liaison and transfer centres or technology transfer companies. We were told that it is more economical and far more effective to have agreements with one or several specialized companies created specifically to assess technologies and take risks, or to share resources with other universities in the region, or to work more closely with IRAP personnel. Consortia and alliances provide access to specialists by industrial sector, an increasingly necessary practice.

As we saw earlier (Section 4.2.4) one of the most difficult steps of the commercialization process is to perform a realistic assessment of the value of the intellectual property to be transferred. This is a specialized job which also requires an assessment of the potential market for the technology and the human resources to do so. If universities use agents for this step, they, and the researchers, must have full confidence in their agent. Trust, collaboration, and partnerships are essential. Technology transfer professionals (whether or not they are employed by a university, an agent, a technology company or a venture capital company) will use their own experience and contacts (as well as the research group's contacts) to assess whether or not the invention is promising enough to undertake protection procedures and how to identify potential receptors of the technology.

We saw in Section 3.3.2 that most IP needs added value before it is market ready. This is a costly and complex part of the commercialization process.

Stakeholders (including some from the universities themselves) are concerned at the proliferation of UILOs. Universities have them, within the institutions or at arm's length from them. Some hospitals have them. Universities and their affiliated hospitals should share resources. Ontario Centres of Excellence and Networks of Centres of Excellence also use their own services. And in some areas, private companies offer such services. Are we coming to a

point where there are too many offices competing for the same human resources (and, to some extent, for the same intellectual property)? Should some rationalization and/or sharing occur[25]? Should there be regional pools of money to help add value to the research (on the understanding that each and every university must retain responsibility for the functions listed at the beginning of this section)?

5.3 Human Resources for Start-up Companies and Investment Firms

Start-ups need to be driven by entrepreneurs and management capabilities have to be brought in early. The challenge is to find entrepreneurs who will carry the technology through. Failures are often due to lack of management and marketing skills, not lack of technology or dedication. The difficulty in finding the right individuals to start a new company and proceed with the commercialization of the invention is a major stumbling block. It is difficult for these individuals to manage the expectations of investors—patient capital is not always patient!

Mentoring and business support are useful. Start-ups have recently been given a great deal more mentoring by the investors themselves, or mentoring is arranged by them (perhaps from companies or individuals that specialize in this area), or mentoring is provided by staff at industry research institutes. In some cases, graduate students are used in what amounts to a research-oriented co-op program, working with industry both to solve technical problems and to act as low-cost sources of due diligence information. But experienced people are few and far between. Many competent individuals have retired early in the downsizing era of the early nineties. These young retirees are a potential resource to tap:

> *"We desperately need to put old heads on young bodies."*

Overall, there is general agreement that the lack of skilled entrepreneurial business management is a serious handicap to start-ups, and that UILOs don't have the resources or skills to provide advice.

Government could help through more programs such as the NSERC Intellectual Property Management program, through providing grants to start-ups to help them find skilled senior managers, through various types of mentoring programs, or through tax relief.

On the investor side, there is an acute need for specialists who understand technology, understand the risks associated with its development, realize the potential rewards associated with successful investment, and take a long view. Early venture capital firms require both scientists and financing experts and strong partnerships between the two.

5.4 Role of Researchers in the Commercialization Process

The best researchers with the best ideas are often overworked. In most instances, their first loyalty is to their basic research and their students. If they stumble on a good idea, they will disclose it and may agree to proceed with adding value and commercialization, but they may be reluctant to put in the additional time and effort due to competing commitments.

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[25] Not all universities would support this, and some have tried and failed.

Yet, there is consensus that it is next to impossible to add value to IP without the active involvement of the inventor. Investors will not be attracted if the inventor is not fully committed to the project. One way to do this is by hiring the researcher under contract to do further research to improve the product or process. But the researcher has to find the time. This brings us back to the reward system (see Section 3.3.5).

Most researchers are not interested in moving to the company that develops and commercializes the technology and choose to act only as technical advisors and part owners of the company.

5.5 Suggestions and Recommendations

Several provincial discussion documents (in Alberta, Ontario and Québec) dwell on human resources as a stumbling block to commercialization and make a number of recommendations to this end. NSERC recently brought in a number of experts to advise it on the human resource aspects of intellectual property management, and numerous suggestions were made at that meeting. Well-respected mentor and venture capitalist Denzil Doyle (in part through his column in Silicon Valley North), sends loud and clear messages to the effect that the transfer system is broken and he offers a number of suggestions to fix it. The following paragraphs summarize the major suggestions and recommendations made to both levels of government, universities and industry:

Governments:

- facilitate the establishment of mentoring for SMEs;
- facilitate the development of angel networks (for education and matchmaking, as angels are the best people to act as mentors[26]);
- expand market development assistance and export financing assistance programs;
- involve IRAP personnel in the commercialization of university research;
- create an internship program to provide university graduates with practical experience working in UILOs;
- establish a Canada-wide Internet-based network to motivate and assist emerging engineer-entrepreneurs;
- set up one or more innovation and technological entrepreneurship centres in each province to stimulate start-ups

Universities (as learning institutions):

- create more specialized MBAs or similar degree programs;
- offer more training in entrepreneurial and business skills not only for students, but for faculty members as well;
- establish campus-wide entrepreneurship centres, and ask business and engineering schools to establish joint programs;

[26] Some already exist, such as at the University of Calgary.

- develop better management and business training programs for scientific staff of start-up companies;
- integrate students more close into commercialization activities (as appropriate given their research and publication needs);

Universities (UILOs):

- recruit more personnel with industrial and commercialization experience;
- introduce a system of advisors and mentors to involve experienced business managers in ongoing activities of university liaison offices;
- engage business students to provide help;
- participate in exchange programs to help interested and gifted individuals learn the profession of technology transfer manager.

Colleges:

- strengthen entrepreneurship training for college and vocational schools students in science, engineering and technology.

Investors and industry:

- succession plans should be in place right from the beginning for most inventor-owned companies;
- venture capital companies should ensure that their staff have the necessary skills for the timely assessment of projects.

6. Conclusions

6.1 Overview

Overall we have found much reason for optimism. Changing cultures is a slow process—but we are getting there. We hope that the challenges outlined in this paper will help the expert panel develop strategies that will foster more effective commercialization of university research. Our report is blunt, because we were asked to focus on what does not work rather than on what does work. However, we are convinced that the system requires nudging, not fixing. Organized commercialization of university research is a rather new activity and all stakeholders are still in the learning phase.

In fact, much of the action required should be driven by the stakeholders rather than direct government intervention. We are convinced that the sharing of experiences, joint efforts to modernize existing policies and develop best practices, and the sharing of IP management services constitute effective and relatively inexpensive means of increasing the effectiveness of university activities. The gradually-increasing recognition that "commercialization" includes much more than just patenting and selling new products is an excellent example of how experiences are now being shared.

Universities and industry (through their associations), together with the investment community, could get together to air the issues and fix irritants. Governments should encourage these efforts as well as improve training programs to help increase the professional skills of IP managers from all sectors. Governments should also investigate the development of better indicators and gather more data in order to assess the benefits to Canada of IP management activities (but only if simple to do for all stakeholders), as well as consider the tax regime.

6.2 Summary of Key Challenges and Action Items

The table below summarizes the challenges and action items discussed earlier.

Key Issues, Barriers or Constraints	Suggested Actions
At the Universities	
Funding for basic research is too low (consensus)	• Federal government should increase funding for granting councils.
There is general consensus that commercialization is (and should be) embedded in the mandate of universities, and that the primary goal of commercialization is (and should be) to generate benefits for Canada. However, there is a lack of a strong and consistent university culture of commercialization. There are policies that inhibit	• Universities should send clearer messages to faculties and students about the importance of commercialization and the nature of its goals. • "Benefits to Canada" should mean national social and economic benefits for Canadian society. This appears simple, but the jury is still out on what process (say licensing to a foreign company or a start-up) is best in what situation. Examples of best practices would be useful.

commercialization, inconsistencies in the application of policies, and lack of harmonization between policies of universities and affiliated hospitals.	• Universities should review their promotion and tenure policies, ensuring commercialization is rewarded. • There appears to be no need for uniform policies, but universities should work together at developing best practices that foster commercialization, and ensure that these policies are understood and followed in practice. • Universities and affiliated hospitals should harmonize their policies.
Industry and investors often find themselves at odds with universities that come to them with excellent ideas that have no market. The challenge is to marry the two concepts.	• Early identification is needed of industrial partners and there should be more building of partnerships (granting councils have excellent programs to foster this type of interaction).
There is a lack of financial and human resources in UILOs (consensus), yet the abilities and actions of individuals are critical to success There has been a proliferation of UILOs.	• Additional expertise is required inside UILOs to identify promising intellectual property. • UILOs need staff with business and entrepreneurship experience. • Universities should make more use of industry sector expertise (e.g., at industrial research institutes or consortia). • Other provincial governments should follow the lead of Alberta and British Columbia and provide earmarked support for university technology transfer activities. • The federal government should provide the granting councils with additional funding to support UILOs through block grants to universities. • Industry or investment sources should contribute. • The federal government should provide the granting councils with additional funding expansion of programs such as the NSERC Intellectual Property Management Program. Such programs should include incentives for sharing and partnership among institutions.
At the Transfer Point ("The Gap")	
There is consensus that this is a critical point which involves: adding value, bundling technologies, human resources, student involvement, partnerships, access to capital, "guided entrepreneurship", mentoring, incubator support, etc., especially for start-ups. This takes a great deal of time (years) and money.	• All stakeholders should think of commercialization as far more than just patenting IP and selling new products. • Better advice, nurturing and financial support is needed through programs such as IRAP and those of industry and investors, and IRAP should be better integrated into the process. • There should be development of best practices.

There is a lack of "pre-seed" capital for bench scale development, prototyping, and demonstrations, especially in the NSERC fields. Few government programs address this gap.	• The federal government should ensure that there is no void between the point at which granting council support stops and IRAP support begins. This could be done in various ways, such as providing the granting councils with additional funding, expanding programs such as the NSERC Intellectual Property Management Program, ensuring that IRAP has the necessary resources and flexibility to take over, or encouraging more joint granting councils-IRAP programs. There is no unanimity as to whether or not there should be direct government financial support at this stage (beyond granting councils and IRAP); the venture capital and seed capital supply is much improved recently.
After the Transfer	
The present system makes it very difficult to find high-risk capital, attract "early adopters", or recruit and/or retain highly-skilled entrepreneurs to run start-ups. The weak Canadian dollar also inhibits recruiting.	• There is unanimous agreement that the Canadian personal and capital gains tax structure needs to be changed.
All stakeholders pay too little attention to the fact that commercialization is the last and extremely complex step in the transfer process.	• Integrated business development and entrepreneurship is required with support from all stakeholders. • There is no unanimity as to whether or not there should be direct government support at this stage.
Performance should be measured better.	• The universities, industry, and investors should work with the federal government (through Statistics Canada) to investigate whether a better (but simple) performance measurement system for commercialization could be developed.
Throughout the process	
The lack of skilled human resources at all stages is a major stumbling block to commercialization (consensus).	• Suggestion actions are given in section 5.5
There is lack of trust among universities, industry, and investors, as well as a lack of knowledge of the pressures and constraints facing each sector. All parties accuse the others of not understanding them. Each tends to underestimate the efforts, costs, and risks taken by the others.	• Long-term relationships are necessary for trust to be built, and there are not enough research partnerships that would develop them. This is a slow process which takes time to build. Research partnerships of the granting councils and some provinces are good vehicles to foster such relationships. • The AUCC could take a leading role in helping build this trust.

Industry, investors, and government do not take seriously enough the universities' concerns about the impacts of commercial activities on research and teaching, or their problems with conflicts of interest. And universities are not making researchers comfortable enough with these activities.	• There need to be strong and consistent policies at universities stating that the first option of researchers and students is always to publish their results even if they are of commercial value. Only if they decide to engage in commercialization do restrictions apply.
Many SMEs don't even consider universities as sources of innovation.	• Government goals and expectations should be realistic. Only a sub-set of Canadian firms can realistically make use of university technologies (start-ups and R&D-intensive firms).
The social sciences and humanities are routinely ignored or given little attention.	• SSHRC should be given additional funding to foster partnerships between researchers and users of research results, recognizing that, in these areas, effective application of research results (and benefits to Canada) is often through better policies, programs and organizations than through commercialization.

Appendix A: Bibliography

Appendix A: Bibliography

(We thank Leanne Elliott of the AUCC and Karen Corkery of the ACST Secretariat who helped us identify many of these documents. We also thank Vice-presidents (research) of Canadian universities who responded to our e-mail query.)

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Appendix B: Interview Respondents

Appendix B: Interview Respondents[27]

Respondents for the ACST study

Grant Allan	President and CEO, Materials and Manufacturing Ontario (to come)
Nicole Bégin-Heick	Council of Ontario Universities
Lloyd Beverley	President, Machinery and Equipment Manufacturers Association of Canada
Michael Brown	President, Ventures West Management
Michel Bureau	Président, Fonds de recherche en santé du Québec (FRSQ)
Max Cairns	Program Director, Science Council of British Columbia
Sylvie Dillard	Présidente, Fonds FCAR
Jérôme Doutriaux	Professeur, Faculté d'administration, Université d'Ottawa
Denis Gagnon	Canada Foundation for Innovation
Mark deGroot	COO, University Medical Discoveries Inc. (UMDI)
Stefan Dupré	President, Canadian Institute for Advanced Research and member of ACST
Colin Harper	President and CEO, Industrial Research & Development Institute (IRDI)
Stephen Herst	Manager, Canadian Genetic Diseases Network (CGDN)
Adam Holbrook	Leader SFU Innovation Systems Research Network, Simon Fraser University
Réginald Lacroix	CRÉPUQ
Louis LeCasse	President, GeneChem Management
Camille Limoges	Président, Conseil de la science et de la technologie
Bernie MacIsaac	President, GasTOPS; Board Chair, PRECARN Associates

[27] See also Appendix 1 of AUCC 1998a.

John Meldrum	President, Manitoba Economic Innovation Technology Council and Secretary of the Economic Development Board.
Lorne Miekle	President and CEO, Biocatalyst Yorkton
Peter Morand	President, Canadian Science and Technology Growth Fund (CSTGF); Chair, Ottawa Life Sciences Council
Heather Munroe-Blum	Vice-President (Research and External Relations), University of Toronto
Maury Parsons	Founder, Creativity, Technology & Investment Ltd (CTI), and Teknekron, University of Calgary.
Pierre Pedneau	Directeur, Bureau de valorisation des applications de la recherche, Université Laval
Jim Reichert	President and CEO, Science Council of British Columbia
Chris Riddle	Ontario Ministry of Energy, Science and Technology
Harry Rogers	President and CEO, PRECARN Associates; Director, Institute for Robotics and Intelligent Systems (IRIS).
George Rosenberg	President, PAPRICAN; Director, Chemimechanical Wood Pulps Network
Gordon Stokell	Ontario Ministry of Energy, Science and Technology
Janet Walden	Director General, Research Partnerships, NSERC
Martin Walmsley	Consultant, Toronto (principal researcher on 1995 CIAR study of commercialization)
David A. Wolfe	Centre for International Studies, Department of Political Sciences, University of Toronto
Janusz Zieminski	Conference Board of Canada

Respondents for AUCC Study

Since this ACST study followed on the one we recently conducted for the AUCC (AUCC. 1998a), below we show the list of individuals interviewed for that earlier study on Intellectual Property Management in Canadian Universities:

Thomas Brzustowski	NSERC
Alain Caillé	Université de Montréal
Arthur Carty	NRC
Bernard Coupal	T2C2
Leo Derikx	NSERC
Chummer Farina	Industry Canada
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Angus Livingstone	University of British Columbia
Robert Miller	University of Washington
Peter Munsche	University of Toronto
James Murray	University of Alberta
Gordon Owen	Nu-Tech, Halifax
Michael Owen	Ryerson Polytechnic University
Brent Sauder	BC Advanced Systems Institute
Beverley Sheridan	University Technologies International
Lewis Slotin	Medtech
Gilles Trempe	CEFRIO