

Canada Doubles Down on Key Strengths to Boost Innovation



By Debbie Lawes

Canada is getting serious about innovation. After more than a decade of expert reports lamenting our country's low productivity growth and poor track record in translating excellent research into business innovation, the federal government has promised to deliver a "bold, coordinated strategy on innovation" that calls on all sectors of society to take action.

"We don't need another report on what our challenges are. We need fresh ideas and a joint action plan that will make innovation a national priority," Innovation minister Navdeep Bains said in June. The government is currently reviewing more than 1,300 responses to an online consultation that will inform a new innovation agenda, with emphasis on: internships, apprenticeships and continuous learning; collaborative research; and growing small and medium-sized enterprises (SMEs).

Fortunately, Canada is starting from a strong base. We produce many of the world's best educated students and our academic research is internationally renowned. Canadians have found creative ways to turn their challenges – vast geography, small population and strained public budgets – into a competitive advantage through partnerships that are breaking barriers between scientific silos and building bridges across industry, academia and government.

Just ask Canada's perennial research powerhouse Bombardier Inc. The Montreal-based plane and train maker collaborates with suppliers, universities and other research centres on innovative ways to outflank larger global competitors with much deeper pockets. Its most advanced plane ever, the CSeries jet, uses new engine technology and lightweight composite materials that have cut fuel consumption by 20%. It is also the quietest commercial jet in the sky.

Dr. Fassi Kafyeke, Senior Director of Strategic Technology and Advanced Product Development at Bombardier Aerospace, says Canada is "doing very well" internationally considering that other big aerospace countries, notably the United States and France, have access to much larger pools of government support for R&D.

This challenge was flagged in a 2012 report by former Cabinet minister David Emerson that called on government to support technology trials and research collaborations. The government responded with funding for a new Aerospace Technology Demonstration Program, which supports higher risk, large-scale projects, and for the Consortium for Aerospace Research and Innovation in Canada. CARIC links large aerospace companies with SMEs and academic experts from across Canada, and increasingly with Europe and the United States.

"It's a model that mandates collaboration between at least two academic partners and two industrial partners on a single project," says Marc St-Hilaire, VP Technology and Innovation at Ottawa-based CAE Inc, known worldwide for its training and flight simulators.

CAE is one of Canada's largest research spenders, investing \$1.3 billion in R&D over the past decade. It has since leveraged its experience in modelling, simulation and training to expand into new markets such as mining and healthcare, the latter generating more than \$100 million in sales annually.

LINKING SMALL AND LARGE FIRMS

St-Hilaire attributes the company's success to its culture of innovation, highly skilled university graduates, and collaborations with suppliers. CAE's next generation training system includes components designed and

manufactured by suppliers in Quebec and Ontario. The tool analyzes individual behaviour in real time in a simulator and then uses this big data to customize the training to each pilot's individual requirements. If a pilot has problems landing in crosswinds, the software will focus on that skill until the pilot masters it.

"We don't innovate alone, we innovate with our suppliers," says St-Hilaire. "Every year we buy \$380 million of equipment from our Canadian suppliers ... we bring them to the table with their ideas and their innovations and they suggest to us designs for new equipment to be more competitive."

Collaborations are now critical to doing research faster and bringing smaller firms into global supply chains. "It's very difficult for a small company in this sector to do research in isolation," says Kafyeke. "And it's difficult for a SME to get to the market unless they collaborate with people like us or other OEMs (original equipment manufacturers) or Tier 1 companies that will eventually be their customers."

In one project, Bombardier Aerospace partnered with Quebec SME Texonic, CTT Group – a technology transfer centre associated with the Cégep de Saint-Hyacinthe – and others, to develop preforms (preliminary moulds) for manufacturing lighter composite materials for airplanes using high-tech platforms such as 3-D weaving looms.

CTT Group was founded in 1987 in partnership with industry to support Quebec's textile sector. Faced with growing international competition, CTT Group has played a key role in the industry's transition to advanced fibres, smart textiles and geosynthetics.

"Advanced textiles are an important material for the future," says Dr. Olivier Vermeersch, VP of R&D at CTT Group. "Using natural fibers blended into polymers, you can develop a fabric with a lot of capacities to protect people (e.g. first responders and military personnel), measure vital signs and reinforce composite parts for airplanes, automobiles and building construction."

Today, about 80 technicians, engineers and scientists, including 40 students, support CTT Groups' more than 100 member companies. "Not only does it help the companies we work with, it is also valuable professional experience for students," says Vermeersch.

Campuses across Canada are embracing experiential learning as a way to inspire innovation and make graduates more job-ready. Lambton College's Dr. Mehdi Sheikhzadeh says they do research to provide students with real-world training, to keep faculty up-to-date, and to help companies develop, test and implement solutions that grow sales, minimize costs, create jobs and increase competitiveness and productivity.

"You have students working side by side with people from industry on real-life problems. They are also using equipment, software, infrastructure and methodologies that are not always covered in the classroom," says Sheikhzadeh, Dean, Applied Research and Innovation at the Sarnia, Ontario-based college.

Every college or university has its own academic and research strengths. Lambton's expertise in green energy helped it win a \$2.3-million grant from the Natural Sciences and Engineering Research Council in September to establish the Lambton Energy Research Centre, which complements the college's experience in bioindustrial and water processes and technologies.

"The centre will operate as a hub for research and development of green energy technologies in this region while supporting the growth of Sarnia-Lambton Sustainable Energy Cluster," says Sheikhzadeh.

EXPORTING PROVEN MODELS

Canada's more successful innovation models are being adopted in other countries. Most notable among these is Ryerson University's network of 10 "Innovation Zones", which specialize in everything from urban energy and fashion to design and social innovation. Its first zone, the DMZ, is now one of Canada's largest business incubators. The 260 start-ups it has helped have since raised \$206 million in seed funding and created more than 2,400 jobs.

These zones see faculty, students, and industry partners working together on industry problems, while enabling students to learn by working with industry clients or by creating their own companies.

"We focus on career-ready graduates," says Dr. Usha George, Interim VP, Research and Innovation at Ryerson. "To catch up with the demands of a knowledge economy we need people who are creative, can innovative

and think of different solutions to existing problems."

Ryerson's zone model has been adopted by South Africa's University of the Witwatersrand and in India by the Bombay Stock Exchange, Barclays and Amrita University. Ryerson also recently launched Zone Start-ups Calgary with GE Canada to focus on industrial Internet and energy-start-ups, as well as the Sport Innovation Hub in Toronto to connect sport entrepreneurs with experts from the Canadian sports industry.

"We pride ourselves on being community engaged and a city builder," says George. "Creating knowledge that is useful to the end user drives a lot of our thinking."

That same thinking led Brock University to create five transdisciplinary research hubs where students and faculty work with community partners to address the development needs and problems of the Niagara Region.

"Each hub is quite different, but what unites them is their transdisciplinarity and their efforts to work with partners," says Dr. Steven Renzetti, Brock's Interim VP Research. "The Social Justice Research Institute, for example, has about 40 partners with very strong ties with the Niagara community, poverty groups, the United Way and groups representing recent newcomers to Canada."

The hubs address complex community challenges that cannot be solved within the narrow silos of traditional academic disciplines. The Environmental Sustainability Research Centre, for example, sees hydrologists and ecologists working with social scientists to understand sustainability issues. The other hubs focus on biomanufacturing, health and well-being and human development.

"What the world has in many cases are issues and challenges and what universities have are departments. We have to get over that," says Renzetti. "When you see this proliferation of centres and institutes at universities, that's the clearest signal of the institution's way of getting around departmental silos."

SHARING RESOURCES AND EXPERTISE

IBM is using its technology and global footprint to build partnerships and drive innovation. Its Southern Ontario Smart Computing Innovation Platform – one of several IBM research initiatives across Canada – allows companies and researchers from 16 academic institutions to share a distributed network of high performance super computing resources to speed up research and tackle complex challenges.

Since its launch in 2012, SOSICP has supported more than 60 projects in areas as diverse as agile computing, health, water, energy, cities, mining, advanced manufacturing, digital media and cybersecurity. It has engaged or created 38 small businesses and established a pipeline of nearly \$2 billion in revenue for these firms.

"For the use of our equipment and technology and mentoring we're helping to build a strong ecosystem" that includes highly skilled workers, says Patrick Horgan, IBM Canada's VP, Manufacturing, Development and Operations. "There is more need for analytic skills and jobs than there are people with those skills so we decided to help push that ball forward in Canada... This isn't altruism, it's very long term in our thinking."

Horgan says Canada could up its innovative potential if governments did more to support research collaborations. "That sometimes requires a flexible approach. If you're being too prescriptive on how the rules and programs need to be done then it often slows things down."

And, don't be afraid to favour sectors where Canada excels, such as health care, fresh water and ocean research, energy, natural resources, smart grids, digital media and cybersecurity. "These are things Canadians should lead, and can lead on the world stage," says Horgan.

High-tech clusters often gather round colleges and universities with both the research expertise and skilled graduates companies need to innovate and compete. Metro Vancouver is home to the world's largest hydrogen and fuel cell industry. Big corporate players include Ballard Power Systems, which is opening new markets in China for fuel cell powered buses, and Mercedes, which invested \$70 million in Vancouver to create the world's first automated fuel cell manufacturing plant.

Assisting these companies is Simon Fraser University, one of the strongest institutions globally in the area of fuel cells. "That research excellence is one reason why indus-

tries are moving to BC. They want to work with us because they recognize we have really good science happening in that area," says Dr. Joy Johnson, SFU's VP Research.

More universities are abandoning the traditional "push" form of tech transfer that sees inventions developed without consulting with industry first, and then pushing a technology out before it's ready for commercial prime time. To address that infamous "valley of death" between research and commercialization, in 2007 SFU opened the 4D Labs to help companies develop solutions in the areas of fuel cells and other advanced materials.

"4D Labs is an operating model that responds directly to requests from industry partners on particular issues they are struggling with. Smaller companies don't always have good R&D facilities on site so they can come in to get trained on our tools and work within the lab, or they can partner with our researchers and students," says Johnston. "Innovation happens when people solve problems together."

THE SCALING UP CHALLENGE

Such is the case in Western Canada, where mining companies have teamed up as part of Canada's Oil Sands Innovation Alliance to co-develop and share technologies that reduce the industry's environmental footprint. Since forming in 2012, COSIA's member companies have shared 819 technologies and innovations – more than 130 of which relate to tailings management.

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One of those solutions is a centrifuge technology developed by Syncrude Canada that speeds the release of process water from fine fluid tailings, accelerates tailings reclamation and minimizes the size of tailing ponds. Last year, the company deployed the technology in a \$1.9-billion commercial-scale centrifuge plant north of Fort McMurray. Syncrude has since shared the technology through COSIA with Shell Canada.

"Part of the COSIA model allows us to share data freely among each other and that allows us to accelerate the pace of the application of new technologies," says Mal Carroll, R&D Manager at Syncrude Canada. He adds that about 50% of the company's R&D budget is focused on environmental initiatives, many in collaboration with other COSIA partners.

Carroll stressed that it's not enough for companies to develop a technology, "you need to be able to scale up, perform pilot tests and carefully and cautiously develop the technology." Scaling up an innovation often costs more than the actual R&D, he adds.

For example, Syncrude recently started a full-scale commercial operation of a new wet crushing technology to more efficiently process oil sands and reduce the amount of bitumen that ends up in tailings ponds. To help offset scale up costs, Syncrude sold the oil that was produced during the pilot testing. "We look for opportunities like that to self-fund the projects we have," says Carroll.

The proliferation of incubators and accelerators across Canada is making it more likely that promising academic research will spur the growth of new companies. The University of Toronto is the North American leader in the number of new research-based start-ups, with 350 new companies founded on its research. Through U of T programs like UTEST, nascent companies receive start-up funding, work space, mentoring and business strategy support.

"If you look around our city, there are so many more resources available for our students and faculty members who want to develop a product, create a company and grow it," says Dr. Vivek Goel, VP Research and Innovation at U of T.

Unfortunately, too much of this intellectual property is licensed to multinational firms to create jobs and profits in other countries. "The good news is that we are seeing an increase in investment disclosures, patents and our company creation. But we continue to have this unfortunate pattern where either we have to out-license the technologies (to foreign firms) or, when we do get a company

going, it gets bought up a few years out. We have to really turn our attention to that scale up challenge."

Goel says academia or industry can't fix this problem on their own. They need government intervention that leverages public sector procurement, provides tax incentives for company founders to stay in Canada, and encourages later stage, long-term capital.

PARTNERING FOR BETTER HEALTHCARE

Collaborative research is becoming the norm in a growing number of fields, particularly health care. Last year, the McGill University Health Centre merged its basic laboratory, clinical and evaluative research into a single hospital complex in Montreal.

Along with new state-of-the-art facilities, more opportunities were created for its 460 investigators and over 1,200 students and fellows to work across disciplines on 1,700 ongoing research projects, from infectious diseases and experimental therapeutics to child health and human development. The Research Institute of the MUHC also merges the pediatric and adult components of research so that scientists can investigate disease across a person's lifespan.

Dr. Vassilios Papadopoulos, who stepped down in September as Executive Director of the RI-MUHC, described the new facilities "a dream come true for investigators doing translational research, in other words, those who work to apply the results of basic research to improve patient care."

The new facility includes the McConnell of Innovative Medicine – described as a "hospital within a hospital" with beds for patients who participate in clinical studies. "The beauty of this set up is that we're fully immersed in health care," says Dr. Bruce Mazer, the interim head of RI-MUHC. "It allows our researchers to focus on these problems in novel ways and look at piloting new approaches, new drugs and even new apps to improve patient care."

One phone app developed at RI-MUHC to remind children to take their kidney transplant drugs is leading to new apps for diabetes management. "What better way to monitor your diabetes than to have a beep on your cell phone?" says Mazer. "The more the community works together and understands that these collaborations are bearing fruit, the greater the chances for amazing successes."

Canada is particularly good at linking pockets of expertise across the country through virtual networks. The University of Ottawa has hosted two such national initiatives – the Canadian Stroke Network and the Stem Cell Network. One of the stroke network's biggest successes was the development and implementation of a national stroke strategy that has improved stroke prevention, care and rehabilitation in communities across Canada.

"We want multidisciplinary research but we're a large country ... Networks of Centres of Excellence are extremely effective vehicles to harness the research strengths from across the country," says Dr. Mona Nemer, VP Research at U of O.

Today, Ottawa is a global leader in clinical trials for innovative stem cell therapies. One recent trial led by U of O scientists found that replacing a diseased immune system with a new one using blood stem cells can halt the progression of multiple sclerosis, allowing it to repair itself.

Looking ahead, Nemer stresses that more funding is needed for fundamental research that cuts across disciplines and for early proof of principle research. "That area is really very critical. Institutions need to have the seed funding to move these things forward."

IBM's Patrick Horgan says Canada's adeptness at collaborative research is demonstrating that such investments pay huge dividends.

"We have a reputation in Canada for being good at collaborations and being able to build on our strengths," he says. "And we're still at really early stages. There's a ton more that can be done."

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