Special

Research · Innovation · Enterprise

Universities and funding agencies are finding new ways to encourage collaborations between research and business

Clearing a path for partnerships

Collaborative research drives value for businesses. That's a bottom-line message – and an opportunity – that Canada's universities and the public agencies that fund scientific R&D not only want the corporate sector to hear, but also tap into.

In fact, a new online tool now makes it easy for companies to find post-secondary institutions to partner with. There are good reasons why businesses should pay heed.

Three years ago, the founders of Burnaby's Cooledge Lighting were in the early stages of research and development for a new product and needed a way to test many ideas in a short period of time. After searching the continent, they ultimately found what they needed in their own city: Simon Fraser University's 4D LABS.

Home to some of Canada's most advanced research infrastructure for materials science and engineering, 4D LABS provided Cooledge with a ready suite of tools, equipment and expertise to accelerate the development of the company's flexible light sheet, an energy-efficient film of LED lights for use in unique lighting designs. As a result of its work with 4D LABS, Cooledge, which launched its premier product last spring, was able to access the right combination of materials and processes faster and at a lower cost than it could have on its own.

"In the long run, we want companies to see that the university is truly a partner in helping them grow."

Dr. Digvir Jayas
University of Manitoba

Fostering state-of-the-art research facilities like 4D LABS to the point where they can help companies gain economic advantages takes ongoing effort and investment, says Canada Foundation for Innovation (CFI) president and CEO Gilles Patry.

"Innovation can stall if you do not sustain your investments in research. At various places in the research-to-commercialization continuum, there's a role for government funding organizations, a role for the academic environment and a role for the private sector," he says, adding that collaborations are essential for helping to carry the momentum to the point of gaining tangible results.

While Cooledge's pursuit of an R&D partner fortuitously led it to 4D LABS, a new online tool created by CFI promises to streamline the process.

This week, the CFI launched an online directory highlighting research facilities it has funded to help facilitate these connections. Called the CFI Research Facilities Navigator, the directory helps industry connect with experts who can tackle "problems that businesses need to address and for which they need access to specialized equipment and the people trained to operate it," explains Dr. Patry.

By providing companies with ready access to labs that are conducting fundamental discovery work but that can apply their know-how to real-world business problems "the Navigator offers a way of connecting a community of users, both from the private sector and from academia, and telling them what's happening and what's available," says Dr. Patry.

Partnerships also play an important role in defining research needs as well as ensuring that research is shared in the community and with business, says Wendy Cukier, Ryerson University's vice-president of research and innovation. "If you look at any of the big research initiatives at Ryerson, it's almost inevitable that you find that we're working with industry or community partners."

When Ryerson's Centre for Urban Energy was created in 2010, industry collaboration was at its core. Among its initiatives, the university partnered with the biggest players in Ontario's energy sector – Hydro One, Toronto Hydro and the Ontario Power Authority. The aim: to address emerging needs like creating better smart grids, incorporating alternative energy sources into the traditional supply and finding new ways to manage the demand for electricity during peak hours.

Many universities are exploring ways of encouraging collaborations by smoothing over what can sometimes be thorny issues. For example, the University of Manitoba is implementing a new intellectual property (IP) program to make research more accessible to the private sector.

"We have created a model where our partners manage the IP coming out of the collaborative research," says vice-president, research and international, Digvir Jayas. He says that lengthy negotiations over potential royalty fees and control of IP have been replaced by a clearly defined process that has already received positive feedback.

Private-sector partners who utilize this model have full control of the technology, but once it is successful as a commercialized product or service, they are asked to share part of their returns with the university.

As a result, Dr. Jayas envisions the University of Manitoba's research program becoming stronger, increasingly enabling students to work on problems that find application in industry.

The success of industry collaborations, in turn, would positively impact the economy, Dr. Jayas says. "In the long run, we want companies to see that the university is truly a partner in helping them grow."

"Collaboration between research and business comes naturally to many companies and researchers," says Dr. Patry. "These kinds of partnerships have repeatedly been proven to be successful in institutions across Canada. Making sure this continues will take innovative thinking from research institutions, business and organizations like ours."

ABOUT CFI

The Canada Foundation for Innovation (CFI) gives researchers the tools they need to think big and compete globally, across the spectrum of research, from discovery to applied. By investing in state-of-the-art facilities and equipment in Canada's universities, colleges, research hospitals and non-profit research institutions, the CFI is helping to attract and retain the world's top talent, to train the next generation of researchers, to support private-sector innovation and to create high-quality jobs that strengthen the economy and improve the quality of life for all Canadians. For more information, visit Innovation.ca.

Saskatchewan Institute of Applied Science and Technology research technician Courtney Belair (left) and PhD student Courtney Phillips (far right) work with University of Saskatchewan professor Derek Peak (centre) on soil sample analysis using a beamline at the CFI-funded Canadian Light Source synchrotron. SUPPLIED

ENVIRONMENT

Collaborative effort advancing eco-friendly gas station clean-up

A unique Saskatchewan public-private research partnership is advancing eco-friendly remediation techniques and technology that could make it easier to clean up contaminated soil at former gas station and petroleum-impacted sites in Canada and around the world.

The collaboration among the University of Saskatchewan (U of S), the Saskatchewan Institute of Applied Science and Technology (SIAST) and Federated Co-operatives Limited (FCL) on behalf of retail co-ops in Western Canada involves testing new sustainable methods of remediating these sites, while also providing hands-on research training for three U of S PhD students and 18 SIAST bioscience and technology students.

The new methods have the potential to reduce clean-up costs at these sites by more than 30 per cent.

In Canada alone, there are an estimated 30,000 of these contaminated municipal "brownfield" sites. Until now, the traditional approach has been to dig up the surrounding soil and dump it into a landfill.

Clean-up, CFI 2

ROADS AND BRIDGES

Municipal infrastructure gets a boost from university expertise

Canadians must be wondering what's happening to their infrastructure. From concrete chunks falling off big-city expressways to shopping mall collapses and water main breaks, it all seems to be crumbling at the same time.

In a way, it is. Much of Canada's infrastructure was built during the post-Second World War development boom. Since it was estimated to last about 50 years, it has simply passed the best-before date. And this is happening at the same time as a massive migration to urban centres, increasing the need for new infrastructure and further stressing aging structures.

In 2012, the Federation of Canadian Municipalities released its Infrastructure Report Card, which found that roughly 30 per cent of Canada's infrastructure was in need of repair or replacement. Municipal roads, it reported, demanded "urgent attention" and would cost more than

Infrastructure, CFI 4

INSIDE

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RESEARCH • INNOVATION • ENTERPRISE

OPINION

When business and research connect, everybody wins

By **Dr. Gilles Patry**
President and CEO of the Canada Foundation for Innovation

William Vincent, research and development manager at Shape Foods in Brandon, Man., is driven by a goal: to see bottles of his company's flax oil right next to the olive oil on the shelves of every major grocery store in North America. It could be a relatively straightforward endeavour, save for a problematic group of molecules that start to break down after nine months on the shelf creating a bitter, fishy taste.

To better understand this troublesome chemical reaction, Mr. Vincent's company turned to Oleg Krokhin at the Manitoba Centre for Proteomics and Systems Biology at the University of Manitoba and his suite of state-of-the-art mass spectrometers.

"The CFI ensures that Canada's best researchers have access to the advanced labs and equipment necessary to conduct world-class research across all disciplines, and from discovery to applied research."

As a result of the analysis carried out by Dr. Krokhin and his colleagues, the company is several important steps closer to solving the niggling technical problems that stand between Shape Foods' flax seed oil and that coveted grocery store shelf.

If Mr. Vincent's team and their research partners find a way to short-circuit the chemistry that is currently keeping their product from the mainstream market, it would mean significant growth not just for Shape Foods – which already sells its products globally and provides 35 jobs in Brandon – but for the entire flax industry in Canada. And making highly nutritional flax seed oil readily available to consumers could help address the chronic lack of Omega-3 fatty acids in the North American diet, a deficiency that is implicated in a host of health problems, from cardiovascular disease to type 2 diabetes.

This is one example of what can happen when business and research come together. And this is innovation – when a company can gain an edge in the marketplace by finding an inventive solution to a problem.

Supporting innovation of all kinds is at the core of the Canada Foundation for Innovation's (CFI) three-fold mandate. As the leading federal organization devoted to funding research infrastructure in universities, colleges and research hospitals, the CFI ensures that Canada's best researchers have access to the advanced labs and equipment necessary to conduct world-class research across all disciplines, and from discovery to applied research. Having the best tools helps to attract and retain the best talent from around the world and provides a vibrant environment in which to train the next generation of researchers and innovators.

The third element of our mandate is to enhance the capacity of our funded institutions to use their research infrastructure to support innovation and commercialization. Collaborations like that between Shape Foods and the CFI-funded labs at the University of Manitoba are evidence that we are succeeding.

This kind of mutually beneficial partnership is happening across Canada: according to a recent report by the Association of Universities and Colleges of Canada, our universities conduct almost $1 billion worth of research in collaboration with the private sector annually, which provides "the intellectual raw material that drives innovation and builds prosperity."

But it can be challenging for companies to tap into the research resources at post-secondary institutions – they are either not aware what resources they can access or they don't know what kind of labs or expertise are available. Clarifying this is the driver behind a new online tool the CFI launched earlier this week, called the Research Facilities Navigator. This is a searchable directory of participating research labs and facilities in universities, colleges and research hospitals across Canada that are open to working with business. Some 300 labs from virtually every discipline have submitted entries for the Navigator, and this number is growing. Every facility listed contains advanced research equipment and includes highly skilled researchers and students who have the kind of expertise that is attractive to companies seeking to propel their business toward the cutting edge.

The Navigator was created to help businesses connect with research facilities as a first step toward establishing partnerships and collaborations. For research facilities, it is a way to promote their research capabilities to the private and public sectors; for companies, it is a venue to find the research facilities that can help their business grow, stay competitive, design new or better products or processes, and foster relationships with highly skilled people.

Tapping into Canada's incredible storehouse of research capability to open up a company's potential is a notion that comes naturally to companies like Shape Foods, and one that has repeatedly been proven in institutions across Canada. Making sure these connections continue and new connections are facilitated is what the Navigator is all about.

Visit the CFI Research Facilities Navigator at Innovation.ca/navigator.

A partnership between the University of Manitoba and Shape Foods looks at the molecules in flax oil that start to break down after nine months.The research aims to extend the product's shelf life, making it suitable for major grocery stores. SUPPLIED

CFI BY THE NUMBERS

$6 billion +
Overall amount invested by the Canada Foundation for Innovation (CFI) in research facilities and equipment in Canadian universities, colleges and research hospitals since its creation in 1997

8,206
Total number of research infrastructure projects funded by the CFI since it began

142
Number of institutions that have received funding from the CFI

26,000 +
Number of highly qualified personnel – post-doctoral fellows, graduate students and undergraduates – who trained using CFI-funded infrastructure in 2012-13, 1,843 of whom completed their training and moved into the workforce

1,768
Number of jobs created at institutions in spinoff companies or with private-sector partners in 2012-13 as a result of CFI-funded research infrastructure

Brian Smith
Insider Trading Database
wlu.ca/sbe/fsrc

Hind Al-Abadleh
Atmospheric Chemistry
wlu.ca/wins

Tripat Gill
Market Insight and Innovation

Robert McLeman
Citizen Science
RinkWatch.org

Jennifer Baltzer
Forests and Global Change
forestecology.ca taigaplains.ca

Dmitri Goussev
Green Chemistry

Stephanie Dewitte-Orr
Functional Antiviral
Immune Responses

Mark Eys
Group Dynamics and
Physical Activity

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FROM CFI 1

Clean-up: Research looks at nutrients for biodegradation

"There's nothing sustainable about a practice like that," says Trevor Carlson, FCL's environmental affairs director. "In addition to being disruptive, especially in congested urban areas, all you're really doing is moving the problem."

So with the goal of setting a world standard of excellence in co-operative retailing, FCL set out to find a more sustainable solution.

"We wanted a solution that we could share with the rest of the world because our situation is hardly unique – these kinds of sites exist all over the world," said Mr. Carlson.

FCL tested its initial concepts at numerous co-op petroleum sites across the four western provinces, many of them "legacy" sites dating back to the 1930s and '40s when facilities were not built to today's more stringent standards.

Applying science and ingenuity, FCL tackled the problem in a unique way, adding phosphates and trace nutrients to the sites in order to stimulate naturally occurring microbes in the soil to "eat up" the gasoline, ultimately transforming it into non-toxic constituents such as water and carbon dioxide.

The good news was that the process worked well on most sites, though on others the process occasionally seemed to stall. It was at that point, three years ago, that FCL decided it was time to reach out.

"We realized there were some problems we couldn't solve, so we decided to expand our team," says Mr. Carlson.

FCL approached the U of S and teamed up with Steven Siciliano, a professor of soil environmental toxicology, and Derek Peak, an associate professor specializing in environmental soil chemistry, for the expertise and advanced techniques to adapt and refine the remediation technology. Dr. Peak is an expert in using the Canadian Light Source synchrotron at the U of S to gather information at the molecular level about the structural and chemical properties of soil samples from contaminated sites.

More recently, the team approached the SIAST Office of Applied Research and Innovation. Blaine Chartrand, who leads the BioScience and Technology program, was keen to test lab-based models for the remediation technology and evaluate its application across test sites.

Dr. Siciliano is optimistic about the prospects for success due to the innovative and collaborative approach and the team's access to both Canada's only synchrotron and the new SIAST BioScience Applied Research Centre for soil analysis.

The partnership has already led to a greater understanding of the role that phosphorus in the form of phosphate, an essential nutrient for biodegradation, plays in the remediation process.

"We knew it was important to get nitrogen to the organisms that degrade gasoline, but we didn't have a handle on the phosphate-soil interactions," says Dr. Siciliano. "We now have a better understanding of this role and are confident we are working on the last piece of the puzzle."

The three-year project is not only helping solve a major real-world environmental problem, but is also giving students an unprecedented training opportunity.

"Our students are learning sophisticated techniques and using state-of-the-art instrumentation that is going to make them that much more valuable to future employers," says Mr. Chartrand.

HARNESSING BIG DATA

RYERSON UNIVERSITY IS USING BIG DATA TO SOLVE BIG CHALLENGES

Big data is a rapidly growing area of research at Ryerson University. With computing power increasing exponentially and the number of active mobile devices set to exceed the global population by 2014, the ability to store and analyze these complex data sets – or "big data" – is a pressing issue for industry, governments and organizations.

Identifying patterns and trends in big data will make governments more effective, businesses more profitable and individuals more productive.

Big data research at Ryerson University has led to the creation of a number of startups, including EidoSearch, which offers real-time financial analytics, and WhoPlusYou, which provides real-time analysis of labour markets.

Ryerson researchers also partner with industry, government and community organizations such as Toronto Hydro, the Ministry of Transportation, Metrolinx, Amos Kedmey, GE Healthcare, NexJ Systems, Warranty Life, Winston Inc., BlackBerry, Kanetix Inc., and Pitney Bowes to harness big data to solve real-world problems.

With the support of the Canada Foundation for Innovation, here are just a few examples of how Ryerson researchers are harnessing big data to solve big problems.

HEALTH + WELL-BEING

By analyzing massive units of data in the form of electrical signals generated by the human body, researchers are pioneering new ways to diagnose illnesses, supporting lower cost procedures and developing less invasive patient treatments.

BUSINESS + FINANCE

By combining big data analytics with geo-visualization and business geomatics, researchers can predict the value of commercial properties, model financial markets or drive strategy.

SOCIAL MEDIA + CONSUMER BEHAVIOUR

Researchers are developing tools to aid in mining vast amounts of unstructured data to better understand consumer sentiment and behaviour.

SMART INFRASTRUCTURE

Ryerson researchers help transportation systems adapt to changing local travel patterns in real time to reduce congestion, and their "smart grid" technologies are optimizing power systems to promote conservation.

DIGITAL HUMANITIES + CULTURAL STUDIES

Ryerson researchers have developed a state-of-the-art digital library and archive that uses data to promote Canadian heritage and improve Canada's cultural outreach.

Ryerson's work in this area is supported by the Canada Foundation for Innovation (CFI), Canada Research Chairs Program, the Tri-Councils, FedDev Ontario, Ontario Centres of Excellence (OCE), MITACS, the Ontario Ministry of Research and Innovation, and the Ministry of Economic Development, Trade and Employment.

To learn more about how you can partner with us to harness the potential of big data, visit ryerson.ca/research.

RYERSON UNIVERSITY

Everyone Makes a Mark

RESEARCH • INNOVATION • ENTERPRISE

OPINION

Strong management key to better innovation performance

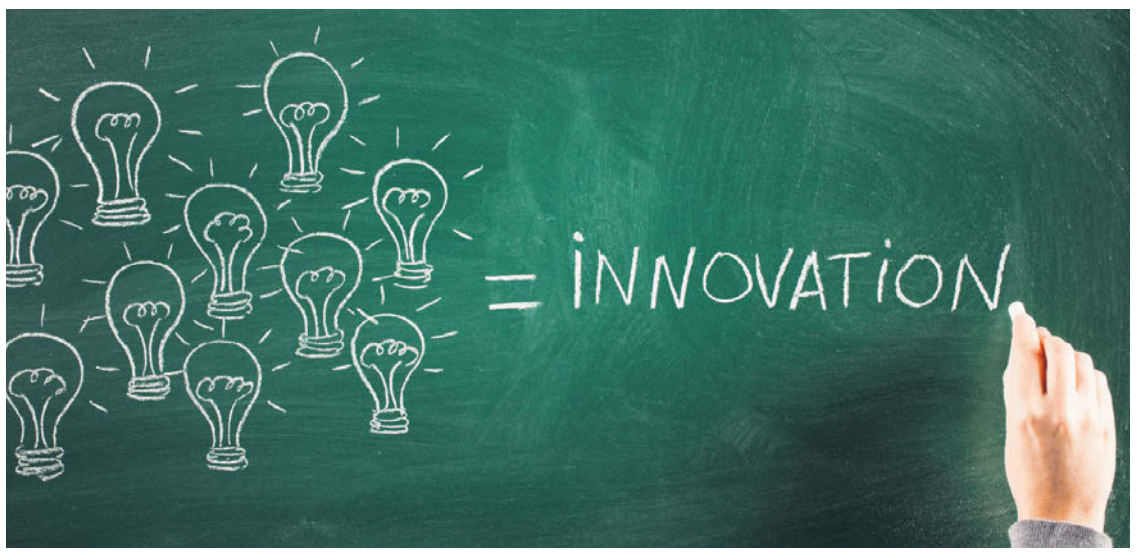
By **Michael Bloom**, vice-president of Organizational Effectiveness and Learning, the Conference Board of Canada, and **Bruce Good**, executive director, the Conference Board of Canada's Centre for Business Innovation

Innovation is a crucial economic engine for Canadian prosperity, yet the Conference Board of Canada's annual report card rates our national innovation performance a mediocre "D"– a score that has not moved since 1996. It's not for lack of good research; we have some of the best university and college research environments in the world. Unfortunately, this is not yet translating into commercialized innovation; we're good at idea generation, but not so great when it comes to turning those ideas into profitable ventures. Still there's surprisingly little sense of urgency among business leaders to change that. The Conference Board's 2012 CEO Challenges Survey found that a majority of CEOs ranked "innovation" only seventh as a priority, down one position from the previous year. Clearly, we need to raise the alarm and push for renewed action if we want to achieve our economic goals for innovation. But action needs to be driven by business.

Successful innovation comes down to management. The size of public or private investments in innovation matters too, but what matters more is how wisely these investments are made and managed inside the firm. A recent Conference Board of Canada survey on business innovation shows that 50 per cent of Canadian firms do not formally manage their own innovation, including proper metrics and measurements. As a result, their performance is significantly below average. That's despite often substantial investments of time and money.

Part of the problem is that many businesses don't realize that innovation is actually much more than R&D. They tend to limit their tracking to traditional BERD (business expenditure on R&D) missing what matters most – the quality and effectiveness of deeper firm-level management across all critical competitive domains, including business models, strategies, resources, culture, corporate processes, services, and yes, technology and products.

Governments all over the world, including Canada's, are also starting to recognize the benefits of supporting an innovation ecosystem that strengthens firm-level management capacity. They are helping local companies compete through their increasing support of new and revamped financial programs, venture capital and education, and by emphasizing the need for an entrepreneurial culture. Most importantly, progressive governments understand the advantages of the strategic procurement of early-stage innovation. This is seen as a means to help companies manage difficult growth stages, which enables them to reach their potential as global success stories.



The Centre for Business Innovation is a Conference Board initiative bringing together industry, government and academic partners to tackle the challenges Canada faces when it comes to innovation. ISTOCKPHOTO.COM

To make the most of government and other sources of funding, Canadian firms of all sizes and in all sectors must first and foremost apply the best in innovation management techniques. They will succeed by using the most up-to-date management methods and tools to direct and drive their innovation activities as a crucial ingredient in their recipe for success. Aligned with this, firms need to strive towards creating and maintaining a strong internal culture that encourages innovation. This will help steer their companies more quickly towards business goals – at the same time helping Canada to achieve a greater degree of competitiveness.

Sector strategies can help individual firms. In fact, improving business innovation performance is an industry challenge that needs to be addressed by each of Canada's key industry sectors. It must be done in the context of their innovation support ecosystems, including universities/colleges and governments. The Centre for Business Innovation (CBI) is a Conference Board initiative bringing together industry, government and academic partners to tackle the challenges Canada faces when it comes to innovation. The CBI is producing evidence-based research aimed at finding insights and solutions to the challenges facing individual firms and sector-level innovation ecosystems in Canada.

Learn more about the CBI and its recent research by visiting www.conferenceboard.ca/cbi.

FROM CFI 1

Infrastructure: Research offers affordable solutions

$90 billion to replace – more than $7,300 for every Canadian household.

"It's a perfect storm of factors," says Nemkumar Banthia, a professor of civil engineering at the University of British Columbia (UBC). "Investment in infrastructure has not kept up, and greater traffic and other loads have increased the demands on these structures compared to when they were constructed." The resulting "infrastructure gap" – the value of current infrastructure relative to the value of infrastructure that is needed – is growing wider every day.

To help fill the void, leading Canadian researchers are devising new ways to build these structures (and innovative ways to maintain old ones), which could save on replacement costs and add years to the service life.

At UBC, Dr. Banthia developed a mixture of high-performance fibres that can be sprayed onto older concrete, increasing its strength and durability. The spray is embedded with fibre optic sensors, which send signals back to engineers and allow them to detect any deterioration in the structures in real time. "It's analogous to health monitoring online," says Dr. Banthia. "Sort of like a pacemaker in a body."

For city bridges and overpasses, the invention could mean the difference between a timely repair job and a sudden collapse.

To effectively maintain our critical infrastructure, says Lamya Amleh, an associate professor of civil engineering at Ryerson University, we have to learn more about how and why it deteriorates. Dr. Amleh and her students conduct large-scale experiments on concrete structures used for bridges and roadways, testing how they behave under varying deterioration conditions.

"Corrosion of reinforcing steel in concrete is a multi-billion-dollar problem," says Dr. Amleh. "When corrosion attacks the steel, byproducts (iron oxides) accumulate along the steel bar, increasing internal volume and pressure enough to crack the surrounding concrete."

Dr. Amleh uses a "corroding tank" to test how different materials, such as common road salts, will penetrate concrete and corrode the steel. By better understanding what causes deterioration and how rapidly it occurs, Dr. Amleh is developing new models for predicting a structure's service life and new criteria for identifying when infrastructure must be replaced.

In the face of failing infrastructure and ongoing municipal funding crunches, innovation may be Canada's best hope.

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INSIDE THIS REPORT

COMMUNICATION

Opening new channels for wireless technology

Advancements in smart antennas could soon enable your car to communicate with other vehicles around it as well as the road ahead to alert you to things like traffic jams and road obstructions. It's just one of many ways in which wireless technology is changing the way we live, says Sujeet K. Chaudhuri, co-director of the Centre for Intelligent Antenna and Radio Systems (CIARS) at the University of Waterloo.

"The prediction is that 10 to 15 years from now, you're going to have wireless connectivity with at least 1,000 sensors a day," he says, explaining that an increasing number of devices will relay more information at a faster pace.

CIARS, one of the most advanced facilities in the world for testing electromagnetic devices, is leading the charge. The research facility opened last September and features four interconnected indoor laboratories, one outdoor lab and a highly advanced computational component. The state-of-the-art equipment at CIARS is used to measure electromagnetic fields radiated by objects as tiny as a human hair to as big as a two-tonne truck, with the highest precision over the widest range of frequency possible. Much of CIARS' work focuses on the potential of terahertz (THz) technology which exploits uncharted territory within the electromagnetic spectrum, says Dr. Chaudhuri.

Terahertz, a channel of the electromagnetic spectrum wedged between radar and visible light, could provide alternative frequencies for increasingly crowded networks of wireless communication. Terahertz technology has a large advantage over fibre optics since "there is no infrastructure required," says Dr. Chaudhuri, making its application even more attractive in wireless technology that can, for example, enable cars to receive information through smart antennas.

Dr. Chaudhuri explains that intelligent vehicle antennas could assist the driver with navigation and emergency response situations in addition to improving safety with instantaneous road condition information. "Using smart antennas, [cars] will know which way to look on the road and what to do, just like your eyes and ears do now."

Visitors get a tour of the University of Waterloo's CIARS facility in September 2013. SUPPLIED

TRANSPORTATION

New materials and design give bus passengers safer and more comfortable ride

Dr. Christine Wu knows motor coaches. Since 2007, the professor of mechanical and manufacturing engineering at the University of Manitoba has been working with Motor Coach Industries Ltd. (MCI), the leading builder of intercity coaches in Canada and the U.S., to make them safer and more reliable.

Dr. Wu says she and her team add a specialized dimension to MCI's work.

"Our role is not to design and build the vehicles. MCI has a very accomplished team that does that," she says. "What we add is capacity for advanced analysis."

For example, she explains, MCI is constantly integrating new technologies, materials and methods to produce safe, reliable coaches.

"When new concept materials and technologies are introduced to a design, they have to be rigorously tested. That's what we do."

Dr. Wu says commercial vehicles, such as motor coaches, are often required to pass costly and time-consuming durability tests before entering the market. Using specialized simulation test equipment that puts structural components under higher stress levels, researchers accelerate the occurrence of failures. "Done correctly, accelerated durability testing can reduce the amount of field testing, which in turn reduces the time and cost of development," says Dr. Wu. "Getting the testing right is the difficult part."

Together with MCI engineers, Dr. Wu's team successfully developed a more streamlined method for setting up test parameters for the simulation equipment. The key step was defining a "loading profile" – the code that simulates the stresses a component would be subjected to throughout its lifetime.

Dr. Wu's research team succeeded not only in developing these loading profiles, but also came up with a way to reduce the complexity and time to set up and complete an accelerated durability test. These new methods are now used by MCI as part of its durability testing program.

Jim Macdonald, MCI executive director of engineering, says Dr. Wu's expertise and scientific knowledge will allow his company to make exceptional new breakthroughs, improving the structure and comfort of its motor coaches.

In addition to funding Dr. Wu received from the Canada Foundation for Innovation for upgrading lab equipment, new funding from the Natural Sciences and Engineering Research Council of Canada (NSERC) and MCI will allow her to continue the collaboration the next five years.

This year, Dr. Wu was awarded the NSERC/MCI Industrial Research Chair in Heavy Ground Vehicles and Transportation Equipment.

Noting that improving multi-passenger vehicles presents a key opportunity to transform transportation in North American cities, NSERC's acting vice president, research partnerships programs directorate, Pamela Moss said, "Working closely with Motor Coach Industries, the work of Dr. Wu and her team will lead to safer rides for passengers on buses and similar large vehicles and will strengthen Canada's reputation as a technical innovator in this field."

Dr. Christine Wu and Jim Macdonald have had a long and productive partnership in improving motor coaches. MIKE LATSCHISLAW

SHIPPING

Safe passage

For more than 500 years, the Port of Saint John, N.B., has been an important centre of marine activity that has contributed to the development of a network of core industries and spinoff businesses in the area.

In 2012, the east coast's major bulk facility handled 28 million tonnes of liquid petroleum products, in addition to dry bulk and containers. The port also welcomed 75 cruise ships carrying 188,000 passengers last year.

But manoeuvring in and out of the port, where the Saint John River and Bay of Fundy tides deposit substantial loads of sediment, can be tricky for the increasingly large container vessels and cruise ships. Ensuring proper traffic flow comes with a hefty price tag: dredging an average of 450,000 cubic metres of sediments a year costs the port authority millions of dollars.

Led by Dr. Katy Haralampides, a team from the University of New Brunswick and the Institut national de la recherche scientifique in Quebec studies sedimentation, currents and ecology of the harbour to better predict sedimentation volumes. The multidisciplinary research program works closely with the Saint John Port Authority to develop more cost-efficient and environmentally sustainable ways of disposing of dredge spoil. As a result, the study will end up helping pilots safely berth their vessels.

RESEARCH • INNOVATION • ENTERPRISE

HEALTH

Bad news for bad cholesterol

When researchers at the Institut de recherches cliniques de Montréal reported their discovery of an enzyme that directly regulates so-called "bad" cholesterol in 2003, their findings were met with great expectations. Excess low density lipoprotein (LDL) – the kind of cholesterol that leads to clogged arteries – is one of the main risk factors for cardiovascular disease, which is among the leading causes of death around the world.

"A lot of studies show that high levels of LDL cholesterol are directly associated with cardiovascular disease," says Nabil G. Seidah, director of the Institut's Biochemical Neuroendocrinology Laboratory. "So, how do you lower LDL cholesterol?"

The notable enzyme, called PCSK9, could be instrumental in getting to an answer.

Until recent discoveries relating to PCSK9, the most effective drugs available were statins, which inhibit a critical enzyme that is important in the synthesis of cholesterol, Dr. Seidah explains. "These drugs saved a lot of people. However, many patients develop side-effects, usually muscle pains. And some don't tolerate [statins] or do not adequately respond to these drugs," he says.

"One injection [of an antibody] every 14 days reduces LDL cholesterol levels by about 70 per cent."

Dr. Nabil G. Seidah
Institut de recherches cliniques de Montréal

Other drugs prevent the absorption of cholesterol from food. Ezetimibe, for example, lowers cholesterol by about 10 to 20 per cent, according to Dr. Seidah, who adds that some pharmaceutical companies combine statins and ezetimibe-like drugs.

"Our bodies synthesize around 75 per cent of the cholesterol we need; the other 25 per cent comes from food. If you block both synthesis and absorption, your cholesterol levels are likely to drop," Dr. Seidah says. "But statins cannot reduce cholesterol by more than a factor of two. For example, if you are unlucky and have a LDL cholesterol level of eight millimoles per litre, you are not going to go down much below four [by taking statins]."

But physicians recommend an LDL cholesterol level below 1.8 millimoles per litre, especially for people at risk of heart disease. "How do you reach that goal?" Dr. Seidah asks, explaining how the discovery of PCSK9 has brought researchers closer to an answer.

In collaboration with a group led by Dr. Catherine Boileau of the Laboratoire de Biochimie et de Génétique Moléculaire Hôpital Bichat-Claude Bernard in France, Dr. Seidah and his team found genetic mutations that cause PCSK9 to be more efficient and are associated with hypercholesterolemia, a condition marked by the presence of high levels of cholesterol in the blood.

"PCSK9 acts as a buffer to make sure you don't have too little cholesterol," Dr. Seidah explained. So, the more PCSK9 a person has or the better that enzyme functions, the higher are his or her LDL cholesterol levels.

A study conducted in the U.S. discovered that in addition to people who had a mutation that increased the function of the enzyme, there was a group showing the opposite effect.

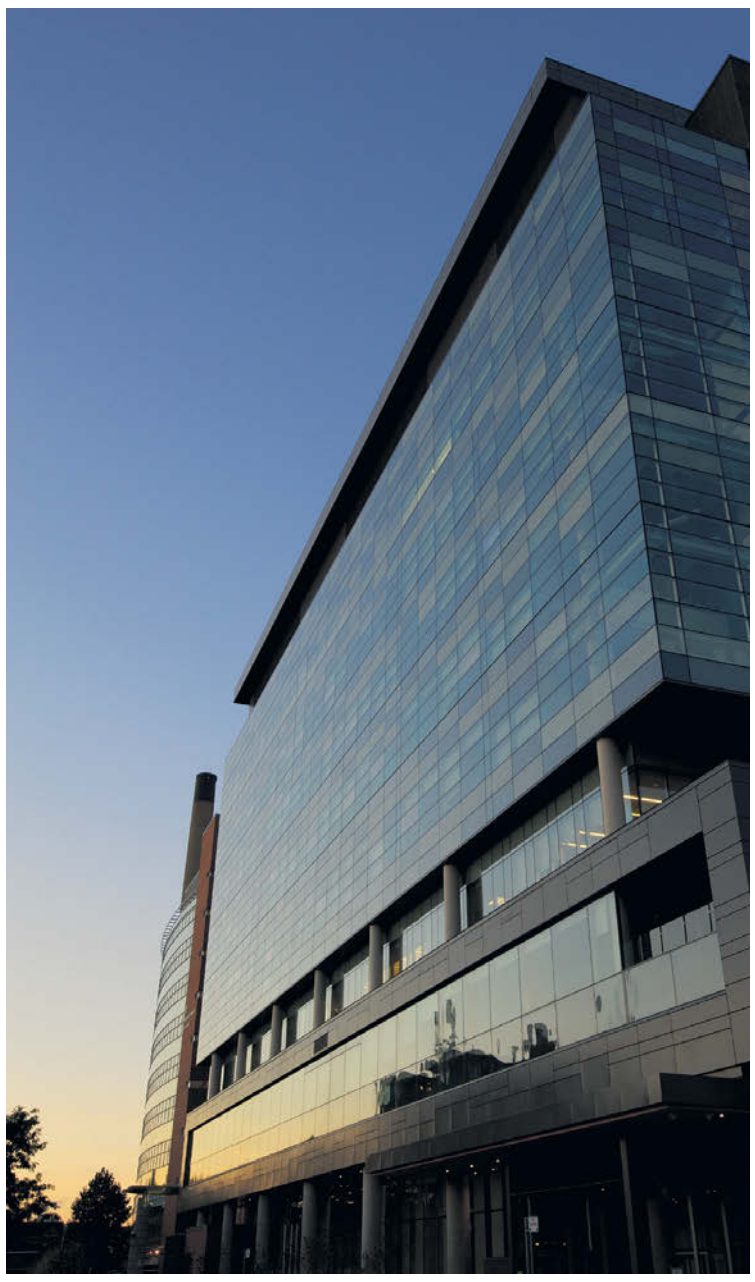
"They looked at members of families who had very low levels of cholesterol and identified individuals with a loss of function of PCSK9 that is inherited from one parent," says Dr. Seidah. "The study found that the chance of having a heart attack over a 15-year period was reduced by 88 per cent for this group." He says he'd never seen such a powerful mutation before.

This prompted more questions: "Can we decrease cholesterol by reducing PCSK9? And, if we lose 100 per cent of this enzyme, do we survive?" Dr. Seidah says that two people have now been identified, one in the U.S. and one in Zimbabwe, who have mutations that make PCSK9 null.

Since testing has confirmed that humans and mice can live without PCSK9, researchers came up with the idea to "silence" the enzyme's function. Dr. Seidah said this can be done by injecting an antibody that kills the function of the PCSK9 as it is secreted by its major source, the liver.

"This approach was found to be effective. One injection every 14 days reduces LDL cholesterol levels by about 70 per cent. From what I've heard and read, people seem to tolerate the antibody very well," he says.

For now, the treatment is evaluated in phase three clinical trials worldwide. Dr. Seidah says in three to four years, more data will be available about the drug's safety and efficacy. But he is hopeful and adds, "I believe that lowering PCSK9 activity has a bright future for many diseases in which cholesterol exacerbates the pathology."



FACILITIES

New tower a pillar of health sciences research

It was the combination of a climate of collaboration between researchers and clinicians, expertise in neurological science and access to a state-of-the-art research facility that prompted internationally recognized Alzheimer's specialist Don Weaver to join the Toronto Western Research Institute (TWRI) as its director and senior scientist.

"The institute's commitment to the discovery of disease-modifying or curative therapeutics for a wide range of diseases, and the resources offered by [the Krembil Discovery Tower] were certainly crucial and central to my relocating from Halifax to Toronto," says Dr. Weaver.

TWRI's Krembil Discovery Tower, officially opened earlier this month, is a new world-class research facility with the latest in labs and equipment. It was built with the support of the Canada Foundation for Innovation. Dr. Weaver plans to bring in more researchers to help him continue his investigation of new drug therapies for Alzheimer's disease, while directing 150 specialists that make up the largest concentration of neurologists, neurosurgeons, neuroradiologists and neuroscientists in Canada.

The facility also houses TWRI researchers in vision science, arthritis and other musculoskeletal diseases, as well as the rehab medicine company Altum Health and the University of Toronto's Tanz Centre for Neurodegenerative Disease.

Multidisciplinary research at the new Krembil Discovery Tower aims to develop new diagnostic tools and treatments for chronic diseases. SUPPLIED

"This facility was created to support the best of modern research and will foster multidisciplinary approaches to answering important research questions," says Christopher Paige, vice president of research at the University Health Network, which includes the TWRI and four other Toronto research institutes. "It includes facilities for everything from basic science – such as molecular biology and genetics – to behavioural research labs and experimental operating rooms."

With an "open-lab" concept, the Krembil Discovery Tower will allow researchers and clinicians from various fields to collaborate more closely, says Dr. Paige, and he's confident that will spur further advances.

"There is no question – having top-level facilities and equipment, and the opportunities for scientists to interact in new ways – this will be an accelerator of innovation," he adds.

Dr. Weaver agrees. "I really think this facility will foster the creative spirit and the cross-fertilization of ideas necessary to achieve the research mandate of the TWRI, which is to develop new diagnostic tools and treatments for many of our most debilitating chronic diseases, including Alzheimer's and other forms of dementia, Parkinson's, arthritis and blindness."

The other strength of the research facility is its affiliation with the Toronto Western Hospital, says Dr. Weaver. "We are built in the middle of a patient-care centre and as such, it puts the patient at the forefront in all our work."

OPINION

Investments for a healthier future

By **Greg Rickford**
Minister of State (Science and Technology)

"Science, technology and innovation are fundamental to Canada's high standard of living, creating jobs, growth and long-term prosperity."

Our government has been, and continues to be, committed to science, technology and innovation. In fact, since 2006 we have made significant investments in research to create jobs and economic growth and improve the quality of life of Canadians.

Even during the global economic recession, our government never wavered in its support for science and technology (S&T) initiatives, understanding that by investing today, we were laying the foundations for a more prosperous tomorrow. We increased support with strategic and targeted economic stimulus measures such as the Knowledge Infrastructure Program, introduced in Economic Action Plan 2009, to ensure that researchers in universities right across the country were equipped with the most up-to-date facilities in which to conduct their work.

It's for these very reasons that Canada is ranked number one among G7 countries for our support for research and development in our colleges, universities and other institutes as a percentage of GDP.

And recent reports show that Canadian S&T is healthy, growing and recognized around the world for its excellence, attracting world-renowned researchers to Canada and keeping home-grown talent right here.

Science, technology and innovation are fundamental to Canada's high standard of living, creating jobs, growth and long-term prosperity. And research is vibrant and flourishing right across the country – in our universities, colleges and polytechnics. We're seeing more and more ideas from labs enter the marketplace to improve the health and quality of life of Canadians.

And our government is taking action and delivering concrete results for our researchers to ensure they have the cutting-edge tools they need to do their jobs.

Much of the great discovery-oriented research conducted in Canada is supported by the Canada Foundation for Innovation (CFI). Our government's support for CFI is providing our universities, colleges and hospitals with the lab space and equipment they need to drive the important process of discovery and innovation, so our researchers can get their ideas into the marketplace.

For example, I recently had the opportunity to participate in the grand opening of the Peter Gilgan Centre for Research and Learning at the Hospital for Sick Children in Toronto. Our government invested more than $91 million through the CFI to support the centre – an investment for a healthier future. We make these kinds of investments because we know that science, technology and innovation lead to discoveries that will find cures and improve the quality of life of Canadians.

Where we see an opportunity, where we can improve, is ensuring our programs strengthen partnerships to get more scientific ideas from the lab to the marketplace.

Encouraging better collaboration between the research community and industry is paramount. We know the most rapid and sometimes the most long-lasting returns are realized when academic research is integrated downstream with private-sector know-how.

That is why Economic Action Plan 2013 introduced important new measures to take business innovation to the next level. These measures included funding to support research partnerships between post-secondary institutions and companies.

In addition, our government reinforced our commitment to science, technology and innovation in the Speech from the Throne. A renewed science, technology and innovation strategy means creating a more competitive economy while creating high-paying jobs. This will ultimately lead to more opportunities for the growth of research and development.

Science, technology and innovation are, and will always be, critical priorities for our government. We will continue to make strategic investments to expand on our wealth of knowledge, to get more ideas from the lab to the marketplace – to strengthen Canada's position as a leader in the global economy.

In an era of rapid technological change, we cannot ignore the potential of science in the marketplace. We will continue to support research in all its forms, which lead to job creation, economic growth and prosperity for all Canadians.

GENETIC TESTING

Green light for personalized medicine partnership

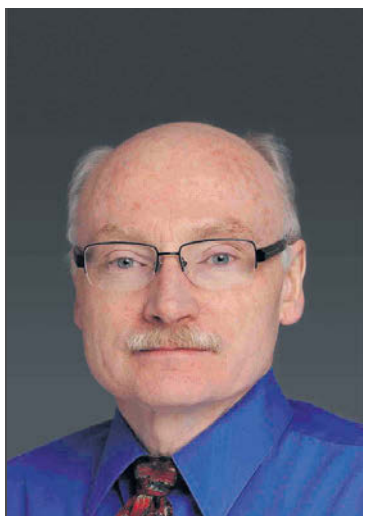
Personalized medicine allows prescriptions to be tailored to a patient's needs by taking genetic dispositions into account, says James Kennedy, director of the Neuroscience Research Department of the Centre for Addiction and Mental Health (CAMH).

Dr. Kennedy has been instrumental in creating the stoplight system that alerts physicians with green, yellow or red indicators to medications that are beneficial, or potentially harmful. "We deliver genetic information directly into the hands of doctors for their decisions with the prescription pad," he explains.

The impetus for the system dates back to the 1980s, when Dr. Kennedy was in medical school and learned that the liver enzymes responsible for breaking down medication are different in each person, yet there hadn't been an accurate way to measure that. As part of a study using the stoplight system, prescriptions for mental health patients are now being adjusted based on saliva samples that are used to analyze variations of five genes to predict a patient's response to common antidepressant and antipsychotic medications. The results are already having an impact.

"One patient who has undergone the test, for example, reported that he felt better and had fewer side-effects after his doctor changed his medication," says Dr. Kennedy, adding that the patient also mentioned that he welcomed the fact that his prescription was now based on science, eliminating an element of trial and error.

Dr. Kennedy sees two important benefits of using genetic testing: first, patients get better faster, have fewer side-effects and are more likely to stick to their medications; second, the stoplight system saves money since it reduces the number of repeat visits to the doctor for adjusting medications.



Genetic testing gives physicians better tools for making decisions with the prescription pad, says Dr. James Kennedy. SUPPLIED

Recently, CAMH has gained a powerful ally: pharmaceutical company AssureRx Health Inc. "This is the first partnership between a major health testing company and a mental health facility," Dr. Kennedy says.

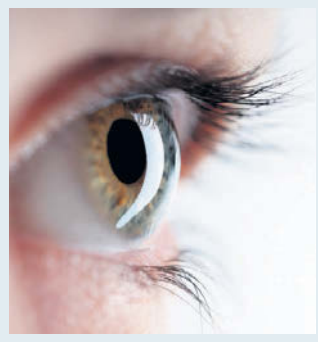
The company will license the discoveries from CAMH's lab, helping Canadian researchers get their intellectual property incorporated, according to Dr. Kennedy. He also welcomes AssureRx's plans to embark upon a global program of development and expansion to implement personalized medicine on a larger scale.

The Peter Gilgan Centre for Research and Learning at the Hospital for Sick Children in Toronto, in part funded by the Canadian government through the Canada Foundation for Innovation, is seen as an an important investment for a healthier future. SUPPLIED

VISION HEALTH

Exploring edges of eyesight

A former hockey arena at York University in northern Toronto will soon be home to exciting new research in the study of peripheral vision. The large space will accommodate areas of the university's Centre for Vision Research (CVR).



Peripheral vision research has implications for elderly and Parkinson's patients. ISTOCKPHOTO.COM

A $790,000 CFI grant will help CVR build a suite of state-of-the-art display systems to investigate peripheral vision – the edges of a person's visual field – to explore the effects of peripheral vision on walking, stumbling and falling, says Laurence Harris, a York psychology professor and director of CVR.

"What we eventually discover will especially benefit elderly people and those who have impaired vision or diseases such as Parkinson's," he says. "Ultimately, we hope our findings will assist in the development of new techniques and equipment to correct those problems."

CVR will combine state-of-the-art virtual reality and specially constructed real environments, such as a rotating room, to observe how people react to various visual situations.

"We'll be able to ask questions such as: How do you know which way is up and how do you maintain posture within a normal or unusual gravity field?" he says.

"At the moment, there is not a great understanding of peripheral vision," Dr. Harris adds. "If you wear glasses, they only go out to about 30 degrees on each side. But your visual field goes out to 110 degrees, so there are 80 degrees beyond that on both sides – and thus a lot to study."

EN YEARS OLD.
AKE MY MARK.

In my head, I say the words. I repeat them over and over. I'm not trying to convince myself. I believe it with all my heart. Girls can do anything boys can do. And I am willing to get my hands dirty to prove it.

I have never put limits on what I can accomplish. And I have never allowed others to put limits on me. Since the moment I arrived at the U of M years ago, the people here have supported my goals and pushed me to succeed. Now, I am a professor and a researcher here, studying the effects of pesticides on our soil and water. And I am an activist, fighting to ensure that everyone has the right to safe drinking water.

The University of Manitoba has given me a place to fulfill my passion. We share the belief that neither ethnicity nor gender can keep people from achieving their goals. This has helped me become a leader in a field where women rarely go.

I AM A TRAILBLAZER.

Annemieke Farenhorst is the UM/NSERC Chair for Women in Science and Engineering for the Prairie region and a professor of soil science at the University of Manitoba.

umanitoba.ca/trailblazer

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RESEARCH • INNOVATION • ENTERPRISE

ORNITHOLOGY

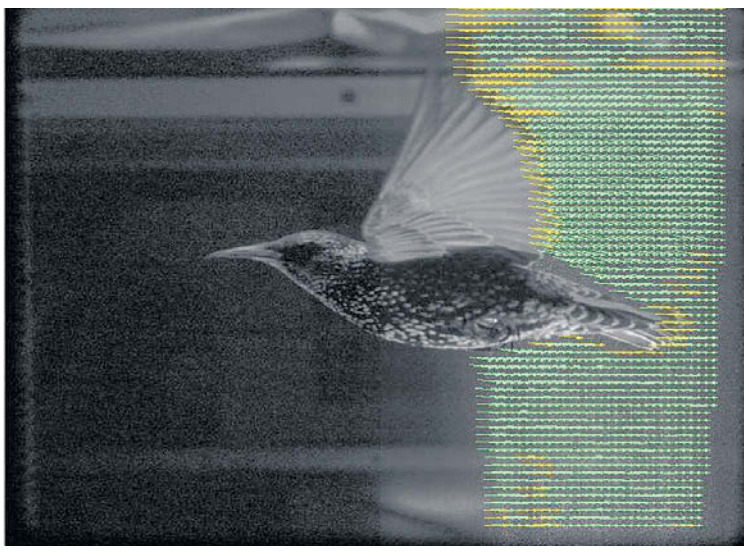
Taking flight, bird studies offer far-reaching insights

Even for a Canadian, the northern wheatear is well travelled. As the songbird with the longest migration in the world, the tiny species flies some 30,000 kilometres twice a year between its breeding grounds in Canada's Arctic and its wintering territory in sub-Saharan Africa.

Soon we may know the exact route it takes, as well as the effects of the changing climate, development and pollution on its flight. Fitted with radio transmitters on tiny harnesses, such birds will be tracked from space as part of a "transformative" effort to learn more about declining bird populations, says Christopher Guglielmo, a biology professor and co-director of the Advanced Facility for Avian Research (AFAR) at Western University in London, Ont.

AFAR, a $9.2-million facility opened in 2009, jointly financed by the Canada Foundation for Innovation (CFI) and the Ontario Research Fund, is used by the university's biology, psychology and engineering faculties to study subjects like bird behaviour, biomechanics, physiology and aerodynamics. It includes the world's first hypobaric climatic wind tunnel, where researchers study birds in flight in different wind, temperature, light, pressure and humidity conditions.

Next year, a new $3.4-million project will allow scientists to move into the natural environment, tracking even the smallest birds, such as thrushes, using digital telemetry arrays in Ontario and Atlantic Canada.



Birds in flight are the objects of study in the hypobaric climatic wind tunnel at Western University. SUPPLIED

Next year, AFAR Takes Flight, a new $3.4-million project supported by the CFI in partnership with the University of Guelph and Acadia University, will allow scientists to move into the natural environment, tracking even the smallest birds, such as thrushes, using digital telemetry arrays in Ontario and Atlantic Canada. On a global scale, the birds will be followed by a network of low-orbit satellites and the International Space Station, when AFAR teams up in 2015 with the Max Planck Institute for Ornithology in Germany in its International Cooperation for Animal Research Using Space (ICARUS) initiative.

Dr. Guglielmo notes that ICARUS could help explain the sharp drop in the numbers of grassland birds such as bobolinks, aerial insectivores such as swallows and shorebirds like the red knot, which breeds in the high Arctic and winters in Patagonia.

Some 80 per cent of bird deaths can occur during such migrations, he notes. "It's not enough to document the trends, we have to go into the field to try to understand the mechanisms."

Birds have long been harbingers of compromised ecosystems, from canaries once used to test the air in coal mines to peregrine falcons that taught us the dangers of DDT. But they have also proven valuable in studying other areas, such as brain networks, Dr. Guglielmo says, where they act as useful models for memory and language learning in humans.

FOOD SECURITY

Diagnosing bees in search for answers to collapsing colonies

Honey bee colonies are dying around the planet, with bees from one-third of all colonies disappearing each year since the Colony Collapse Disorder appeared in 2006. "Annual colony losses of 30 per cent to 40 per cent are now routine globally, and can go as high as 100 per cent," says bee biologist Mark Winston, author of *Biology of the Honey Bee*.

The loss of these essential pollinators is potentially devastating to the world's food supply, so accurately mapping and analyzing bee health is critical. The National Bee Diagnostic Centre (NBDC) in northern Alberta, launched by the Grande Prairie Regional College Centre for Research and Innovation in September 2012, aims to do just that.

"As a national centre, we've started to get a larger picture of the disease presence in Canada, which will enable industry to make informed decisions and help beekeepers better manage their colonies."

Dr. Bruce Rutley
National Bee Diagnostic Centre

Researchers at the National Bee Diagnostic Centre at Grande Prairie Regional College are trying to find out what is harming bee colonies. SUPPLIED

While much research has been aimed at identifying a single cause, the most recent and comprehensive research points to systemic harm: "1,000 little cuts" such as mono-crop agriculture, which reduces nutrient diversity and pesticides that, while thought to be harmless in minute exposures, make bees more vulnerable to viruses and mites, says Dr. Winston.

"There are three different categories of suspect causes: biological, chemical and nutritional," says Bruce Rutley, director of the NBDC. "We're focusing on identifying the biological causes – we have the only laboratory in Canada specializing in bee diagnoses."

Beekeepers across the country send samples of their stock to the lab, which detects the presence or absence of numerous pest pathogens or parasites.

"As a national centre, we've started to get a larger picture of the disease presence in Canada, which will enable industry to make informed decisions and help beekeepers better manage their colonies," says Dr. Rutley.

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Our commitment to research, innovation and technology set in motion 10 years ago has made SAIT Polytechnic Canada's number one research college today.

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Engineering
a better tomorrow

Electrical and computer engineering researchers at the University of Alberta are leaders in fields as diverse as communications, health, energy and the environment, enabled through state-of-the-art micro and nanotechnology facilities at the U of A nanoFAB, an open-access cleanroom environment for micro/nano fabrication and characterization.

Collaborating with industry, government and academics around the world, and supported by funding agencies including the Canada Foundation for Innovation, our researchers address some of society's most pressing challenges.

Roger Zemp is exploring Micro-Electromechanical Systems (MEMS) ultrasound transducers to develop medical imaging technology that will provide doctors with more precise patient diagnoses.

Mahdi Tavakoli's leading-edge work on telerobotics for surgical and therapeutic applications could enable physiotherapists or surgeons to provide direct care to patients in remote locations.

Karthik Shankar is exploring innovative ways to reduce greenhouse gasses through the use of nanostructured semiconductors for solar cells and photocatalytic reduction of CO_2 gas.

Ashwin Iyer is engineering the properties of metamaterials—artificial materials designed to have novel electromagnetic properties. Applications for metamaterials cross many fields, including medical imaging, sensing and wireless communications.

Yasser Mohamed's research into smart grids is vital to ensuring the continued stability and flexibility of our electrical power grid systems as they absorb the growth of renewable energy sources.

University of Alberta Department of Electrical and Computer Engineering professors Karthik Shankar, Yasser Mohamed, Roger Zemp, Ashwin Iyer and Mahdi Tavakoli are at the forefront of research, developing new technologies to improve our quality of life.

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WATER QUALITY

Effort aims to build common ground among resource industry, regulators and communities

Wilfrid Laurier University research scientists Jim McGeer and Scott Smith believe their work to understand how to better preserve aquatic habitats and ensure sustainability when faced with the pressure of natural resource development is going beyond academic investigation.

They see it as a potentially valuable foundation for a less confrontational approach to resource development.

Dr. McGeer, an associate professor of biology at Laurier and director of the Laurier Institute of Water Science, says a key finding of their research so far is that the sensitivity of organisms to contaminants varies across environments and that the threshold for impacts in one ecosystem might not be protective in another.

"The response of aquatic organisms to metal contamination is a dynamic process, dramatically influenced by environmental conditions as well as by their physiological resilience and capacity to respond," explains Dr. McGeer. "This understanding has been incorporated into mathematical models that are being applied in water quality guideline and criteria development."

"In nature, chemistry and biology are inextricably linked, so tackling real-world problems requires combined multidisciplinary approaches."

Dr. Scott Smith
Wilfrid Laurier University

Dr. Smith, an associate professor of chemistry at the university, says the research will have practical applications.

"The goal is to position it at the interface of science and environmental policy," he says. "By understanding the uncertainties and gaps in this context, the research improves our ability to assess and mitigate risks to the environment."

He adds that the research has applications to water quality, setting industrial discharge limits and refining remediation targets for contaminated sites.

"By reducing uncertainty, our science helps to establish common ground among industry, regulators and communities and to build confidence among stakeholders that resource development can be done in a sustainable manner."

Dr. McGeer says the work is also helping develop the upcoming generation of water scientists, managers and regulators and is establishing partnerships that are essential to the research.

"Students, with their enthusiasm, dedication and perseverance, are the key to making progress; they are at the leading edge of understanding environmental protection needs," he says. "And partners provide both the relevant real-world problems and the means for our research to be taken up and implemented to sustain and improve aquatic health while maintaining the social and economic benefits of resource development.

By collaborating, the two men are approaching common problems from different perspectives.

"In nature, chemistry and biology are inextricably linked, so tackling real-world problems requires combined multidisciplinary approaches," says Dr. Smith.

Dr. Scott Smith of Wilfrid Laurier University tests the water for metal contamination. SUPPLIED

MARINE LIFE

Collecting data for the preservation of the world's oceans

Scientists are sounding the alarm bells to draw attention to the effects of climate change on the world's oceans, saying it is critical to understand how human impacts and warming temperatures are affecting marine life and to develop new strategies for ocean conservation and management.

Canada is at the forefront of this global endeavour, and Dalhousie University in Halifax is doing its part as the headquarters of the Ocean Tracking Network (OTN). Ocean researchers from around the world work with OTN to create unprecedented scientific knowledge on the impacts of environmental change on sea life.

"We are building an entirely new ocean observation system for the world," says Sara Iverson, OTN's scientific director. "Science and technology advances are allowing us to measure marine animal movements, habitat use and survival in relation to changing ocean conditions in revolutionary new ways. By working together, nations can build an international social and legal framework for better governing the ocean."

The OTN is centralizing ocean data collected by more than 15 countries, and the list is expanding. The monitoring relies on a range of technologies, including lines of acoustic receivers on the ocean floor that act as "listening stations," recording data from fish and other marine animals tagged with electronic tracking devices.

A $45-million investment from the Canada Foundation for Innovation and the Natural Sciences and Engineering Research Council is helping the OTN further develop Canada's state-of-the-art tracking technologies, which give ocean researchers incredible new tools. These include "roboprobes" – self-powered vehicles that roam the waters collecting data during year-long missions.

Tagged fish allow scientists to collect data about the world's oceans. SUPPLIED

"We are even employing some of the marine animals themselves to go out and do our biological sampling," says Dr. Iverson, who says they act as OTN's "bioprobes."

"We have a number of grey seals carrying receiver/transmitters plus Bluetooth-enabled satellite tags that uplink information in real time," she says. "The seals tell us when they have passed by or eaten a tagged cod or salmon, for example, while also providing data on the ocean temperature, depth and other properties."

ONLINE

For a directory of university, college and research hospital facilities that are open for business, visit the CFI Research Facilities Navigator.

innovation.ca/navigator

Research
with impact

York researchers are exploring the boundaries of innovation and scholarship as they seek ways to improve the lives of individuals both nationally and globally.

Professor Laurence Harris, director of York University's Centre for Vision Research is examining the role of peripheral vision in controlling posture, determining orientation and guiding movement. His CFI-funded research, the Full-Field Perceptual Environment (F2PE) project, aims to inform the development of health technologies to aid balance and movement, leading to the improved health and safety of workers in challenging environments.

York University celebrates the achievements of all of our researchers and the contributions they make to advancing knowledge in Canada and the world. Research at York is research with an impact and research that makes a difference.

yorku.ca/research

YORK UNIVERSITÉ UNIVERSITY

OceanPower
Wealth of knowledge. Global network. Deep understanding.

The Ocean Tracking Network (OTN), headquartered at Dalhousie University, is using Canadian-made technology to build an entirely new ocean observation system, one centred on tracking marine animals, habitat use and survival in relation to changing ocean conditions.

OTN is creating data and knowledge in collaboration with scientific partners around the world. With support from the Canada Foundation for Innovation, the Natural Sciences and Engineering Research Council of Canada, and various international funding agencies, this $168-million research initiative benefits people in important ways. From assessing the health of fish stocks to better protect marine resources, to monitoring shark movements to avoid tragic attacks, OTN is placing Canada at the forefront of international marine research, innovation and technology development.

The knowledge starts on Canada's east coast. The results research around the globe.

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RESEARCH • INNOVATION • ENTERPRISE

INFORMATION TECHNOLOGY

Harvesting needles of insight in haystacks of health data

One of the hallmarks of the information age is a surging volume of content: people around the world produce trillions of pieces of information in tweets, blogs, status updates, location check-ins, video, photo uploads and more.

Leveraging this abundance of "big data" is of keen interest to many sectors of society, including industry, but it presents complex challenges, says Wendy Cukier, vice president of research and innovation at Ryerson University.

"In these haystacks of data lie needles of insight that could make governments more effective, businesses more profitable and individuals healthier and more productive," she says.

The potential of big data in the field of health is illustrated by the work of Ryerson researcher Sri Krishnan, who studies signals from the human body to detect and treat heart attacks, neuromuscular conditions and sleep-related disorders.

"Most people understand the use of electrocardiograms (EKG), but we also use medical imaging techniques such as functional magnetic resonance imaging (fMRI)," explains Dr. Krishnan, interim dean of Ryerson's faculty of engineering and architectural science and Canada Research Chair in Biomedical Signal Analysis.

The fMRI images, which are similar to video, have huge file size requirements. His team applies engineering expertise to find algorithms and analyze the data to provide clinicians with the information they need for accurate diagnoses.

Complex electrical signals generated by the heart may be a key to help prevent sudden heart attacks, says Dr. Sri Krishnan, Canada Research Chair in Biomedical Signal Analysis. NATION WONG

They are also working with clinicians to analyze the data collected when a patient wears a heart monitor for 24 hours, making it possible to detect subtle heart rhythm irregularities. "But doctors cannot analyze 24 hours of data," says Dr. Krishnan, "so the engineering team has developed algorithms to analyze and translate it to provide clinicians with an accurate visual representation."

The results are promising: using big data, clinicians are accurately diagnosing potentially fatal heart disease that would have been overlooked with an EKG.

Other opportunities for the application of big data include better understanding of consumer behaviour in marketing and deriving new insight from millions of existing literary texts in the humanities sector, Dr. Cukier notes.

In order to mine these opportunities, limitations of storage, pattern recognition and computing power must be overcome. In addition, she says, "as so many of the meaningful kinds of big data occur in real time, there is the issue of veracity: do we know what the sources of the data are, and can we tell if they are reliable?"

Technology is not the only issue. There is a huge gap between "what companies aspire to do and the availability of talent to do it," she says. "It is probably the single biggest challenge companies are facing."

With the aim of addressing that gap, Ryerson's big-data initiative focuses on meeting industry needs while leveraging the university's strengths in technology, tools and vertical applications. Key areas of research expertise include data mining techniques and predictive models for finance and business; tools and analysis of social media and consumer behaviour; using big data to understand patterns of disease; analysis of big data to inform smart infrastructure; and exploring privacy and regulatory perspectives.

By bringing this broad expertise to partnerships with industry and the health sector, the faculty at Ryerson is assisting in the evolution of big data analysis.

NANOTECHNOLOGY

Controlling matter at the nanometre level

In Karthik Shankar's laboratory at the University of Alberta, a nanometre is the standard unit of measurement. That's because his team specializes in the research and development of hybrid nanostructures, impossibly small devices that combine semiconductors, metals and organic materials to enhance and exploit interactions between light and matter, and which have the capacity to change the way we live, work and do business.

"Our objective is to make useful materials that are very small."

Dr. Karthik Shankar
University of Alberta

The concept of nanotechnology can be mind-boggling. A nanometre is one billionth of a metre – a human hair is between 50,000 and 100,000 nanometres thick.

Nanotechnology is generally described as the branch of technology that deals with dimensions of less than 100 nanometres and focuses mainly on the manipulation of individual atoms and molecules.

"Our objective is to make useful materials that are very small," explains the associate professor of electrical and computer engineering. "By combining different classes of materials into a hybrid, we are taking nanotechnology to a new level of functionality in manipulating electrical fields and charges at the nanoscale."

In essence, he says, nanotechnology involves the construction of extremely small devices with the ultimate aim of being able to control matter at the nanometre level.

There are two basic approaches to nanomanufacturing; top-down or bottom-up. Top-down reduces the size of large components, such as computer chips, by carving them down to nanoscale. But this approach can be wasteful because it requires a large amount of material and is prohibitively expensive for devices that take up a large area, such as solar panels.

The bottom-up approach that Dr. Shankar uses creates products by building them up from atomic and molecular-scale components. It's this approach that makes the construction of hybrid nanostructures possible.

Backed in part by funding from the Canada Foundation for Innovation, Dr. Shankar has created a research and learning environment that has been instrumental over the past four years in helping educate more than 50 highly qualified personnel, many of whom are now working for companies in Alberta and elsewhere.

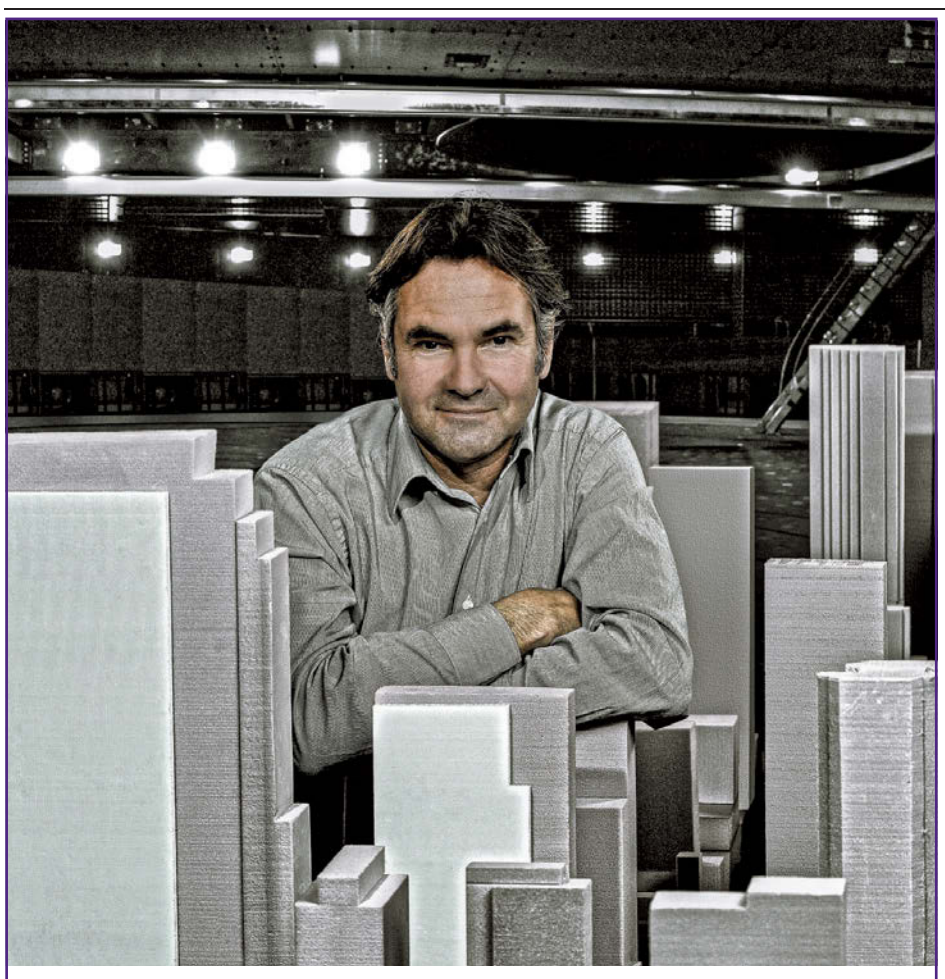
Dr. Shankar's team is currently working to create what are called plasmon-enhanced and functionalized TiO_2 nanotube arrays.

A plasmon is a wave-like oscillation in the charge density of metals, which can be excited either by light or by other electrons. Plasmons can be either in the bulk of a material or on the surface. From a nanotechnology perspective, surface plasmons are more important and their resonance is thought to be excited by light in nanotechnology applications. By controlling these plasmons, strong enhancements in the local electromagnetic fields can be achieved, which enable the light-matter interactions to be intensified, in some cases by many orders of magnitude.

TiO_2 is a large band-gap semiconductor whose transparency, abundance, chemical inertness and compatibility with solution-based fabrication make it attractive for a variety of low-cost, mass-manufacturing technologies.

By combining these components, Dr. Shankar's team is creating nanotube arrays that could be used in products such as solar cells and carbon dioxide reduction photocatalysts that use solar energy to convert carbon dioxide into higher-energy products such as methanol.

Though much of Dr. Shankar's cutting-edge research is still several years away from incorporation into engineering processes, earlier generation nanotechnology is already in use every day in products such sunscreens that contain nanoparticles of zinc oxide or titanium oxide, scratch-resistant coatings that include aluminum silicate nanoparticles, and antimicrobial bandages that use silver nanoparticles.



ONLINE

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Winds of change

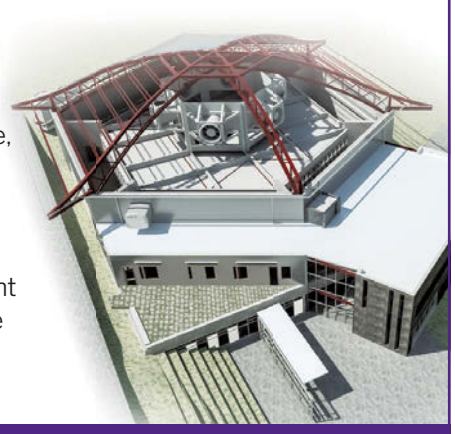
Inside the world's first hexagonal wind dome, Horia Hangan plays Mother Nature.

With a team of Western researchers, he creates tornadoes that destroy miniature cities and structures.

Discoveries from WindEEE will impact how engineers design a safer, more sustainable world.

The raw power of wind can devastate, but professor Hangan also believes it can be used to innovate.

To learn more about the Wind Engineering, Energy and Environment Research Institute (WindEEE) please visit: **www.eng.uwo.ca/windeee**



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Inspiring hope through discovery

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SMART CONSTRUCTION

Measuring a home's energy efficiency

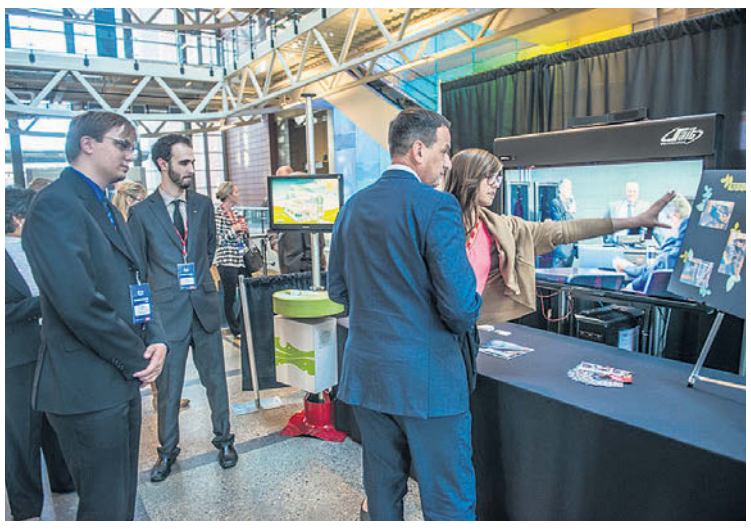
Take a green building and add a trio of IT students. The result? An award-winning applied research and innovation project that collected and centralized data from a net-zero home. Jeffrey Perry, one of the three graduates of SAIT Polytechnic involved in the project, says the unusual combination of disciplines was an added attraction. "What drew me to this project was that we got to apply our studies in IT in a non-conventional field."

The home is "net zero" because it draws on alternative energy sources to produce more energy than it consumes in the summer, and consumes more energy than it produces in the winter. It is part of a lineage of Discovery Homes that were built by SAIT's Applied Research and Innovation Services (ARIS) in partnership with Avalon Master Builder, a construction company based in Alberta, according to Mr. Perry. The research team worked on a system that fed information from different sensors, measuring a variety of variables from moisture in the walls to energy consumption, into a database.

"The system tells us how the different components work together, what things are going well and what could be improved," says Mr. Perry. "We can take that data and build something even more efficient the next time around." The project was part of Polytechnics Canada's Applied Research Student Showcase, an event that was co-hosted by SAIT earlier this month and saw teams from Polytechnics Canada's 11 member institutions engage in friendly competition.

"It was a big honour," Mr. Perry says. "Especially since SAIT was just named the number one research college in Canada."

SAIT recently placed first in the new top 50 research colleges list, released by RE$EARCH Infosource Inc. The ranking validates the work of SAIT's research and innovation program, says Alex Zahavich, director of ARIS. He added that it also indicates that polytechnics and colleges across Canada play an important role in applied research.



SAIT Polytechnic students Richard Then, Jeffrey Perry and Ashley Kieran show Greg Rickford, Minister of State (Science and Technology), their project at the 2013 Polytechnics Canada Student Applied Research Showcase hosted at SAIT earlier this month. SUPPLIED

"Polytechnics and colleges have strong industry partnerships and collaborate with universities to help bring ideas into the market," Dr. Zahavich says. "Getting this kind of recognition means we are on the right track."

Although SAIT is relatively new to applied research, it has an impressive and diverse portfolio. "We have aligned research areas along market segments. Every project has practical applications," says Dr. Zahavich. He notes that initiatives are guided by industry needs as well as value to the community.

"We are a bit like an applied research dating service that matches students with industry partners," Dr. Zahavich jokes, adding that the industry gains access to facilities, talent and pooled resources while the policy of mandatory student involvement gives SAIT graduates a competitive advantage.

Dr. Zahavich believes that the college's long-standing partnerships, like the four-year collaboration with Avalon Master Builder, show that the process works. "We've been involved in three of the five Discovery Homes. We built two houses on campus, broke them into modules and relocated them into subdivisions. People live in them while the home is being monitored for energy efficiency," he says.

The fact that the house was already in use added another challenge for the three IT students. "The family had been living in the home for two years when we worked on the system. That was big for us because we couldn't really mess things up," Mr. Perry says.

GREEN BUILDING

Illuminating the power of industry connections

"Think of a light pole that is not connected to anything other than solar and wind power," says Dr. Robert Luke as he describes the result of a research project he can see from his office window at George Brown College on the Toronto campus. Called an "illumient pole," it was developed by Clear Blue Technologies and now lights the Tridel Aqualina parking lot.

"Clear Blue Technologies develops smart systems for off-grid lighting," says Dr. Luke, vice president of research and innovation at George Brown. The company approached researchers at the college's Green Building Centre for help developing its product. "We worked very closely with them to refine and test the prototype and ultimately scale it for manufacturing."

In addition to providing students with valuable hands-on experience, Dr. Luke says Clear Blue Technologies has realized commercial success because of the research collaboration.

"We need to increase the commercialization of the fruits of our labour in our research facilities," he says. "At George Brown College, in particular in our Green Building Centre, we give industry access to talent, equipment and facilities, as well as markets and networks."

But it's not a one-way street. "While the industry innovates, our students gain crucial innovation skills in concert with their technical skills. That gives them an advantage in the job market," says Dr. Luke, adding that George Brown's graduates are likely to "future-proof the economy" by helping their companies innovate.

Expanding on the college's expertise in construction, the Green Building Centre also involves other disciplines, such as computer science or engineering technology, and it fills an important need. "The future of building is green," says Dr. Luke. "That means buildings have to be constructed with environmentally responsible materials, but they also have to utilize technology to make them smart."

Research at the Green Building Centre looks at environmentally responsible construction material and technology that makes buildings smarter. SUPPLIED

Power in partnerships

Federated Co-operatives Limited (FCL), **Saskatchewan Institute of Applied Science and Technology** (SIAST) and the **University of Saskatchewan** (U of S) are working together to advance new techniques and technology that will make it easier to clean up contaminated soil at former gas station sites.

The new remediation methods are better for the environment, less disruptive to businesses, and an example of the ways collaborative research has real impact and practical applications.

With funding from the federal agency NSERC and FCL, the team will use naturally occurring bacteria and fungi in the clean-up process.

The approach, which promises to become standard practice for the industry, has huge potential to tackle the estimated 30,000 contaminated sites across Canada and reduce clean-up costs by more than 30 per cent.

FCL on behalf of retail Co-ops across Western Canada, **SIAST** and the **U of S** are helping bring leading-edge technology to the forefront and, in the process, they're providing hands-on training for tomorrow's petroleum industry workers and soil scientists.

When we work together, everyone benefits.

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RESEARCH • INNOVATION • ENTERPRISE

PEOPLE

New model encourages scientists to communicate, work together

In science, the fundamental things apply.

And so the theories of Pythagoras, Sir Isaac Newton and James Maxwell continue to be at the heart of many of today's newest products.

But many leading-edge thinkers at the forefront of Canada's research and development community also say the emergence of a new model of innovation – one that emphasizes collaboration and communication among academic, public and private partners – is now essential.

Neil Turok, director of Ontario's Perimeter Institute for Theoretical Physics, says that a broader view of innovation is critical.

"Everything in the modern world originates in fundamental discoveries made in physics," says Dr. Turok, noting for example that the transistor, invented in the 1950s and based on theoretical principles discovered in the 1920s, spawned the entire Digital Age.

Perimeter, which opened in 1999 and has been ranked among the world's top five centres in physics and astronomy research, is "looking for discoveries so fundamental that they will drive the industries of the future," he says.

While the anticipated timelines for much of today's research to bear fruit remain long, Dr. Turok says in some instances collaborative research can produce faster results.

He notes work underway by Perimeter's experimental partner, the Institute for Quantum Computing, where researchers are developing new approaches to building quantum devices that in as few as two years could open paths to produce a quantum computer that's vastly more powerful and secure than today's devices.

"If this succeeds, it will completely transform the world of data," says Dr. Turok.

Scientists are becoming more involved in the continuum from research to innovation to enterprise, and communicating the value of their work to Canadians, says Janet Walden, chief operating officer of the Natural Sciences and Engineering Research Council of Canada (NSERC), the federal granting agency that provides students with research experiences and training and helps professors connect with industry.

Researchers have a responsibility to tell people about their work, says Neil Turok of the Perimeter Institute for Theoretical Physics. During Perimeter's recent BrainSTEM Festival, high school students had a chance to explore hands-on exhibits that conveyed the science, critical thinking and creativity behind emerging technologies. SUPPLIED

> ***"The Digital Age is about people connecting with each other in new ways."***
>
> **Dr. Chad Gaffield**
> *Social Sciences and Humanities Research Council of Canada*

Noting that NSERC "invests in people," Dr. Walden says, "it's not just research skills that are essential today. There is strong recognition that generating talent with a combination of research and innovation skills is an increasingly important part of the mandate of the academic system."

Chad Gaffield, president of the Social Sciences and Humanities Research Council of Canada, says that researchers studying human thought and behaviour are also increasingly "a key piece of the research puzzle," and truly make a difference in the lives of Canadians.

A new "people-centred model of innovation" involves collaboration among researchers, institutions, companies and even the public, he says. For example, companies are engaging consumers to help develop products based on their needs, a model of "co-innovation" that is also making us rethink how students are taught in classrooms and how employees can be better engaged in workplaces.

"It's a very interesting time," Dr. Gaffield adds. "The Digital Age is about people connecting with each other in new ways. It has big implications for everything from how companies might be more profitable to how schools can enhance learning outcomes and how communities can be better organized to improve our quality of life."

At the university level, there is competition for talent and funding as well as support for research infrastructure, notes Stephen Toope, president and vice-chancellor of the University of British Columbia. "We create an environment where researchers can do innovative research, collaborate freely and share that experience with students."

UBC has a number of initiatives and programs focused on changing how students learn, are trained and innovate. These include "living labs," industry liaison centres, hosting programs for international scientists and interdisciplinary work.

The new entrepreneurship@UBC program offers seed funding, workshops, office space and mentor networks to students, faculty members, alumni and staff working on new ventures.

Individual research has been transformed into collaborative efforts, Prof. Toope says, with "knowledge mobilization plans" where scientists are "driven to describe how the research can be utilized for the benefit of society."

Researchers have a responsibility to tell people about their work and its significance, rather than "hide away and pursue their ideas," Dr. Turok stresses.

Perimeter, which has been supported by more than $17 million in CFI funding, considers communication and engagement critical to its research, for instance through public lectures and exhibitions, he says.

"We feel very much obliged to explain what we're doing." If this leads to a greater understanding of the impact of research, he says, people will realize that "the investment in basic science is truly cost-effective."

PRODUCT IMPROVEMENT

Adidas turns to Canadian expertise to build high-performance footwear

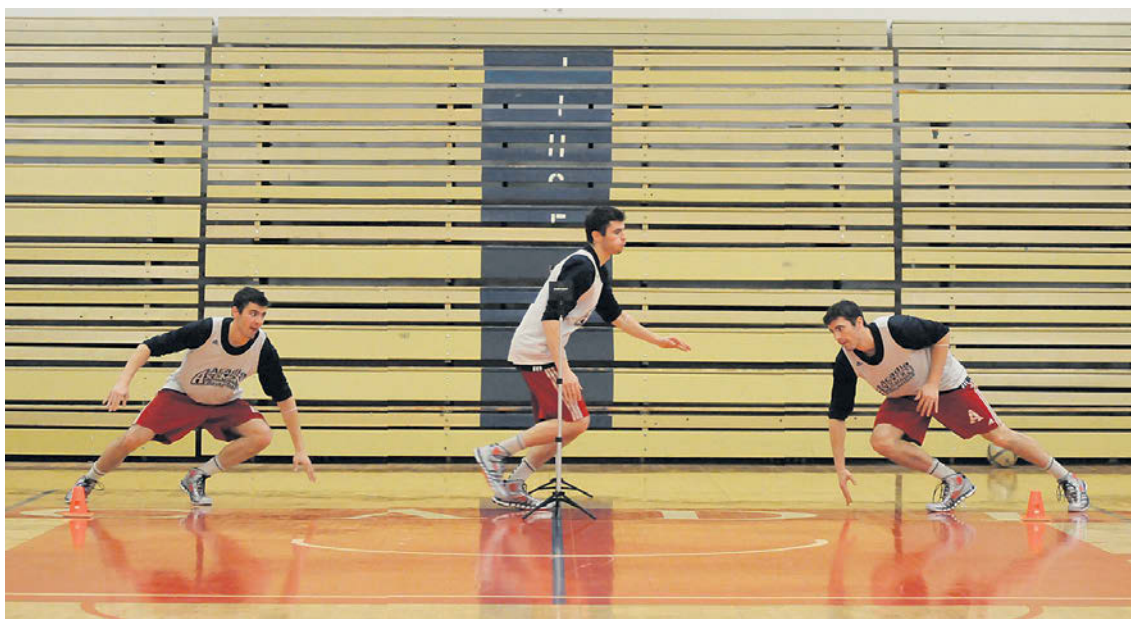
For high-performance athletes, everything from diet and sleep schedule to body mass index and heart rate is measured to ensure top conditions. Choosing the right equipment is also critical.

Basketball is ranked as one of the most injury-prone sports, and one of the world's leading athletic apparel companies, adidas, has partnered with researchers at Acadia University in Nova Scotia, to test its latest product, the adidas adipure Crazyquick, to see how it helps athletes perform on the court. The company turned to Acadia for lead researcher Scott Landry's biomechanical expertise, the university's soon-to-open Human Motion Lab, and its strong ties between academia and athletics; adidas is also the title sponsor of Acadia's Varsity Athletics Program.

Dr. Landry and his kinesiology research team enlisted the help of the university's men's basketball team, ranked second in the country last year, to test the Crazyquick.

"We were challenging traditional basketball footwear convention by giving athletes the ability to move more naturally during extreme lateral movements while still supporting the foot in the critical areas," says Elysia Davis, senior sport researcher at adidas. She says that Acadia was well equipped to compare the performance of the Crazyquick to other basketball shoes.

The research results from various studies within Landry's lab are shared with adidas to help the company improve shoe design related to performance and increase its understanding of injury prevention. In exchange, Acadia benefits from adidas investments, which are used to support sport science research.



Members of the Acadia varsity basketball team perform a pro-agility drill in the new adidas adipure Crazyquick basketball shoe. SCOTT LANDRY, ACADIA UNIVERSITY

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