Universities and the Knowledge Economy

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EXECUTIVE SUMMARY

Universities have a key role to play in positioning British Columbia in the new knowledge economy. It is being recognized around the world that investments in post-secondary education and research drive social and economic development. As a result, governments have been investing in education and research as never before. Universities play a key role in the education of society, in the development of new ideas and innovations, and in the transfer of knowledge to society.

In British Columbia, a rapid expansion in the capacity of post-secondary education is providing important opportunities for domestic students. Coupled with an aging population, the reduction in the number of students graduating from Canadian high schools over the coming decade will mean that Canadian universities need to recruit an increasing number of international students to Canada to meet labour market demands. The growing need for graduates of Master's and PhD programs will require BC to develop a comprehensive graduate fellowship program like that of other major provinces. The research output of the province's research universities, measured on a per faculty member basis, is relatively high, but when we look at research intensity per provincial population, BC's ranking drops dramatically. Growth in the capacity of BC's research universities and provincial investment in research funding have started to improve this situation.

Universities have worked to improve the transfer of knowledge to the community, resulting in dramatic increases in the level of commercialization of university ideas over the past decade. British Columbia has a significant opportunity to enhance our national and global competitiveness by ushering in a new era of collaboration between universities, government and the private sector. Guided by a clear and broad vision of the role of universities in the province's education system and the provincial economy, our universities are, and will remain, the engines of innovation in the new knowledge economy.

INTRODUCTION

As the first decade of the 21st century comes to an end, British Columbia is caught in the gales of a global economic storm. Throughout the public and private sectors, we look for ways to encourage economic recovery, and we may be relatively well positioned to succeed. The economic downturn demands more than short-term responses, however. Adversity will give way to opportunity and renewed growth in the long-term, especially if we renew our vision of the future beyond 2010, and keep our eyes fixed on long-term goals. These goals are easily stated: they are to maintain and enhance the social, cultural and economic prosperity of the province and the health and well-being of our growing population.

Through their integration of research and teaching, universities produce the highly-qualified personnel that our economy needs, and they create the knowledge that drives innovation, productivity, and competitiveness.

Though easy to articulate, the goals are formidable and difficult to achieve. Our post-secondary system has a key role to play, and should be part of a long-term strategy of development—BC's "2020 Vision." Universities are in a unique position because in all their activities, short-term and long-term goals coincide. Through their integration of research and teaching, universities produce the highly-qualified personnel that our economy needs today, and they create the knowledge that drives innovation, productivity and competitiveness for tomorrow. They can help take us toward the new research-driven knowledge economy of the future.

Big economic changes have always begun with creative thinking and innovative applications of processes and resources. Britain's industrial revolution began with an idea about steam power and with new mental maps about how to organize machines and human labour in new production systems. The difference in the 21st century is that ideas, skills and creative talent are generated institutionally, over the lengthy educational maturation of individuals in schools from K through post-secondary. The other difference today is that both economic productivity and social health require a very wide investment in literacy, knowledge and skills in the population as a whole. These trends began in the 20th century, when the increase in educational attainment in the labour force contributed as much to economic growth as did all new equipment and technology.[1] In recent decades we have seen a rapid growth in the returns on ideas and innovation, and an accelerating shift from jobs requiring manual skills to occupations requiring analytical skills and social intelligence.[2] British Columbia is part of this transformation, but we also occupy a unique space, richly endowed with the natural resources of land and sea. Our challenge is to harness ideas and skills to our endowments of human and natural resources, and to marry our resource economy to the knowledge economy. We must *think* our way into the future, into a new ecosystem of ideas—a place where the boundaries between university and society are fluid and the entire province is "a campus of learning."[3]

This paper explores the role and potential of research and teaching universities in shaping our future beyond 2010. We focus on the three main aspects of the knowledge continuum—the

1 William L. Marr and Donald Paterson, *Canada: An Economic History* (Toronto: Gage, 1980).

2 Roger L. Martin and Richard Florida, *Ontario in the Creative Age* (Martin Prosperity Institute, February 2009).

3 The phrase is that of Geoff Plant in *Campus 2020: Thinking Ahead—The Report* (April 2007).

creation, transmission and application of knowledge—and we have organized our discussion in three related sections:

- The demand for knowledge
- Knowledge creation
- Knowledge transfer and application

For each of these areas, the paper presents an overview of relevant trends and suggestions about the way forward.

1. THE DEMAND FOR KNOWLEDGE

British Columbia has an intricate post-secondary system that includes colleges, institutes, regional universities, private universities, and public research-intensive universities. In the first decade of the 21st century, the system was expanded significantly, in an effort to increase our degree completion rates and participation rates among under-represented groups and regions of the province. We depend on this system to provide the highly qualified personnel required for specialized, highly skilled jobs in all sectors—business, government, social and health services, the arts, sciences and engineering. Eleven public universities prepare degree graduates possessing specialized scientific insight, cultural awareness and social intelligence; universities prepare their graduates to serve society as global citizens and in this way, graduates contribute to the development of civil society in all they do.

Context

We are not alone in valuing human capital and wishing to develop our national economy as "a state of minds," as Tom Courchene calls it.[4] We are now witnessing a global race for talent unlike any seen before. Countries around the world are investing in post-secondary education generally, and research universities in particular, in order to ensure the development of human capital, research capacity and knowledge transfer. Nowhere is this more apparent than in Asia. In China, the total number of university students increased from 3.8 million in 1998 to over 16 million in 2004[5] and China is now the fifth most significant destination country for university education in the world.[6] The global recession and its aftermath will increase the competition for research talent, as both developed and developing countries seek to leverage education and innovation in their efforts to stimulate economic recovery.[7]

> The recession and its aftermath will increase the global competition for research talent, as countries seek to leverage innovation to stimulate economic recovery.

4 Tom Courchene, "Canada as a "State of Minds in the Knowledge Era," Policy Options, July-Aug 2007, p. 60.

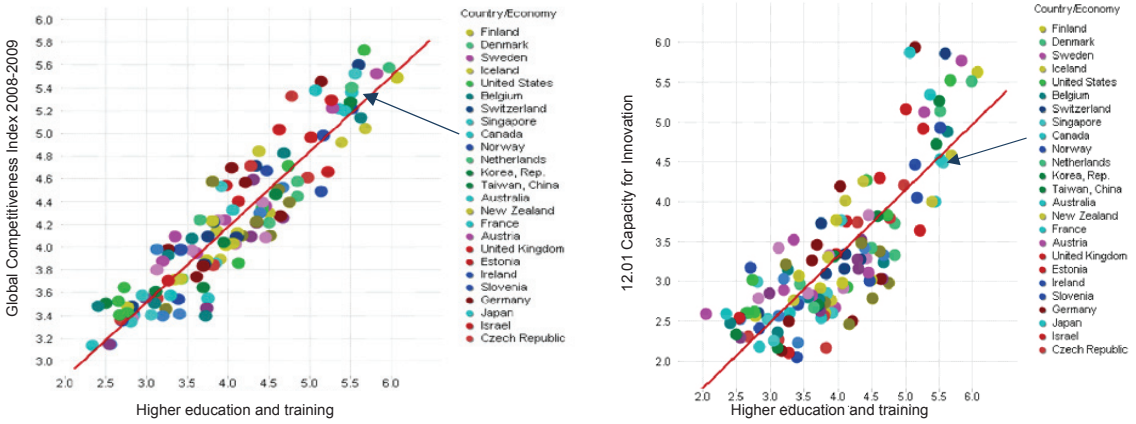
5 GlobeNewswire, ChinaCast Education Corporation, "ChinaCast Education Corporation Enters PRC For-Profit Post-Secondary Education Market," Sept. 5, 2007.

6 "China Moves Up to Fifth as Importer of Students," *Chronicle of Higher Education,* 19 September 2008.

7 *Driving Economic Recovery For Australia Through Knowledge* (Universities Australia Pre-Budget Submission 2009–10, January 2009), p. 2.

The benefits of post-secondary education to a society's innovation and competitiveness are well known. At the micro-economic level, there is a strong relationship between education and innovation: innovative businesses are much more likely than non-innovative firms to have employees with post-secondary credentials.[8] At the macro-economic level, there is a strong relationship between levels of education and GDP: countries with the highest gross domestic product are the best educated. Figure 1 shows the strong relationship between higher education and national innovation and competitiveness in countries around the world. This relationship is bidirectional: increases in education increase innovation and competitiveness, and highly innovative and competitive countries can also afford to invest more in education.

FIGURE 1: ***The World Economic Forum's Global Competitiveness Index demonstrates the competitive advantages of nations with strong higher education and training.***



Source: World Economic Forum: The Global Competitiveness Report 2008–2009

The benefits of higher education to society accrue through both private benefits to individuals and public benefits to society more broadly (Figure 2). The private benefits derived from educational attainment include higher income and higher employment rates for university graduates. For example, earnings for those aged 25–54 with a university education are more than double those of workers with no high school[9] and high school graduates experience unemployment rates up to three times higher than rates experienced by university graduates.[10] Economists tell us that the total public or social rate of return to Bachelor's degrees was consistently above 6 percent between 1960 and 2000; in the current decade it is above 10 percent. The social rate of return has been rising since the 1980s, and is likely to continue to rise.[11]

The social rate of return on university education has been rising since the 1980s, and is likely to continue to rise.

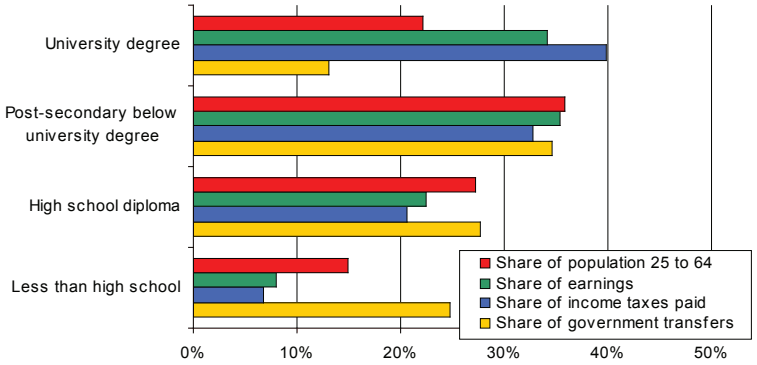
8 Statistics Canada Innovation Analysis Bulletin, Catalogue 88–003-X, vol. 11 no. 1 (June 2009).

9 Canadian Council on Learning, *Post-Secondary Education in Canada: Strategies for Success* (2007), p. 34

10 Ibid., p. 31

11 Herb Emery, "Total and Private Returns to University Education in Canada: 1960—2030 and in Comparison to Other Post-Secondary Training" (John Deutsch Institute, 2004) at http://jdi.econ.queensu.ca/Files/Conferences/PSE.html.

FIGURE 2: *Social benefits of education*



Source: AUCC estimates using Statistics Canada, Survey of labour and income dynamics, as found in *Momentum*, 2008, p. 119

The public benefits of a university education are driven by both economic and social considerations. From an economic perspective, increased educational attainment yields a decrease in dependence on government and an increase in the share of income taxes paid. From a social perspective, educational attainment also correlates with increased adaptability, increased civic engagement and a lower per capita need for social services.

Together the private and public benefits of education are primary drivers of social, cultural and economic prosperity. In British Columbia, for every dollar invested in university teaching, research, infrastructure and operations, there is a multiplier effect of 1.7; using that metric, the total annual economic impact of university activity exceeds $14 billion.

In the last two decades, the demand for people with higher levels of education has increased more rapidly than the demand for those with only high school graduation, and the fastest growing occupations are those that require a high proportion of employees with a university degree. In fact, with only one exception, Statistics Canada occupational classifications exhibiting above-average job growth also demonstrate higher-than-average requirements for a university education. Between 1990 and 2006, jobs for university graduates increased by more than 30% compared to aggregate growth of 12% for all jobs. During the same period, the number of jobs filled by those who had a university education doubled from 1.9 million to 3.8 million in Canada. The demand for graduates of Master's and PhD programs is also increasing dramatically. Over those 16 years, the number of full-time jobs filled by graduate degree holders has grown from 550,000 in 1990 to more than a million in 2006.[12] The increased demand

Most of the fast-growing occupations require a university degree. Jobs for university graduates increased by 30% between 1990 and 2006.

12 Association of Universities and Colleges of Canada (AUCC), *Trends in Higher Education, Vol. 1: Enrolment,* 2007, p. 34. See also Human Resources and Social Development Canada, *Looking Ahead: A 10-year Outlook for the Canadian Labour Market 2006–2015,* at http://www1.servicecanada.gc.ca/eng/publications_resources/research/categories/labour_market_e/sp_615_10_06/LA06-Demand-29Jan07.pdf.

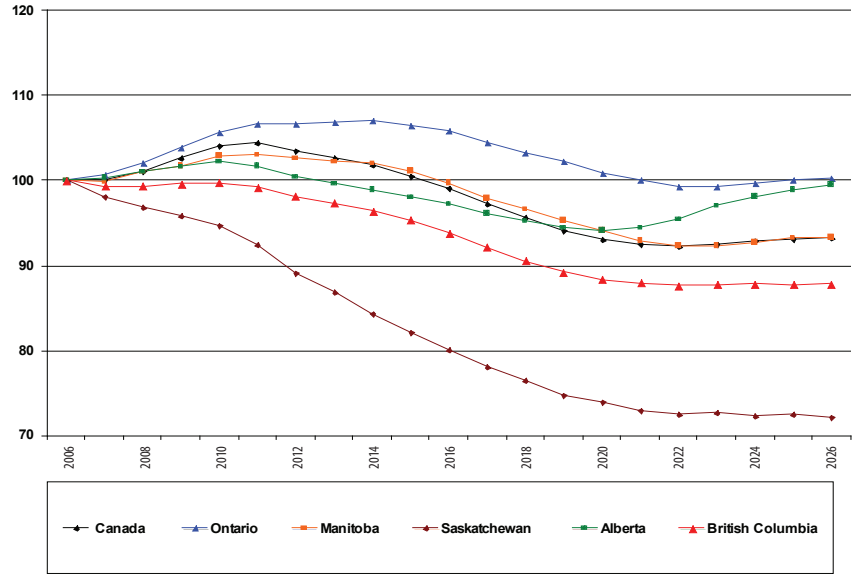
In B.C. the major industry groups projected to have the largest annual average employment growth rates include: Health Care and Social Assistance; Professional, Scientific and Technical Services; Management, Administrative and Other Support; and Accommodation and Food Services. See *Employment Outlook for Britsh Columbia: COPS BC Unique Scenario for 2005 to 2015* (Feb. 2007) at http://www.aved.gov.bc.ca/labourmarketinfo/reports/COPS_BCUnique_2006.pdf.

for university graduates is also mirrored by an increased demand for college graduates, indicating that broad-based investments in post-secondary education are important.

The way forward

While demand for university and college graduates will grow, demographics will have a significant impact on the future supply of university graduates. The retirement of baby boomers over the next decade will increase the demand for skilled workers, adding to anticipated shortages in some highly skilled occupations. But this increase in demand will be happening at the same time that the 18–21 year old population—the traditional university-attending group—starts to decline around 2011 (Figure 3). The trend is national, but in British Columbia the decline in this age cohort will be particularly steep. The implications of these trends are striking and require a focused effort in BC and beyond. To respond effectively, we will need to do at least two things: 1) increase the participation rates in university, particularly for under-represented groups; and 2) rely more heavily on immigration.

FIGURE 3: *Population change in the 18 to 21 age cohort will have strong negative impacts in Manitoba, British Columbia and Saskatchewan*



Source: Statistics Canada, Population Projections for Canada, as found in *Trends*, Vol. 1: p. 25

Initiatives and programs designed to increase the participation of under-represented groups in post-secondary education have had some success. Nevertheless, participation rates for some groups remain low, and for those who do enter college or university, completion rates are lower than they should be. Of particular note is the need to increase both participation and completion by First Nations youth and by students from lower socio-economic backgrounds. We need a better understanding of the dynamics of post-secondary access and success, and we need to design more effective programs to overcome barriers to participation by these groups.

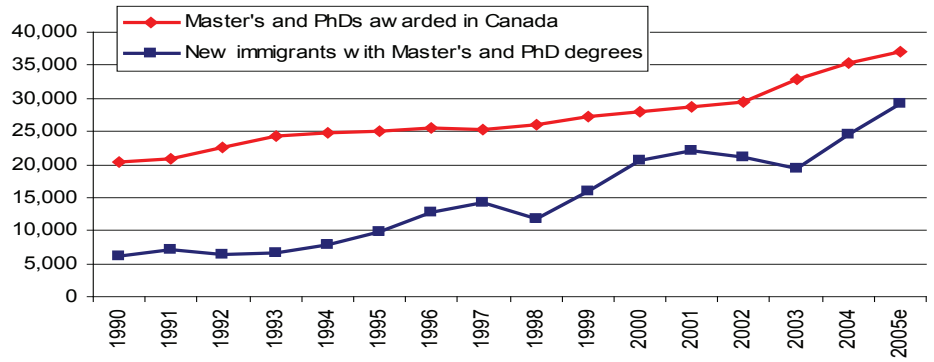
Immigration will also play a role in meeting the long-term shortage of highly qualified personnel in Canada and BC. Universities have played and will continue to play an important role in help-

We should be thinking of our international educational services as part of Canada's balance of trade: we import skill and talent, and we earn foreign revenue by selling a high-quality educational service.

ing attract international students, who often choose to make Canada their home. The growth of a broad middle class in many developing countries has vastly increased the demand for post-secondary education. We should be thinking of our international educational services as part of Canada's balance of trade: we import highly qualified personnel, and we earn foreign revenues by selling a high-quality education service.[13] The number of visa students on Canadian university campuses has grown rapidly in recent years to approximately 70,000 full-time and 13,000 part-time students[14] and any reduction in those levels would have dire consequences in the longer term. The international perspectives these students bring to the country are a valuable part of university life, as is their potential contribution to the labour market. The population of international students in our universities should continue to grow in the next decade, and we must do even more to compete with other countries that effectively market their post-secondary education services.[15] Our universities, in BC and Canada as a whole, urgently need a co-ordinated marketing effort to raise the profile, value and attractiveness of our universities around the world.

Recent changes in federal immigration policy have also emphasized the recruitment of highly skilled immigrants to the labour market. In 2005, 46% of recent immigrants to Canada had a university degree. The number of yearly immigrants to Canada with either a Master's or a PhD is now approaching the number of Master's and PhD graduates awarded at Canadian universities (Figure 4).

FIGURE 4: *Recent immigrants are accounting for a growing share of new graduates in our labour force.*



Sources: Statistics Canada, Citizenship and Immigration Canada, as found in Trends, Vol. 1, p. 34

For a number of reasons, however, we should not rely on immigration alone to fill our labour market demand for highly qualified personnel. First, it is clear that international students do not always stay in Canada, and economic growth in Asia has already been encouraging more to return to their home countries. Census 2006 revealed that the number of foreign students who stayed in Canada

13 International education earns Australia over AUD 11 billion a year. It is the third largest earner of export dollars after only coal and iron ore. *Driving Economic Recovery For Australia Through Knowledge* (Universities Australia Pre-Budget Submission 2009–10, January 2009), p. 6.

14 Association of Universities and Colleges of Canada (AUCC), *Trends in Higher Education,* Vol. 1: Enrolment, 2007, p. 16.

15 This is a major recommendation in Alex Usher and Ryan Dunn, *On the Brink: How the Recession of 2009 Will Affect Post-Secondary Education* (Toronto: Education Policy Institute, 2009).

after earning a doctorate was significantly smaller between 2001 and 2006 than in earlier intercensal periods.[16] Furthermore, the demand for people with graduate degrees will exceed supply, even with immigration. By 2016 Canadian universities will need to replace more than 20,000 faculty members due to retirement and attrition. At the same time there is growing demand for Master's and doctoral graduates throughout the Canadian economy.

Immigration affords no easy solution, if only because we are in a global race for the same talent. We will be competing globally for the university-educated personnel that we are not able to educate in our own country and province. And we start the race needing to catch up to our competitors. Current university participation rates in Canada are below those of many countries, trailing behind countries like the United States, Australia, the United Kingdom, France and other European countries. The latest OECD report indicates that Canada places 15th among OECD countries in graduation rates.[17] We are also behind in our training of the most highly qualified: the OECD reports that Canada trails far behind leading nations in the number of doctoral degrees awarded. For instance, in the 2005 cohort of graduates aged 25 to 29, U.S. universities awarded twice as many Master's degrees and 30% more doctoral degrees per capita than did Canadian universities.[18]

Recognizing the impact of education on their country's economic and social agenda, many countries have been investing heavily in their education systems, particularly at the post-secondary level. An index of change in expenditures compiled by the OECD shows numerous countries with higher rates of change between 1995 and 2005 in expenditures on tertiary educational institutions than Canada. Without further initiatives to increase the participation of young people in post-secondary education, Canada's international ranking could slip even further, impacting the country's ability to meet the demand for highly skilled labour and, eventually, the country's competitiveness.

British Columbia faces a unique situation. Currently we rank second among the provinces in terms of the proportion of the population aged 25 to 54 with a university degree (Figure 5). Traditionally, however, BC has produced fewer degrees per capita than any other province. The discrepancy is explained by the high rates of in-migration to BC by holders of university degrees. BC's underperformance in producing university graduates is a major concern that has been recognized by the provincial government through the funding of a 25,000 seat expansion of post-secondary education in BC. The effects of this investment on our national rankings are only beginning to show (Figure 6).

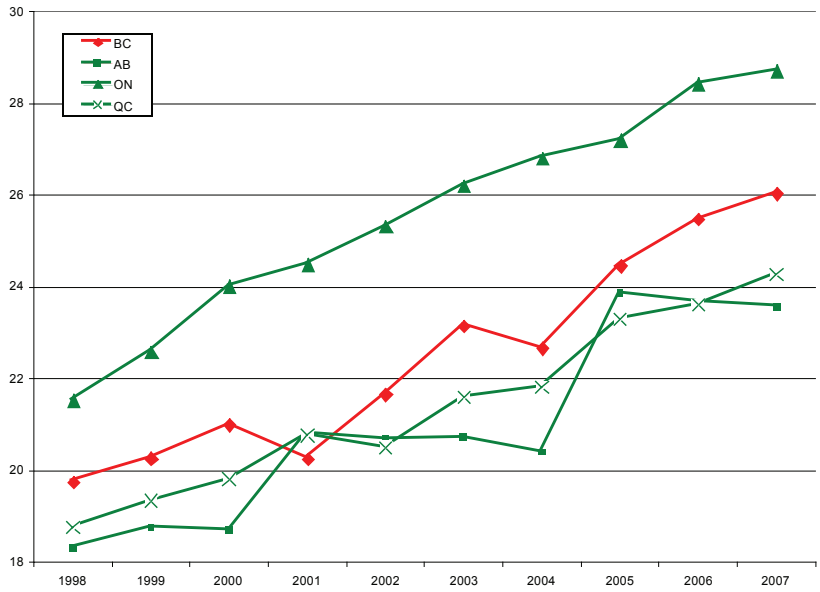
It is a safe prediction that in the next decade British Columbia will be challenged by the intersecting pressures of demographic change, increasing demand for highly qualified personnel and competition for the same personnel at national and global levels. We must continue to attract international students and immigrants. Universities will also have to work with governments and accreditation bodies to ensure that programs are in place to evaluate and, as required, upgrade foreign credentials. But we cannot rely on immigration alone. We should build on recent efforts to increase college and university participation rates, especially among underrepresented groups. We can also use our existing comparative advantages to attract highly qualified personnel from elsewhere in Canada. These advantages include much more than scenery and a temperate climate; they include a superior

16 *Momentum* (AUCC, 2008), p.40.

17 *Education at a Glace 2008* (OECD), cited in Canadian Council on Learning, *Post-Secondary Education in Canada: Meeting Our Needs?* (February 2009), p. 36.

18 *Momentum,* p. 44.

FIGURE 5: *BC university completion*

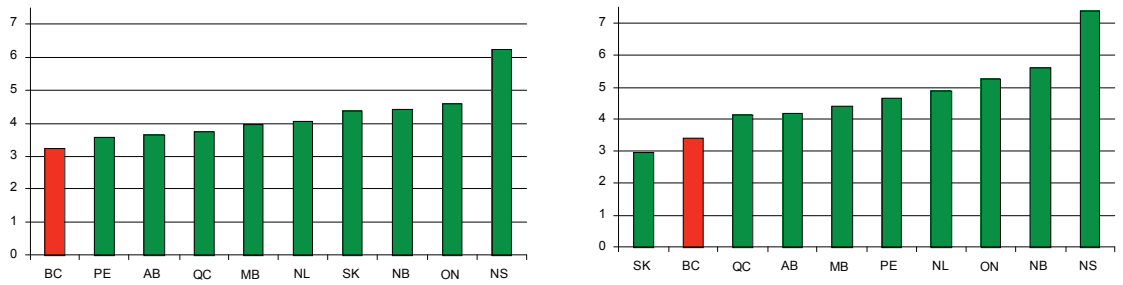


Source: BC Progress Board, BC Stats, Statistics Canada as found in the BC Progress Board 8th Annual Benchmark Report 2008, p. 46

K-12 education system for the children of newcomers to the province, a strong health care system, and an abundance of cultural riches. We should continue to attract creative minds and leaders of the future when they are young, at formative stages in their careers. This means attracting students, especially graduate students, from elsewhere. In the race for talent, perhaps no initiative is more important, as a step in the right direction, than the provincial government's new funding for graduate students at BC's research universities. To be successful will require the development of a major provincial graduate scholarship program, similar to those available in Ontario and Quebec. In the global race for talent such strategic investments will reap significant future gains.

> We should continue to attract creative minds and leaders of the future when they are young, at formative stages in their careers. No recent initiative is more important than funding for graduate students.

FIGURE 6: *Undergraduate degrees granted per 1,000 provincial population in 2000/01 and 2005/06*



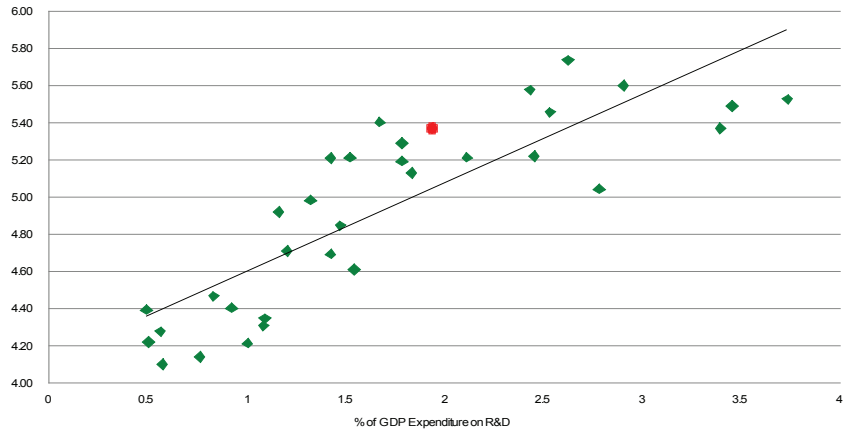
Compiled by UVic Institutional Planning and Analysis

2. KNOWLEDGE CREATION

Context

At the global level, research is being influenced by key drivers of change. First and foremost is the recognition by governments and societies around the world that research and knowledge creation are key drivers of economic prosperity. Countries with high levels of investment in research tend to be those that are the most innovative and competitive (Figure 7). As is the case with higher education, this relationship is bidirectional. Not only do countries with high investments in research develop more innovative and competitive economies, but successful economies can also afford to invest more in research. The relationship reinforces the global race for talent, since the best minds are highly mobile in today's global economy.

FIGURE 7: *Global competitiveness index and % of GDP expenditure on R&D for 33 countries*



Source: The Global Competitiveness Report and OECD Figures 2008

At the same time, the complexity and costs of leading-edge research are rising. Researchers are increasingly having to build research programs and platforms that span the disciplines and institutions in a way almost unheard of a few decades ago. A major international project such as CERN (the European Organization for Nuclear Research), for instance, is a multibillion dollar initiative involving researchers from twenty countries, and its organizational complexity is far greater than anything previously undertaken.

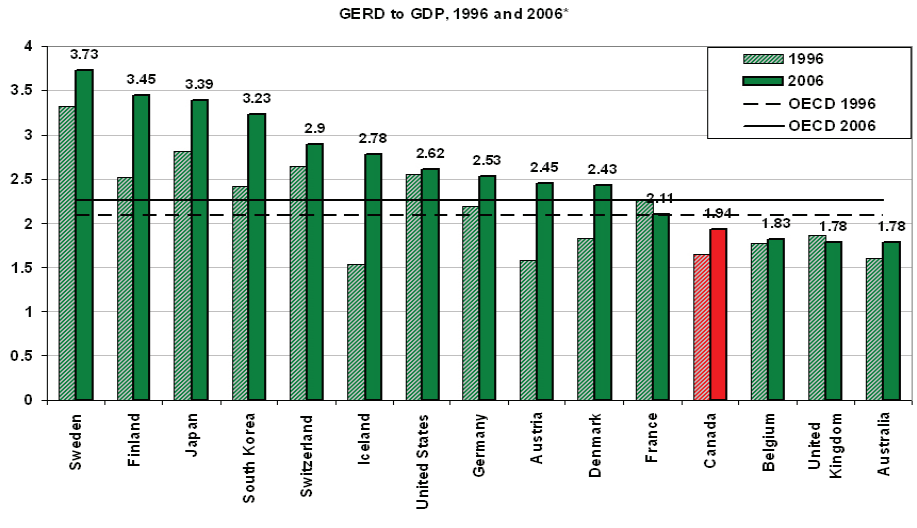
In Canada, recent investments by federal and provincial governments through the Canada Foundation for Innovation and provincial matching programs like the BC Knowledge Development Fund have enabled Canada to launch some major globally competitive research platforms. Examples include UVic's projects VENUS and NEPTUNE Canada (the world's first plate-scale ocean observatory), the Sudbury Nutrino Observatory and the Canadian Light Source in Saskatchewan.

The increase in the complexity and cost of research has resulted in a welcome increase in accountability for the use of resources in the research enterprise. Around the world, there is an increased emphasis on measuring the returns on investments in research and development (R&D). This is potentially challenging, particularly given the complexity of the R&D effort and the time lags between initial research and measurable outcomes.

Countries with high levels of investment in research tend to be those that are the most innovative and competitive.

There is increasing international recognition that Research and Development is a central driver of competitiveness, closely linked to national prosperity and quality of life. A standard measure of a nation's research intensity is the ratio of gross expenditures on R&D (GERD) to GDP. Many countries have set as their target a GERD-to-GDP ratio of 3%, and some have already met this target. Figure 8 shows that Canada ranks 12th in the OECD in GERD-to-GDP ratio, well below the level of world leaders.

FIGURE 8: *Canada's GERD-to-GDP ratio has not kept pace with increases observed in leading competitor countries*



Source: OECD, Main Science and Technology Indicators 2008/1

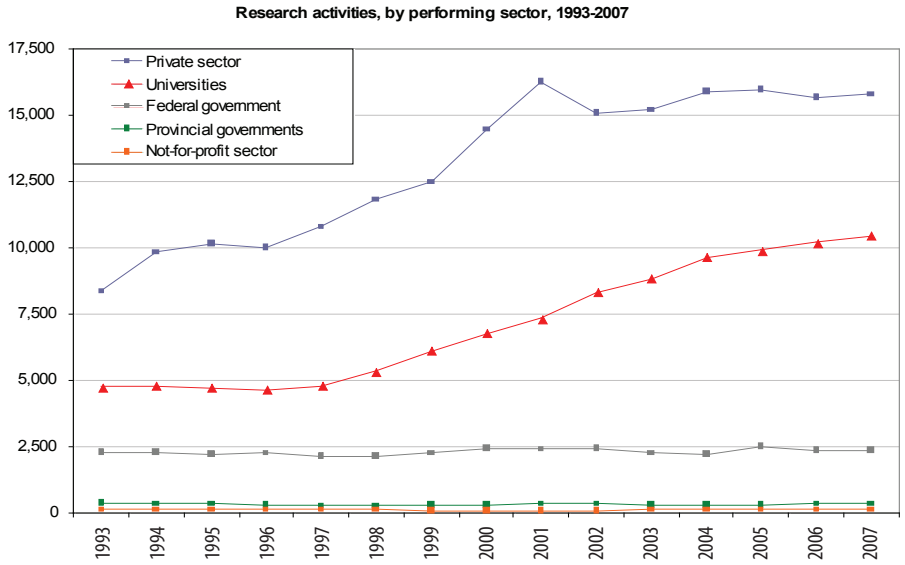
The way forward

Our research universities will play a central role in increasing Canada's research intensity. The most recent figures (2007) show that $29 billion per year is invested in research and development in Canada. The business sector invests almost half (47.8%) and universities now account for approximately 36%.[19] The total contribution of universities to the national research effort has increased significantly over the past decade (Figure 9), due to a significant increase in federal government research support. Research efforts in universities and the private sector often involve a high degree of collaboration. These university-private sector collaborations serve the country well and must continue to do so. Canadian universities already have developed strong capacities for transferring research developments to the private sector and for reducing the "transaction costs" of such transfers.

As governments attempt to stimulate more private-sector R&D investment, we must take care to maintain a balance between research targeted to specific commercial or market opportunities and "basic," "discovery" or "blue skies" research, as it is often called.

19 Canadian Council on Learning, *Post-Secondary Education in Canada: Meeting Our Needs?* (February 2009), p. 88, using data from Statistics Canada.

FIGURE 9: ***Over the last 15 years, research activities in the private sector and universities contributed most significantly to the increase in Canada's overall research performance***



Source: Statistics Canada as found in *Momentum* 2008

Universities are uniquely positioned to conduct long-term, independent research—flexible, curiosity-driven research that leads to outcomes not necessarily anticipated at the outset. The history of science tells us that great innovations often come from accidental discoveries and chance observations made while pursuing other goals.[20] The discovery of penicillin by Alexander Fleming is merely one example. Similarly, there would have been no discovery of insulin without the existing medical research infrastructure at the University of Toronto when an unknown surgeon named Frederick Banting showed up in 1920 with his good idea about isolating the internal secretion of the pancreas.[21] And lasers have many uses in industry and medicine today, but the technology emerged from deep roots in the physics of radiation and wave theory; not until many years after the invention of the laser in the 1950s did its industrial uses become apparent. Innovations of great economic and social benefit cannot be prescribed in advance. They require the presence of a strong "pure science" infrastructure.

As these examples suggest, it is impossible to make a clear distinction between applied and "pure" research.[22] What we need is a research infrastructure developed to match provincial and national needs and comparative advantages, and to maximize exchanges between universities, government, and businesses of all sizes. We also need much more specific metrics, targeted to the multiple benefits of research. As Geoff Plant argued in 2007, "we need to ensure that we can measure the value received for public research and innovation funding in terms other than commercial success." We must learn to measure the value of research with respect to all of its contributions: to lifelong learn-

20 Belinda Linden, "Basic Blue Skies Research in the UK: Are We Losing Out?" *Journal of Biomedical Discovery and Collaboration,* 3:3 (2008).

21 Michael Bliss, *The Discovery of Insulin* (McClelland & Stewart, 1982).

22 In Britain the Russell Group report of 2008 on 82 economic projects distinguished the commercialization of "blue skies" research from commercial projects emerging from applied, problem-targeted research, and discovered that average returns for the former were twice as high as for the latter. Hannah Fearn, "Reach for the Skies," *Times Higher Education,* 13 November 2008; "Basic Research Trumps Applied in Value Created," *CAUT Bulletin,* 56, 1 (January 2009).

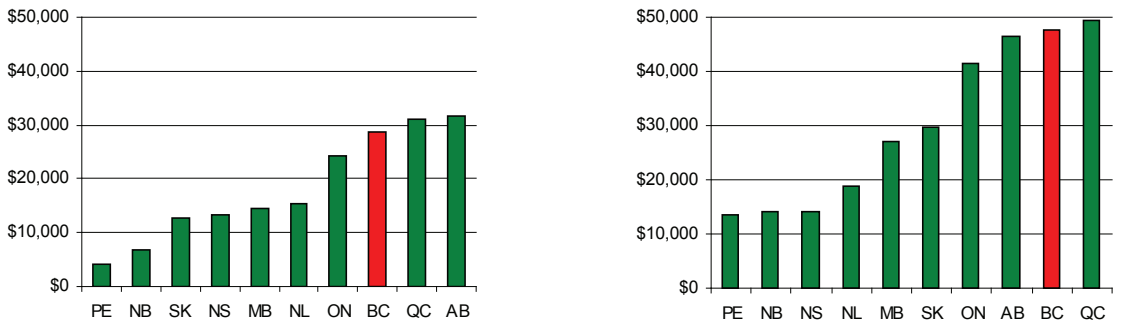
ing, to social cohesion, and to cultural capacity, as well as to productivity and specific commercial outcomes.[23]

A strong research infrastructure is essential. It would be short-sighted to make all university research funding contingent upon specific commercial outcomes.

In our fast-changing world we must expect the unexpected. Of course we cannot predict the unpredictable, but we can prepare. A strong research infrastructure is essential if we are to take advantage of a sudden new opportunity or to respond to an unanticipated crisis. In the 1970s, who would have guessed that there would suddenly be a demand for specialists in retroviruses, following the discovery of AIDS? Who in 2000 would have guessed that there would suddenly be an enormous demand for specialists in Islamic studies? For these reasons we cannot make university-based research funding contingent on economic benefits to be specified in advance. But we do need to think hard about British Columbia in the global context, in order to build a research infrastructure and an ideas ecosystem capable of responding to new and unpredictable opportunities.

Our university-based R&D is driven, above all, by people—by the faculty at research universities. Faculty at BC research universities rank second of the 10 provinces in terms of research funding per faculty member from the federal granting councils—the Natural Sciences and Engineering Research Council (NSERC), the Canadian Institutes of Health Research (CIHR) and the Social Sciences and Humanities Research Council (SSHRC) (Figure 10).

FIGURE 10: *Federal granting council funding (SSHRC, NSERC, CIHR) per faculty member by province—2000/01 and 2007/08*



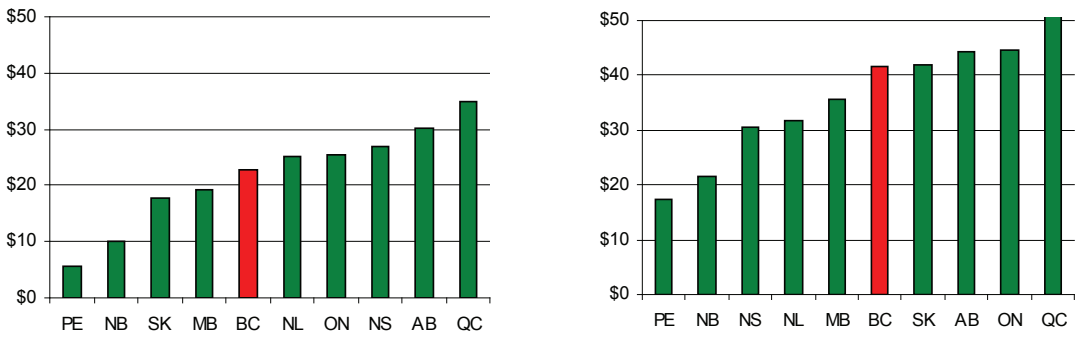
Compiled by UVic Institutional Planning and Analysis

When federal granting council funding to BC is expressed on a per provincial population level, however, BC's ranking changes considerably (Figure 11). In this analysis, BC ranks fifth among the provinces—hardly a leadership position in the emerging knowledge economy. Taken together, the data in these figures suggest that, although the quality of BC research intensive universities is very high in the Canadian context, provincial capacity needs to improve.

The success of Alberta, Ontario and Quebec relative to BC has been attributed in part to the much higher level of support for graduate students in these provinces relative to BC. Graduate students conduct significant amounts of the national research effort and their engagement is key to British

23 *Campus 2020: Thinking Ahead—The Report* (April 2007), p.84.

FIGURE 11: *Federal granting council funding (SSHRC, NSERC, CIHR) by provincial population—2000/01 and 2007/08*



Compiled by UVic Institutional Planning and Analysis

Columbia's success. Recently, the province of BC has recognized the importance of graduate education and has increased the number of funded graduate spaces in the province. There have been modest investments in increasing graduate scholarship programs but more is needed to effectively position BC universities for continued success.

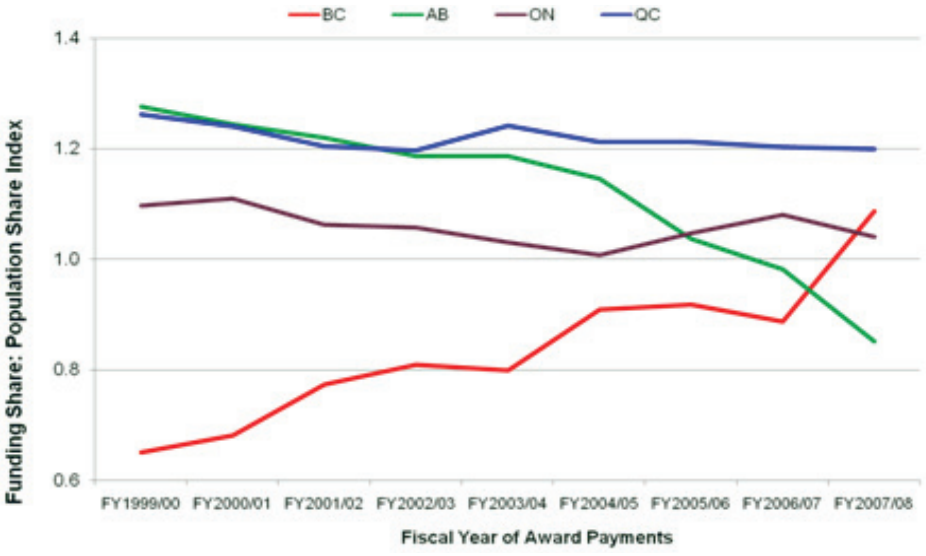
Two other factors will play a key role in expanding our knowledge infrastructure. The first is the number of faculty members at research-intensive universities. The second is the ability of researchers in all BC universities to leverage federal research funding. In recent years there has been a significant investment by the province of British Columbia in addressing these issues. Since 2000, the number of faculty at BC's research universities has increased by 39%—from 3,108 to 4,320. In addition, there has been a significant increase in funding to health-related research. The effect of these two types of investment on the intensity of health research in BC has been dramatic.

In 2000, BC was receiving less than 70% of the Canadian Institutes for Health Research (CIHR) funding one would anticipate considering BC's share of the Canadian population. Through the growth in research faculty numbers and the leverage provided by provincial agencies such as the Michael Smith Foundation for Health Research and Genome BC, British Columbia's success in attracting health research funding has increased greatly (Figure 12). Such major investments in health research enabled BC researchers' role in the sequencing of the SARS genome—an example of our success in world-leading research initiatives. Similar progress in the natural and social sciences, engineering and humanities may have comparable effects in bringing additional research funding to British Columbia.

In BC we have expanded our university system, but in terms of university researchers per capita, we are 20% below the national level.

Research funding is but one metric of research activity. More important are the results of that research and whether they are viewed as significant. Figure 13 shows that Canada ranks seventh in papers published and sixth in terms of citations. These results indicate that the Canadian research effort is productive by global standards and the quality of the work is extremely high.

FIGURE 12: *CIHR funding for BC, AB, ON and QC by population*



Source: Michael Smith Foundation for Health Research

FIGURE 13: *Canada's international standing in published papers and citations*

	Papers	Citations	Citations per Paper	Rank: Papers	Rank: Citations
USA	2,864,275	39,027,838	12.63	1	1
Japan	777,992	6,612,826	8.5	2	4
Germany	738,067	7,935,567	10.75	3	3
England	653,177	7,955,521	12.18	4	2
France	529,636	5,414,557	10.22	5	5
PR China	471,890	1,894,810	4.02	6	13
Canada	**393,143**	**4,377,986**	**11.14**	**7**	**6**
Italy	371,205	3,594,444	9.68	8	7
Russia	275,945	1,057,928	3.83	9	18
Spain	270,139	2,248,541	8.32	10	11
Australia	249,892	2,442,466	9.77	11	9
Netherlands	220,881	2,837,971	12.85	12	8
India	215,847	895,528	4.15	13	21
South Korea	192,361	1,005,008	5.22	14	19
Sweden	168,574	2,053,237	12.18	15	12
Switzerland	159,667	2,285,847	14.32	16	10
Brazil	137,159	720,131	5.25	17	22
Taiwan	130,281	693,017	5.32	18	23
Poland	121,061	658,927	5.44	19	24
Belgium	118,411	1,295,296	10.94	20	14
Israel	106,122	1,098,417	10.35	21	17
Scotland	102,053	1,286,716	12.61	22	15
Denmark	87,496	1,129,465	12.91	23	16
Finland	82,001	948,501	11.57	24	20

Source: http://in-cites.com/countries/2007allfields.html

In British Columbia we benefit from research of very high quality in our universities. We have greater depth than breadth, however, and in thinking about the future of the knowledge economy, we need to acknowledge that our research university system is relatively small. We rank eighth among provinces in expenditures on post-secondary education per provincial GDP.[24] We have

24 CAUT Almanac 2008–09, Table 1.3, using data for 2006–07. Provincial expenditures as a percent of GDP were 1.10% in B.C. compared to 1.14% nationally. By this measure BC ranks behind Newfoundland, PEI, Nova Scotia, New Brunswick, Quebec, Manitoba and Saskatchewan.

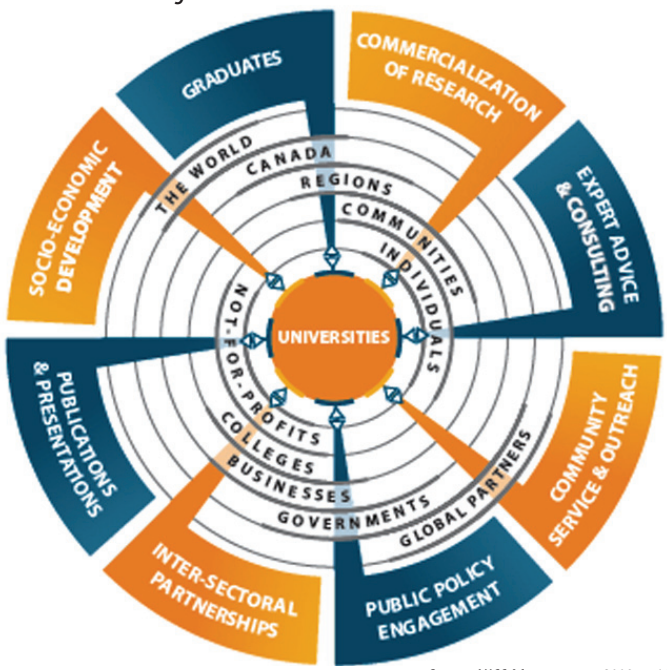
excellent university-based researchers, but relatively few of them. In terms of university researchers per capita, we were 20% below the national level in 2006–07. To bring our numbers up to the national level, we needed to add more than 800 to our current complement of full-time research university faculty.[25] The creation of new universities in 2008 helped to narrow the gap, but a big gap remains. We need to re-consider the size of our university research infrastructure, especially in terms of its complement of research personnel.

3. KNOWLEDGE TRANSFER AND APPLICATION

Context

For new knowledge to be of use to society, the transfer of knowledge from the university to society must be effective. Knowledge transfer happens in many ways. The most extensive transfer is through the movement of university graduates into the work place and society more broadly. Other mechanisms include publishing, consulting, support of policy development, community outreach, work with industry on industrial development, and a host of other activities that circulate knowledge.[26] Figure 14 summarizes the many forms and benefits that university knowledge mobilization can take.

FIGURE 14: *Knowledge transfer*



Source: AUCC *Momentum* 2008, p. 66

25 According to Statistics Canada there were 4,296 full-time university teaching staff in BC in 2005–06, and 14,676 in Ontario. The Canadian total was 39,615. The ratio for BC was 1.01 per thousand population; for Ontario it was 1.16 per thousand, and for Canada 1.22 per thousand. Statistics Canada UCASS Reports (University and College Academic Staff System).

26 Association of Universities and Colleges of Canada (AUCC), *Momentum:* the 2008 report on university research and knowledge mobilization, 2008, p. 67.

Some of the current measures used to demonstrate the contribution of the research universities to commercialization and knowledge transfer are illustrated in Figure 15.[27]

FIGURE 15: *Indicators of knowledge transfer activities by universities*

	1999	2006	1999 to 2006 increase
Operational expenditures on IP management ($ millions)	22	42.5	93.20%
Disclosures	893	1,356	51.80%
New patent applications	656	1,442	119.80%
Number of spin-offs	718	1,068	48.70%
New Licenses	232	437	88.40%
Value of industrial research contracts ($ millions)	153.8	370.5	140.90%

Source: Statistics Canada as found in AUCC, *Momentum* 2008, p. 128

These data show a dramatic increase in the commercialization activities of Canadian universities. Between 1999 and 2006 disclosures by Canadian universities have increased by 51.8%, patent applications 119.8%, spin off companies 48.7% and licences 84.4%. These results show the increasing emphasis universities place on the transfer of knowledge to the community. Within BC, our universities have an exceptional track record in these same transfer activities.[28]

There is a critical connection between knowledge transfer and the location of knowledge creation. The "silicon valley" phenomenon is well-known: high-technology industries tend to concentrate around pre-existing research hubs (silicon valley in California, the greater Boston area, and the North Carolina research triangle).[29] Recent research suggests that the industry-research clustering is an even wider phenomenon. There is a paradox here: in a global village of offshoring, cross-border capital flows, and global communication, knowledge spill-overs tend to be highly concentrated in specific locations or "industry clusters."[30] In a recent report to the Ontario government, Roger L. Martin and Richard Florida argue that Ontario has an above-average concentration of clustered industries, and "this should create a sizeable productivity advantage for the province." But they add that Ontario's clusters "have less creative content" than 14 U.S. peer states. They argue for a broadly-based strategy of investment in both talent and technology. Talent, in the form of human capital and creativity-oriented occupations, is strongly associated with innovation, productivity, and regional prosperity.[31] We would do well to heed such lessons in British Columbia: to maximize the benefit of knowledge transmission, we must assemble knowledge and creativity within the province. Researchers think globally but act locally.

27 See also Natural Sciences and Engineering Research Council of Canada: Analysis of Program Activities by Strategic Outcome at http://www.tbs-sct.gc.ca/dpr-rmr/2007-2008/inst/nse/nse02-eng.asp.

28 In 2007 alone, SFU, UBC and UVic generated 108 new patent applications and 260 disclosures; license income for the three universities in 2007 totalled $13,157,987. AUTM [Association of University Technology Managers] *Canadian Licensing Activity Survey,* 2007, Data Appendix.

29 The vast literature is summarized in Richard Florida, Gary Gates, Brian Knudsen, and Kevin Stolarick, *The University and the Creative Economy* (December 2006), at the web site of the Martin Prosperity Institute: http://www.martinprosperity.org/.

30 "Q & A with Michael Porter," Business Week, 21 August 2006.

31 Roger L. Martin and Richard Florida, *Ontario in the Creative Age* (Martin Prosperity Institute, February 2009).

In the last two decades BC's universities have responded rapidly to the demand for commercial applications of research, by creating university-industry liaison offices and research parks. The university-industry liaison offices organize knowledge translation, community outreach, management of intellectual property, and technology transfer.[32] Research parks, such as the Vancouver Island Technology Park, have become the university's transfer hubs—the places where much of the university-private sector collaborations occur. Also at the cutting edge of the university-private sector collaboration is Discovery Parks, a private trust that operates facilities on five of our campuses. These parks foster the commercialization of research, they house spin-off companies, and they provide a range of services relating to commercialization and intellectual property. They provide low operating costs, affordable rent, and commercial facilities that are environmentally sustainable.

These positive developments are helping to counteract specific Canadian weaknesses in the areas of science, technology and innovation. These weaknesses also exist in BC and must be confronted directly as we think about the future. *State of the Nation 2008,* the report by the federal Science, Technology and Innovation Council, argues the importance of "talent indicators," and notes that two in five working-age Canadians lack the skills of literacy and numeracy required to work effectively in a knowledge-based economy.[33] A further problem is that Canada performs poorly in formal workplace training, investing much less than the US and many European countries. Real per capita investment in "on the job" training actually fell between 1996 and 2006.[34] In the area of commercialization of research, *State of the Nation* notes that Canadian universities produce spin-off companies and other transfers at relatively high rates, and that the private sector directs a relatively high level of research spending towards universities. The weakness is that the proportion of Canadian businesses collaborating with universities in research and development is relatively low by international standards. Most Canadian businesses have no contact with university-based R&D.[35]

These weaknesses may relate to cultural differences between Canada and the US, especially at the levels of small and medium-sized business. "Go to Canada and knock on 500 high-tech companies and ask how many PhDs are doing research and you'll be lucky if you find one or two," says Dr. Arvind Gupta, Director of MITACS (Mathematics of Information Technology and Complex Systems), based at Simon Fraser University. Comparable companies in the US tend to employ many more PhDs, and to have their own research departments as well as direct connections to a university. "In the US if you ask a company why they do research it will look at you strangely: 'We do research because we have to develop our next product.'" The tendency in Canada is to see research as a cost yielding uncertain benefits. In Canada, all too often the measure of success is a profitable sell-out to a major corporation rather than sustained independent growth.[36]

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32 *Momentum,* p. 49. See, for instance, the web sites of the University-Industry Liaison Offices at UBC and SFU, and the Innovation and Development Corporation at UVic.

33 *Learning a Living: First Results of the Adult Literacy and Life Skills Survey* (Statistics Canada 89–603-XWE, 2005). Statistics Canada estimates that a 1% increase in average literacy and numeracy would permanently raise GDP per capita by 1.5%. Coulombe Serge, Tremblay, J-F and Marchand. *Literacy scores, human capital and growth across fourteen OECD countries*. Statistics Canada, 2004.

34 *State of the Nation 2008,* pp. 8, 40.

35 *State of the Nation 2008,* pp.7, 36.

36 Gupta's views are summarized by Gary Mason, "Scarcity of R&D driving top minds from Canada," *Globe and Mail,* 21 February 2009.

Whatever the reasons for the weaknesses identified by the *State of the Nation* report, universities must build on existing strengths to help provide solutions.

The way forward

Bearing in mind these contexts, we proceed now to suggest ways in which universities are assisting with solutions and can expand their capacity to do so in future. Simply put, in Canada and British Columbia we need nothing less than a new level of engagement between universities and society as a whole. We need to create a culture that is passionate about creating, acquiring and sharing knowledge and skills. We need to build a passion for applying knowledge and skills to improve the economic, social and environmental fabric of our society.

Universities have a key role to play. They must expand their capacity for knowledge and technology transfer, by persuading more businesses to welcome collaboration with university-based researchers. Universities must encourage and expand knowledge transfer activities on their campuses. This will require a new level of collaboration between government, universities, the private sector and the not-for-profit sector. Government support for tech transfer and broadly based knowledge transfer activities must be increased, and universities must more fully support knowledge mobilization efforts in all areas of their institutions, not just science and engineering. New programs to support university faculty secondments to business and government settings and private sector and government secondments to universities should be developed.

Engaging students in knowledge transfer will also yield great dividends. One of the great success stories in British Columbia is co-operative education. Every year thousands of students take jobs as part of their education. In 2008/09 the total number of job placements by post-secondary students was over 10,000. Collectively, these students are agents for knowledge transfer. MITACS Accelerate offers another example of students as a conduit for knowledge and innovation. This program sends student interns into businesses to solve specific problems, to reduce the firm's R&D costs, and to stimulate internal research programs. In 2007/08, Accelerate projects involved 319 off-campus partners and 1,025 students.[37] These programs and others like them must be expanded.

We occupy a unique space in the global economy; British Columbia is resource rich, talent rich and our comparative advantages include our geographic location. The knowledge economy will not displace our resource-based industries; rather it is changing our ways of working with nature's elements. There are many examples of past innovations in forestry, mining, agriculture and the marine sector, and our geography has always encouraged innovation in the areas of energy, transportation and communications. Today the universities also contribute directly to innovation in health and medical sciences, to IT innovation, green technology and climate change solutions, digital media, and electronic infrastructure—major pillars of future development for BC, as recognized by the Premier's Technology Council. British Columbia is also Canada's gateway to the Pacific Rim and Asia, and we must think hard about our relationship to the Asian economic powerhouses of the 21st century. In BC we need to produce more mathematicians and scientists—and we also need graduates who are fluent in foreign languages.

37 See the MITACS site at http://www.mitacs.math.ca/main.php.

Our natural riches and our activities in developing our creative capacity will help position BC as a jurisdiction of innovation; a place where knowledge flows seamlessly between the universities and society more broadly and where the benefits derived from that knowledge accrue to all members of society. This is an ambitious but realistic goal that requires that universities, governments and the private sector work together and challenge one another to be among the most innovative and entrepreneurial economies in the world.

The university sector plays an essential role in producing the next generation of skilled, adaptable and creative citizens.

Our measures of performance must therefore be both local and global. We must benchmark ourselves against the best in the world using indicators such as publications, patents, licenses, spin-off companies and economic and social benefits of research. We must measure the private sector's commitment to innovation and research and work to enhance the culture of innovation in our industries, especially those where we have strong comparative advantages. We need to focus on how to increase our success, but whatever new metrics emerge, the strong tripartite collaboration between universities, the provincial government and business will be critical to the formulation and attainment of long-term goals for the province.

CONCLUSION: VISION FOR BRITISH COLUMBIA

The universities' focus on knowledge—the creation of knowledge (research), the transmission of knowledge (developing human capital) and the application of knowledge—is fundamental to the attainment of British Columbia's economic and social goals. In developing our 2020 vision for British Columbia, we should be guided not only by the importance of the "knowledge economy," but also by a wider vision—the fully attainable goal of a society in which innovation and creativity grow from an educated population dedicated to continuous learning throughout the life course. This means applying scientific and technological knowledge to specific problems, and it demands much more. It means building the conditions in which innovations arise, as if spontaneously, from many pools of talent and many local synergies of art and science.

A knowledge economy means building the conditions in which innovations arise from many pools of talent and many local synergies of art and science.

Finally, let us understand that we are in the middle of a sweeping economic transformation that is both local and global. The long historical trend towards increased education attainments and skill levels in national populations has not ended; if anything, it is accelerating. While knowledge transfer is localized in regional clusters, possessors of knowledge are highly mobile, and the best will be recruited aggressively, not only by employers in the United States but also increasingly by emerging economies in Asia. We are in a strong position to meet this global competition. The university sector will continue to play an essential role in producing the next generation of skilled, adaptable and creative citizens; in retraining those who are caught in a world of changing skill requirements; in creating and transferring knowledge; and in building the knowledge infrastructure essential to a

creative society. We are "beautiful BC," as the slogan says, but we must be much more—bountiful British Columbia, the province of learning, as abundant in knowledge and talent as we are rich in nature's gifts.

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