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Canada's University Innovation Leaders

A SUPPLEMENT PREPARED BY RESEARCH INFOSOURCE INC., AN IMPACT GROUP COMPANY

RESEARCH INCOME GROWTH SLOWS — Canada's Top 50 Research Universities reported a 3.0% increase in combined research income in Fiscal 2009, down from 6.0% the previous year. Total research income rose to

Canada's Top 50 Research Universities 2010

Rank		University	Sponsored Research Income			Full-time Faculty**	Research Intensity	Province
2009	2008		FY2009 \$000	FY2008 \$000	% Change 2008-2009	2008-2009 #	\$ per Full-time Faculty \$000	
1	1	University of Toronto***	\$858,182	\$844,861	1.6	2,445	\$351.0	Ontario
2	3	University of British Columbia*	\$524,569	\$470,146	11.6	2,214	\$236.9	British Columbia
3	2	University of Alberta*	\$507,613	\$491,742	3.2	1,644	\$308.8	Alberta
4	4	Université de Montréal*	\$486,179	\$468,729	3.7	1,890	\$257.2	Quebec
5	5	McGill University*	\$432,118	\$418,554	3.2	1,605	\$269.2	Quebec
6	6	McMaster University*	\$377,732	\$373,542	1.1	1,221	\$309.4	Ontario
7	7	Université Laval*	\$282,657	\$278,621	1.4	1,335	\$211.7	Quebec
8	9	University of Calgary*	\$264,358	\$236,202	11.9	1,560	\$169.5	Alberta
9	10	University of Western Ontario*	\$241,700	\$222,336	8.7	1,407	\$171.8	Ontario
10	8	University of Ottawa*	\$236,977	\$245,524	-3.5	1,221	\$194.1	Ontario
11	12	Queen's University*	\$178,180	\$192,502	-7.4	816	\$218.4	Ontario
12	13	University of Manitoba*	\$172,067	\$161,700	6.4	1,173	\$146.7	Manitoba
13	11	University of Saskatchewan*	\$169,450	\$203,546	-16.8	1,086	\$156.0	Saskatchewan
14	15	University of Waterloo	\$157,152	\$135,152	16.3	990	\$158.7	Ontario
15	14	University of Guelph	\$154,850	\$142,119	9.0	804	\$192.6	Ontario
16	16	Dalhousie University*	\$125,689	\$123,950	1.4	993	\$126.6	Nova Scotia
17	17	University of Victoria	\$104,812	\$112,429	-6.8	672	\$156.0	British Columbia
18	18	Université de Sherbrooke*	\$96,833	\$91,557	5.8	996	\$97.2	Quebec
19	19	Simon Fraser University	\$83,838	\$86,739	-3.3	843	\$99.5	British Columbia
20	20	Carleton University	\$72,750	\$84,033	-13.4	717	\$101.5	Ontario
21	22	Memorial University of Newfoundland*	\$72,604	\$69,044	5.2	894	\$81.2	Newfoundland
22	23	York University	\$68,099	\$63,919	6.5	1,413	\$48.2	Ontario
23	21	Université du Québec à Montréal	\$63,724	\$70,232	-9.3	984	\$64.8	Quebec
24	24	Institut national de la recherche scientifique+	\$51,656	\$49,771	3.8	156	\$331.1	Quebec
25	25	University of New Brunswick	\$51,169	\$46,540	9.9	561	\$91.2	New Brunswick
26	26	Concordia University	\$37,178	\$38,647	-3.8	858	\$43.3	Quebec
27	27	University of Windsor	\$34,733	\$27,421	26.7	519	\$66.9	Ontario
28	29	Laurentian University*	\$21,963	\$19,949	10.1	423	\$51.9	Ontario
29	30	Ryerson University	\$21,839	\$19,922	9.6	711	\$30.7	Ontario
30	28	University of Regina	\$20,258	\$20,528	-1.3	366	\$55.3	Saskatchewan
31	31	Université du Québec à Chicoutimi	\$19,560	\$19,022	2.8	219	\$89.3	Quebec
32	34	Royal Military College of Canada	\$18,301	\$17,285	5.9	195	\$93.9	Ontario
33	32	Lakehead University*	\$18,047	\$17,685	2.0	282	\$64.0	Ontario
34	38	Université du Québec à Trois-Rivières	\$17,966	\$14,853	21.0	342	\$52.5	Quebec
35	36	University of Northern British Columbia	\$17,766	\$16,589	7.1	180	\$98.7	British Columbia
36	40	Université du Québec à Rimouski	\$17,439	\$14,146	23.3	186	\$93.8	Quebec
37	35	University of Lethbridge	\$15,956	\$16,683	-4.4	339	\$47.1	Alberta
38	37	University of Prince Edward Island	\$15,855	\$16,421	-3.4	222	\$71.4	Prince Edward Island
39	39	École de technologie supérieure+	\$14,644	\$14,475	1.2	141	\$103.9	Quebec
40	42	Université du Québec en Abitibi-Témiscamingue	\$14,422	\$12,713	13.4	105	\$137.4	Quebec
41	33	Trent University	\$13,490	\$17,321	-22.1	252	\$53.5	Ontario
42	41	Brock University	\$12,905	\$13,568	-4.9	546	\$23.6	Ontario
43	43	St. Francis Xavier University	\$10,554	\$12,679	-16.8	234	\$45.1	Nova Scotia
44	45	Nova Scotia Agricultural College+	\$10,407	\$8,968	16.0	66	\$157.7	Nova Scotia
45	46	Université de Moncton	\$10,148	\$8,815	15.1	333	\$30.5	New Brunswick
46	68	OCAD University+	\$9,259	\$383	2,317.5	87	\$106.4	Ontario
47	47	Wilfrid Laurier University	\$9,182	\$8,347	10.0	468	\$19.6	Ontario
48	50	University of Ontario Institute of Technology+	\$8,777	\$5,592	57.0	138	\$63.6	Ontario
49	44	Saint Mary's University	\$8,507	\$10,497	-19.0	237	\$35.9	Nova Scotia
50	52	University of Winnipeg	\$6,101	\$4,416	38.2	243	\$25.1	Manitoba

Notes:

1. Sponsored research income: includes funds to support research paid in the form of a grant, contribution or contract from a source external to the institution.
2. Financial data were obtained from Statistics Canada.
3. Faculty data were obtained from Statistics Canada, Conférence des recteurs et des principaux des universités du Québec (CREPUQ) and the RESEARCH Infosource Canadian University R&D Database. For confidentiality reasons, Statistics Canada randomly rounds the figures either up or down by a multiple of "3".
4. Data are provided for the main university/college including its affiliated institutions, where applicable.
5. All institutions are members of the Canadian Association of University Business Officers (CAUBO).

*Has a medical school

+Not a full-service university

++Sponsored research income administered by affiliated hospitals was reported one fiscal year in arrears

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Research Universities of the Year 2010

Three universities gain RESEARCH Infosource's designation of *Research University of the Year* in their category for their performance on a balanced set of input, output and impact measures for FY2009. These full-service universities demonstrated superior achievement both in earning research income and in publishing research in leading scientific journals.

Rank	Medical/Doctoral	Score*	Rank	Comprehensive	Score*	Rank	Undergraduate	Score*
1	University of Toronto	99.7	1	University of Waterloo	94.7	1	University of Northern British Columbia	74.4
2	McGill University	71.1	2	University of Guelph	88.7	2	Ryerson University	71.8
3	University of Alberta	69.6	3	University of Victoria	73.1	3	Trent University	71.6
3	University of British Columbia	69.6						

* The Score in each category is out of a possible 100 points based on the following indicators and weighting: 2 input measures: total sponsored research income (20%), and research intensity (20%); 2 output measures: total number of publications (20%) and publication intensity in leading journals (20%), and 1 impact measure: publication impact (20%). For each measure, the top ranking institution is assigned a score of 100 and the other institutions' scores are calculated as a percentage of the first ranking institution. See www.researchinfosource.com for details.

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\$6.24 billion in Fiscal 2009, compared with \$6.06 billion in Fiscal 2008. The pace of income growth has slowed markedly from the high single and double-digit rises that were typical in the early part of the past decade.

Part of the decline this year resulted from hiatus in activity at the Canada Foundation for Innovation, which did not hold a major competition in Fiscal 2009. Also dragging down research income growth in Fiscal 2009 was a -27.7% drop in funding from Individuals, which came on the heels of a -20.4% decline the year before. In addition, income from Endowments/Investments fell by -6.6% between Fiscal 2008 and Fiscal 2009. Reduced donations by Individuals and less income from Endowments/Investments likely reflect the uncertain economic climate. Disappointingly, Corporate contributions grew by only 0.3%, compared with 10.3% in Fiscal 2008. On a positive note, Foreign sources expanded by 17.1% in Fiscal 2009, following a -22.8% decline the year prior.

THE \$100 MILLION CLUB HOLDS FIRM

Seventeen universities gained \$100 Million Club status, each recording research income of \$100 million or more, accounting for 85% of total Top 50 research income in Fiscal 2009. Most Club members have medical schools and affiliated research hospitals or health authorities, which attract considerable amounts of research support. However, 3 institutions (University of Waterloo, University of Guelph and University of Victoria) achieved Club status without the benefit of medical schools or research hospitals/health authorities. Overall, 13 Club members saw their research income grow, while 4 others saw a decline.

The \$100 Million Club		
2009 Rank	University	Research Income \$000
1	University of Toronto*	\$858,182
2	University of British Columbia*	\$524,569
3	University of Alberta*	\$507,613
4	Université de Montréal*	\$486,179
5	McGill University*	\$432,118
6	McMaster University*	\$377,732
7	Université Laval*	\$282,657
8	University of Calgary*	\$264,358
9	University of Western Ontario*	\$241,700
10	University of Ottawa*	\$236,977
11	Queen's University*	\$178,180
12	University of Manitoba*	\$172,067
13	University of Saskatchewan*	\$169,450
14	University of Waterloo	\$157,152
15	University of Guelph	\$154,850
16	Dalhousie University*	\$125,689
17	University of Victoria	\$104,812

*Has a medical school

MIXED PROVINCIAL PERFORMANCE

On a provincial basis, research income gains in Fiscal 2009 were strongest in New Brunswick, where the

province's 2 universities expanded their combined income by 10.8%. The other provinces where reported research income growth exceeded the national average income increase of 3.0% were: Manitoba (7.3%), British Columbia (6.6%), Alberta (5.8%) and Newfoundland (5.2%).

Provincial shares of total research income were largely unchanged, but Alberta's 3 Top 50 institutions increased their portion in Fiscal 2009 to 13% of the total up from 12% in Fiscal 2008, as did British Columbia moving from 11% of total Top 50 research income in Fiscal 2008 to 12% of total income in Fiscal 2009.

Top 50 – Leading Provinces	
Province	% of Total
Ontario (19)	40
Quebec (12)	25
Alberta (3)	13
British Columbia (4)	12

GAINERS AND LOSERS

Twenty-eight of the Top 50 universities recorded increases in their research income in Fiscal 2009 that exceeded the national average of 3.0%. The top gainers were led by OCAD University (2,317.5%), University of Ontario Institute of Technology (57.0%) and University of Winnipeg (38.2%). Other universities that also made impressive gains in Fiscal 2009 included University of Windsor (26.7%), Université du Québec à Rimouski (23.3%) and Université du Québec à Trois-Rivières (21.0%).

For a number of other universities, Fiscal 2009 research income growth results were disappointing.

SMALL INCREASE IN RESEARCH INTENSITY

Slowing overall research income growth (3.0%), combined with a slight rise in full-time faculty numbers produced a tepid 1.4% increase in research intensity (research income per full-time faculty position) in Fiscal 2009. On average, each university attracted \$167,200 of research income per full-time faculty position, compared with \$164,800 the year before. While University of Toronto maintained its leadership position attracting \$351,000 per full-time faculty position, McMaster University (\$309,400) and University of Alberta (\$308,800) had solid claims on second and third place respectively.

TIER SHARES UNCHANGED

Sixteen Medical/Doctoral universities accounted for 81% of total research income in Fiscal 2009, the same share as in Fiscal 2008. Also unchanged were the shares of the 12 Comprehensive institutions (14% of total research income) and the 22 Undergraduate universities (5% of the total). Interestingly, the Undergraduate institutions posted an impressive 7.8% gain in research income between Fiscal 2008 and Fiscal 2009, compared with a 2.7% increase by Medical/Doctoral universities and 2.6% by Comprehensive institutions.

RESEARCH UNIVERSITIES OF THE YEAR

RESEARCH Infosource once again shines the spotlight on 3 Research Universities of the Year – the leading institutions that excel on a balanced scorecard of research input and output/impact indicators.

This year's winners were: University of Toronto in the Medical/Doctoral category, University of Waterloo in the Comprehensive category and University of Northern British Columbia in the Undergraduate category.

SPOTLIGHT – DECADE IN REVIEW

RESEARCH Infosource presents a special feature, Decade in Review that shines the spotlight on three key metrics over the past decade.

Kudos for first place winners for *Research Income Growth* (1999-2009) went to McMaster University (339.7%) in the Medical/Doctoral category, University of Victoria (364.6%) in the Comprehensive category and University of Prince Edward Island (432.0%) in the Undergraduate category. The first place winners for *Research Intensity Growth* (1999-2009) were Université Laval (219.6%) in the Medical/Doctoral category, University of Victoria (287.9%) in the Comprehensive category and University of Prince Edward Island (324.2%) in the Undergraduate category. Finally, the first place winners for *Research Publication Growth* (1999-2008) were University of Calgary (90.6%) in the Medical/Doctoral category, Simon Fraser University (104.9%) in the Comprehensive category and Ryerson University (379.4%) in the Undergraduate category.

THIS YEAR AND NEXT

The “golden age” of university research funding is coming to an end. The spectacular gains in research income from Fiscal 1999 to Fiscal 2009 (see *Decade in Review* page 6) are no longer in the cards as all funders come to grips with a perilous economy. Research income growth slowed to 3.0% in Fiscal 2009 from 6.0% the previous year. In a best case scenario the “new normal” will be research income growth that keeps pace with inflation.

Government sources accounted for 68% of all Top 50 research income received by Canadian universities in Fiscal 2009, down slightly from 69% the previous year. Government income increased by 2.6%, compared with a 3.0% overall research income growth. Part of this softening reflects the absence of a major funding competition from the Canada Foundation for Innovation (which attracts matching contributions from provincial governments and others). But another part reflects the fiscal realities facing the federal and provincial governments. Even with the best of intentions governments will be severely constrained in their ability to further expand the country's academic research base. As time goes on many of the infrastructure investments made in the 2000s will reach the end of their useful life and available resources will need to be directed to replacement rather than expansion.

Whereas Government investments in research can be somewhat isolated from the annual vicissitudes of the economy (through borrowing), that is not the case for the

Top 10 Research Intensive Universities**			
2009 Rank		Research Intensity	Research Intensity (\$ per full-time faculty) \$000
Overall	University		
1	1	University of Toronto*	\$351.0
2	6	McMaster University*	\$309.4
3	3	University of Alberta*	\$308.8
4	5	McGill University*	\$269.2
5	4	Université de Montréal*	\$257.2
6	2	University of British Columbia*	\$236.9
7	11	Queen's University*	\$218.4
8	7	Université Laval*	\$211.7
9	10	University of Ottawa*	\$194.1
10	15	University of Guelph	\$192.6

*Has a medical school
**Includes full-service institutions only

Top 10 Universities by Growth			
2009 Rank		Income Growth	% Change 2008-2009
Overall	University		
1	46	OCAD University ⁺	2,317.5
2	48	University of Ontario Institute of Technology ⁺	57.0
3	50	University of Winnipeg	38.2
4	27	University of Windsor	26.7
5	36	Université du Québec à Rimouski	23.3
6	34	Université du Québec à Trois-Rivières	21.0
7	14	University of Waterloo	16.3
8	44	Nova Scotia Agricultural College ⁺	16.0
9	45	Université de Moncton	15.1
10	40	Université du Québec en Abitibi-Témiscamingue	13.4

⁺Not a full-service university

Bottom 10 Universities by Growth			
2009 Rank		Income Growth	% Change 2008-2009
Overall	University		
1	41	Trent University	-22.1
2	49	Saint Mary's University	-19.0
3	43	St. Francis Xavier University	-16.8
4	13	University of Saskatchewan*	-16.8
5	20	Carleton University	-13.4
6	23	Université du Québec à Montréal	-9.3
7	11	Queen's University*	-7.4
8	17	University of Victoria	-6.8
9	42	Brock University	-4.9
10	37	University of Lethbridge	-4.4

*Has a medical school
Apparent ties due to rounding

important Non-Government funding sector. These sources – including Corporate, Not-for-Profit, Individual and Endowments/investment – had been growing rapidly until recently, buoyed by a rising economic tide. Now that the tide is receding, many components of Non-Government income are falling.

It is hard to avoid the conclusion that the years to come will see some belt-tightening in the research community. But at the same time the need has never been greater for the academic research community to drive economic growth.

Real-world solutions for real-world challenges

Ryerson University researchers make a difference

Research at Ryerson has a practical bent that builds on traditional strengths. Our investigators shape their research questions around real-world problems, and often work together across disciplinary boundaries to find innovative solutions.

For example, Colleen Carney of the Department of Psychology left Duke University to set up Ontario's first clinical-psychology sleep lab at Ryerson. Funded by the National Institutes of Health, the premier medical-research agency in the United States, Carney is exploring the relationship between depression and insomnia, and how cognitive behavioural therapy, a non-medicinal treatment, can help put you on course for a good night's sleep.

Or consider Sri Krishnan of the Department of Electrical and Computer Engineering. As holder of the Canada Research Chair in Biomedical Signals, his research focuses on understanding human physiology from an engineering perspective. One area that Krishnan is exploring is how to reduce sudden cardiac death. By capturing the complex electrical signals generated by the heart, converting them into data and conducting analyses, Krishnan is using the results to identify people who are at risk of a heart attack. Ultimately, this knowledge will help physicians make better-informed decisions.

Thanks to the work of Carney, Krishnan and other first-rate researchers, externally funded research at Ryerson has more than doubled in the past five years. In addition, Ryerson is proud to be ranked second in the undergraduate category for top Canadian Research University of the Year, and top performer in Research Publication Growth 1999-2008.

If you would like to learn more about research at Ryerson, and how our researchers are making their marks in a variety of fields, please visit www.ryerson.ca/research.

Top: Colleen Carney
Bottom: Sri Krishnan





Innovative by nature



University of Victoria

FEEL THE POWER OF THE OCEAN. Our researchers do, every day. Whether they're investigating how to turn waves and tides into renewable energy, transforming how we study the oceans, advancing our understanding of climate change or working with vulnerable coastal communities, UVic researchers are national and international leaders in innovation. Don't just take our word for it. We're on the 2010 *Times Higher Education* list of world-class universities. And, among Canada's comprehensive universities, we're *ReSearch Infosource's* top performer of the past decade in research income growth and research intensity growth. Check us out—we're going places.

www.uvic.ca/research



We're going places

Innovation: Curiosity, Collaboration and Creativity



Professor Stephen J. Toope
President and Vice-Chancellor
The University of British Columbia

RESEARCH AND DEVELOPMENT AT universities looks very different from what we witnessed at the turn of the millennium.

The 1990s model was all about intellectual property, spinoff companies and a focus on blockbuster technologies that would float the next Google. Today, dramatic spikes from techno dreams have been smoothed down with approaches that are more open, sustainable, collaborative,

entrepreneurial, and potentially more effective. This is an exciting time to be involved in R&D in our country.

The University of British Columbia, like Canada's other research-intensive universities, has done well by the old model: UBC research discoveries have generated more than \$5 billion from the sale of products. But if we measure success only in the rarified atmosphere of commercial IP, we're cutting ourselves off from the oxygen it takes to breathe life into Canada's R&D future. While transformative technologies like Google make for transfixing social narratives, the vast majority of advances in human knowledge are incremental.

If we accept that premise, the obvious next question must be: how can we accelerate the increments? The IP-spinoff approach has been one such spur, and it still has an important role to play in the rapid deployment of new ideas. But there are other less proprietary ways to get there, such as open source, and they are transforming the global landscape in which Canada must

find ways to flourish as an innovation leader.

Advances in human knowledge aren't simply incremental, they are frequently just happy accidents on the road to somewhere else. There are payoffs from enjoying the scenery and the people we encounter even as we keep our eyes on the road. Here are some examples from my own university.

Don Mavinic, a professor of Civil Engineering, started work on the problem of phosphorus buildup in wastewater treatment pipes. It turned out he also found a way to avoid polluting our waterways while providing a sustainable source of phosphorus. The result is a technology that not only prevents phosphorus from clogging wastewater pipes but also converts it into valuable environmentally friendly fertilizer. Municipalities in Canada, the US and the UK are already benefitting from this revolutionary technology.

Prof. Kishor Wasan was working on fundamental research in drug delivery using lipids (the body's fat)

as a conveyance mechanism. He discovered that a drug previously delivered only by very expensive injection means could now be taken orally. This promises to dramatically lower the cost of treating a fatal developing world disease, visceral leishmaniasis, affecting 200 million people.

What accelerants propelled these ideas from the university into the world community? They are exactly the kind of things that I believe we need to extend Canada's R&D innovation leadership.

Collaboration is a key element in these stories, Prof. Mavinic with government and business leaders to bring the technology to a global market scale, and in Prof. Wasan's case the foresight to connect to an existing partnership between UBC's University Industry Liaison Office and the international student group Universities Allied for Essential Medicines. The resulting Global Access Initiative allowed UBC to play a leading role with Harvard, Yale and other US institutions to promote access to essential health innova-

tions in the developing world.

Direct collaboration with industry is very important. For example, UBC has embarked on an exciting clean energy project that shows how universities can make living laboratories of their campuses and lead social change. Faculty in several UBC units are working on a pilot project with Canadian biomass gasification leader Nexterra and global giant GE that will use waste wood on our Vancouver campus to generate enough clean electricity to power 1,500 homes, reduce the university's natural gas consumption by up to 12 per cent and eliminate up to 4,500 tonnes of greenhouse gas emissions per year – the equivalent of taking 1,100 cars off the road.

What are the other accelerants that will drive Canada's R&D success in the 21st century? Clearly, increasing the number of highly qualified and innovative people is at the heart of what universities do. The federal and provincial governments must promote policies to support and promote this badly needed increase.

Canada lags well behind other OECD countries, especially the United States, in the production of Masters and PhD graduates.

University graduates become even more qualified when they are given opportunities beyond the standard classroom experience. It is UBC's goal, for example, to offer every undergraduate student – not just every Science or Engineering student – a meaningful research experience. When we couple this approach with programs like work coops or international exchanges, the opportunities multiply. When we recognize the value of alliances with organizations like the BC Innovation Council, we signal institutional support for entrepreneurship across our community of students, faculty and alumni.

We can't be certain which R&D model will most advantage Canada in the next 10 years, but any system that aligns intellectual curiosity with creative collaborations and an increase in the number of qualified and innovative graduates will surely have the best chance of success.

UPEI IS HERE

#1 in Research Income Growth (1999-2009)
#1 in Research Intensity Growth (1999-2009)
(Undergraduate category)

UPEI

UNIVERSITY of Prince Edward ISLAND

on the Island • in Atlantic Canada • around the World

upei.ca

people • excellence • impact

R&D and Innovation: Forging the Way Ahead



Robert Fripp
Senior Associate
The Impact Group

LAST YEAR IN THIS SPACE I WROTE about *Restoring Our Economy: Great Expectations for R&D*. A year later, R&D thrives and delivers in many fields. Trouble is, poor international rankings eclipse too many Canadian innovation success stories. For example, regarding innovation the Conference Board of Canada reports: “Canada receives a 'D' grade and ranks 14th out of 17 countries. The Canadian economy remains a below-average performer on its capacity to innovate.” Fortunately, many organizations regard negative news as a spur, forging ahead, riding innovation to success, hauling the country along. That’s our story here.

Optimistic Signs

“A step forward for science – a step back for Britain’s science sector. Cambridge team reveals potential breakthrough for brain-damaged patients – but lack of funding means [the researchers are] moving to Canada.” That story in Britain’s *Independent* newspaper (September 21, 2010) stated that as many as seven Cambridge researchers may move to the University of Western Ontario. Principal investigator Dr. Adrian Owen calls this a case of “pull, not push.” The Canada Excellence Research Chair program aided Owen’s move with \$10m worth of “pull.”

From medical research to industry: Good news from resurgent Linamar Corporation. Canada’s second largest auto parts maker has carved a share in many precision

engineering fields. In 2010, Linamar returned to profitability (\$21 million in the first quarter) after the collapse of the auto sector. CEO Linda Hasenfratz says, “Back from the depths! We have a solid three-part strategy in place around diversifying our business ... globalising, focusing on green technology, tapping into opportunistic markets – power-trains, energy, heavy machining...” while striving for “best fuel efficiency and lowest emissions... We are scaling up vehicle gears, shafts and housings into parts for wind turbines. Electric vehicles! We will be well positioned for vehicles of the future. That’s our three-part innovation strategy: Globalize, diversify, go green!” Even so, “To become a \$10 billion company by 2020, our top need is people-development: attracting, retaining, developing and motivating people... We need lots more. We’re working with education establishments at all levels.”

Industry Meets Education

Looking at “working with education establishments” from the other end, Lakehead University’s V.P. of Research, Professor Rui Wang, stresses the need for regional universities to reach out to their local communities and companies. Lakehead has one of four full natural resource and management faculties in Canada, its emphasis on forestry extending to biomass management. When the provincial government closed its coal-fired power plant, the town of Atikokan (pop. 5,000) looked “ready to die,” says Wang. The Ministry of Natural Resources enlisted the faculty’s help. After a two-year study, Atikokan’s plant came back on line, burning wood-waste biomass with “a combustion efficiency of wood at almost 100 percent,” Wang adds. “Two years after receiving funding of \$3.8 million, the project returned \$7.5 million. Lakehead has trained 73 students and other specialists to fill the new jobs.” Atikokan’s web site boasts: “Atikokan is quickly becoming a model town for regeneration.”

David Johnston, the former president of Waterloo, would applaud

Lakehead’s policies: “Look to your local strengths. Develop your academic strengths around those strengths – like Sudbury for mining engineering; like Victoria and Dalhousie for some of the best marine biology in the world.” Johnston relates the story of Ira Needles, who was the CEO of BF Goodrich in 1956. Needles pushed this idea in a speech: “Here’s a manufacturing community [Waterloo] that doesn’t have an engineering school. Let’s start one!”

“Since its early days,” Johnston went on, “Waterloo has chosen to specialize, doing just a few things but doing them well. Hence our focus on science, engineering and

“INNOVATION. You can’t schedule it, though many have tried, including Novelis. It generally defies the myriad structures devised to corral it... What you can do, and what Novelis has done successfully, is to create an environment that enables – key word, enables – all the aspects of the company to come together in customer-focused teams to solve problems with innovation...”

Charles Belbin, *Harnessing the Elusive Power of Innovation*
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computer science. Today, we have the largest faculty of engineering and computer science, by numbers, in the world, and the largest faculty of engineering in Canada.

“Growing, Waterloo made policy choices. First, 60 percent of our students alternate academic courses with employment and all our engineers do that. Blending theory and practice helps implement technology transfer and make contact with commercial companies.

“Our intellectual property policy is also unusual. We help creators commercialize their IP, but Waterloo takes no ownership. It’s complicated enough to transfer technology. The fewer steps, the better. So Waterloo concentrates on serving as the marriage-broker but not being part of the party.”

He continued, “We used to think of science development flowing one way, from theory to experiment to prototype to early commercial product. We increasingly see a two-way street where applications inform the experiment and experiment informs the theory. That two-way street will

power the next decade, accentuating the need for talented people, of whom Canada is short.”

Johnston cites an example. “The Premier came here. He approved \$50 million invested in the Institute of Quantum Computing at Waterloo; and before that, in the Perimeter Institute of Theoretical Physics. He looked at RIM, at DALSA (specialized imaging devices), at Open Text and at other companies occupying 28 buildings. Then he said: ‘I understand what you mean about *continuum* here: Perimeter does the theory; Quantum Computing does the experiments; and the applications come from RIM, from Open Text, and companies like them.’ ”

Bits and Bytes: Bulky Possibilities

“The good news for science is that everything is getting bigger, better, faster, cheaper,” says Don Aldridge, General Manager Research & Life Sciences at IBM Canada. “Processing will not be the issue. The issue is: How do we curate data, filter it, use it, transport it – and *store* it? Big science presents emerging challenges.” Might the next trend be: Do we keep data or dump it? “Exactly,” Aldridge agrees. “That’s the concept underlying data streaming, which says: process it, use it, then save it – or not.”

The trend to massive data files is everywhere. The Artemis Project captures and analyzes large amounts of data from babies in the neo-natal care unit at Toronto’s Hospital for Sick Children. “It’s a relatively low data flow compared to some things, but still beyond what humans can ingest without computational processing. The Artemis system can warn about certain conditions at least 24 hours earlier than trained nurses.”

Imagine a future in which computing opportunities extend over all hori-

zons. “We need people with a broad set of skills, experts in public policy with an appreciation of what the technology can do, to fully grasp the opportunities. That’s our main need,” says Aldridge: “People with skills in science, math *and* the humanities.”

Loosening the Oil Tap

“I often refer to Cenovus as a technology company with oil and gas assets,” CEO Brian Ferguson told the *Edmonton Journal* (June 17, 2010). Innovation significantly benefits resource industries. Harbir Chhina, Executive V.P. of technology development and reverse engineering at Cenovus Energy, adds: “Our policy is: work on about fifty innovation projects annually, develop those that work, and implement one each year.

One major innovation is recently patented “wedge well” technology, by which Cenovus drills a horizontal well between pairs of existing vertical wells to extract the wedge of bitumen trapped between them. *The Canadian Mining Journal* (April, 2010) applauded this accomplishment with the headline, “Well done!”

Other innovations include fibre optics underground, and electric submersible pumps. “Six years ago, no pump in the world could work at our production rate in an environment of more than 180°C. Through collaboration we now have pumps that can work at 210°C. We think we can go higher” – yielding correspondingly greater production. The list of Cenovus’s innovations is too long to fit here.

“The next [innovation] to roll out is low-pressure steam-assisted gravity drainage,” says Chhina. “Our intention: to operate at lower temperatures and pressures, lower steam ratios, lower water usage and lower emissions.” His metrics on the results: “recovery, profit and environmental conservation will all improve by significant numbers.”

Metals: Innovating, Going Green

Similar “Green” economies are catching on. ArcelorMittal Dofasco

announced in September that it had completed its \$100 million “product and process innovation upgrades” while increasing capacity for steel production by 20 percent, adding 50 jobs, and achieving “significant energy-efficient gains and environmental improvements.” CEO Juergen Schachler hailed “one of the most productive and energy-efficient advanced steel manufacturing plants in the world.” The company’s several innovations won it the 2010 Dow Jones Sustainability World Index (DJSI World).

From steel to aluminum – specifically Novelis, best known for recycling 35 billion beverage cans each year, including at its Can Facility in Aurora, Ontario. Ontario hosts Novelis’s Global Technology Centre at Kingston, too. Company products and processes are myriad, including panels for BMW cars. I remarked to Mike Thomas, Director of Global R&D: “Few companies I come across publish a booklet about innovation for their staff.” Restricted to internal distribution, *Harnessing the Elusive Power of Innovation* contains sections such as: “How to avoid killing a big idea,” “Role of innovation in 2010 turnaround” and “Making innovation work.” Thomas responded, “Our innovation capability is demonstrated by our position in the market – typically the market leader or number two.”

Quantum Valley: Coming Soon

David Johnston, now Canada’s Governor General, expects in ten years we might be calling the Technology Triangle around Waterloo University, “Quantum Valley.” Johnston talks about Ray Laflamme, his quantum computer, and the Institute for Quantum Computing at Waterloo.

So let’s ease up on the gloom! Government agencies, universities and businesses are taking to heart the seemingly intractable challenges of Canada’s innovation performance. Many are working hard – collaborating – to revise and adopt appropriate policies, encouragements, taxes and triage that will make innovation, and Canada, fly.



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SPOTLIGHT

Decade in Review

RESEARCH Infosource shines the spotlight on universities that made the greatest gains in research income, research intensity and number of research publications over the past decade.

University Research Income Growth 1999-2009 ⁽¹⁾		
Rank	Medical/Doctoral	% Change
1	McMaster University	339.7
2	University of British Columbia	277.1
3	University of Saskatchewan	231.8
Tier Average (16)		180.2
Rank	Comprehensive	% Change
1	University of Victoria	364.6
2	Simon Fraser University	271.8
3	University of Windsor	246.8
Tier Average (11)		162.7
Rank	Undergraduate	% Change
1	University of Prince Edward Island	432.0
2	University of Lethbridge	384.2
3	Brock University	382.1
Tier Average (14)		236.9
Overall university research income growth (41): 179.3%		

University Research Intensity ⁺ Growth 1999-2009 ⁽¹⁾		
Rank	Medical/Doctoral	% Change
1	Université Laval	219.6
2	McMaster University	210.1
3	University of Saskatchewan	203.4
Tier Average (16)		140.4
Rank	Comprehensive	% Change
1	University of Victoria	287.9
2	University of Windsor	176.6
3	University of Regina	167.1
Tier Average (11)		106.1
Rank	Undergraduate	% Change
1	University of Prince Edward Island	324.2
2	Université du Québec à Rimouski	275.4
3	Lakehead University*	272.7
Tier Average (14)		148.1
Overall university research intensity growth (41): 130.3%		
+Research income per full-time faculty (full, associate and assistant only) *Has a medical school		

University Research Publication Growth 1999-2008 ^{(2) (3)}		
Rank	Medical/Doctoral	% Change
1	University of Calgary	90.6
2	University of Ottawa	75.3
3	University of British Columbia	71.7
Tier Average (16)		59.9
Rank	Comprehensive	% Change
1	Simon Fraser University	104.9
2	University of Windsor	99.6
3	York University	96.6
Tier Average (11)		74.7
Rank	Undergraduate	% Change
1	Ryerson University	379.4
2	Brock University	160.6
3	Lakehead University*	128.6
Tier Average (12)		112.2
Overall university research publication growth (39): 64.1%		
*Has a medical school		

Notes:

(1) Based on full-service universities that have been on the Top 50 list for all 11 years.

(2) Based on full-service universities that have been on the Top 50 list and had 50 or more publications in all 10 years.

(3) Publication data were obtained from Observatoire des sciences et des technologies' (OST) Canadian bibliometric database which contains data from the SCI-Expanded, SSCI and AHCI databases of Thomson Reuters.



Nurturing ideas from inspiration to realization

Our researchers share a common goal – to take the seed of an idea and nurture it to its full potential. Whether it is a new vaccine or a new material, a concept for public policy or the start of a business venture, a different way to view ourselves or a way to express our thoughts to the world, we cultivate innovations that nourish the future. Growing our research funding from \$86 million to more than \$377 million over the past decade is just a start. We are turning over new furrows to grow a healthier, safer and more sustainable future for generations to come.

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NOUS SOMMES PRÊTS.



 www.sfu.ca/vpresearch

Historians of science will look back on the past decade as the Golden Age of research funding in Canada. Of course, funding cannot continue to grow forever. Even before the current economic crisis funding increases had begun to level off. It would be unrealistic, for the foreseeable future, to expect research funding growth to exceed economic growth. Some belt-tightening might even be in order. Nevertheless, the alarm that university presidents sounded in 1997 seems a distant memory.

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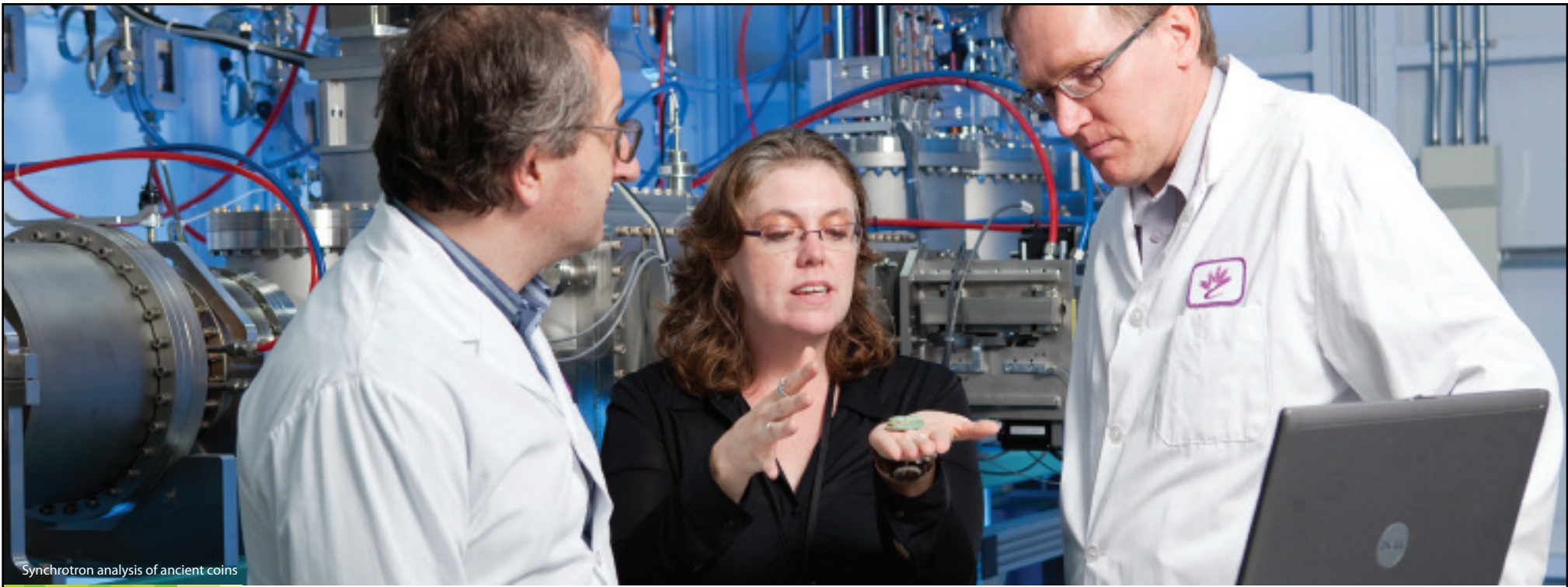
With the support of the Government of Canada, the CFI has been providing researchers across the nation with the tools they need to make discoveries — vital discoveries that are changing peoples’ lives.

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- Probing potential links between oilsands mining and pollutants in rivers and finding solutions for remediation—at our unique-in-Canada Toxicology Centre

We are building momentum as one of Canada's top research-intensive universities—third in Canada in the medical/doctoral category for both research income and intensity over the past decade.* Our discoveries help drive commercialization at Innovation Place, one of North America's most successful research parks.

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Water research in northern Saskatchewan



* Source: Research Infosource, 2010

Raise Those Marks: Roadmap for a Canadian Innovation Nation



Professor Heather Munroe-Blum
Principal and Vice-Chancellor
McGill University

AS STUDENTS ACROSS THE COUNTRY brace themselves for final exams, Canada is facing up to some uneven national marks. On the surface, Canada's performance is respectable. We ranked #10 in the 2010 World Economic Forum (WEF) Global Competitiveness Report and #7 in the 2010 IMD World Competitiveness Scoreboard. But a deeper look reveals

that Canada is being out-paced. Like the family gathered around the kitchen table to discuss grades, let's take this opportunity to reflect, refocus and recommit to the goal of excellence through education and innovation.

The electronic mobility of the knowledge revolution is redrawing the map of global influence. Today, any nation of reasonable economic means can play on the world stage to remarkable local benefit – so long as it possesses the ambition, the vision and the commitment to harness the talents of its citizens, and to build a knowledge-and-innovation-based economy. While this worldwide progress is most welcome, it serves as a wake-up call to more established nations. At a time when other countries are racing ahead, Canada can ill-afford complacency and resulting stagnation.

So what can we do to build an innovative, knowledge-based society that will hold its own in the new world order, bringing a stable econo-

my and sustained health and well-being to our citizens? I have four recommendations:

#4: Raise university graduation rates to at least 45 per cent. The Canadian university graduation rate in 2007 was 34 per cent, which places us 18th out of 24 countries tracked by the Organisation for Economic Co-operation and Development (OECD). Our trends in education, and especially our numbers of PhD graduates – often the very people who most drive innovation – are particularly troubling. The average university graduation rate for OECD member countries nearly doubled between 1995 and 2007, a 195 per cent increase, while Canadian rates grew by only 26 per cent. The aggressive progress of educational success in “emerging” economies is also particularly striking; in China, for example, the number of graduates from universities and specialized colleges has grown by almost 400 per cent in less than a decade. Canada must do better.

#3: Re-think intellectual property practices. Rather than continuing the time-intensive tradition of closed IP – patents, licenses, contracts and associated streamed income – we should focus on opening the flows of information across universities, government research labs and business. A new approach to IP can be created, protecting student contributions and the right of professors to publish, while accelerating the number and productivity of the rich, targeted mutual partnerships that Canada needs to increase competitiveness and grow quality of life. Open IP needn't prevent universities from profiting from runaway successes, either (such as Université de Sherbrooke's contribution to the VoiceAge audio compression technology that is used by millions of cellphone users worldwide every day); a standard “wind-fall” clause in university-industry research agreements could exist to kick in if, and only if, an invention becomes highly profitable.


#2: Connect clusters of innova-

tion. Canada already boasts many productive clusters of talent, investment and innovation. Let's leverage their power strategically by creating large-scale, international and inter-sectoral collaborations, in targeted areas of strength and importance, between industry, universities and colleges, NGOs and government agencies.

#1: Reinvest in research. Canada must reinvest in research – basic as well as applied – across disciplinary domains. The humanities and social sciences, the physical and life sciences, and engineering – all make major contributions to Canada's innovation capacity. Of the nine countries ahead of us in the WEF ranking, all but the Netherlands spend a greater proportion of their GDP on research and development – a key measure of innovation and a predictor of future success. Although Canada's federal investments in university research grew by an average of 11 per cent annually, from 1997 to 2007, the country's overall R&D spending as a proportion of GDP has

grown only marginally since 1995 – while in countries like Singapore (1st IMD, 3rd WEF) it has more than doubled. The last decade has seen dramatic advances in Canada's capacity to recruit and retain outstanding talent, but our progress is threatened by a shortage of effective, sustained and predictable research funding that is competitively allotted. This kind of investment may take time to bear fruit, but medium- and long-term vision is of the utmost importance. Funding sports arenas and casinos at the cost of research does not serve our society well.

If this sounds worried or pessimistic, don't be fooled. I have enormous confidence in the capacity of our nation to do what we do best: to succeed on the basis of our strong communal values and our openness, engaging with the world and welcoming it in. Embracing education and innovation as our top provincial and national priorities will be the best way to do so, as we enter the second decade of this new millennium.



Where the robot entered my brain.

"I'm Paige Nickason, the first person to have brain surgery performed by a robot. The machine is called neuroArm, and it was created by Dr. Garnette Sutherland, his team and students from the University of Calgary's Faculty of Medicine. It allows surgeons to operate with unprecedented precision and confidence. Now that neuroArm has removed the tumor from my brain, it will go on to help many other people like me around the world."

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LEADERS' CORNER



As we continue to adapt to a vastly different global economy, the next decades will depend on research and innovation more than ever before. Our drive to build an innovation culture must be accompanied by increased partnership between numerous constituencies – governments, universities, hospitals, venture capitalists and business and industry, just to name a few. Partnership has gone beyond buzzword status and is now an essential component of the new economy.
~ *Dr. R. Paul Young, FRSC, Vice President, Research, The University of Toronto*



Université de Sherbrooke plays a key role in university-industry partnerships with the emergence of open innovation and we have recently shown our capability to seize the opportunities for strategic partnerships in establishing the Centre de technologies avancées BRP-UdeS (CTA) and the



MiQro Innovation Collaborative Centre in Bromont, Québec.
~ *Prof. Jacques Beauvais, Vice-President, Research, Université de Sherbrooke*



Curiosity guides knowledge creation. We need to provide the environment for new researchers to think critically and investigate questions from different points of view. Sometimes innovation in the form of a practical application will come out of this, sometimes not. Either way, out of imagination, fundamental knowledge is created and ideas evolve.
~ *Dr. B. Mario Pinto, Vice-President, Research, Simon Fraser University*



Nation building requires the engagement and ingenuity of all. Our geography and history have endowed us with a firm grasp of the importance of technology to overcome barriers of distance, terrain and



human understanding. We can lead in this new digital era if we have the will to do so.
~ *Bernard A. Courtois, President and CEO, Information Technology Association of Canada (ITAC)*



Canada's research-intensive colleges and polytechnics contribute to economic growth by solving industry commercialization problems. Through more efficient and targeted research and development (R&D) services for SMEs, we mobilize our faculty, students and research facilities to improve business innovation in Canada.
~ *Nobina Robinson, CEO, Polytechnics Canada*



These are exciting times in Canada, and especially in Ontario where a new culture of innovation and commercialization initiatives has emerged. The new



Markham Convergence Centre, the Digital Hub in Waterloo, and Hamilton's social networking initiatives are just a few examples of a growing tide of R&D investments.
~ *Stephen Chait, Director, Economic Development, Town of Markham*



To transform Canada into an innovation leader and successful competitor on the international stage, Canada needs to harness the power of research to spur economic growth and train the next generation of innovators. Universities are where ideas are put into action to solve real-world global challenges.
~ *President Peter MacKinnon, University of Saskatchewan, and member of the federal Science, Technology and Innovation Council*



Innovation-based economic development begins with well-functioning innovation systems. The local conditions for cluster development need to be



well-organized and aligned with the needs of local companies and entrepreneurs. That coordination must be complemented with targeted venture services, learning opportunities, and networking to support company growth and build a sense of community.
~ *Douglas Robertson, President and C.E.O., Tech South East Inc.*



To forge a strong knowledge-based economy, we must move beyond supporting R&D to supporting collaboration between entrepreneurs, companies, researchers and investors. Alberta Innovates – Technology Futures, part of Alberta's new research and innovation system, is focusing on consolidated funding programs and business services to help companies grow and be successful globally.
~ *Dr. Gary Albach, President & CEO, Alberta Innovates – Technology Futures*



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With the CERC award and support from other partners totalling \$35 million in funding, the team's focus on the Arctic's role in global climate change cement's the University of Manitoba's position as a leader in environmental and climate change research.

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The De Bondt Collection of car advertisements at the Canada Science and Technology Museum is a one of a kind, popular culture tour de force. The collection contains approximately 10,000 printed automobile advertisements dating from the early 1900s through to the 1980s, and showcases advertisement artwork in Canada during this period.

When the museum decided to digitize part of the collection, a conversation led the museum to Public History students at Carleton. It was a perfect challenge for them. Working closely with the museum, the students researched

and designed a website in collaboration with the museum to ensure that this one of a kind historical experience would be driven home in a way that was **anything but textbook.**



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Dr. Kevin Lynch
Vice-Chair
BMO Financial Group

INNOVATION RANKS AMONG THE MOST important, least understood and least discussed policy issues of our time. Despite its public obscurity, innovation sits at the intersection of research and commerce; scientist and entrepreneur; change and status quo; and, public good and private gain. Innovation and productivity are not only crucial to Canada's competitiveness, but also key to the living standards of Canadians. They bridge economic policy and social policy, public good and private gain.

The global economy is now in the thrall of "structural drivers of change" which are reshaping economies, societies and the global centre of gravity. These trends include globalization, demographics, the Information Revolution, climate change and innovation. They are inexorably reshaping the existing world order.

Canada's innovation and productivity performance is mixed. The good news is that public sector investment in research is among the front rank of OECD countries. The less good news is that business sector investment in innovation in Canada ranks 15th among OECD countries in R&D expenditures as a percentage of the economy. Canadian business R&D spending is only 1 per cent of GDP, well below the OECD average of 1.6 per cent, half of what the U.S. spends and only one third of countries such as South Korea and Sweden.

Therein lies our challenge. Innovation lies at the heart of modern competitiveness. It allows us to create new products and services, produce existing products in new ways, and develop new markets. It drives productivity, growth; and our living standards. Our problem is that Canada is not an innovation leader, particularly in our business sector, and we cannot sustain our above average living standards with below average innovation investment.

So, how can we break out of this innovation deficit. First, we need better engagement mechanisms to keep innovation on the "front burner" of public attention and business strategy, holding up a "mirror" of best innovation practices to Canadian business leaders and governments. Canada should consider the establishment of a "Productivity and Innovation Council." Its mandate would be to encourage innovation and productivity by Canadian business. Its focus would be clear: to benchmark Canadian business to best practice in innovation and productivity in our top competitor countries on a sector-by-sector basis. These benchmarks would be public, and something managements, corporate boards and markets should use in judging the performance of a company.

Second, we need to address the weakness in our venture capital sector, which has fallen far behind countries ranging from the United States to Israel to Singapore. We need a blueprint for a venture capital sector structured to meet Canada's research strengths and innovation needs, and designed to help reduce Canada's innovation deficit.

Third, we need to unclog the pipes connecting Canada's good science to our less-than-stellar commercialization of this research into new Canadian products, services and processes. These pipes are blocked with too many disincentives: a plethora of intellectual property right regimes across our universities; a costly tax incentive system for R&D, which is not delivering even average business innovation

performance; a lack of large-scale collaborative research projects in key sectors with the potential for a national payoff; under-investment in highly trained graduate students, who can be "innovation generators; and a missing "connectivity vision" to reverse our huge ICT investment gap vis-à-vis the United States.

Fourth, Canada lacks a culture and support for strong university-business interaction and collaboration. As Don Stokes has convincingly pointed out, much research and innovation is motivated by problem-solving, but this requires a deep understanding of business and consumer needs. Since Canada has a high proportion of R&D delivered through public channels, this partnership culture is particularly important.

Fifth, business needs to understand the risks of organizational bias against innovation. This is the crucial issue raised by Govindarajan and Trimble in their insightful new book: "business organizations are not built for innovation; they are built for efficiency." In their view, the business innovation challenge is less paucity of ideas than poverty of execution; management teams are incented to optimize the profitability and growth of existing products, processes and markets, and not the costs, disruption and risks implied by innovation.

In conclusion, the global context over this decade will be characterized by uncertainty and change. It will put a positive premium on those firms, sectors and countries that are flexible, have solid fundamentals, and are capable of incenting innovation.

Productivity and innovation will crucially determine our future living standards. There is no reason for Canada to be a productivity and innovation laggard, no insurmountable obstacles before us. The solutions of better capturing research and innovation for the public good lie in our hands. If productivity and creativity are driving the economy of the future, being average is just not good enough.

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Every day University of Windsor researchers like Dr. Ming Zheng, at left, work with corporate, community and government partners on societal and technological innovations.

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In the last decade, our annual research funding revenue has almost doubled and our number of graduate students has expanded significantly to nearly 1,500.

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— Dr. Ming Zheng, Canada Research Chair in Clean Diesel Engine Technologies

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FOCUS ON COLLEGE RESEARCH



Colleges: Hidden Gems of the Innovation Ecosystem



Robert Fripp
Senior Associate
The Impact Group

AS GOVERNMENTS AROUND THE WORLD increasingly turn their attention to the economic returns from public investments in research, policymakers are beginning to recognize the value of colleges beyond their traditional training role. While universities focus on basic research to discover new knowledge, colleges work on applied research problems that are user-centric and often bring immediate benefits to society. The two kinds of institutions are complementary, together helping to prepare Canadians for success in the knowledge economy.

“In the spectrum of R&D, curiosity- and discovery-driven basic research is generally the realm of universities,” explains Nobina Robinson. The CEO of Polytechnics Canada describes the differences and complementarities between universities and

colleges, and about the different roles for the research they produce. Downstream from universities, businesses frequently approach colleges to help develop aspects of new or improved products. College faculties and students respond, creating a major route for transferring technology into commercialization. “College-based applied research helps to achieve either new outcomes that bring productivity, competitiveness, new products or commercial benefits.”

The college sector has shifted significantly over the last twenty years. “Colleges tended to be purely training institutions,” says Chris Hawkins, Vice President Research at Yukon College. “Most colleges have moved to an applied role in research because they have strong technology programs – and that’s what small and medium-sized businesses need. No matter what they do, businesses look for technical expertise, hence the changing role of colleges.”

Robinson agrees. “That confirms what has always been in colleges’ DNA: solving industry’s problems.” Colleges are now working way beyond their original mandate: on product development, process-testing models, building prototypes and planning marketing. Or, businesses might ask them: “Could you add two more applications to our I.T. software?”

“Commercialization exposes our students to innovation-literacy and

gets them job-ready to apply to the real world what they’ve been learning in college.” Companies benefit from colleges’ enhanced courses and revised vision, while students, led by their faculty, do the last-stage tinkering (late stage commercialization) that leads to commercial release.

Colleges assign many business-based problems to their students and faculty: Prototyping, scaling, avoiding costs incurred by poor production. “Not sexy, not profound,” says Robinson. “We’re not going to win a Nobel Prize,” adds James Watzke, Dean of Research at Humber Institute of Technology & Advanced Learning. He adds, “But someone else might, working with something we helped create!”

While college faculty are not paid to do research, like their university colleagues, their research is an important part of their training mandate. “That we do research for industry is a byproduct of what we do one hundred percent of the time, which is to train,” says Robinson.

The college community as a whole offers a powerful latent tool, “an innovation tool kit that governments could harness for the benefit of businesses.” That has been proposed, but the college community feels that an ancient, enduring paradigm persists: that governments are trying to enforce university standards on colleges; while colleges feel that they should be “down-

stream,” because “what we do does not compete with universities.”

Biology applies a term, convergent evolution, when different animals adopt similar characteristics. Convergent evolution may also be true of human societies. Colleges across Canada have adopted similar procedures to deliver applied research to the needs of different regional populations. Here we showcase a selection of colleges, their research and their impact:

Centennial College

“Colleges were mandated to teach, to enhance students’ employability,” says Trish Dryden, Associate V. P. Applied Research. Industry and community partners help us understand what employers need in curricula, applied research and innovation. All along, businesses have come to us, asking for help, for our staff, labs and equipment – although that part of our role has been a hidden gem until recently. In a sense we are almost a finishing school for universities: 48% of our students have under-graduate degrees. They come back to college to get the applied industry-based know how.”

And to get leverage! Centennial partnered with “a very small company” which had an electronic controller for large buildings. It eventually won a “Mind to Market” award from the Ontario Centres of Excellence. “That kind of support is what people need. The impact of college applied research is very powerful,” Dryden adds. The Conference Board of Canada will issue a report soon to tell us just how powerful! Meanwhile, one finding is clear: Industries invest much more with colleges than they do with universities, and the number of students who graduate into employment with industries where they worked as students is very high.

novaNAIT – Centre for Applied Research and Technology Transfer

“ ‘NOVA’ is short for Innovation,” says Executive Director Stuart Cullum. “The traditional role of colleges has long been exceeded. I think we are all proceeding in a similar direction in our approach to innovation.”

“Is novaNAIT business oriented?” I ask. Cullum responds, “More outcomes oriented. We look at what the impacts of research are, or could be, to impact society, to generate commercial products or to assist industry. In a sense we are always looking for the return on investment – not always in a monetary sense. We have an outcomes-based approach to everything we do.”

“There are many opportunities for

colleges and technical colleges to add value for SMEs – even for entrepreneurs, the early-stage folks who want to build a company. There are those opportunities where we do feel responsible for ensuring that a business case is solid. SMEs often need more than a technical capacity. They need a business solution as well.”

Cullum mentions that Alberta supplies funding for NOVANAIT to support companies “in terms of their product development requirements. Companies leverage our facilities and faculty (complement: 1,000).”

In terms of outstanding projects, NOVANAIT administers the Boreal Research Institute, which its website describes as “a partnership of the private sector, the education system, and the community.” The Boreal reclamation program serves industries in reclaiming up to 40,000 old oil and gas well sites in the Peace River region. “Shell, and native groups, need us to meet immediate and mid-term requirements for reclamation,” says Cullum. “Here’s a good example of how a college can play a really important role.”

Humber Institute of Technology & Advanced Learning

“College-based, or applied, research serves the needs of small and medium sized companies,” says James Watzke, Dean of Research. You could argue that colleges’ needs are under-served, but they connect well with SMEs. “At Humber we call it solutions-based research, Research for the real world,” he adds. Applied research at a college is “very much about connecting to a business outside the college who says, ‘I have a problem. Can you help?’”

“Innovation literacy helps college grads get jobs quickly. This has economic implications. We try to train them so they are in a position to innovate. We want them skilled for a quickly changing landscape.” Humber offers 160 programs, each with a program advisory committee of industry personnel. The result, as Watzke puts it, is that “thousands and thousands of industry people are in our minds every day.”

Success stories include expandable musical drums, for professionals; the entrepreneur is exploring agreements with major drum manufacturers. Fig Jam, a snowboard and skateboard clothing retailer, was doing a poor job with e-commerce, so Humber brought it in to work with students on “really interesting” open source technology. There are many success stories. Suffice to say, industries and Humber Institute make good friends.

Saskatchewan Institute of Applied Science and Technology (SIAST)

“We are extending our research capacity through our communities and industry centres – thereby supporting economic development in Saskatchewan.” Cristina Holguin-Pando, Director of Applied Research, can’t wait to advance the cause of applied research. “We support many fields, aligning our agenda with national and provincial research strategies. We focus on four key priority areas.”

Those areas are: urban development; natural resources and environment; health education; information technology and communications – “and of course we support scholarly activities in those areas.”

In partnership with two local industries and supported by NSERC-funding, SIAST’s applied research into waste-water management, led by its chemical technology program, may be incorporated into recycling, purification, and sewage treatment.

Another partnership, this time with SaskEnergy, the Salvation Army and others, called Share the Warmth, helps lower-income families capture energy savings. “It’s a basic, grass-roots type of project. Volunteers survey houses, assessing energy consumption to see what modifications have to be done to optimize energy consumption. It’s one of our proud stories.”

SIAST is also exploring partnerships developing alternative energy, possibly extending wind energy work being done by its Technology Division. “Industry really knows that SIAST is into applied research, and that we have the expertise, facilities, and the resources.”

Applied research gives SIAST students on four campuses hands-on experience, better preparing them to become solution providers in the working world, ultimately impacting both social and economic development.

“Industries come to us; we go to them. We work both ways. Industries, agencies, universities, students and teaching staff – We make a good marriage, and the Office of Applied Research and Innovation acts as the match-maker.”

Holland College

“We differ from universities in that we’re not doing discovery work. Our applied research consists of industry problems that they bring to us. They may ask us to fix a problem in beta testing, prototype

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Innovative SOLUTIONS to everyday challenges



Through our office of Applied Research and Innovation, SIAST is facilitating opportunities for faculty and students to link with Saskatchewan’s industry and provide technical solutions to everyday challenges.

SIAST has recently achieved institutional eligibility for federal research funding support. An extraordinary example is led by the Chemical Technology program, headed up by Dr. Salim Khalid in SIAST’s Science and Health division. Dr. Khalid has developed a strong applied research program in wastewater management in partnership with two Saskatchewan companies, which has allowed SIAST to attract a College and Community Innovation Program grant from NSERC.

This is only one example that showcases the institute’s commitment to take a leading role in shaping and supporting Canada’s innovation strategy. SIAST is inviting industry partners to explore future collaborations with one of Canada’s most reputable technical institutes.

SIAST is Saskatchewan’s primary public institution for post-secondary technical education and skills training, recognized nationally and internationally for its expertise and innovation, as well as for its consolidation of applied research activities.


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www.goSIAST.com



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We are on the front lines of climate change, creating leading-edge solutions for northern climate challenges. Using an integrated approach of traditional knowledge and social and natural sciences, our northern researchers are advancing the North, one innovative solution at a time.

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Find out more:
www.YukonCollege.yk.ca/research

FOCUS ON COLLEGE RESEARCH

The Role of Canada's Colleges in Research and Innovation



James Knight
President and CEO
Association of Canadian Community Colleges

CANADA'S COLLEGES, INSTITUTES, polytechnics, cégeps and university colleges are leaders in applied research and technology transfer, yet the role of these institutions in Canada's research and development agenda is not adequately understood. They help businesses start, develop and grow, and are vital contributors to our innovation system. Building on a half-century of experience, they embody an enormous concentration of expertise on the application of technology to process improvement and product development. They are graduating our next generation of innovators and entrepreneurs. More than any other institutions, they are key to improving Canada's lagging productivity.

By focusing research on product development, prototyping, business incubation, model simulations and commercialization, they address real-world challenges, and produce the highly-skilled talent needed to apply and sustain an innovative practices workforce.

They house centres of excellence and technology transfer that work with industry partners in fields such as manufacturing, cold climate innovation, agriculture, biotechnology, aquaculture, sport innovation, boreal research, sustainable infrastructure, aerospace, photonics, plastics, microelectronics and nanotechnology.

College faculty and student involvement in applied research is a win-win situation for all involved. Faculty members maintain their close ties with industry; students participate in real-world application of the skills they've learned, and make industry contacts for future employment possibilities; and, facilities and expertise are available to businesses that may not possess sufficient research capacity.

In the words of private sector partner Shaun Jackson, technical advisor at HydroFlow Canada Inc., "Our partnership with Georgian College and its students was a new concept to us. We had no idea such resources were available to us in our community. The manufacturing engineering students conducting this project have demonstrated to us that they have the ability to apply what they have learned in their academic studies. We see this project as the first of many applied research projects with Georgian. In fact, we are currently developing our next project with them."

According to a report released in February 2010 by the Association of Canadian Community Colleges (ACCC), private sector investment in applied and industry-driven research at Canada's colleges increased ten-

fold over the last four years. Partnerships for Productivity and Advanced Skills: The Role of Colleges in Canada's Innovation System compared results with a prior study in 2005-2006 and found that private sector investment ballooned from \$4 million to \$45 million. In the same time, private sector partnerships with colleges increased seven-fold, with 3,602 companies now participating in applied research projects.

The private sector has a real hunger for what colleges offer and turns to them for new technologies, prototyping and process improvement. The results translate into productivity gains, enhanced competitiveness and new jobs. Colleges are particularly adept at helping small- and medium-sized enterprises (SMEs) with their research needs – a vital contribution, since the vast majority of new jobs are created by SMEs.

Colleges are undertaking projects in 142 areas of research specialization, most of which fall within the four priority areas of the federal Science and Technology Strategy.

The report also showed an increase in provincial/territorial government investment from \$13 to \$25 million and an investment of \$35 million by the colleges themselves. However, federal investment dropped from \$28 to \$27 million.

Canada leads in per capita public investment in discovery research, but is at the bottom of the barrel in productivity growth. Innovation and the diffusion of new technologies characterize the college/institute model and investment here will increase productivity. However, colleges

receive a fraction of federal R&D investments.

Recent funding announcements by the federal government, including a \$32.5 million investment through the Canada Foundation for Innovation, dedicated exclusively to colleges, recognize the unique contribution of these institutions to private sector innovation and demonstrates growing understanding of the key contribution of colleges to Canada's productivity and eco-

nommic growth. But it's not enough.

New research by the Institute for Competitiveness & Prosperity indicates that "increased investment in education is critical to build an economy that survives and thrives in the face of increased global competition. As larger economies become more sophisticated and cross the innovation tipping point, our creative skills will be tested, and it is by no means certain that we will be able to assume prosperity as usual.

Education is a critical foundation for the broad skills we will need, and we need to step up our investments in this area."

ACCC will continue to advocate for increased federal investment, particularly for applied research in colleges, institutes, polytechnics, cégeps and university colleges and for a widespread understanding of the important role these institutions play in Canada's economic competitiveness.



Social Innovation Research Leader

As a Social Innovation Research Leader, Bow Valley College is constantly researching innovative strategies to reach out to diverse learners. Bow Valley College is leading a consortium of seven colleges and eCampusAlberta on establishing best practises in eLearning.

Any time, any place, any path, any pace learning provides advanced skills training wherever and whenever needed. Our grads are ready fast with the skills they need to provide value add to employers. Innovative social research fosters new pathways to success.

Dr. Rena Shimoni, Dean of Applied Research & Innovation
Rshimoni@bowvalleycollege.ca 403-410-1435





AN ENVIRONMENT for innovation

The boreal forest is a vital wildlife habitat, a source of economic opportunity, and home to numerous oil and gas wells, pipelines and service roads. Researchers at novaNAIT's Boreal Research Institute are working together with government, the oil and gas industry, and First Nations and Métis communities to develop best practices in land reclamation to restore industrial sites to near-natural condition. Aiding novaNAIT's efforts is a \$2.3 million grant recently awarded by the Natural Sciences and Engineering Research Council of Canada (NSERC).

The Boreal Research Institute is just one of NAIT's many applied research initiatives to help industry create sustainable approaches to business practices, creating an environment for innovation that reaches far beyond the campus community.



novaNAIT | APPLIED RESEARCH AND TECHNOLOGY TRANSFER

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To find out more, visit centennialcollege.ca/applied.

The Future of Learning

COLLEGE
TRAINING
CENTRE

FOCUS ON COLLEGE RESEARCH

Colleges: Hidden Gems of the Innovation Ecosystem

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development, processing issues, or technical enhancement...”

Dr. Audrey Penner, Director of Applied Research, continues, “So, problems come from industry, solutions from us. Our students benefit because we are closely tied to industry and industrial advisory committees, so students get occupational training, ensuring they are ready to go into industry. That’s often how we discover what industrial problems are, and, in a perfect circle, industry comes back to us for help.

“As a community college our mandate is about community economic development. For example, we research food products in what we call ‘Canada’s Smartest Kitchen.’ An industry asked us for: ‘a better

product for the school market, because schools have strict guidelines for vending machines.’ Working with our research chefs, UPEI and the Food Technology Centre of PEI, we made twelve formulations for vegetable-based Maximum Nutrition Snacks. Four fit the school criteria. Others work for diabetes, weight control, etc. There’s an example of multi-party collaboration, government investment, and an industry in need of help. We met an industrial need, and gave it several markets.”

Niagara College

“We approach research from the company side,” says Marti Jurmain, Director, Research and Innovation Division. “It starts when a company

or a government department approaches us with a problem, be it an idea, a new product, a process for improvement, marketing strategy... Industries see colleges not just as suppliers of graduates, but also as solution providers.”

“More and more we use course-based projects to support industries that have little cash. If a client-industry can wait, our students can take it on during a course, at no cost. Course-based research involved 700 students this past year. With typically 50 clients a year, we involve multiple faculties and about 40 teaching staff. Afterwards, intellectual property belongs to the client, and often we help them assert it.”

The result is many success sto-

ries, including from innovative, supportive Walker Industries. “We are testing their compost. Then we have green roof applications, an irrigation system company, and a firm that makes containers for green roofs. We grow grapes and make wine, of course – package it, label it, design the labels.”

“SMEs are the backbone of Canada’s economy, representing over 65% of the country’s base. They are critical to us as a nation, but they’re challenged on all sides. They often lack resources, so, for SMEs, colleges are a great resource.”

Lethbridge College

Applied research at Lethbridge College started with carp,” says Peter Leclaire, V.P. Academic, and Chief Learning Officer. Alberta has one million acres under irrigation, and it was decided that carp could eat weed in the canals. However, the canals had to be drained every year, so fast-breeding carp proved unsuitable. Lethbridge College then researched and created sterile carp. Applied research was born!

Lethbridge always had a strong environmental program, strengthened by local partnerships with Agriculture Canada’s Research Facility and its provincial equivalent. Applied research abounds, currently occupying 500 students and “we have fifty faculty leveraged on behalf of our community, whether for local or international benefit,” says Peter Leclaire, V.P. Academic and Chief Learning Officer. “Closeness with our community has triggered the bulk of the applied research we do.”

Sterile carp never reached Alberta’s irrigation channels, but the fish became biological controls in ponds and golf course water traps, eliminating chemical herbicides from dugouts, a major water source for agriculture.

Taking that a step further, Lethbridge became one of the first colleges to win a CFI grant and become an aquaculture centre of excellence. “We produce aquaculture and aquaponics ‘in a box,’ moving fish around in large containers that we can put anywhere.” Farmers can empty a container into a pond to grow carp; the fish eat the weeds, the nutrient-rich waste from the fish is separated, becoming fertilizer, while the cleansed water is recycled – “A source of protein and vegetables, too! People can grow their own fish.”

Fanshawe College

“Applied research at Fanshawe is oriented toward problem-solving,” says Greg Weiler, Dean, Applied Research, Innovation & University Partnerships. “In many cases we work with something already known, bending, applying or adjusting it to solve someone’s business problem. We call that ‘putting knowledge to work.’ We generally use an industry ‘pull’ model, where businesses bring their problems to us rather than us inventing something at the college.

“Government is interested in helping companies, particularly small and medium-sized companies (SMEs), become more innovative. Making those changes can be difficult when a firm’s resources are lean

and focused on immediate results. We can help them innovate processes, products and services,” he says.

“Right now, Fanshawe is working on the creation of more efficient solar collectors, improved solar energy storage and management systems, a better small wind turbine and solar powered utility vehicles in our new Centre for Sustainable Energy & Environments, funded by a grant from the NSERC-administered College & Community Innovation program.”

The role that Canadian colleges can play in fostering innovation has now been recognized, Weiler says. “We are finally seeing resources allocated to help mobilize colleges’ potential.”

Yukon College

“Colleges used to be training institutions. Many have moved to an applied research role because they have strong technical programs – and no matter what you’re doing, you need technical expertise, hence industrial partnerships with colleges,” says Dr. Chris Hawkins, V.P. Research. Yukon College has two specialist fields. The first is climate change, (applied research that resembles a traditional university course). Second, we have our Yukon Cold Climate Centre. That comes in conjunction with the Yukon Technical Innovation Centre.

“The first of these focuses on technology for cold climates – in hopes we can sell it around the circum-polar region. The second is about developing knowledge-based technologies we can market anywhere. We’re trying to take advantage of the creative economy we have in the Yukon.

“Because we have a thinly distributed population, Yukon College has a local campus in almost all communities. Eleven in all. People approach us; we try and get their project going, whatever, wherever it is.”

One special project involves generating electricity in water moving under ice. “Rivers and creeks freeze up here,” says Hawkins. Nevertheless, Yukon College is researching generating year-round run-of-river hydro. Diesel-generated electricity in northern communities costs 80-90 cents per kilowatt-hour. Water-generated hydro would cost about 30 cents. “Generating hydro is the easy part,” says Hawkins. “Keeping the ice from destroying things is more difficult.” The big question: “How much depth of water do we need beneath the ice?”

Seneca College

“For us at Seneca, applied research involves solving real world problems. We deal with SMEs and assist charitable associations, but all projects must involve our students, our faculty, and have meaning within the scope of our curricula. Applied research is happening in virtually all our faculties,” says Laurel Schollen, Dean, Applied Science and Engineering Technology. “Two of them are really busy; Applied Science, and the Faculty of Information, Arts and Technology.”

She describes two projects for which Seneca received CCI grants: The first, \$2.3 million to Seneca’s School of Aviation and Flight Tech-

nology to expand research and innovation, and explore simulation technology to advance pilots’ technical and non-technical skills transfer. (The number of Canadian flight schools is declining, while the International Civil Aviation Organization predicts a shortage of pilots.) One major investigation: How can simulation improve such non-technical needs as situational awareness, decision-making, and workload management in a cockpit?

Meanwhile, the Faculty of Information won a grant for its Centre for Development of Open Source Technology. “We are strong in open source. This CCI grant will let us grow that. Working with partners such as Mozilla, IBM and Red Hat, we are developing tools to enhance enterprise-scale use of open source – and help SMEs partner with open source developers.”

Schollen encourages the federal government’s “financial opportunities” for colleges. “Recognizing the importance of colleges is good news for Canada. In fact, since colleges and universities complement each other, it’s good news for them both.”

Bow Valley College

“What we do is about developing the whole person. That’s our core business. We have a leading role in Canada for people on the margins, and our applied research is about finding solutions to help them access education and therefore the workplace.”

A human at work needs nine essential skills, says Sharon Carry, President and CEO: Communication, disciplined thinking, numeracy, using information... “We invented TOWES (Test of Workplace Essential Skills) to measure some of these. Every jurisdiction in Canada uses it to measure and remediate people’s skills. We commercialized it over a decade ago. Industries use it for hiring decisions, or to offer applicants essential skills. We call TOWES the Velcro to which all learning sticks.”

Then there is “Canadian Drug Speak.” Bow Valley teaches a program for pharmacy technicians in which the Canadian Drug Speak tool helps students master the names of prescription drugs. “All sorts of colleges and companies have bought it. Invented here, we took it commercial. It’s an important example of research leading to a commercial opportunity.”

With more than 20 locations, Bow Valley College is growing to offer careers to 20,000 full- and part-time students. “Revenues have grown from \$15 million to \$75 million, substantially through entrepreneurial efforts.”



UNDER OUR microscope

We’re putting a few things “under the microscope” at Lethbridge College these days. The results are eye-catching.

We’ve been studying the DNA of cougars in Western Canada to help biologists determine their range and genetic diversity to ensure sustainable populations.

On the human side, we’ve developed a psychological study for a major Canadian company to help it determine driver characteristics that could predict high-risk behaviour.

Our applied research combines innovative instructors with motivated students to provide applicable solutions for real-life situations.


Lethbridge College
lethbridgecollege.ca





Niagara Research

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Applied Research - real world, real skills.



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Decade in Review

INDUSTRIAL RESEARCH
IN CANADA

ROLLERCOASTER DECADE

What a rollercoaster decade it has been for industrial research in Canada. The decade spanned the heady days of the tech boom and the depths of the recession. Brand-name companies – many of them stalwarts on the industrial research scene – have disappeared due to mergers, acquisitions and bankruptcies. Other firms have risen to take their place.

Take the case of Nortel Networks Corporation. In Fiscal 1999, Nortel was by far Canada's largest R&D spender, dedicating over \$4.55 billion to worldwide research. In other words, this one company accounted for a substantial portion of all spending on research by all firms. In Fiscal 2009 – probably Nortel's final year on the *Top 100 Corporate R&D Spenders List* – this disappearing firm posted \$864.5 million of R&D spending. Meanwhile, Research In Motion has stepped up to the plate, boosting its own R&D spending from only \$18.2 million in Fiscal 1999 to \$1.1 billion today, therefore occupying the top position among the leading R&D companies.

In Fiscal 1999, the total of Nortel and RIM's R&D spending was \$4.57 billion. In Fiscal 2009, the total was \$1.97 billion. In other words, all the other performers

needed to make up nearly \$2.6 billion of "lost" research in order for Canada's total spending to stay even (with no accounting for inflation); a tough chore indeed, when the average company spending is running at about \$0.8 million today.

But the bottom line is that at the end of the decade total research spending by all companies in Canada (including the Top 100 Corporate R&D Spenders) is not appreciably higher than it was ten years ago, even though many more firms (over 20,000 today compared with fewer than 10,000 ten years ago) appear to be engaged in research. Corporate revenues were generally rising throughout the period.

A RAY OF SUNSHINE

There have been some positive developments over the decade. One is that for Fiscal 1999 RESEARCH Infosource reported only 11 Top 100 companies with R&D spending with \$100 million or more. In Fiscal 2009, that number has doubled to 22 companies. However, the 11 companies spent a total of \$6.25 billion on research in Fiscal 1999, compared with the total R&D spending of \$7.42 billion by the Fiscal 2009 *\$100 Million Club* members. A number of firms – Pratt and Whitney Canada is a good

example – continue to spend at high levels year after year.

NEW LEADERS EMERGE

Many firms have made admirable progress in boosting their investments in research over the decade. Take TELUS Corporation as an example. In Fiscal 1999, this telecommunication services company reported spending only \$2.5 million on research compared with \$653 million in Fiscal 2009 – an increase of 26,020%. Not far behind was Research In Motion, which boosted its R&D spending during this period by 5,964.1% largely on internal growth, and Suncor Energy, which increased its spending by 5,132.9%, partly on the strength of acquisitions.

Research is far less concentrated today among the largest performers than 10 years ago, meaning the country is not as dependent on the performance of a single large company. According to Statistics Canada, which tracks all R&D performers – in 1999 the 100 largest Canadian performers accounted for 63% of total R&D spending, compared with only 53% in 2009.

REST-IN-PEACE

Many household names on the Canadian technology scene at the beginning of the

decade are no longer with us. Most were acquired by foreign or Canadian companies. Many of these continue to operate in Canada under different corporate ownership. Others went (or are going) bankrupt. In some instances, acquirers maintained the Canadian R&D operations at their former level. In others, R&D was reduced, and in some instances it ceased altogether. Capitalism is an inherently messy system, but it is always troubling when technology stars leave the scene.

WITHER INDUSTRIAL RESEARCH?

The federal government has announced plans to review the industrial research scene, including incentives provided to companies for research. Policymakers will need to sift through considerable data in order to understand the underlying dynamics and future possibilities. Whereas industrial research used to be the preserve of large manufacturing firms (and to some extent resource companies) with in-house laboratories, the changing composition of the economy means almost half of all 20,000 industrial R&D performers are now in the services

sector. R&D means different things to this sector and incentive programs have been slow to adjust to this reality.

They will also need to balance the bad news – no overall growth in research spending – against the good news – more companies apparently engaged in research. A particular issue is to review Canada's aging and fragmented system of research incentives, and most importantly, figure out how to change the balance of incentives from indirect support through the tax system to direct support through managed funding programs such as IRAP. A further challenge is to activate the potential of research in the social sciences and humanities, which is currently excluded from government commercialization support.

A strong base of industrial research (or university research for that matter) is a necessary condition for economic and social progress. It is not, however, a sufficient condition. The bottom line is ... the bottom line: Producing high quality made-in-Canada commodities, goods and services that the world wants at prices it is willing to pay. That's our real long-term challenge

The \$100 Million Club					
2009			1999		
Rank	Company	R&D Expenditures \$000	Rank	Company	R&D Expenditures \$000
1	Research In Motion***	\$1,101,848	1	Nortel Networks*	\$4,548,034
2	Nortel Networks*	\$864,494	2	Pratt & Whitney Canada (fs)	\$335,000
3	BCE	\$806,000	3	Atomic Energy of Canada	\$203,568
4	TELUS	\$653,000	4	Ericsson Canada (fs)	\$200,552
5	IBM Canada (fs)	\$556,500	5	ATI Technologies**	\$171,149
6	Magna International*	\$553,870	6	Magna International*	\$167,895
7	Pratt & Whitney Canada (fs)	\$398,000	7	Mitel	\$149,800
8	Atomic Energy of Canada	\$393,051	8	CAE	\$128,273
9	Alcatel-Lucent (fs)	\$224,000	9	Bombardier**	\$132,200
10	Ericsson Canada (fs)	\$197,000	10	Hydro-Québec	\$110,072
11	Apotex	\$188,773	11	Geac Computer Corporation+	\$102,240
12	sanofi-aventis Group (fs)(1)	\$181,621			
13	Suncor Energy	\$172,687			
14	Bombardier***	\$161,022			
15	GlaxoSmithKline Canada (fs)	\$147,813			
16	Biovail**	\$137,935			
17	Open Text*	\$132,659			
18	CAE	\$121,647			
19	Ontario Power Generation	\$112,000			
20	Novartis Pharmaceuticals Canada (fs)	\$110,000			
21	Pfizer Canada (fs)	\$109,378			
22	Hydro-Québec	\$100,000			
Total		\$7,423,298	Total		\$6,248,783

Notes: *Converted to CDN\$ at annual average 2009 = \$1.1420, 1999 = \$1.4858 (Bank of Canada)

+Not current name ++Fiscal 2010/Fiscal 2000 results were used for year ended January or February

fs = Foreign subsidiary (includes R&D expenditures for Canadian operations only)

(1) Includes sanofi-aventis Canada Inc. and Sanofi Pasteur Limited.

RIP... A Small Selection of Canadian Corporate R&D Heroes	
Company	Merger/Acquisition
724 Solutions	Foreign
Alcan	Foreign
Allelix Biopharmaceuticals	Foreign
ATI Technologies	Foreign
BioChem Pharma	Foreign
Biovail	Foreign
Cognicase	Canadian
Cognos	Foreign
Creo	Foreign
Dofasco	Foreign
Emergis	Canadian
Falconbridge/Noranda	Foreign
Geac Computer Corporation	Foreign
Genpharm	Foreign
Hummingbird	Canadian
Husky Injection Molding Systems	Canadian
Inco	Foreign
JDS Fitel	Foreign
JetForm	Foreign
Leitch Technology	Foreign
Microcell Telecommunications	Canadian
Moore Corporation	Foreign
Newbridge Networks	Foreign
Novopharm	Foreign
Petro-Canada	Canadian
Skyjack	Canadian
Tundra Semiconductor	Foreign
Wescam	Foreign

The \$100 Million Club Ranked by R&D Expenditures Growth				
2009 Rank R&D Growth		R&D Expenditures		
Overall	Company	FY2009 \$000	FY1999 \$000	% Change 1999-2009
1	4 TELUS	\$653,000	\$2,500	26,020.0
2	1 Research In Motion***	\$1,101,848	\$18,170	5,964.1
3	13 Suncor Energy	\$172,687	\$3,300	5,132.9
4	3 BCE (1)	\$806,000	\$32,205	2,402.7
5	17 Open Text*	\$132,659	\$16,898	685.1
6	6 Magna International*	\$553,870	\$167,895	229.9
7	19 Ontario Power Generation	\$112,000	\$36,000	211.1
8	20 Novartis Pharmaceuticals Canada (fs)	\$110,000	\$36,720	199.6
9	21 Pfizer Canada (fs)	\$109,378	\$37,570	191.1
10	16 Biovail**	\$137,935	\$49,225	180.2
11	5 IBM Canada (fs)(2)	\$556,500	\$220,000	153.0
12	11 Apotex	\$188,773	\$85,200	121.6
13	8 Atomic Energy of Canada	\$393,051	\$203,568	93.1
14	15 GlaxoSmithKline (fs)(3)	\$147,813	\$100,643	46.9
15	14 Bombardier***	\$161,022	\$132,200	21.8
16	7 Pratt & Whitney Canada (fs)	\$398,000	\$335,000	18.8
17	10 Ericsson Canada (fs)	\$197,000	\$200,552	-1.8
18	18 CAE	\$121,647	\$128,273	-5.2
19	22 Hydro-Québec	\$100,000	\$110,072	-9.2
20	2 Nortel Networks*	\$864,494	\$4,548,034	-81.0
---	9 Alcatel-Lucent (fs)	\$224,000	na	
---	12 sanofi-aventis Group (fs)(4)	\$181,621	na	

Notes: *Converted to CDN\$ at annual average 2009 = \$1.1420, 1999 = \$1.4858 (Bank of Canada)

+Not current name ++Fiscal 2010/Fiscal 2000 results were used for year ended January or February

na = not available ---Unable to rank

fs = Foreign subsidiary (includes R&D expenditures for Canadian operations only)

(1) Fiscal 1999 R&D expenditures includes results for Bell Canada and BCE Emergis Inc. only.

(2) Fiscal 1999 R&D expenditures is the result for Fiscal 2000; Fiscal 1999 was unavailable.

(3) Fiscal 1999 R&D expenditures includes results for Glaxo Wellcome Inc. and SmithKline Beecham Pharma combined prior to the merger.

(4) Includes sanofi-aventis Canada Inc. and Sanofi Pasteur Limited.

10 Steps to a More Innovative Canada



The Honourable John Manley
former Deputy Prime Minister of Canada
President and CEO of the Canadian Council of Chief Executives

IT IS NO SECRET THAT CANADA'S weak overall innovation performance undermines our global competitiveness and standard of living.

The question is: What to do about it?

Last spring, I and Paul Lucas, President and CEO of Glaxo-SmithKline Inc., assembled a national coalition of leaders from business, academia and supporting

organizations with the aim of building consensus around a focused and achievable agenda for action.

In our report, we present 10 priority items that we believe Canadians can begin to put in place within the next 12 months:

Reform tax support for research and development. The Scientific Research and Experimental Development (SRED) program is a powerful tool, but inconsistently applied. Ottawa's review of the program should seek to make the credits more broadly, consistently and predictably accessible. The review should benchmark other OECD countries to ensure that Canada's system produces the best possible results.

Expand the pool of risk capital. Building a larger pool of risk capital is essential if we are to create and grow tomorrow's successful enterprises. One approach that is gaining favour in Canada and elsewhere is the establishment of government-sponsored co-investment funds that invest in innovative companies alongside private investors. At the same time, banks and

pension funds that once were significant providers of risk capital need to rebuild their management talent in this sphere – drawing on established entrepreneurs with operational experience.

Adopt the world's strongest intellectual property regime. Canada should aim for a reputation as the best place in the world in which to research, develop and bring to market new products and processes. It is imperative that Canada achieve the gold standard of intellectual property protection and thereby create a more attractive environment for innovation.

Strengthen business-academic links. Businesses and educational institutions engage in a wide variety of cooperative ventures, but their efforts to collaborate often have been stymied by barriers ranging from issues of funding and intellectual property ownership to less tangible considerations such as differences in expectations and culture. Business and academia should consider a pilot program that would identify up to 25 partnerships that would be nurtured through access to top coaches and

other support. The goal should be to build a portfolio of successes that would inspire further innovation.

Tap private-sector expertise when spending public money. Ottawa spends billions of dollars annually to support research and innovation, and in recent years has sought to increase private-sector representation at the granting council level. We strongly endorse this approach. At the same time, we recommend that governments also take advantage of private sector experience in developing new research and innovation initiatives and in evaluating existing programs.

Speed adoption of innovative products and services. Canada ranks middle of the pack by OECD standards in business investment in new machinery and equipment. Tax incentives would help, but even more important is heightened recognition by business managers and boards of directors of the need and potential for productivity improvement. Governments, too, can spur innovation by becoming early adopters of

innovative products and services.

Launch a national learning and innovation initiative. Governments across Canada should agree on ambitious goals for learning that could include: a 90 percent high-school graduation rate; expanding post-secondary enrolment in science, engineering and business programs; ensuring that researchers have access to people with the commerce competencies needed to drive commercialization; and increasing graduation rates at the Master's and Ph.D. levels. At the same time, the private sector must take more responsibility for work-based skills training and lifelong education.

Seek out the best and brightest. Academic institutions already recruit abroad for students. These efforts should be reinforced by federal and provincial support for overseas marketing and recruitment and in making it easier for foreign students to obtain visas, work permits and health care while studying in Canada. Other provinces should consider adopting the British

Columbia model of providing standard per-student grants for international graduate students.

Nurture innovation clusters. Governments should align their policies to support regional and local innovation clusters. Educational institutions should work to ensure their research and training efforts meet the needs of local clusters. Private sector leaders should consistently communicate their needs to local post-secondary institutions and research centres. All three sectors should form a national network to share best practices.

Ensure ongoing advocacy for innovation. Governments, business and academia should collaborate in the creation of an independent advocacy body with the single mandate of encouraging innovation by Canadian business. An interim step, and possible alternative, would be to mandate an existing organization with this responsibility.

Even these measures will not solve the problem entirely. But our recommendations are practical. Many can be put in place quickly. We believe they would make a real difference in putting Canada on track toward an innovative future.

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Continued from page 16

trend in R&D spending for the 4th year running. Additionally, for the first time in almost a decade, the Top 100 companies posted a substantial drop in revenue (-16.4%), as the full force of the world economic situation hit home.

Paradoxically, the sharp drop in Top 100 revenues had the effect of boosting research intensity growth (research spending as a percent of income) by 15.0% between Fiscal 2008 and Fiscal 2009, reversing 7 years when revenues grew faster than R&D. Had tech star Research in Motion (RIM) not stepped in to fill the spending void created by the decline of Nortel Networks, the Top 100 results would have undoubtedly been worse. RIM is now Canada's leading R&D spender with \$1.1 billion of research. (In its heyday, Nortel was spending in excess of \$4 billion on research, in current dollars).

Overall, only 44 companies expanded their research spending versus 55 that cut back on research (1 company reported 0% growth). Last year, 59 companies achieved positive R&D growth.

THE \$100 MILLION CLUB

Although overall R&D spending fell in Fiscal 2009, 22 companies boasted \$100 million or more each of research spending, up from 19 firms the year before. Fourteen of these companies were Canadian companies and 8 were Foreign Subsidiaries. In Fiscal 2009, Club members accounted for \$7.42 billion (73%) of total

The \$100 Million Club		
2009 Rank	Company	Industry
1	Research In Motion	Comm/telecom equipment
2	Nortel Networks	Comm/telecom equipment
3	BCE	Telecommunications services
4	TELUS	Telecommunications services
5	IBM Canada (fs)	Software and computer services
6	Magna International	Automotive
7	Pratt & Whitney Canada (fs)	Aerospace
8	Atomic Energy of Canada	Engineering services
9	Alcatel-Lucent (fs)	Comm/telecom equipment
10	Ericsson Canada (fs)	Comm/telecom equipment
11	Apotex	Pharmaceuticals/biotechnology
12	sanofi-aventis Group (fs) ⁽¹⁾	Pharmaceuticals/biotechnology
13	Suncor Energy	Energy/oil and gas
14	Bombardier	Aerospace
15	GlaxoSmithKline Canada (fs)	Pharmaceuticals/biotechnology
16	Biovail ⁺	Pharmaceuticals/biotechnology
17	Open Text	Software and computer services
18	CAE	Aerospace
19	Ontario Power Generation	Electrical power and utilities
20	Novartis Pharmaceuticals Canada (fs)	Pharmaceuticals/biotechnology
21	Pfizer Canada (fs)	Pharmaceuticals/biotechnology
22	Hydro-Québec	Electrical power and utilities

fs = Foreign subsidiary (includes R&D expenditures for Canadian operations only)

+ Not current name

(1) Includes sanofi-aventis Canada Inc. and Sanofi Pasteur Limited

Top 100 R&D spending. New to the Club were Suncor Energy, Biovail, Ontario Power Generation and Novartis Pharmaceuticals Canada. Dropping out of the Club this year were Merck and Astra Technologies.

Among the 22 \$100 Million Club members, 10 companies increased their R&D spending while 11 companies decreased spending between Fiscal 2008 and Fiscal 2009. One company reported no growth.

Companies in the ICT (information and communications technology) sector were strongly represented in the Club. Eight of the 22 members are in the ICT sector, followed by 6 firms in Pharmaceuticals/biotechnology. Three Aerospace firms were also members of the \$100 Million Club.

INDUSTRY PERFORMANCE

Thirteen Top 100 performers in the Communications/telecom equipment sector led the pack in Fiscal 2009, accounting for a combined total of \$2.76 billion of research spending, or 27% of the Top 100 R&D spending total. Next in spending volume were 28 Pharmaceuticals/biotechnology companies, which posted \$1.72 billion of spending. Four Telecommunications services firms were responsible for \$1.56 billion of research, or 15% of the total.

Six of the 10 leading sectors recorded declines in their research spending: Automotive (-20.4%), Communications/telecom equipment (-10.9%), Aerospace (-7.7%), Energy/oil and gas (-7.2%), Pharmaceuticals/biotechnology (-5.7%) and Electronic parts and components (-2.3%). However, there were strong gains in 4 other sectors: Software and computer services (30.8%), Telecommunications services (22.2%), Engineering services (17.4%) and Electrical power and utilities (21.1%).

THE TOP 10 R&D INTENSIVE FIRMS

Eight of the 10 most research-intensive firms were in the Pharmaceutical/biotechnology sector. This is somewhat to be expected, since large up-front investments are required for success in this sector. These firms tend to spend more on research than they gain in revenues because they are early-stage companies whose products have yet to enter the market.

GAINERS AND LOSERS

The top ten firms in growth stand out because of their substantial gains in research spending (50% or more) between Fiscal 2008 and Fiscal 2009. Heading this list is TELUS, which posted a stunning 211.0% gain in research spending. Sierra Wireless (83.9%), Ericsson Canada (56.3%), Dragon-Wave (52.7%), Rogers Communications (52.5%), Research In Motion (51.0%) and

Nexen (50.0%) were other well-known firms that posted strong gains in research spending during this period. The largest group of gainers this year was in the ICT sector.

Fiscal 2009 was not kind to a number of other high profile companies. Angiotech Pharmaceuticals (-52.3%), EnCana (-49.8%), Nortel Networks (-48.5%), Labopharm (-44.7%) and Tembec (-42.3%) were among the most recognizable firms that cut back on research spending during this period.

LOOKING AHEAD

Fiscal 2009 was a tough year for many Canadian firms, especially those not operating in the hot commodities sector. Strong evidence comes from the reported -16.4% drop in total revenue among the Top 100 Corporate R&D Spenders. In light of the sharp Top 100 revenue decline, the overall -1.8% decline in research spending seems comparatively moderate. But then R&D spending is a lagging, not a leading indicator.

Obviously, the real challenge for firms is whether they will be able to sustain their R&D spending – their investment in the future – in the face of continuing tough economic times. The challenge is compounded for large companies that are not profitable. These firms cannot take advantage of federal and provincial research and development tax credits, because they have no profits against which to apply those credits. Small firms, for whom research tax credits are refundable, are in a better position to weather the storm, but then their overall prospects are dimmer because they rely on growing sales in a tough market.

Canada's strong economic and fiscal performance in the decade past has allowed policymakers to paper over underlying difficulties in corporate R&D performance that have been apparent for some time. Much of our support for research is indirect (e.g. tax credits) rather than direct (e.g. grants, contracts), which is in contrast to most other OECD countries. Our major industrial research programs were designed decades ago when circumstances were quite different from today. Current economic conditions are bringing the policy challenges and contradictions to the fore, at a time when the country is less able to make the required investments. Governments are reluctant to go back to the drawing board and redesign our system (actually systems) of industrial research support in light of new challenges and opportunities.

Meanwhile, corporate leaders need to balance their short-term revenue and profit circumstances against their need to boost innovation and productivity. Companies such as Research in Motion have stepped up to the challenge. Other firms need to find their way too.

Last year we said “*The full effect of the deteriorating world economy will be reflected in next year's Fiscal 2009 corporate R&D spending results. It is hard to envisage better overall performance than in 2008 ... In consequence total corporate R&D spending will undoubtedly be affected – in a downward direction*”. In retrospect it was not such a difficult call. Next year? Let's hope that adverse circumstances bring out the best in our corporate and government leaders.

Top 100 – Leading Industries	
Industry	R&D Spending (% of Total)
Comm/telecom equipment (11)	27
Pharmaceuticals/biotechnology (28)	17
Telecommunications services (4)	15
Software and computer services (10)	9
Aerospace (5)	7
Energy/oil and gas/electric power (9)	6
Automotive (2)	6

Top 10 Research Intensive Companies**			
2009 Rank		R&D as % of Revenue	
Research Intensity	Overall Company		
1	71 MethylGene	732.4	
2	81 Transition Therapeutics	714.0	
3	90 Azure Dynamics	165.6	
4	79 Tekmira Pharmaceuticals	129.5	
5	70 Theratechnologies	127.2	
6	8 Atomic Energy of Canada	101.6	
7	40 AEterna Zentaris	69.9	
8	54 QLT	67.9	
9	61 BioMS Medical	62.5	
10	95 Labopharm	57.0	

**\$1 million or more of revenue

Top 10 Companies by Growth			
2009 Rank		R&D Growth	% Change 2008-2009
Overall	Company		
1	4 TELUS	211.0	
2	86 Enablence Technologies	183.1	
3	24 Sierra Wireless	83.9	
4	69 Enobia Pharma	62.2	
5	10 Ericsson Canada (fs)	56.3	
6	59 Evertz Technologies	54.2	
7	88 DragonWave	52.7	
8	28 Rogers Communications	52.5	
9	1 Research In Motion	51.0	
10	44 Nexen	50.0	

fs = Foreign subsidiary (includes R&D expenditures for Canadian operations only)

Bottom 10 Companies by Growth			
2009 Rank		R&D Growth	% Change 2008-2009
Overall	Company		
1	64 Angiotech Pharmaceuticals	-52.3	
2	55 EnCana	-49.8	
3	2 Nortel Networks	-48.5	
4	95 Labopharm	-44.7	
5	65 Tembec	-42.3	
6	71 MethylGene	-40.5	
7	61 BioMS Medical	-38.7	
8	78 Dorel Industries	-38.6	
9	56 Cardiome Pharma	-37.5	
10	70 Theratechnologies	-37.1	

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RESEARCH Infosource Inc. is Canada's source of R&D intelligence. Data used for this table were extracted from our Canadian Corporate R&D Database, a proprietary database. Companies wishing to be included in future editions of the Top 100 List, or who wish to adjust their figures should contact us directly.

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November 5, 2010

Canada's Corporate Innovation Leaders

A SUPPLEMENT PREPARED BY RESEARCH INFOSOURCE INC., AN IMPACT GROUP COMPANY

R&D SPENDING CONTINUES TO FALL — In Fiscal 2009, spending on research by the Top 100 Corporate R&D Spenders fell to \$10.22 billion from \$10.40 billion in Fiscal 2008, a drop of -1.8%. This continues a negative

Canada's Top 100 Corporate R&D Spenders 2010

Rank		Company	R&D Expenditures			Revenue	Research Intensity	Industry
2009	2008		FY2009 \$000	FY2008 \$000	% Change 2008-2009	FY2009 \$000	R&D as % of Revenue**	
1	6	Research In Motion Limited***	\$1,101,848	\$729,892	51.0	\$17,076,582	6.5	Comm/telecom equipment
2	1	Nortel Networks Corporation*	\$864,494	\$1,677,884	-48.5	\$4,668,496	18.5	Comm/telecom equipment
3	2	BCE Inc.	\$806,000	\$983,000	-18.0	\$17,735,000	4.5	Telecommunications services
4	11	TELUS Corporation	\$653,000	\$210,000	211.0	\$9,606,000	6.8	Telecommunications services
5	5	IBM Canada Ltd. (fs)	\$556,500	\$397,000	40.2	nd		Software and computer services
6	3	Magna International Inc.*	\$553,870	\$692,900	-20.1	\$19,833,114	2.8	Automotive
7	4	Pratt & Whitney Canada Corp. (fs)	\$398,000	\$442,000	-10.0	\$2,969,000	13.4	Aerospace
8	7	Atomic Energy of Canada Limited	\$393,051	\$329,406	19.3	\$387,016	101.6	Engineering services
9	8	Alcatel-Lucent (fs)	\$224,000	\$237,000	-5.5	nd		Comm/telecom equipment
10	14	Ericsson Canada Inc. (fs)	\$197,000	\$126,000	56.3	\$615,923	32.0	Comm/telecom equipment
11	9	Apotex Inc.	\$188,773	\$218,944	-13.8	\$1,190,276	15.9	Pharmaceuticals/biotechnology
12	10	sanofi-aventis Group (fs) ⁽¹⁾	\$181,621	\$211,542	-14.1	\$590,961	30.7	Pharmaceuticals/biotechnology
13		Suncor Energy Inc. ⁽²⁾	\$172,687	\$200,179	-13.7	\$25,480,000	0.7	Energy/oil and gas
14	12	Bombardier Inc.***	\$161,022	\$182,286	-11.7	\$22,115,972	0.7	Aerospace
15	13	GlaxoSmithKline Canada (fs)	\$147,813	\$149,751	-1.3	\$1,130,784	13.1	Pharmaceuticals/biotechnology
16	20	Biovail Corporation**	\$137,935	\$98,972	39.4	\$936,931	14.7	Pharmaceuticals/biotechnology
17	17	Open Text Corporation*	\$132,659	\$112,883	17.5	\$897,229	14.8	Software and computer services
18	16	CAE Inc.	\$121,647	\$113,138	7.5	\$1,662,200	7.3	Aerospace
19	27	Ontario Power Generation Inc.	\$112,000	\$75,000	49.3	\$5,640,000	2.0	Electrical power and utilities
20	21	Novartis Pharmaceuticals Canada Inc. (fs)	\$110,000	\$96,000	14.6	nd		Pharmaceuticals/biotechnology
21	15	Pfizer Canada Inc. (fs)	\$109,378	\$122,897	-11.0	\$2,784,783	3.9	Pharmaceuticals/biotechnology
22	19	Hydro-Québec	\$100,000	\$100,000	0.0	\$12,334,000	0.8	Electrical power and utilities
23	22	Merck (fs) ⁽³⁾	\$95,356	\$115,114	-17.2	\$1,282,209	7.4	Pharmaceuticals/biotechnology
24	41	Sierra Wireless, Inc.*	\$94,662	\$51,484	83.9	\$601,131	15.7	Comm/telecom equipment
25	26	Imperial Oil Limited	\$89,000	\$83,000	7.2	\$21,292,000	0.4	Energy/oil and gas
26	18	Aastra Technologies Limited	\$86,201	\$105,463	-18.3	\$832,897	10.3	Comm/telecom equipment
27	23	AstraZeneca Canada Inc. (fs)	\$83,746	\$88,912	-5.8	\$1,360,195	6.2	Pharmaceuticals/biotechnology
28	39	Rogers Communications Inc.	\$81,000	\$53,100	52.5	\$11,731,000	0.7	Telecommunications services
29	38	CGI Group Inc.	\$76,000	\$54,759	38.8	\$3,825,161	2.0	Software and computer services
30	42	Constellation Software Inc.*	\$74,952	\$51,407	45.8	\$500,127	15.0	Software and computer services
31	30	Mitel Networks Corporation*	\$68,634	\$66,732	2.9	\$839,484	8.2	Comm/telecom equipment
32	29	Wyeth Pharmaceuticals (fs) ⁺	\$67,975	\$73,090	-7.0	\$282,950	24.0	Pharmaceuticals/biotechnology
33	31	Vale Inco Limited (fs) ⁺	\$64,000	\$63,000	1.6	\$4,567,000	1.4	Mining and metals
34	40	Boehringer Ingelheim (Canada) Ltd./Ltée. (fs)	\$63,500	\$51,500	23.3	\$371,200	17.1	Pharmaceuticals/biotechnology
35	28	PMC Sierra, Ltd. (fs)	\$60,501	\$73,511	-17.7	\$107,735	56.2	Electronic parts and components
36	32	Cangene Corporation	\$59,632	\$62,200	-4.1	\$238,751	25.0	Pharmaceuticals/biotechnology
37	45	Synchrude Canada Ltd.	\$56,190	\$50,323	11.7	nd		Energy/oil and gas
38	33	Honeywell Canada (fs)	\$54,528	\$61,258	-11.0	\$1,010,475	5.4	Aerospace
39	44	Zarlink Semiconductor Inc.*	\$52,532	\$50,848	3.3	\$259,462	20.2	Electronic parts and components
40	34	AEterna Zentaris Inc.*	\$50,496	\$61,240	-17.5	\$72,217	69.9	Pharmaceuticals/biotechnology
41	57	Bayer Inc. (fs)	\$49,799	\$35,536	40.1	\$803,663	6.2	Pharmaceuticals/biotechnology
42	36	Novelis Inc.* (fs)	\$46,822	\$55,432	-15.5	\$11,622,134	0.4	Mining and metals
43	36	NOVA Chemicals Corporation* (fs)	\$45,680	\$55,432	-17.6	\$4,625,100	1.0	Chemicals and materials
44	66	Nexen Inc.	\$45,000	\$30,000	50.0	\$4,895,000	0.9	Energy/oil and gas
45	49	MacDonald, Dettwiler and Associates Ltd.	\$43,629	\$46,427	-6.0	\$1,000,890	4.4	Software and computer services
46	43	Janssen-Ortho Inc. (fs)	\$42,626	\$50,912	-16.3	\$608,149	7.0	Pharmaceuticals/biotechnology
47	53	DALSA Corporation	\$41,209	\$39,273	4.9	\$162,539	25.4	Electronic parts and components
48	68	Axcan Pharma Inc.* (fs)	\$41,154	\$29,874	37.8	\$476,144	8.6	Pharmaceuticals/biotechnology
49	59	EXFO Electro-Optical Engineering Inc.**	\$40,834	\$34,596	18.0	\$197,427	20.7	Medical devices and instrumentation
50	55	Cascades Inc.	\$35,200	\$37,600	-6.4	\$3,877,000	0.9	Forest and paper products
51	54	Gennum Corporation*	\$34,908	\$39,001	-10.5	\$97,344	35.9	Electronic parts and components
52	72	Westport Innovations Inc.	\$33,003	\$26,684	23.7	\$121,837	27.1	Transportation
53	64	Pharmascience Inc.	\$33,000	\$31,000	6.5	\$584,000	5.7	Pharmaceuticals/biotechnology
54	63	QLT Inc.*	\$32,650	\$31,519	3.6	\$48,085	67.9	Pharmaceuticals/biotechnology
55	24	EnCana Corporation*	\$30,700	\$61,100	-49.8	\$12,692,188	0.2	Energy/oil and gas
56	46	Cardiome Pharma Corp.	\$30,493	\$48,789	-37.5	\$54,672	55.8	Pharmaceuticals/biotechnology
57	52	Ballard Power Systems Inc.*	\$30,409	\$39,625	-23.3	\$53,357	57.0	Machinery
58	65	SNC-Lavalin Group Inc.	\$29,340	\$30,251	-3.0	\$6,101,737	0.5	Engineering services
59	89	Evertz Technologies Limited	\$28,719	\$18,629	54.2	\$315,905	9.1	Comm/telecom equipment
60	88	SMART Technologies Inc.*	\$28,563	\$21,949	30.1	\$534,634	5.3	Computer equipment
61	48	BioMS Medical Corp.	\$28,486	\$46,502	-38.7	\$45,605	62.5	Pharmaceuticals/biotechnology
62	74	Sandvine Corporation	\$28,162	\$25,921	8.6	\$68,848	40.9	Comm/telecom equipment
63		Cenovus Energy Inc.*	\$27,300	\$27,400	-0.4	\$11,579,880	0.2	Energy/oil and gas
64	35	Angiotech Pharmaceuticals, Inc.*	\$27,067	\$56,703	-52.3	\$319,392	8.5	Medical devices and instrumentation
65	50	Tembec Inc.	\$26,646	\$46,144	-42.3	\$1,786,000	1.5	Forest and paper products
66	66	Husky Energy Inc.	\$26,380	\$30,000	-12.1	\$15,074,000	0.2	Energy/oil and gas
67	61	Linamar Corporation	\$24,383	\$33,568	-27.4	\$1,675,910	1.5	Automotive
68	60	Bell Aliant Regional Communications LP	\$24,214	\$33,789	-28.3	\$2,757,310	0.9	Telecommunications services
69		Enobia Pharma Inc.	\$23,165	\$14,282	62.2	\$0		Pharmaceuticals/biotechnology
70	58	Theratechnologies Inc.	\$22,226	\$35,326	-37.1	\$17,468	127.2	Pharmaceuticals/biotechnology
71	56	MethylGene Inc.	\$22,119	\$37,199	-40.5	\$3,020	732.4	Pharmaceuticals/biotechnology
72	79	Xerox Canada Inc. (fs)	\$21,877	\$23,171	-5.6	\$1,141,453	1.9	Machinery
73	94	Miranda Technologies Inc.	\$21,799	\$17,758	22.8	\$131,751	16.5	Comm/telecom equipment
74	77	Tundra Semiconductor Corporation ⁺	\$21,260	\$24,752	-14.1	\$66,398	32.0	Electronic parts and components
75	82	Rio Tinto Iron & Titanium Inc. (fs)	\$20,408	\$22,107	-7.7	\$768,200	2.7	Mining and metals
76	76	Psion Teklogix Inc. (fs)	\$20,023	\$24,927	-19.7	\$303,745	6.6	Computer equipment
77	87	ViXS Systems Inc.**	\$19,850	\$19,450	2.1	\$65,540	30.3	Electronic parts and components
78	62	Dorel Industries Inc.*	\$19,624	\$31,957	-38.6	\$2,444,010	0.8	Other manufacturing
79	97	Tekmira Pharmaceuticals Corporation	\$18,679	\$16,767	11.4	\$14,428	129.5	Pharmaceuticals/biotechnology
80	83	Allen-Vanguard Corporation	\$18,079	\$21,833	-17.2	nd		Medical devices and instrumentation
81		Transition Therapeutics Inc.	\$17,942	\$13,023	37.8	\$2,513	714.0	Pharmaceuticals/biotechnology
82	78	ratiopharm inc. (fs) ⁺	\$17,811	\$24,180	-26.3	nd		Pharmaceuticals/biotechnology
83	99	Bridgewater Systems Corporation	\$17,718	\$14,935	18.6	\$66,676	26.6	Software and computer services
84	95	COM DEV International Ltd.	\$17,475	\$17,381	0.5	\$240,410	7.3	Comm/telecom equipment
85	85	ArcelorMittal Dofasco Inc. (fs)	\$17,000	\$19,900	-14.6	\$2,589,000	0.7	Mining and metals
86		Enablence Technologies Inc.	\$16,805	\$5,936	183.1	\$45,238	37.1	Electronic parts and components
87		Descartes Systems Group Inc.***	\$16,558	\$12,214	35.6	\$84,243	19.7	Software and computer services
88		DragonWave Inc. **	\$16,224	\$10,628	52.7	\$171,104	9.5	Comm/telecom equipment
89	86	20-20 Technologies Inc.*	\$15,698	\$19,717	-20.4	\$72,068	21.8	Software and computer services
90	84	Azure Dynamics Corporation	\$15,568	\$21,500	-27.6	\$9,403	165.6	Transportation
91	80	Teck Resources Limited	\$15,000	\$23,000	-34.8	\$7,674,000	0.2	Mining and metals
92	96	March Networks Corporation	\$14,431	\$17,668	-18.3	\$101,191	14.3	Comm/telecom equipment
93	100	MKS Inc.*	\$14,202	\$14,782	-3.9	\$66,713	21.3	Software and computer services
94		Winpak Ltd.*	\$14,068	\$11,389	23.5	\$577,842	2.4	Rubber and plastics
95	75	Labopharm Inc.	\$14,013	\$25,339	-44.7	\$24,572	57.0	Pharmaceuticals/biotechnology
96		SXC Health Solutions Corp.*	\$13,648	\$10,772	26.7	\$1,642,920	0.8	Software and computer services
97		Resverlogix Corp.	\$13,616	\$14,730	-7.6	\$0		Pharmaceuticals/biotechnology
98		Héroux-Devtek Inc.	\$13,505	\$12,315	9.7	\$337,635	4.0	Aerospace
99	90	MEGA Brands Inc.*	\$13,441	\$18,621	-27.8	\$387,038	3.5	Other manufacturing
100	98	Bioniche Life Sciences Inc.	\$13,315	\$15,973	-16.6	\$33,281	40.0	Pharmaceuticals/biotechnology

Notes:

- We have attempted, wherever possible, to provide gross R&D expenditures before deduction of investment tax credits or government grants.
- FY2008 R&D expenditures figures may have been adjusted, as more accurate information became available.
- Canadian-owned company results include worldwide R&D expenditures; foreign subsidiaries (fs) include R&D expenditures for Canadian operations only.
- We have attempted, wherever possible, to provide revenue figures net of interest and investment income.

*Converted to CDN\$ at annual average 2009 = \$1.1420, 2008 = \$1.0660 (Bank of Canada)
+Not current name
++Fiscal 2010 results were used for year ended January or February
nd = Not disclosed **\$1 million or more of revenue
fs = Foreign subsidiary (includes R&D expenditures for Canadian operations only)
(1) Includes sanofi-aventis Canada Inc. and Sanofi Pasteur Limited.
(2) Fiscal 2008 R&D expenditures is the combined amount for Suncor Energy Inc. and Petro-Canada prior to the merger.
Fiscal 2009 R&D expenditures is the combined amount for

Suncor Energy Inc. and Petro-Canada. Fiscal 2009 revenue is for Suncor Energy Inc. only (excludes any pre-merger Petro-Canada revenue).
(3) Fiscal 2008 R&D expenditures is the combined amount for Merck Frosst Canada Ltd. and Schering-Plough Canada Inc. prior to the merger. Fiscal 2009 figures for R&D expenditures and revenue are the combined amount for Merck Frosst Canada Ltd. and Schering-Plough Canada Inc.

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