University Affairs
Affaires universitaires

Unfinished business
Taking stock of the Naylor report, 5 years on

Dossier inachevé
Le point sur le rapport Naylor cinq ans plus tard

Solving the student housing crisis
Juguler la crise du logement étudiant

Social media has fundamentally changed armed conflict and political violence.

By mining data from Facebook posts, YouTube videos, and Tweets, the University of Regina's **Dr. Brian McQuinn** has revealed how insurgent groups, like the Taliban, are using these platforms to recruit new members, publicize their views, and finance their operations.

It's happening here.

University of Regina

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What became of the Naylor report's recommendations?

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Qu'est-il advenu des recommandations du rapport Naylor?

COVER ILLUSTRATION/ILLUSTRATION DE LA PAGE COUVERTURE: NATHALIE LEES

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> We have to continue trying to reach youth in ways that will be meaningful to them, and in the media that they access.
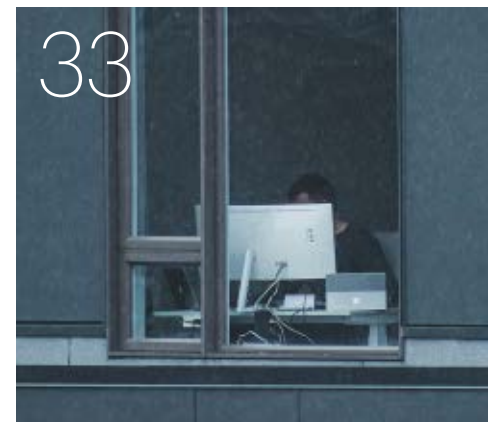
Roseann O'Reilly Runte, president and CEO of the Canada Foundation for Innovation, commenting on a survey about attitudes toward science among 18- to 24-year-olds, pg. 36

We're getting there

May this be the last semester of pandemic disruptions

WHAT A LONG, strange winter it's been. Thankfully that means the finish line for another remarkably challenging academic year is just around the corner.

The coming of spring also means the busiest season for real estate sales is almost upon us. And the Canadian market looks set to hit new highs yet again, pushing home ownership beyond the reach of many more people. The average price of a house in this country rose nearly 18 per cent between December 2020 and December 2021, according to the Canada Mortgage and Housing Corporation. While the acute supply shortage rightfully generates endless media coverage, little ink has been spilt on how the situation is affecting those in the postsecondary community. As Vancouver-based urban affairs writer Frances Bula discovered in researching her feature on the topic, hundreds of thousands of new housing units are needed from coast to coast just to keep up with student demand, particularly as postsecondary institutions recruit more heavily from abroad.

This issue also include an important piece of accountability journalism from science writer Brian Owens. He examined the Naylor report and its legacy five years on. While that document became a yardstick for measuring science policy when it was released in 2017, Mr. Owens found there is still a significant amount of work to be done to implement many of its recommendations.

Next, we have an excerpt from a book on academic integrity by University of Calgary professor Sarah Elaine Eaton, who has devoted much of her career to studying plagiarism, contract cheating, and misconduct policies. Finally, our Campus section features a few light-hearted stories, about a robotic dog, a prehistoric embryo, and a science course on beer-making. I hope they will educate and entertain, as the colder months give way to warmer weather and we all hopefully find more opportunities to recuperate and recharge.

Ian Munroe
Editor

La lumière au bout du tunnel

Puisse-t-il s'agir du dernier trimestre chamboulé par la pandémie

UN HIVER TOUT AUSSI interminable qu'étrange s'achève. Heureusement, ce changement de saison indique qu'une autre année universitaire ponctuée de grands défis tire à sa fin.

L'arrivée du printemps annonce également le début de la haute saison du marché immobilier. Encore une fois, le marché canadien semble susceptible d'atteindre des sommets inégalés, rendant l'accès à la propriété hors de portée pour plusieurs. Selon la Société canadienne d'hypothèques et de logement, le prix moyen d'une demeure au pays aurait bondi de 18 % entre décembre 2020 et décembre 2021. Si la pénurie de logements fait l'objet – avec raison – d'une très grande couverture médiatique, ses répercussions sur le milieu universitaire n'ont fait couler que bien peu d'encre. Comme le révèle l'article de Frances Bula, une rédactrice en affaires urbaines habitant à Vancouver, des centaines de milliers de nouveaux logements sont nécessaires partout au pays pour répondre aux besoins des étudiants, notamment maintenant que les établissements postsecondaires recrutent davantage à l'étranger.

Le présent numéro comprend également un article d'envergure du journaliste scientifique Brian Owens, qui a analysé les retombées du rapport Naylor sur une période de cinq ans. M. Owens dénote que, bien que le rapport ait été perçu comme étant la référence en matière d'évaluation des programmes scientifiques au moment de sa publication en 2017, d'importants efforts doivent encore être déployés pour mettre en place bon nombre de ses recommandations.

Ce numéro contient aussi un extrait d'un livre portant sur l'intégrité universitaire. L'auteure, Sarah Elaine Eaton, une professeure de l'Université de Calgary, a consacré une bonne partie de sa carrière à l'étude du plagiat, de la fraude universitaire et des politiques relatives aux inconduites. Enfin, la section Campus propose quelques articles empreints de légèreté, notamment au sujet d'un chien robot, d'un embryon préhistorique et d'un cours de science axé sur la production de bière. J'espère que vous trouverez ces récits tout aussi instructifs que divertissants, et que l'arrivée des beaux jours après la saison froide offrira à tous l'occasion de faire le plein d'énergie.

Ian Munroe
Rédacteur en chef

Un léger divertissement

Au sujet de la chronique « Does Netflix's The Chair get it right? » (publiée dans le numéro de janvier-février 2022) : j'ai regardé la série *The Chair* parce que vous en avez parlée, sinon je n'aurais pas regardé cette série! Il est certain que la pédagogie revisitée à la lumière des nouvelles technopédagogies attirent les étudiant.e.s davantage. Bon! Les jeunes profs sont aussi populaires! Toutefois la représentation des profs séniors dans cette série est un peu vieillotte et stéréotypée. Il est un peu désolant de voir les représentations de profs plus âgés si terriblement diminuer au masculin! Mais, la nouvelle « chair » spécialiste de Chaucer est tout à fait sympathique et on aime bien cette conclusion! Divertissement léger et il ne faut pas l'oublier!

Gabrielle Saint-Yves
Mme Saint-Yves est linguiste et chargée de cours à l'Université du Québec à Chicoutimi.

Nurses are key

A NURSE PRACTITIONER on campus ("U of Regina opens 'first of its kind' student wellness centre," January-February 2022) has been happening at the University of Northern British Columbia (UNBC) since pre-2007. It is a great model!

Sabreena MacElheron
Ms. MacElheron is the director of international student services at Lakehead University.

We need to wake up

AS SOMEONE WHO has written extensively on the edubusiness orientation of North American universities over the past 200 years (see Nelsen 2017 for example) I appreciate Marc Spooner's insightful review of the latest iteration ("Canadian universities are quietly being repurposed," published online Jan. 27). Those of us entrusted to care for the university need to continue being critical of the direction currently being charted. Time to fight back to save whatever is left of the university as a place that promises critical observations and creative thought. It is past time to wake up.

Randle W. Nelsen
Dr. Nelsen is a professor emeritus of sociology at Lakehead University.

Things will never be the same

THANK GOD I'M RETIRED now (faculty/senior admin). The way it was pre-pandemic is over. It's a brand new world out there ("Canadian universities are quietly being repurposed," published online Jan.27). Lack of funding, cutbacks, fighting for dollars, Zoom, too many PhD doctors and not enough jobs, etc. etc. etc. Best of luck, folks.

William George Lindsay
Dr. Lindsay is a retired senior director of Indigenous directions at Concordia University.

Happy to be retired

SO HAPPY TO read this ("Canadian universities are quietly being repurposed," published online Jan. 27). I truly think the sector is losing its way, to the cost of future Canadians. And I too am glad to be retired from my university professional staff position.

Susan Elgie
Ms. Elgie is a retired research consultant from the Ontario Institute for Studies in Education at the University of Toronto.

Ici et là / Here and there

Campus
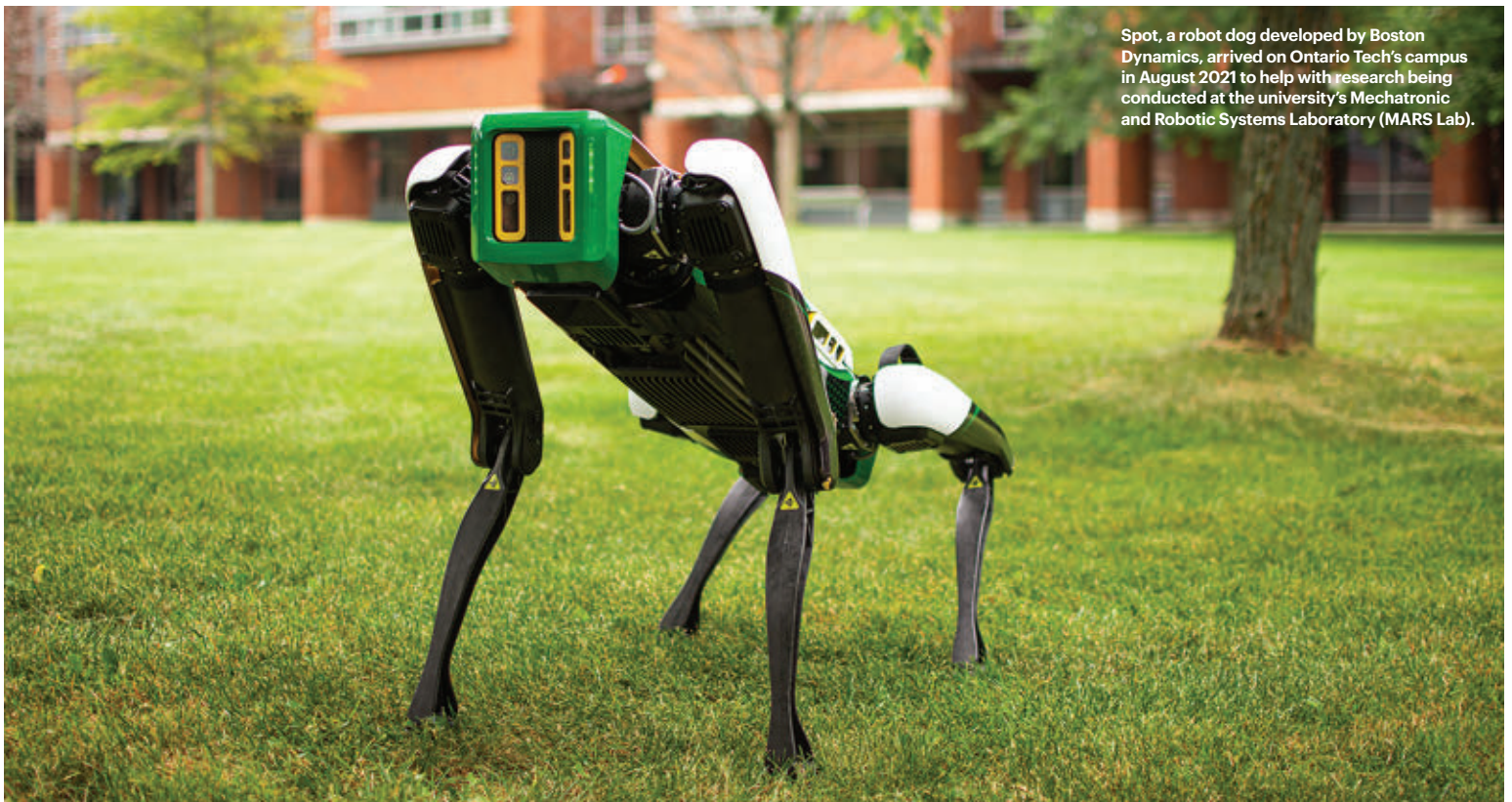
Spot, a robot dog developed by Boston Dynamics, arrived on Ontario Tech's campus in August 2021 to help with research being conducted at the university's Mechatronic and Robotic Systems Laboratory (MARS Lab).

Technology

Ontario Tech University explores the future of industrial robotics with a four-legged friend

Researchers will explore the capabilities of Boston Dynamics' Spot robot over the next 3 years

WITH PLANS IN motion to decommission Ontario Power Generation's (OPG) nuclear power plant in Pickering, Ont., in the coming years, making sure that process is as safe as possible is of the utmost concern for the energy corporation, its employees, and the surrounding community. Nearby Ontario Tech University is working with OPG to test a four-legged solution that is part of an emergent field of engineering which could change how the maintenance of nuclear power plants is performed, and by whom.

Enter Spot, an "agile mobile robot" built by U.S. design and engineering company Boston Dynamics. Spot's capabilities in the field of industry are largely untested, so researchers are looking to understand its full potential prior to putting it to use doing field work. "It's an exciting opportunity," said Scott Nokleby, chair of the department of automotive and mechatronics engineering at Ontario Tech. "These Spot robots are at the forefront of a new wave of robotics, taking a step out of the research world and into more industrial applications." Dr. Nokleby, the research lead on this project, is working alongside PhD student Christopher Baird, who will be testing the robot for his degree over the next three years.

Using Spot's camera and artificial intelligence, Dr. Nokleby and Mr. Baird are testing Spot's ability to see differences in gauges, valves and to notice overall changes in its environment – like a puddle or fire, all essential aspects of the maintenance work required daily at OPG. They've even tested its ability as a first response unit, equipping it with a fire extinguisher, which it successfully used to put out a diesel fire.

– MICHAEL RANCIC

PHOTO: ONTARIO TECH UNIVERSITY

La première cohorte en formation compte 17 leaders autochtones provenant de six nations différentes.

Enjeux autochtones

HEC Montréal lance son École des dirigeants des Premières Nations

COCONSTRUITE AVEC l'École des dirigeants de HEC Montréal, l'École des dirigeants des Premières Nations (EDPN) offre des formations universitaires de courtes durées destinées aux Premières Nations. Les professeurs de HEC Montréal unissent leurs forces à celles des formateurs autochtones pour outiller les élus, les gestionnaires et les entrepreneurs des communautés et organisations autochtones.

L'avocat innu Ken Rock et la consultante Mi'gma Manon Jeannotte sont deux diplômés du programme EMBA McGill-HEC Montréal. Ensemble, ils ont voulu créer une école qui incarnait les valeurs et le leadership des Premières Nations. « Ken et moi avons discuté avec d'autres membres des Premières Nations et on s'est vite rendu compte qu'on avait besoin d'une école avec plusieurs programmes. C'est comme ça que l'EDPN est née », raconte Mᵐᵉ Jeannotte, qui en est désormais directrice.

Selon la coinstigatrice du projet, les élus et administrateurs en contexte autochtone font face à des défis qui leur sont propres. Une formation adaptée à leur réalité s'impose. Le programme actuel, *Devenir un leader dirigeant agile et innovant*, s'adresse aux chefs, grands chefs et aux président.e.s des conseils d'administration. « C'est beaucoup relié aux responsabilités, explique-t-elle. Les conseils doivent gérer des responsabilités qui se regroupent normalement au municipal, provincial et fédéral. Ça va de l'éducation, à la santé en passant par les services municipaux. »

Les cours de la cohorte actuelle s'échelonneront jusqu'en mai. Les inscrits apprennent et appliquent des notions sur le leadership authentique et les relations constructives. Le but est qu'ils puissent également engendrer des changements collectifs et gouverner avec intégrité et responsabilité.

> « Des leaders compétents et des organisations autochtones fortes, il faut commencer par là pour atteindre l'autonomie des Premières Nations. »

D'ailleurs, la valorisation de l'oralité est un exemple de pratique pédagogique adaptée aux Autochtones, constate François Rompré, président de la Commission de développement économique des Premières Nations du Québec et du Labrador et participant à la première cohorte. « Dans la plupart des ateliers, on a intégré le cercle de discussion avec le bâton de parole. Pour chaque point, chaque personne du cercle devait prendre la parole. Souvent, dans les cours plus traditionnels, il y a des personnes qui ne prendront jamais la parole. C'est une différence marquante. »

Avec cette approche, le souci de développer le programme en collaboration et d'adapter l'apprentissage aux réalités autochtones, l'EDPN suscite de l'intérêt ailleurs au Canada et même, à l'international. M. Rompré croit que la création de l'EDPN améliorera les conditions de vie des communautés. « Des leaders compétents et des organisations autochtones fortes, il faut commencer par là pour atteindre l'autonomie des Premières Nations. »

– ÉMÉLIE RIVARD-BOUDREAU

Perfectly preserved

A recently discovered fossilized dinosaur embryo is giving researchers a rare opportunity to study the insides of a prehistoric egg

WHAT DOES A dinosaur embryo look like just before hatching? That was an unanswered question until December 2021 when a team of international scientists published a paper describing a startling find: a fossilized egg, discovered in southern China, containing the perfectly preserved embryonic skeleton of an oviraptorid dinosaur. Estimated to be between 66 million and 72 million years old, the fossil has been dubbed Baby Yingliang after the museum that now houses it.

Baby dinosaur bones are small and fragile and rarely preserved as fossils, making this a very fortunate find, said Darla Zelenitsky, an associate professor in the department of geoscience at the University of Calgary, who was part of the team assembled to study the embryo. She suspects this relic survived because it was buried quickly by a flood, protecting it from scavengers.

Incredibly, the fossilized egg was unearthed in 2000 during the construction of an industrial park in Jiangxi province in southern China but ended up in storage and was forgotten until about 15 years later, when the curator of the Yingliang Stone Nature History Museum made a chance discovery. After he noticed some bones on the broken section of an egg, he arranged for fossil preparation – a process that involves removing the rocky matrix surrounding the bones, scraping off part of the eggshell and cleaning the fossil. This revealed the embryo's full skeleton. Measuring 27 cm long and lying curled inside a 17 cm-long egg, the fossil has been identified as an oviraptorosaur, a two-legged, feather-covered dinosaur.

A world authority on dinosaur eggs, Dr. Zelenitsky recalls her surprise when she first locked eyes on the specimen. "I was completely stunned. I couldn't believe my eyes. I had never seen anything like it and I've been studying dinosaur egg fossils for 25 years. You can see the embryo perfectly curled with all its bones in place from the tip of its snout to the end of its tail. It looks as though the animal died just yesterday." – KERRY BANKS

The fossilized embryo of an oviraptorid dinosaur curled in its egg, seen here in a position similar to that of birds just prior to hatching (Courtesy Xing et al., 2021).

Dalhousie professor turns students into craft brewers

IT WAS BOTTOMS UP for 15 students at Dalhousie University last November when they gathered to sample five different types of beer they had developed during their process engineering and applied science course: "Brewing Science." In it, the students learned the intricacies of brewing, fermentation, maturation and packaging of beer production.

Taught by Gianfranco Mazzanti, associate professor of process engineering and applied science, the course offered hands-on experience for students, who got the opportunity to use the faculty of engineering's TUNS Brewery on Dalhousie's Sexton campus. Dr. Mazzanti, who has a background in food science and food engineering, agreed to teach under the condition that he could make use of the brewery as a learning environment – which had never been done before.

"The department was kind of skeptical that we would be able to pull this off," said Dr. Mazzanti. "But I have a lot of experience with industrial equipment and plants, so I had faith in it."

At first the students experimented by using only water, but the course gave them a chance to learn the unique characteristics of the various ingredients that go into beer – like malt, hops, barley, and wart – and the impact they have on flavour. –HANNAH LIDDLE

Overheard

Over 400,000(!) of you have signed up to take the Indigenous Canada course at the @UANativeStudies. If you haven't taken it already, might I suggest giving yourself and those you love the gift of education. It's free. You won't regret it.

Dan Levy, Canadian celebrity and star of Schitt's Creek, encouraging his 1.2 million Twitter followers to sign up for the University of Alberta's Indigenous Canada MOOC.
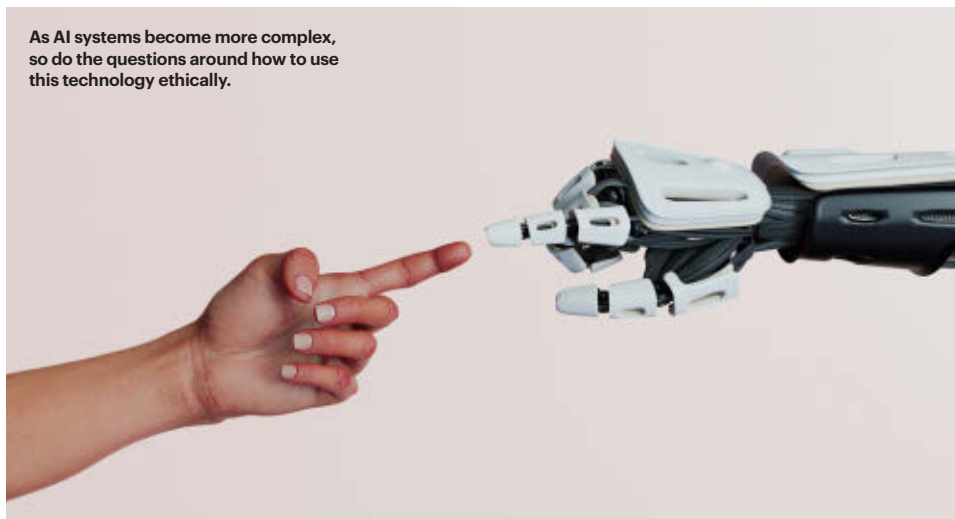
As AI systems become more complex, so do the questions around how to use this technology ethically.

Artificial intelligence

New microcredential focuses on the importance of AI ethics

AS FOUNDER AND CEO of Edmonton-based company Ethically Aligned AI, Katrina Ingram spends much of her time consulting with organizations on how to foreground ethical considerations when designing and deploying artificial intelligence. That's why she's helped design Canada's first university microcredential focused on AI ethics — a four-course certificate program offered by Athabasca University.

According to Ms. Ingram, this kind of training should be foundational for any professional working in digital systems. Yet the Athabasca program is the first of its kind in Canada, and one of relatively few worldwide.

"People doing computer science degrees, of any sort, need ethical training," she said. "That's one audience that needs to be served... the other big audience is people who are already working professionally, all the people working in companies, designing these systems, they need training too, and the microcredential program is flexible, not too time-consuming and works for them."

The courses were co-designed with Trystan Goetze, a philosopher and ethicist currently completing his postdoctoral fellowship in computer ethics at Harvard University.

What kinds of ethical issues are at stake? Bias is a major one, said Dr. Goetze. AI can reaffirm and even exacerbate existing prejudices. Consider an AI system tasked with choosing promising job applicants, which bases its decisions on a dataset of previous hires. If historic hiring practices were flawed or biased against particular candidates, those biases will be integrated into the AI as well.

Another consideration is how data used by AI systems is collected – i.e., is it scraped from social media profiles or other online sources in a consensual and privacy-compliant way? And then there's "robo-ethics," including concerns around misuse of facial recognition technology, or safety issues caused by the testing of AI-powered autonomous vehicles on public streets.

"People doing computer science degrees, of any sort, need ethical training."

Besides academic thinkers, the courses will include interviews and contributions from activists, professionals and business leaders, who can bring different facets of the subject to light.

"Athabasca has put a great deal of creative effort into these courses," Dr. Goetze said. "They're visually designed in a beautiful way, with video and animations. It's not something that looks like it was slapped together in haste during the last lockdown, which I think is a testament to the fact that when we have the time and resources, we can produce online education experiences that are truly special." – MATTHEW HALLIDAY

Between curiosity
and knowledge,
there's a bridge.

CISCO
The bridge to possible

A JOB HALF DONE

It's been five years since the Naylor report was released, and some say there's been too little progress toward supporting Canadian research in fundamental science.

by Brian Owens

Cinq années se sont écoulées depuis la publication du rapport Naylor, et certains estiment que trop peu de progrès ont été observés en matière de soutien à la recherche fondamentale canadienne.

par Brian Owens

DES RÉSULTATS MITIGÉS

Illustration by/par Nathalie Lees

IN 2016, THEN science minister Kirsty Duncan convened a panel of experts to conduct a comprehensive review of Canada's academic science and research ecosystem. Led by David Naylor, former president of the University of Toronto, it was the first such exercise in almost 40 years.

The resulting Fundamental Science Review (FSR), released a year later, included recommendations on how to streamline, support and improve the country's research landscape. It became the lodestar for Canada's science community, and for a time at least, the federal government as well. Now, five years later, the work to implement those recommendations is at best only partly done. And while the FSR, also known as the Naylor report, remains a top priority for academics, it seems to have largely slipped off the government's agenda.

"The FSR tends to evoke strong emotions," says Farah Qaiser, director of research and policy at Evidence for Democracy, a non-profit group that advocates for science-based policy decisions. "Some believe the government has fallen very short, while others say there has been a lot of progress. Everyone has strong opinions."

Ms. Qaiser and her colleagues have reviewed the progress that's been made so far. Of the report's 35 recommendations, they found that nine have been completed. Another 13 are in progress, and 13 are incomplete. "I think progress on 22 out of 35 is pretty good news," says Ms. Qaiser.

Some of the completed recommendations include steady, permanent funding for the Canada Foundation for Innovation (CFI), a review of the Canada First Research Excellence Fund, and streamlining the federal government's innovation programs. Another was the creation of the Canada Research Coordinating Committee (CRCC) to improve cooperation and collaboration between the three research funding councils (the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council, and the Social Sciences and Humanities Research Council) as well as CFI and the National Research Council.

The CRCC has resulted in greater coordination among the various agencies, and the councils are working well together, says Dr. Naylor. But he adds that the CRCC's effectiveness is somewhat undercut by having the chair of the committee rotate annually between the presidents of the Tri-Councils, instead of being given to the chief scientific advisor as the report recommended. That, says Dr. Naylor, is a recipe for internal horse-trading rather than tackling thorny issues head-on, such as deciding how to divvy up shared pots of funding. "We won't see the really challenging issues resolved without outside brokering," he says.

The review also recommended that a new high-level body, the National Advisory Council on Research and Innovation (NACRI), be created to provide broad oversight of the federal research and innovation ecosystems. The council, consisting of distinguished scientists, innovators, and civil society members, would replace the largely defunct Science, Technology, and Innovation Council (STIC). STIC is no longer operating, and a new Council on Science and Innovation (CSI) was announced in January 2019, when the government issued a call for applications for members. But since then, there have been no further details on the mandate, membership or whether the council is functional. "There's still no federal oversight body," says Ms. Qaiser. "I'm curious what happened with that council."

A spokesperson for Innovation, Science and Economic Development Canada says the government "continues to work towards" implementing the council but offered no specific details or timeline.

According to Dr. Naylor, the FSR's most important recommendation is one that remains only partly complete: boosting funding for the research councils' open competitions, and for students and trainees. "Those are critical elements of the report that saw some traction, but they didn't do all that was recommended, and they need to take stock of where they are now, particularly in light of COVID-19 and the disruption it's had," he says.

EN 2016, LA MINISTRE des Sciences de l'époque, Kirsty Duncan, avait réuni un panel d'experts ayant pour mandat d'examiner à la loupe l'écosystème universitaire de la science et de la recherche au Canada. Cet exercice, dirigé par l'ancien recteur de l'Université de Toronto, David Naylor, n'avait pas été entrepris depuis près de 40 ans.

Le rapport du Comité consultatif sur l'examen du soutien fédéral à la science fondamentale, publié en 2017, comportait des recommandations visant à simplifier, à soutenir et à améliorer le milieu de la recherche au Canada. Ce rapport a servi de fil conducteur pour la communauté scientifique canadienne et, au moins pendant un temps, pour le gouvernement fédéral. Cinq ans plus tard, le travail nécessaire pour mettre en œuvre ces recommandations n'a été que partiellement accompli, et si le rapport (aussi connu sous le nom de rapport Naylor) est toujours au cœur des priorités des chercheurs, il semble avoir disparu de celles du gouvernement.

« Généralement, l'examen du soutien fédéral à la science fondamentale suscite de vives réactions », note Farah Qaiser, directrice de la recherche et des politiques chez Evidence for Democracy, un organisme à but non lucratif qui milite pour des décisions politiques fondées sur la science. « Certains pensent que le gouvernement n'en fait vraiment pas assez, tandis que d'autres croient qu'il a fait beaucoup de progrès. Tout le monde a des opinions bien arrêtées », ajoute-t-elle.

Avec son équipe, elle a mesuré les progrès réalisés jusqu'à présent. D'après leur évaluation, neuf des 35 recommandations du rapport ont été mises en œuvre, 13 sont en cours de déploiement et 13 n'ont pas été adéquatement appliquées. « Je trouve que 22 recommandations sur 35 qui progressent, c'est plutôt une bonne nouvelle », commente Mme Qaiser.

Parmi les recommandations mises en œuvre, on compte le financement régulier et permanent destiné à la Fondation canadienne pour l'innovation (FCI), la révision du Fonds d'excellence en recherche Apogée Canada et l'uniformisation des programmes d'innovation du gouvernement fédéral. À ces efforts s'ajoute la création du Comité de la coordination de la recherche au Canada (CCRC), dont l'objectif est de renforcer la collaboration entre la FCI, le Conseil national de recherches et les trois conseils canadiens de financement de la recherche, soit les Instituts de recherche en santé du Canada, le Conseil de recherches en sciences naturelles et en génie du Canada (CRSNG) et le Conseil de recherches en sciences humaines.

Selon M. Naylor, le CRCC a permis de renforcer la coordination entre ces différentes organisations, et les conseils collaborent véritablement. Il ajoute toutefois que l'efficacité du CRCC est quelque peu affaiblie par le roulement de sa présidence, qui alterne d'une année à l'autre entre les présidents des trois conseils subventionnaires, alors qu'elle pourrait être confiée au conseiller scientifique en chef, comme le recommande le rapport qui porte son nom. Pour M. Naylor, ce fonctionnement incite aux négociations internes plutôt qu'à la résolution de réelles problématiques, comme la répartition des subventions partagées. « On ne pourra pas régler les problèmes les plus pressants sans arbitrage externe », conclut-il.

Le rapport Naylor a aussi recommandé la création d'un Conseil consultatif national sur la recherche et l'innovation. L'objectif de cet organe consultatif de haut niveau serait d'évaluer l'ensemble des écosystèmes fédéraux de recherche et d'innovation. Ce conseil, qui réunirait d'éminents scientifiques, des experts de l'innovation et des membres de la société civile, remplacerait le Conseil des sciences, de la technologie et de l'innovation (CSTI), qui est essentiellement obsolète. La nouvelle version du CSTI, soit le Conseil des sciences et de l'innovation (CSI), a été annoncée en janvier 2019 sous la forme d'un appel de candidatures. Depuis, pourtant, aucune précision n'a été communiquée sur son mandat, sa composition ou sa mise en œuvre. « Il n'y a toujours pas d'organe d'évaluation du côté fédéral, constate Mme Qaiser. Je me demande ce qu'il est advenu de ce conseil. »

Un porte-parole d'Innovation, Sciences et Développement économique Canada assure que le gouvernement « poursuit ses efforts » relatifs à la mise sur pied de ce conseil, sans toutefois donner davantage de détails.

Selon M. Naylor, la recommandation la plus importante du rapport, soit l'augmentation du financement des concours organisés par les conseils de recherche et de celui offert aux étudiants et aux stagiaires, n'a été que partiellement mise en œuvre. « C'est un élément crucial du rapport. Des progrès ont été faits, mais le gouvernement n'a pas entièrement suivi la recommandation. Il doit faire le point sur la question, surtout dans ce contexte de pandémie, qui amène son lot de perturbations », déclare-t-il.

> « Généralement, l'examen du soutien fédéral à la science fondamentale suscite de vives réactions. Certains pensent que le gouvernement n'en fait vraiment pas assez, tandis que d'autres croient qu'il a fait beaucoup de progrès. Tout le monde a des opinions bien arrêtées. »

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> Some believe the government has fallen very short,
> while others say there has been a lot of progress.
> Everyone has strong opinions."

Significant investment

Despite falling short of the recommendations, the money that was forthcoming was a serious and meaningful investment, says Dr. Naylor. The 2018 federal budget committed $925 million over five years for the Tri-Councils. That was just under 60 per cent of the $1.2 billion over four years for direct, investigator-led project funding that the FSR called for. And the 2019 budget included $114 million over five years to create 500 more master's level scholarship awards and 167 more three-year doctoral scholarship awards annually through the Canada Graduate Scholarships program. That was slightly short of the recommended $140 million over four years. The 2021 budget also included big boosts for biomedical research, artificial intelligence, genomics, and quantum research.

The authors of the FSR were "drawing a bit in colour" when they made those funding recommendations, admits Rémi Quirion, Quebec's chief scientist and a member of the FSR advisory panel. "The reality is that governments have to make choices, and budgets are not unlimited," he says. But even acknowledging those constraints, Dr. Quirion says the increase in funding was not as large as he would have hoped for. He also says too much of it was still geared towards government priorities rather than open competitions, even before the pandemic created a new and impossible-to-ignore target.

"Funding is still a challenge," he says. "It's why some scientists are starting to make noise."

Nathalie Grandvaux, a virologist at the Université de Montréal, says scientists welcomed the increase in funding for investigator-led research, but it has not translated into reduced pressure on lab budgets. The success rate for open competitions at the Canadian Institutes for Health Research, for example, remains largely flat at around 15 per cent, she says, because the number of grant applications submitted has risen in concert with the number of grants available. And the amount provided by each grant has not gone up significantly, so their value has actually decreased in real terms. "There has not been enough extra to compensate for the increase in the cost of everything," Dr. Grandvaux says.

The new funding has also not been enough to keep pace with other countries, she says. "Even if we have increased funding, other countries are increasing it faster," she says. "So we are no more competitive than we were before."

Students have similar concerns. Many welcomed the increased number of scholarships announced in 2019, and the 12 months of parental leave for those funded by the three main research councils. But rising tuition and cost of living have made the awards less valuable over the past two decades, says Isabella Lim, a PhD candidate in cognitive psychology at the University of Toronto and co-president of the Toronto Science Policy Network (TSPN), a student-run science policy group. An NSERC PhD scholarship, for example, is worth $21,000 a year for three years, or $35,000 for the top-ranked applicants. "The value of awards has been stagnant since 2003, while costs have increased every year," says Ms. Lim. "So the funding announced in 2019 falls short of what we need, especially considering the disruption of the pandemic."

The expanded number of awards, and parental leave, only applies to students who receive federal funding, leaving those who do not get federal grants scrambling even more to keep up. "We need to support students more broadly," says Frank Telfer, a master's student studying pediatric cancer at the University of Toronto and TSPN's other co-president.

Many in the scientific community also feel that the government no longer has much interest in completing the outstanding recommendations in the report. Since the 2018 budget, significant announcements on research funding have been few and far between – apart from some admittedly large ones dedicated to dealing with the COVID-19 pandemic – and there seems to be little urgency in moving things forward. "There is an impression that the government feels it has ticked that box," says Sivani Baskaran, a PhD candidate in environmental chemistry at the U of T and former president of TSPN.

Dr. Grandvaux agrees that it feels like the government has moved on, and no longer considers science to be a political priority. "The government responded to the report, and did some of the things in it, but I don't have the feeling that it is a philosophy, that it has changed their way of thinking about research," she says.

Un investissement conséquent

Si le gouvernement a fait les choses à moitié, il a tout de même consenti d'importants investissements, d'après M. Naylor. En 2018, le budget fédéral octroyait 925 millions de dollars sur cinq ans aux trois conseils subventionnaires, soit presque 60 % des 1,2 milliard de dollars sur quatre ans demandés dans le rapport pour subventionner des projets menés par des chercheurs. En 2019, le gouvernement a prévu 114 millions de dollars sur cinq ans pour créer 500 bourses de maîtrise supplémentaires et 167 bourses de doctorat d'une durée de trois ans additionnelles dans le cadre du Programme de bourses d'études supérieures du Canada, et ce, sur une base annuelle. Cet investissement se situe tout juste en deçà des 140 millions de dollars sur quatre ans recommandés par le rapport. De plus, le budget de 2021 prévoyait une aide conséquente pour la recherche en biomédecine, en intelligence artificielle et en génomique ainsi que pour la recherche quantique.

Les auteurs du rapport Naylor « n'y sont pas allés de main morte » dans leurs recommandations en matière de subventions, admet Rémi Quirion, scientifique en chef du Québec et membre du Comité consultatif sur l'examen du soutien fédéral à la science fondamentale. « La réalité, c'est que le gouvernement doit faire des choix, et que les budgets sont limités », explique-t-il. Malgré cette lucidité, M. Quirion confie qu'il s'attendait à un financement plus généreux. D'après lui, une trop grande partie de cette aide a été allouée à l'avancement des priorités du gouvernement plutôt qu'aux concours d'octroi de subventions, et ce, avant même que la pandémie ne crée une nouvelle priorité impossible à ignorer.

« Trouver du financement reste difficile. C'est pour ça que les scientifiques commencent à faire du bruit », estime-t-il.

Nathalie Grandvaux, virologue à l'Université de Montréal, explique que les subventions pour les projets menés par des chercheurs ont été accueillies à bras ouverts par ces derniers, mais qu'elles n'ont pas réduit la pression exercée sur les budgets des laboratoires. Le taux de succès des concours des Instituts de recherche en santé du Canada, par exemple, stagne autour des 15 % parce que le nombre de demandes a augmenté au même rythme que le nombre de bourses distribuées, souligne-t-elle. De plus, la valeur de ces bourses n'a pas vraiment augmenté. En fait, c'est plutôt l'inverse en dollars constants. « L'augmentation générale des coûts n'a pas été prise en compte dans les montants alloués », constate Mme Grandvaux.

Ce nouveau financement n'est pas non plus à la hauteur de la concurrence internationale, selon elle. « Même si l'État donne plus qu'avant à la recherche, d'autres pays en font encore plus, dit-elle. Résultat : on n'est pas plus concurrentiels qu'avant. »

Les étudiants sont dans le même bateau. Beaucoup ont applaudi l'augmentation du nombre de bourses annoncée en 2019 et les 12 mois de congé parental compris dans celles offertes par les trois grands conseils subventionnaires. Toutefois, l'augmentation des droits de scolarité et du coût de la vie pendant les 20 dernières années ont réduit la valeur de ces bourses, selon Isabella Lim, doctorante en psychologie cognitive à l'Université de Toronto et coprésidente du Réseau de politiques scientifiques de Toronto, une initiative étudiante. Une bourse de doctorat du CRSNG, par exemple, s'élève à 21 000 dollars par année pour une période de trois ans, ou 35 000 dollars pour les meilleurs candidats. « La valeur des bourses stagne depuis 2003, alors que les coûts augmentent chaque année, déplore-t-elle. Les subventions annoncées en 2019 ne sont pas à la hauteur de nos besoins, surtout depuis la pandémie. »

Les bourses supplémentaires et les congés parentaux ne sont accessibles que pour les candidats qui reçoivent un financement fédéral, il est donc encore plus difficile de s'en sortir pour les étudiants qui ne reçoivent pas d'aide fédérale. « C'est tous les étudiants qu'il faut aider », déclare Frank Telfer, étudiant de maîtrise qui se spécialise en cancers chez les enfants à l'Université de Toronto et autre coprésident du Réseau de politiques scientifiques de Toronto.

Nombreux sont les membres de la communauté scientifique à penser que le gouvernement se désintéresse des recommandations restantes du rapport. Depuis le dépôt du budget de 2018, les annonces sur le financement de la recherche se font rares – à l'exception de celles visant à lutter contre la pandémie, qui sont plutôt conséquentes – et le gouvernement n'a pas l'air de se presser. « On a l'impression que le gouvernement considère le problème comme réglé », soutient Sivani Baskaran, doctorante en chimie environnementale à l'Université de Toronto et ancienne présidente du Réseau de politiques scientifiques de Toronto.

Mme Grandvaux est du même avis. Selon elle, la science n'est plus une priorité politique du gouvernement fédéral. « Le gouvernement a réagi au rapport et a répondu à une partie des recommandations, mais je ne pense pas qu'il accorde une plus grande importance à la recherche qu'avant. »

> « Trouver du financement reste difficile.
> C'est pour ça que les scientifiques commencent
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> "Funding is still a challenge.
> It's why some scientists are starting
> to make noise."

Science vs. politics

While during the 2015 election Justin Trudeau and the Liberal Party assiduously courted scientists disaffected with the Conservative government, science and research has not enjoyed the same amount of attention in subsequent campaigns. "In the last election we didn't hear anything about research," says Dr. Grandvaux. "Not just for the good of science, but for the economy. They don't seem to see it as part of what makes the economy work."

Richard Cannings, the New Democratic Party Member of Parliament for South Okanagan-West Kootenay and the party's former science critic, has also noticed a lack of action. "We haven't seen any new activity on the FSR over the last two or three years," he says. "Everything seems to have gone quiet in government circles."

But Santa Ono, president of the University of British Columbia, says there is more to the government's support for science than just top-line budget numbers at the research councils. There have also been big wins in other areas, he says, such as commitments to improving equity, diversity and inclusion through the Dimensions Charter and strengthened targets for the Canada Research Chairs. He also believes the support offered to students and researchers during the pandemic was among the best in the G7 countries.

"I wouldn't say the government looked away from science. They are looking at other critical programs and investments that are crucial to Canadian science, to make it better and more inclusive," he says. "I don't think we do enough to thank the government for what they did. The FSR is a legacy for this government."

In fact, Dr. Ono would like to see the exercise repeated, preferably on a regular basis, to keep track of changes to the landscape of international science. "There should be a commitment to do this at least every five years," he says. "It's important to take stock of where we are as a nation, how we're supporting the next generation of scientists, how we're doing relative to the rest of the world."

While there is no indication that the government intends to commission another large-scale review of science, MPs may soon get the chance to do some digging on their own. Parliament's new Standing Committee on Science and Research, chaired by former science minister Kirsty Duncan, will examine "all matters related to science and research," and Mr. Cannings, who is also a member, says this should include a follow-up on the FSR. "It might be an idea, for our first study, to say 'let's study the Naylor report and see where the government is on it,'" he says. "We went to a great deal of trouble and talked to a lot of smart people for this report, and I think we should still look to it."

Francois-Philippe Champagne, minister of innovation, science, and industry, says the FSR has been instrumental in guiding the government's decisions on science and research. At an event announcing new grants awarded under the New Frontiers in Research Fund in January 2022, he suggested the government would continue to prioritize funding for science. "The investment that you've seen in the past is a good indication of the importance we give to science and research, and I would say [today's announcement] is a good down payment when it comes to our commitment to science and innovation and research in this country."

Even if the government is in fact placing less emphasis on the FSR as it develops its policies for science, the gaps the report highlighted around Canada's international competitiveness in science remain a major issue. Other countries, including the United States, the United Kingdom and China have all made significant new investments in fundamental science in the wake of the COVID-19 pandemic – investments that Canada, despite a boost in pandemic-related funding, has not been able to keep pace with. The U.K., for example, has pledged to increase spending on science by 35 per cent by 2026. And that will make it harder to attract and retain top scientific talent. "There is a global competition for talent," says Dr. Ono. "Our best and the brightest researchers have options. If we don't address the gaps in programmatic support and infrastructure support, we won't be competitive with other nations."

Addressing those gaps will require a plan, whatever form that might take. "Whether we use the FSR as a guide or not, it's clear that we need to invest in fundamental science," says Ms. Qaiser. "Others are doing so, and Canada risks falling behind." UA

Brian Owens is an award-winning science journalist and author based in New Brunswick.

Science ou politique

Si, lors des élections de 2015, Justin Trudeau et le Parti libéral ont activement courtisé la communauté scientifique laissée-pour-compte par le gouvernement conservateur, la science et la recherche n'ont pas été sous les projecteurs dans les campagnes électorales suivantes. « Lors de la dernière élection, personne n'a parlé de la recherche, constate Mme Grandvaux. Pas seulement pour sa valeur intrinsèque, mais aussi pour ses effets bénéfiques sur l'économie, une association que le gouvernement ne semble pas faire. »

Richard Cannings, député du Nouveau Parti démocratique de la circonscription Okanagan-Sud–Kootenay-Ouest et ancien porte-parole de son parti en matière de science, remarque également cette inaction. « La mise en œuvre du rapport Naylor semble au point mort depuis deux ou trois ans, affirme-t-il. C'est le silence radio du côté du gouvernement. »

En revanche, Santa Ono, recteur de l'Université de la Colombie-Britannique, affirme que le soutien du gouvernement à l'égard de la science ne se compte pas qu'en subventions accordées aux conseils subventionnaires de recherche. Pour lui, d'autres victoires ont été remportées par la communauté scientifique, comme l'engagement du gouvernement à promouvoir l'équité, la diversité et l'inclusion par l'entremise de la charte du programme Dimensions et le resserrement des nouveaux objectifs des Chaires de recherche du Canada. Il pense aussi que le soutien offert par le gouvernement aux étudiants et aux chercheurs pendant la pandémie était parmi les meilleurs au sein du G7.

« Je ne dirais pas que le gouvernement a abandonné la science. Il se penche sur d'autres programmes et investissements de première importance pour la qualité et l'inclusivité de la recherche canadienne, avance-t-il. Je pense qu'on ne montre pas assez de gratitude au gouvernement pour ce qu'il a fait. Le rapport Naylor est un legs de ce gouvernement. »

D'ailleurs, M. Ono souhaiterait que l'exercice se répète, idéalement sur une base régulière, pour pouvoir en suivre les retombées sur l'écosystème scientifique international. « Il faudrait produire ce rapport au moins tous les cinq ans, propose-t-il. C'est important de garder un œil sur nos progrès en tant que pays, sur la façon dont on investit dans les nouvelles générations de chercheurs, et sur comment on se positionne à l'échelle mondiale. »

Rien ne semble indiquer que le gouvernement veuille réitérer ce processus d'évaluation d'envergure, mais les députés pourraient bien trouver leur propre marge de manœuvre prochainement. Le Comité permanent de la science et de la recherche, un nouveau comité du Parlement présidé par l'ancienne ministre des Sciences, Kirsty Duncan, examinera « tous les dossiers qui concernent la science et la recherche ». D'après M. Cannings, qui siège lui aussi au Comité, le suivi du rapport Naylor devrait figurer au menu. « Pour notre premier projet, nous pourrions nous dire "faisons le point sur le rapport Naylor et ses avancées au fédéral", songe-t-il. Nous nous sommes donné du mal et avons discuté avec beaucoup d'experts dans le cadre de la réalisation de ce rapport, alors je pense qu'on devrait continuer de nous en occuper. »

François-Philippe Champagne, ministre de l'Innovation, des Sciences et de l'Industrie, considère que ce rapport a joué un rôle indispensable dans les décisions du gouvernement en matière de science et de recherche. En janvier 2022, à l'occasion d'une activité inaugurant les nouvelles bourses du Fonds Nouvelles frontières en recherche, il a laissé entendre que le gouvernement continuerait de faire des subventions de recherche une priorité. « Nos investissements passés témoignent de l'importance qu'on accorde à la science et à la recherche, et je dirais que [l'annonce de janvier] en est une belle preuve. »

Même si le gouvernement met moins l'accent sur le rapport Naylor parce qu'il progresse dans ses politiques en matière de science, le retard qu'accuse la recherche canadienne à l'échelle mondiale souligné dans le rapport reste un problème de taille. D'autres pays comme les États-Unis, le Royaume-Uni et la Chine ont récemment investi massivement dans la recherche fondamentale dans le sillage de la pandémie. Le Canada, lui, peine à rivaliser avec ces investissements, malgré ses investissements à l'égard des activités de recherche liées à la COVID-19. Le Royaume-Uni, par exemple, a promis une augmentation de 35 % de son budget pour la recherche d'ici 2026. Une initiative qui rendra plus difficile d'attirer et de retenir les scientifiques de talent. « Les pays s'arrachent les scientifiques sur la scène internationale, explique M. Ono. Nos meilleurs talents ont du choix. Si nous ne rattrapons pas le retard en matière de programmes de subventions et de projets d'infrastructure, nous ne resterons pas attractifs. »

Rattraper le retard demande une stratégie, quelle qu'elle soit. « Que le gouvernement se fie au rapport Naylor ou pas, il ne fait aucun doute qu'il doit investir dans la recherche fondamentale, conclut Farah Qaiser. C'est ce que font d'autres pays, et le Canada risque de perdre la course. » AU

Établi au Nouveau-Brunswick, Brian Owens est un journaliste scientifique qui a remporté de nombreux prix.

by Frances Bula

HOUS ING WANT ED

Universities are exploring ways to
build more student accommodations of all kinds
amid a worsening national crisis.

YVONNE KO'S ROOM on the University of British Columbia's campus in Vancouver is almost small enough that she can reach out and touch the walls on each side. The 120-square-foot space includes a bathroom, a fold-down bed that doubles as a desk, and a micro-kitchen.

That's fine by her. Ms. Ko, a film studies major originally from Toronto, is willing to trade off the smallness of what UBC calls its "nano-suites" for a lot of other things: only $750 a month for rent; a quick walk to all her classes and other university activities; and a building that has game rooms, lounges, a private garden that overlooks the campus, and a laundry room in the middle of all that (instead of being stuck in a basement somewhere).

"In a student residence, I felt more support. You have access to so many amenities," says Ms. Ko. She showed off the view of UBC's clock tower and new student gym from her window in the two-year-old Exchange Residence, as she talked about strategies for storing her belongings in a space that's smaller than some hotel rooms. (Lots of creative piling, plus plastic tote boxes.)

Ms. Ko isn't the only student who is enthusiastic about this new form of housing. There are dozens on a waitlist for one of these 71 apartments, says Andrew Parr, UBC's vice-president in charge of housing and community services. Post-occupancy surveys show that students have reacted positively to the small spaces, which went through an intensive design process in advance to make sure they provided what students wanted most. "One of the features that makes it work is the bed/desk combo," he says.

More nano-suites are being planned at UBC, and Ryerson University is looking to emulate them in its next student-residence project. They're just one of the many solutions that universities and colleges across Canada are looking at as they cope with a vise-like squeeze on places their prospective students can live – an aspect of postsecondary life that can weigh as heavily as grades, tuition or exams.

Universities and even some colleges are energetically exploring ways to build more student housing of all kinds, either by themselves or in partnership with private developers. Some are looking to use their existing land more creatively – for example, by building student housing right on top of new academic buildings – as Ryerson is doing. A few have even bought and converted hotels.

UBC is looking to increase its student beds from the current 12,000, the most of any university in Canada, to 17,300 by 2030. The University of Toronto has developed a specialized plan to provide more housing in any future developments by leveraging its considerable land assets. The aim is to significantly increase the current 8,400 beds, especially at its suburban campuses. The latest of many planned projects just broke ground this past December. "Four new residence projects currently underway aim to add more than 1,000 beds at the St. George campus and a further 750 new beds at the Scarborough campus in the next few years. New residences are also planned for the Mississauga campus," says Josh Mitchell, the university's managing director of real estate. "Under its 4 Corners Real Estate strategy, the university aims to add just over 4,000 units of university housing for students, faculty and staff over the next 10 to 15 years on its downtown campus alone to address high demand."

Even at Ryerson, an institution that has typically catered more to local students than to those from other parts Canada or other countries, there's pressure to provide more housing. "We continue to see an increase of students applying to live in residence," says Valerie Bruce, the director of student housing and community care at Ryerson. Until a few years ago, the university only had about 850 beds available for students. It now has 1,150, and more are in the works.

There will be pressure on many postsecondary institutions to do more. Although reliable statistics are hard to come by on how much housing affects student choices about where to go to school, intuitively many feel there's a connection. As well, the issue of student housing goes far beyond these institutions. It affects whole cities and many other residents living in them.

The private housing industry – along with at least one innovative non-profit in Quebec – is also getting more involved, after noticing big gaps in the Canadian market. Those gaps became very evident in the fall of 2021. Tens of thousands of students returned to in-person learning and discovered
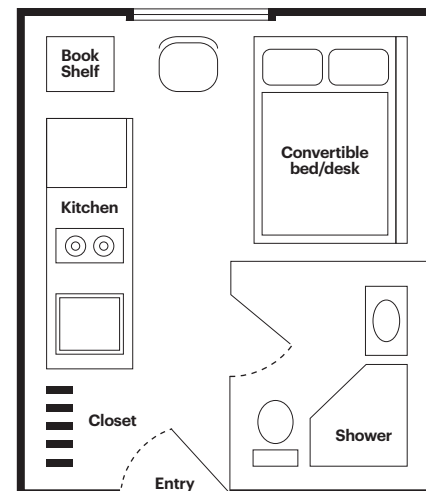
A floor plan of the University of British Columbia's nano-suites, which offer 140-square-foot of living space for $750 per month.

> "The census underestimates students and doesn't allow for a very clear identification of student housing needs. Students are invisible in housing data."

The nano-suites housed in the University of British Columbia's Exchange Residence (above) include a bed that converts into a desk to save space.

that it was tougher than ever to find a place to live, and universities were reducing their residence occupancies as part of COVID-19 precautions. From Halifax to Montreal, Toronto to Edmonton, and especially Vancouver and Victoria, there was a cascade of news stories documenting a start to the academic year in which students faced one of the most pronounced housing crunches on record. "This is something we are hearing more and more about in the last couple of years," says Bipin Kumar, the international student representative and deputy chair for the national graduate students' office at the Canadian Federation of Students (CFS).

A country-wide crisis

It may feel like a local crisis to each city and town with a regular influx of students every year. But the numbers show that it's a national one, related to a few basic statistics that underlie all the individual and regional stories.

The numbers that matter are, first, how much universities have come to rely on tuition and, by extension, high-paying international students in order to meet their budgets, as government funding has lagged behind costs. The second is what that has meant in terms of the numbers of international students that Canadian university cities have been trying to absorb. A 2020 Statistics Canada report outlined those two driving forces clearly. "Previous analysis has shown that the reliance of universities on tuition as a revenue source has grown over the past decade and that international students, who pay substantially higher tuition than domestic students, are an important element of this growth, contributing an estimated 40 per cent of all tuition fees and accounting for almost $4 billion in annual revenue for Canadian universities in 2018/2019," it says.

The report, along with previous ones from StatsCan, show that the number of international students in some provinces tripled in the decade since the 2008/09 academic year, and almost doubled from 2015 to 2020. They now account for almost all of the enrolment growth happening at Canadian universities. International student enrollment in Ontario grew from about 96,000 to almost 193,000 in those five years. In B.C., the province with the next-highest increase, it went from 45,000 to almost 71,000.

> "What we've seen in Quebec and other places was that higher education was forced to step away from housing because of the other financial constraints. And housing agencies just forgot about student demand."

Many of those students ended up going to cities that already had noticeable problems with low vacancy rates and housing shortages. The rising influx can have a big impact on a city through a "studentification," as researchers have labelled it, of key neighbourhoods. "Students look for modestly priced housing, so it displaces lower-income folks," says housing consultant Steve Pomeroy, who has done studies for universities on the economics of student housing and the need for additional supply.

Unlike their domestic counterparts, very few international students have families they can bunk with while going to school. Data from Utile, a Quebec non-profit that researches student-housing issues, show that 60 to 70 per cent of Canadian students end up being tenants. But among international students, it's 100 per cent. Mr. Kumar, from CFS, says he doesn't believe that international students have made the housing problems that much worse than they already were in several cities that had extremely low vacancy rates. But their difficulties in finding apartments are much more acute, because they are often asked by landlords to provide local references or income guarantees that are more of a hurdle for them than for students who are Canadian residents.

Missing data

Even though Canada has become increasingly obsessed with housing issues, somehow student housing has gone under the radar in spite of the undercurrents reshaping the issue, says Utile co-founder and executive director Laurent Levesque. "The census underestimates students and doesn't allow for a very clear identification of student housing needs. Students are invisible in housing data," he says. "So it's been hard to advocate for an issue when there has been no hard student information."

That's changing, as more people start to pay attention to the issue. A Canadian Imperial Bank of Commerce report in 2019 said the Canada Mortgage and Housing Corporation has consistently miscalculated the state of student housing – missing the need for 300,000 more homes to keep up with student demand. The small but growing group of companies looking at private investment in student housing makes the same point. "There is an acute shortage of student housing across Canada," says Derek Lobo, the CEO of SVN Rock Advisors, a company that specializes in marrying private developers of student housing with institutions that need more of it.

There are only 120,000 student beds on campuses across the country and only about 40,000 purpose-built student beds off-campus (20,000 of them in Kitchener-Waterloo, Ont.), Mr. Lobo says; a far lower proportion than other countries that are popular with international students. His company's numbers are matched by those at Alignvest Student Housing REIT, which has found that there are only enough student beds in Canada for about three per cent of the total student population, compared to the 20 or 30 per cent in the United Kingdom and the United States. According to data from Utile, about 1.3 million of Canada's 1.5 million students are in the private rental market.

Both Mr. Lobo and Trish MacPherson, a partner at Alignvest, say the international-student phenomenon doesn't just impact larger cities. "Most people think that international students go to big universities. But they go to where they can get in," says Mr. Lobo. That's why in Prince Edward Island, for example, almost 30 per cent of all students are international and they're feeling the housing pinch too. It's also why Alignvest is looking at building in markets like Hamilton, Ont., and Oshawa, Ont., not just Toronto.

Part of the problem is that there hasn't been a lot of activity by private developers of student housing. "It's a sector that is still in its infancy in Canada," says Brian Flood, a vice-president with Cushman & Wakefield, which just produced a report on the subject. "But the level of investor interest in the sector is very strong."

They have come to the realization quickly, as have many other analysts, that student housing is the one type of low-cost housing that can be profitable. While housing groups and developers have agreed that it's pretty near impossible to build low-cost housing for the general public without some kind of subsidy, the equation is different for student housing.

Students, knowing they are staying a few years at most, are willing to live with less space than someone looking to rent an apartment for perhaps the rest of their life. As well, rents in student housing can be adjusted upwards regularly because tenants move out on a regular basis. Again, that's a contrast to long-term resident housing, since rent controls in many provinces cap how much of an increase an existing tenant can be asked to pay each year.

The Cushman & Wakefield report suggests that student housing can have strong profit potential, with expenses averaging about 35 per cent of a potential revenue stream. "[It can] provide higher potential rental growth as units turn over more frequently. Rental rates achieved at student residence complexes also often exceed market rents for similar traditional apartment units," the report concludes.

For-profit vs. non-profit

But Mr. Lobo says universities need to be careful before they plunge willy-nilly into building hundreds of beds. They need to understand where their students are coming from and what their tastes might be. "Student housing is not a programmatic business. It's a boutique business," he advises. Don't build if the vast majority of students are local commuters, coming from their parents' homes. Make sure you have access to the one thing students value most – a location close to campus. "We say you've got to be able to walk to school with less than three songs on your iPhone," says Alignvest's Ms. MacPherson. Amenities are also a big deal in student housing, so pay attention to the types of students you are catering to. If there are a lot of design students, provide good lighting and access to studio space. Most of all, be aware that the trend is away from dorms, the six-bedrooms-around-a-common-living-space format, away from even two-person residence rooms with the toilet and shower down the hall. Instead, there's a steady move towards one bathroom per bedroom.

Mr. Lobo's word of the day to universities is not to try to do everything themselves. "You're not going to solve your problem without help from the private sector."

The Rose des vents building in Montreal is the work of Quebec-based non-profit Utile, which bills itself as "the future of affordable student housing."

But Utile, the Quebec non-profit, makes a different argument. Because student housing can actually break even, it's something that universities and non-profits should be taking on, rather than just private developers, says Mr. Levesque. "This model doesn't require as much funding as traditional social housing. You can develop affordable housing for free if you get university land," he says.

The non-profit, which was started in 2012 by a group of students concerned about the growing student-housing problems in Montreal, completed its first pilot development in 2020. The $18 million project was paid for in part by leveraging a contribution from the Concordia University student union, which was funded through student fees. Mr. Levesque is the first to admit it wasn't easy, because the concept and the group implementing it – former students from various Quebec universities – were new to the industry. But now, he says, the banks are on board and Utile gets considerable support from Canada Mortgage and Housing Corporation programs. It provided $3 million in 2019 to support Utile's early efforts and, in June 2021, announced another $20 million as a loan to the group.

Utile's Woodnote building in Montreal has 90 apartments that can house 144 students, who pay between 10 and 30 per cent below the market rate. Studios that are 300 square feet go for $740 a month. The group now has a second project underway in Montreal's Rosemont neighbourhood, and it has bought land in Trois Rivieres, Que., and Quebec City. It's also fielding calls from smaller communities that are also dealing with shortages of student housing.

"What we've seen in Quebec and other places was that higher education was forced to step away from housing because of the other financial constraints. And housing agencies just forgot about student demand," says Mr. Levesque. "But once we demonstrated that it's possible, the floodgates have opened." UA

Frances Bula is a Vancouver-based journalist specializing in urban issues and city politics.

ÉTUDIANT CHERCHE LOGEMENT

L'actuelle crise nationale pousse les universités à faire preuve de créativité pour loger leurs étudiants.

par Frances Bula

LA CHAMBRE D'YVONNE KO, située sur le campus de Vancouver de l'Université de la Colombie-Britannique, est si exiguë qu'il lui suffirait presque d'écarter les bras pour en toucher les murs opposés. Cet espace de 120 pieds carrés comprend une salle de bain, un lit escamotable qui lui sert aussi de bureau, et une minicuisine.

Mᵐᵉ Ko ne s'en plaint pas. Venue de Toronto pour étudier le cinéma, elle est prête à vivre dans un « nanoappartement », tant qu'elle en tire des avantages : seulement 750 dollars de loyer par mois, les cours et autres activités à quelques minutes à pied, et un immeuble doté de salles de jeux et de détente, d'un jardin privé avec vue sur le campus et même d'une buanderie. « En logeant dans une résidence étudiante, je me suis sentie davantage soutenue. On a accès à tellement de services », explique-t-elle.

Mᵐᵉ Ko n'est pas la seule étudiante à y voir une aubaine. En effet, des dizaines d'autres figurent sur la liste d'attente pour obtenir l'un de ces 71 appartements, raconte Andrew Parr, vice-président responsable du logement et des services à la communauté à l'Université de la Colombie-Britannique.

L'Université prévoit créer d'autres nanoappartements et l'Université Ryerson voudrait s'en inspirer pour son prochain projet de résidence étudiante. Ce n'est qu'une des nombreuses solutions envisagées par les universités et les collèges du pays pour pallier le manque de logements qui prend les étudiants en étau.

Ayant observé les carences du marché canadien, le secteur privé de l'immobilier – ainsi qu'au moins une organisation à but non lucratif québécoise novatrice – s'implique de plus en plus. À l'automne 2021, le manque de logements s'est particulièrement fait ressentir. Des dizaines de milliers d'étudiants sont retournés sur les campus et se sont heurtés à la très grande difficulté de se trouver un logement. Une réalité aggravée par les restrictions sanitaires qui ont poussé les universités à réduire leur nombre de lits disponibles. « Nous en entendons parler de plus en plus souvent depuis deux ans », témoigne Bipin Kumar, représentant des étudiants étrangers et vice-président du conseil d'administration du bureau national des étudiants des cycles supérieurs de la Fédération canadienne des étudiantes et étudiants (FCEE).

Une crise d'envergure nationale

Les villes qui accueillent des étudiants chaque année pourraient croire qu'il s'agit d'un problème local, mais les statistiques montrent que la crise du logement touche le pays dans son ensemble et que ces situations reposent sur quelques facteurs de base.

Le premier facteur important, c'est la somme que doivent générer les droits de scolarité, et par extension les étudiants étrangers qui paient plus cher, pour que les universités puissent atteindre leurs objectifs budgétaires lorsque les subventions gouvernementales ne suffisent plus. Le deuxième facteur est le nombre d'étudiants étrangers que les villes universitaires canadiennes tentent d'attirer pour atteindre ces objectifs. Un rapport de Statistique Canada publié en 2020 met ces deux facteurs en exergue. « L'analyse précédente a révélé que le recours des universités aux droits de scolarité comme source de revenus s'est accru au cours des 10 dernières années et que les étudiants étrangers, qui paient des droits de scolarité beaucoup plus élevés que les étudiants canadiens, sont un élément important de cette croissance. Les étudiants étrangers ont en effet contribué à une proportion approximative de 40 % de tous les droits de scolarité et ont généré près de 4 milliards de dollars de recettes annuelles pour les universités canadiennes en 2018-2019 », peut-on y lire.

À l'instar de rapports antérieurs de Statistique Canada, celui-ci montre que le nombre d'étudiants étrangers a dans certaines provinces doublé entre 2015 et 2020 et triplé depuis 2008. Dans les universités canadiennes, ces derniers sont maintenant responsables de l'essentiel de l'augmentation des inscriptions.

Dans certains quartiers, cette arrivée massive peut avoir des répercussions de taille, que les experts appellent « l'étudiantification ». « Les étudiants cherchent des logements abordables, ce qui pousse les foyers modestes à chercher ailleurs », explique Steve Pomeroy, un expert-conseil en immobilier qui a enquêté pour le compte d'universités sur l'économie du logement étudiant et les besoins croissants en la matière.

Données manquantes

D'après Laurent Levesque, cofondateur et directeur général d'Utile, une organisation à but non lucratif québécoise qui s'intéresse à cet enjeu, le problème des logements étudiants est méconnu, et ce, malgré tout le bruit qu'engendre la crise de l'immobilier. « Les résultats du recensement ne représentent pas assez bien les étudiants ni leurs besoins. Les données sur le logement ne tiennent pas compte des étudiants, soutient-il. C'est difficile de faire des progrès sur la question sans données fiables. »

Les investisseurs, tout comme de nombreux analystes, n'ont pas mis longtemps à se rendre compte qu'il s'agit du seul type de logement à bas prix qui peut s'avérer rentable. D'après les données d'Utile, environ 1,3 des 1,5 million d'étudiants canadiens se logent grâce au marché locatif privé. Puisqu'ils ne s'engagent qu'à court terme, les étudiants sont prêts à vivre dans des appartements d'une taille qui n'intéresserait pas un locataire à vie. Ce roulement permet donc de revoir régulièrement les loyers à la hausse, un avantage de plus par rapport aux logements à long terme, dont les augmentations annuelles de loyer sont plafonnées dans plusieurs provinces.

Le lucratif face au non lucratif

Toutefois, Derek Lobo, président-directeur général de SVN Rock Advisors, pense que les universités doivent faire preuve de prudence avant de se lancer à plein régime dans la construction à grande échelle. Elles doivent comprendre d'où viennent leurs étudiants et ce qui les intéresse. « En logement étudiant, l'idée n'est pas de ratisser large, mais de satisfaire une clientèle qu'on connaît », explique-t-il. « La règle d'or, c'est qu'un étudiant doit pouvoir arriver en classe en moins de trois chansons sur son iPhone », conseille Trish MacPherson, associée de la société de placement immobilier Alignvest Student Housing REIT. Avant tout, n'oubliez pas que la tendance n'est plus aux logements de type « six chambres et un espace commun », ni même aux duos de chambres avec salles de bain au bout du couloir. Maintenant, de plus en plus d'étudiants veulent des salles de bain individuelles.

Le conseil de M. Lobo aux universités, c'est de ne pas essayer de tout faire soi-même. « Vous ne résoudrez pas votre problème sans l'aide du secteur privé. »

Actuellement en construction, le deuxième projet d'Utile, soit un édifice nommé Rose des vents comptant 123 studios, devrait accueillir ses premiers locataires au cours de l'été 2022.

L'organisation québécoise Utile n'est pas du même avis. Selon M. Levesque, comme les logements étudiants sont potentiellement rentables, les universités et les organisations à but non lucratif devraient s'en saisir plutôt que de laisser le secteur aux promoteurs privés. « Ce modèle demande moins d'investissements que les logements abordables traditionnels. Il est possible de construire des logements abordables à peu de frais si le terrain appartient à l'université », affirme-t-il.

Son organisation, fondée en 2012 par un groupe d'étudiants inquiets quant aux problèmes grandissants du logement étudiant à Montréal, a terminé son premier projet pilote de construction en 2020. Les 18 millions de dollars nécessaires au projet sont partiellement provenus du syndicat étudiant de l'Université Concordia, dont les fonds découlent des droits de scolarité. M. Levesque est le premier à dire que c'était difficile, car le concept et le groupe responsable du projet, des anciens étudiants d'universités québécoises, étaient nouveaux dans le milieu. Les banques se sont désormais engagées et Utile bénéficie d'un soutien considérable grâce aux programmes de la Société canadienne d'hypothèques et de logement. Cette dernière leur a offert 3 millions de dollars en 2019 pour les aider à lancer le projet et a annoncé un prêt de 20 millions de dollars en 2021.

Nommé la Note des bois, le bâtiment construit par Utile à Montréal peut accueillir 144 étudiants dans un total de 90 appartements. Ses studios de 300 pieds carrés coûtent 740 dollars par mois, soit un loyer de 10 à 30 % moins cher que le prix du marché. Utile travaille sur un deuxième projet, cette fois dans le quartier Rosemont, et a déjà acheté un terrain à Trois-Rivières et à Québec.

« Des exemples au Québec et ailleurs montrent que les établissements d'enseignement supérieur ont dû se retirer du marché à cause d'autres contraintes financières. Les agences privées, elles, ont simplement fait fi des besoins des étudiants, analyse M. Levesque. En montrant que c'était possible, on a ouvert les vannes. » AU

Établie à Vancouver, Frances Bula est une journaliste qui se spécialise dans la couverture des enjeux urbains et de la politique municipale.

CHECK YOUR

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AT THE DOOR

Excerpt by
Sarah Elaine Eaton

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When addressing student plagiarism, it is easy to react emotionally, but as educators we need to keep a growth mindset even when we find ourselves in ethically challenging situations. **Photography by** Paul Weeks

THE ISSUE OF ACADEMIC INTEGRITY has been on the mind of Sarah Elaine Eaton ever since, as a sessional instructor at the University of Calgary, she was asked to help prepare an internal report on the subject for the then vice-provost of teaching and learning. She quickly discovered there wasn't a lot of research being done in Canada on academic integrity. So when she received tenure, she decided this would be one of her areas of research. In 2021, she published Plagiarism in Higher Education: Tackling Tough Topics in Academic Integrity. "The book is for faculty members, higher education professionals who work in student affairs, librarians, policymakers, basically anyone who works in higher education," she says. "We need to stop demonizing students. Addressing academic integrity requires a multi-stakeholder approach. We're all in this together. Students have responsibilities, but so do educators and administrators."

Through her research, Dr. Eaton found that students often shoulder most of the blame in circumstances involving breaches of academic integrity. However, in many situations, students are often uninformed or misinformed about what exactly constitutes plagiarism. She would like to see more training for faculty on how to accurately identify plagiarism as well as how to explain it to students, so that they can do their best to avoid it. "Just about every academic out there encounters academic misconduct at some point in their career, and knowing how to address it would be really helpful before it happens."

Dr. Eaton says university teaching and learning centres are starting to provide more professional development for academics, which is helpful because she has found that most academics generally learned how to deal with issues of academic integrity from those who taught them. This in turn can lead to preconceived ideas about plagiarism, instead of approaching situations with a growth mindset.

She highlights this idea in the following excerpt, provides advice on identifying any personal biases faculty might have clouding their judgment, and offers tips on how educators can recognize when a student has plagiarized. – TARA SIEBARTH
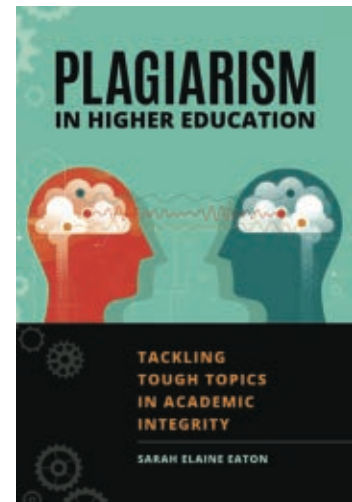
Plagiarism in Higher Education: Tackling Tough Topics in Academic Integrity was released in March 2021.

Maintaining an educator's mindset

As educators, we are often situated within departments, which are nested within faculties that comprise the larger learning organization. Educators might appear to work in insolation but are in fact part of a larger system, which exists, at least in part, to teach and provide learning opportunities. Identifying and dealing with plagiarism and other forms of academic misconduct are related to institutional mandates of upholding quality assurance in education, but we cannot disentangle misconduct from the teaching and learning contexts in which it happens.

Many educators espouse the notion of a growth mindset or the belief behind the growth mindset is that "intelligence is not fixed and can be developed." Carol Dweck, a leading scholar in this area, defines it this way: Individuals who believe their talents can be developed (through hard work, good strategies, and input from others) have a growth mindset. They tend to achieve more than those with a more fixed mindset (those who believe their talents are innate gifts). This is because they worry less about looking smart and they put more energy into learning. Many educators find this approach to be a positive and productive way to approach learning. They will carefully invest time and energy in learning how to cultivate a growth mindset in their learners and promote this approach in their classrooms, only to throw the entire belief system out the window when they encounter a case of plagiarism or other academic misconduct. There have been a number of studies about faculty perceptions of plagiarism and responses to it, but there has been less research examining educators' emotional and psychological responses to plagiarism. The reality is that educators react in emotional ways when they suspect or confirm a case of student plagiarism. It can be confusing, frustrating, and disappointing to realize that a student has plagiarized. Finding a case of plagiarism need not disrupt the belief systems that have guided an educator's entire professional practice. If you are an educator who subscribes to the notion of the growth mindset, it can be helpful to keep that at the forefront of your mind as you find yourself confronted with the complexities of plagiarism or other breaches of integrity. It is crucial to avoid a mindset of "Gotcha!", also known as being the "plagiarism police" or pursuing a witch hunt. It is imperative for educators who suspect or can prove plagiarism to resist a knee-jerk reaction to judge students as being morally corrupt or guilty. It is problematic if we trade our identity as an educator for that of an enforcer, discarding all the aspirational elements of teaching and learning that brought us to the profession in the first place. Do not bypass due process and proceed directly to judgment. Instead, focus on understanding what happened, how it happened, and why it happened before jumping to conclusions. Keep your growth mindset even when you find yourself in ethically challenging situations.

> "It is problematic if we trade our identity as an educator for that of an enforcer, discarding all the aspirational elements of teaching and learning that brought us to the profession in the first place."

Checking our biases

We often ask our students to engage their critical thinking skills, and it is incumbent upon us, as educators, administrators, and support staff, to lead by example and do the same. This starts with being aware of the cognitive biases that we bring to our work, and then take steps to mitigate them. When students plagiarize, professors and others can see this as a blatant disregard for educational expectations and norms and assume that all plagiarism is deliberate, even if that is not the case. Academics can be susceptible to a number of biases when it comes to academic misconduct:

Confirmation bias

This is the tendency for people, including trained scientists, to look more favorably at evidence that confirms their already established point of view. Confirmation bias could lead someone to insist that students who plagiarize do so intentionally, or because they are lazy. Although this may be true in some cases, there is ample research to support that this is not the norm.

Anchoring bias

Anchoring bias, also called "focalism," occurs when someone relies heavily on an initial piece of information to make a judgment, a decision, or a conclusion that may be inaccurate. For example, a professor could erroneously conclude that students who plagiarize do so intentionally, based on an institutional report about academic misconduct that presents information about plagiarism cases and how they were dealt with. Institutional reports can provide important information to understand patterns of how academic misconduct is reported and how cases are dealt with through official institutional channels, but they often omit important information. For example, they do not summarize research findings showing that a high percentage of academic misconduct cases, including plagiarism, are not officially reported and that faculty members tend to bypass formal policies and guidelines in favor of dealing with plagiarism directly with students. Even though institutional reports may present accurate information about the cases handled through official channels, they may still be incomplete in terms of presenting accurate information about actual rates of incidence or reasons why plagiarism has occurred.

Self-serving bias

Self-serving bias can lead people to conclude that when good things happen, it is because they did things correctly and they are responsible for their own success (internal attribution), but bad things happen as the result of external factors (external attribution). With regard to plagiarism, self-serving bias could lead a professor to conclude that a student plagiarized because she or he was lazy or deceitful, without taking into account whether the professor provided clear expectations about how to cite references, or where to seek additional guidance. Further, self-serving bias can lead professors to absolve themselves of any responsibility for students' plagiarism, despite ample evidence showing that explicit instruction can help students understand the expectations for how to undertake the assignment.

Bias blind spot

The bias blind spot phenomenon suggests that individuals see biases as applying to others but not to themselves. In the case of plagiarism, it could lead someone to think that his or her conclusions about why students plagiarize are unbiased and objective, whereas other people's ideas are flawed. It is imperative that those of us who work in education check our biases and refrain from generalizing about why students plagiarize, and even more important to check our assumption that all plagiarism is deliberate. This applies even when we are frustrated or exasperated because we must, as higher education professionals, lead by example and base our understanding on evidence, rather than basing our assumptions on emotional responses or opinions.

Recognizing plagiarism

The process of identifying plagiarism is often called "detection," but this term is problematic because it conjures up notions of the teacher as a detective, which brings with it connotations of policing student work. In turn, this propagates the kind of moral binaries and adversarial relationships between students and teachers that we need to avoid. The words that we use to talk about academic integrity and its breaches matter enormously. For this reason, I prefer "identify" or "recognize" instead of "detect," to avoid subtle underlying connotations of "Gotcha!" or assumptions of guilt. Identifying and recognizing are more neutral terms that can facilitate a growth mindset, rather than a punitive one. There are two main ways that a potential case of plagiarism can be identified: by humans and by software. I say "potential case" because identifying plagiarism is a process rather than a singular moment, and it involves careful analysis, not jumping to a conclusion. Here, I explore several common methods used by educators to recognize plagiarism in student work. I use the term "educator" here inclusively to refer to professors, TAs, librarians, and others who might engage with students and their academic work.

Educator identification of plagiarism

Identifying plagiarism often begins with a hunch or a suspicion that something is not right. When an educator asks if the work that they are reviewing was really created by the person who submitted it, this can be the first sign that something is not right. Educators should trust their instincts and use the hunch as an awareness tool to determine if a deeper investigation is warranted. If something does not seem right with a student's work, do not ignore it or make assumptions about what happened. Trust that as the educator, you are the person who is most likely to be able to identify if academic misconduct has happened, because you are the person most closely connected to the student and the course content. Here are some telltale signs to help you recognize plagiarism in student work:

- **Abrupt changes in tone or style:** Whether it is prose, design, music, art, or computer code, sudden shifts in tone or style can signal that different individuals were involved in the creation of the work. If parts of the work are poorly written, especially the introduction and conclusion, and the rest is flawless, it could be that the student did not write the majority of the work.
- **Changes in font type or colour:** If the font changes abruptly in a paper, it can signal that that portion of the work might have been lifted from somewhere else.
- **Obscure vocabulary or jargon:** The use of specialized professional or technical jargon that the student might not reasonably be expected to know can be a sign of plagiarism, as can the use of archaic words that have fallen out of use.
- **Citing and referencing errors and mixed bibliographic styles:** It is quite common for students to copy citations directly from the source material and paste them into their work. I encourage approaching this particular sign with some caution, as sometimes students who lack confidence in or knowledge of citing and referencing trust that whoever wrote or signed off on the source material likely knew the rules better than them. This can be an indicator that the student's intentions were honorable, but their skills or confidence need more work.

These are just a few ways that educators can recognize plagiarism in students' work, but this list is by no means exhaustive. Recognizing and then confirming plagiarism in student work can involve careful analysis on the part of the educator. **UA**

This is an excerpt from Plagiarism in Higher Education: Tackling Tough Topics in Academic Integrity (ABC-CLIO, March 2021). It has been edited and condensed for length and has been republished with permission.

Sarah Elaine Eaton is associate professor at the University of Calgary, where she also serves as the university's inaugural educational leader in residence, academic integrity.

LAISSEZ VOS BIAIS À LA PORTE

Extrait par
Sarah Elaine Eaton

Face au plagiat étudiant, les émotions peuvent rapidement prendre le dessus, mais en tant que professeurs, il faut chercher à faire grandir les étudiants, et ce, même en situation de manquement à l'éthique.

ALORS QUE SARAH ELAINE EATON était chargée de cours, l'ancien vice-recteur à l'enseignement et à l'apprentissage de l'Université de Calgary lui a demandé de participer à la rédaction d'un rapport interne sur l'intégrité universitaire, depuis, le sujet la hante. Rapidement, elle a constaté que peu d'études avaient porté sur la question au Canada. Une fois son titre de professeure agrégée en poche, elle en a donc fait l'un de ses domaines de recherche. En 2021, elle a publié l'ouvrage *Plagiarism in Higher Education: Tackling Tough Topics in Academic Integrity*. « Le livre s'adresse aux professeurs, aux professionnels des universités qui travaillent auprès des étudiants, aux bibliothécaires, aux décideurs ou à quiconque travaillant dans le milieu de l'enseignement supérieur, affirme-t-elle. Il faut arrêter de diaboliser les étudiants. Pour aborder de front la question de l'intégrité universitaire, il faut adopter une approche transversale. Nous avons tous un rôle à jouer. Les étudiants ont certes une part de responsabilités, mais il en va de même pour les professeurs et les administrateurs. »

Mme Eaton est d'avis que les professeurs devraient être davantage formés quant aux manières de repérer le plagiat et de l'expliquer aux étudiants afin qu'ils puissent l'éviter. « Tous les professeurs sont confrontés à des manquements à l'intégrité universitaire tôt ou tard dans leur carrière, et être bien outillés pour traiter le problème avant qu'il n'arrive leur sera grandement utile. »

Elle précise que les services de soutien à l'enseignement et à l'apprentissage dans les universités commencent à offrir davantage de formation continue aux professeurs. Ce qui s'avère utile, car ses recherches démontrent que la plupart d'entre eux ont appris à gérer les cas de plagiat de leurs propres professeurs. Ce qui peut perpétuer des idées préconçues sur le plagiat plutôt que d'inciter les professeurs à adopter une approche constructive.

En plus de mettre en relief cette idée dans l'extrait qui suit, Mme Eaton offre des conseils aux professeurs pour cerner les biais susceptibles de teinter leur jugement et reconnaître le plagiat.– TARA SIEBARTH

En tant qu'éducateurs, nous travaillons souvent au sein de départements, qui eux font partie de facultés qui forment une organisation vouée à l'éducation. Le fait de repérer et de s'occuper des cas de plagiat et des autres inconduites universitaires s'inscrit dans le mandat institutionnel consistant à garantir la qualité de l'éducation offerte, il est cependant impossible d'extraire les cas d'inconduite du contexte d'enseignement et d'apprentissage dans lequel ils surviennent.

De nombreux éducateurs mettent la croissance des étudiants au premier plan, une idée selon laquelle « l'intelligence peut être développée ». Carol Dweck, experte du domaine, la décrit ainsi : les personnes convaincues de pouvoir développer leurs talents (par le travail appliqué, les bonnes stratégies et l'aide des autres) sont orientées vers la croissance. Elles réussissent généralement mieux que celles qui pensent que le talent est inné, car elles se soucient moins des apparences que de l'énergie qu'elles investissent dans leur apprentissage. Plusieurs éducateurs consacrent du temps et de l'énergie à comprendre comment cultiver cet esprit de « croissance » chez leurs étudiants et à la favoriser dans leurs cours. Une conviction qui finit toutefois à la poubelle dès qu'ils sont confrontés à un cas de plagiat ou d'inconduite universitaire. S'il est vrai qu'il peut être déroutant, frustrant et décevant de réaliser qu'un étudiant a commis cette faute, il faut absolument résister à cette réaction instinctive qui pousse à juger l'étudiant coupable ou immoral. En échangeant notre rôle pour celui du bourreau, nous rejetons tous les principes fondamentaux de l'enseignement qui nous ont inspirés à choisir ce métier. Demandez-vous d'abord ce qui est arrivé, comment c'est arrivé, et pourquoi c'est arrivé.

Connaître nos biais

On demande souvent à nos étudiants de faire appel à leur sens critique. Il est donc normal d'en attendre autant des professeurs, de l'administration et du personnel de soutien, qui doivent tous montrer l'exemple. Cette réflexion commence par une prise de conscience par rapport à nos biais cognitifs et par l'adoption de mesures pour les atténuer. Les professeurs et les autres membres du milieu universitaire peuvent voir le plagiat d'un étudiant comme un manque de respect flagrant envers les attentes liées à l'enseignement et les règles, et conclure hâtivement qu'il est délibéré. Lorsqu'il est question de ce genre d'inconduites, leur jugement peut être influencé par un certain nombre de biais tels que :

Biais de confirmation

Il s'agit d'une tendance à se concentrer sur les éléments qui confirment les préjugés. Le biais de confirmation nous amène parfois à insister sur le caractère intentionnel des cas de plagiat ou de tenir pour acquis que l'étudiant impliqué est fainéant. Ils le sont parfois, mais de nombreuses études montrent que ce n'est pas la norme.

Biais d'ancrage

Aussi appelé « focalisme », il décrit le phénomène selon lequel une personne base l'essentiel d'une décision ou d'une conclusion (potentiellement erronées) sur un premier renseignement partiel. Par exemple, un professeur pourrait conclure par erreur que les étudiants qui commettent du plagiat le font intentionnellement sur la simple base d'un rapport institutionnel faisant état d'exemples de plagiat. Ces rapports aident à comprendre comment ces cas sont officiellement signalés et traités sur le plan institutionnel, mais omettent souvent des renseignements importants. Par exemple, ils ne mentionnent pas les études montrant qu'une grande proportion de professeurs ignorent les politiques et procédures officielles et règlent les cas d'incoduite et de plagiat directement avec l'étudiant. De plus, même si les rapports institutionnels présentent des renseignements précis sur les cas traités dans les règles, ils n'en offrent pas toujours sur la fréquence des cas ni sur les raisons poussant les étudiants à plagier.

Biais d'autocomplaisance

Ce biais nous amène parfois à nous attribuer les mérites des événements positifs et de nos réussites (attribution interne) et à blâmer des facteurs externes pour les échecs (attribution externe). Par exemple, un professeur pourrait juger qu'un étudiant est coupable de plagiat parce qu'il est fainéant ou tricheur, sans se demander s'il a lui-même été clair sur la manière de citer les sources ou de trouver des explications. Parfois, le biais d'autocomplaisance pousse des professeurs à se dédouaner eux-mêmes de leurs responsabilités dans les cas de plagiat, et ce, même si les données démontrent que plus les consignes sont claires, mieux les étudiants peuvent cerner les attentes.

Biais de l'angle mort

Ce biais se manifeste par une tendance à croire que la vision subjective n'appartient qu'aux autres. Dans un cas de plagiat, un professeur pourrait croire que son jugement est parfaitement objectif, mais que celui des autres est subjectif. Quand on travaille en enseignement, on doit impérativement faire attention aux biais et éviter les généralisations sur le plagiat, surtout l'idée selon laquelle il est toujours délibéré. Nous devons faire cet effort malgré la frustration et l'exaspération, car en tant que professionnels de l'enseignement supérieur, nous devons donner l'exemple et nous en tenir aux faits plutôt que de nous laisser guider par nos émotions. AU

Ce texte est un extrait de Plagiarism in Higher Education: Tackling Tough Topics in Academic Integrity (*ABC-CLIO, mars 2021*). *Il a été modifié, raccourci et publié avec les autorisations requises.*

Sarah Elaine Eaton est professeure agrégée et première leader de l'intégrité universitaire en résidence à l'Université de Calgary.

Nota bene

By forcing them to move everything online, the pandemic has made Canadian universities more attractive targets for cyberattacks.

Cybersecurity

Cyberattacks: no need to panic, but...

Whether they like it or not, Canadian universities will have to address the issue of cybersecurity – before it's too late

ARE CANADIAN UNIVERSITIES vulnerable to cyberattacks? Not according to them. Unless regular operations are affected, very few postsecondary institutions report being victims of cybercrime. Case in point: when a major security flaw was discovered in December 2021, it wasn't until the Quebec government demanded that all exposed sites, services and systems shut down as a "preventative measure" that many Quebec universities acknowledged it. The Université de Montréal's

reponse was similar when it was the subject of a global ransomeware attack a few years ago.

This relative radio silence gives the impression that public institutions like universities are immune to cyberthreats. But experts consulted by University Affairs say the reality is likely quite different. "The little data we have comes largely from British cybersecurity centre reports, which show just how vulnerable universities are to these very real threats," said Benoît Dupont, a

professor in Université de Montréal's school of criminology and Canada Research Chair in cybersecurity.

Jisc, a U.K.-based organization whose mission is to digitally empower the country's higher education institutions, conducts a survey every year to see where things stand. The most recent results, published in November 2021, found that approximately 60 per cent of the 166 colleges and universities surveyed had reported a cyberattack in the previous 12 months. The survey also found a huge increase in ransomware attacks in the higher education sector.

The COVID-19 pandemic has contributed to this phenomenon. The public health crisis forced Canadian universities to move everything online. Their IT infrastructure became a ➔

lifeline almost overnight, making them more attractive targets. "The risk of cyberattack was high before March 2020 and it's just as high now. The COVID curveball has made the university community aware of its own vulnerability and the importance of developing responsible digital behaviour," explained Mohammad Mannan, associate professor at Concordia University's Institute for Information Systems Engineering.

"This culture of openness and transparency is vastly different compared to private sector businesses."

Another challenge is that institutions have to balance security concerns with their mission. Practices rooted in academic freedom mean larger networks that are by nature more exposed. "This culture of openness and transparency is vastly different compared to private sector businesses," said Nora Boulahia Cuppens, a professor in the department of computer engineering and software engineering at Polytechnique Montréal. She believes we have to stop thinking of cybercriminals as scammers hiding behind their keyboards. "Cybercrime can also be an inside job."

A danger among us

Now more than ever, research relies on national and international partnerships between a multitude of stakeholders, including researchers, organizations and research centres. But would-be attackers could be hiding under the guise of collaboration. That's why the Canadian government took action in March 2021 by introducing National Security Guidelines for Research Partnerships "to protect Canadian research and intellectual property against foreign interference, espionage and theft."

Going forward, applications for funding under the Alliance grant program administered by the Natural Sciences and Engineering Research Council of Canada (NSERC) for research partnerships involving one or more private-sector organization must also include a risk assessment. "Projects that are deemed high risk, or where the risk cannot be mitigated, will not be funded," Minister of Innovation, Science and Industry François-Philippe Champagne announced in a press release.

For now, the guidelines only apply to a small number of grants in research areas considered "strategic," such as artificial intelligence, nanotechnology and biofabrication. But it's only a matter of time before they're expanded to include other fields, according to Dr. Dupont. "Research teams will be held accountable for risk management, and cybersecurity in particular. Sooner or later, universities will have no choice but to get on board," he said.

And some may have a lot of catching up to do. "The methods universities use to take action on data protection and cybersecurity are limited. Awareness campaigns just aren't going to cut it," said Dr. Dupont, who is also one of the brains

behind an open online course on cybersecurity in academic settings titled, "La cybersécurité en milieu universitaire" (which is available in French). Universities can start by investing in simple safeguards, like setting up multifactor authentication for those that use their IT infrastructure, as well as routinely using virtual private networks to access sensitive data from outside the institution.

And in the long term? Everyone in academia must take responsibility for cybersecurity – starting with students, who make up a majority of the university community. "They are agents for change. They're the ones who will be dealing with tomorrow's threats, like quantum computing and 5G, which will increase the potential target areas," warned Dr. Cuppens, who co-organized an ethical hacking competition in early February. "It's a way to get our students thinking about cybersecurity issues," she said. – MAXIME BILODEAU

Cybersécurité

Cyberattaques : il n'y a pas péril en la demeure, mais...

Que ça leur plaise ou non, les universités canadiennes devront se saisir de la question de la cybersécurité, qui représente actuellement une épée de Damoclès au-dessus de leur tête

LES UNIVERSITÉS CANADIENNES sont-elles vulnérables aux cyberattaques ? Officiellement, non. Hormis lorsque leurs activités sont affectées, rares sont les établissements postsecondaires à rapporter être victimes de délits informatiques. Lors de la faille de sécurité informatique généralisée de décembre dernier, il a par exemple fallu que le gouvernement du Québec exige – par mesure préventive – « de procéder à la fermeture de tous sites, services et systèmes qui ont été exposés » pour que de nombreuses universités québécoises communiquent à ce sujet. Même chose il y a quelques années lorsque l'Université de Montréal a fait face à une cyberattaque mondiale.

Ce relatif silence radio donne l'impression que ces institutions publiques sont à l'abri de ce genre d'actes malveillants. La réalité est probablement toute autre, estiment toutefois divers experts consultés par *Affaires universitaires*. « Les quelques données dont on dispose proviennent

principalement de rapports publiés par des centres de cybersécurité anglo-saxons. Ces derniers soulignent à quel point les universités sont ciblées par ces menaces bien réelles », affirme Benoît Dupont, professeur à l'École de criminologie de l'Université de Montréal et titulaire de la Chaire de recherche du Canada en cybersécurité.

> « Cette culture d'ouverture et de transparence est une différence majeure avec les entreprises du secteur privé. »

L'organisme britannique Jisc, dont le rôle est de soutenir les efforts numériques des établissements d'enseignement supérieur du Royaume-Uni, sonde chaque année les collèges et universités du pays afin de brosser un état des lieux. Dans la plus récente édition de cette étude, publiée en novembre dernier, environ 60 % des 166 institutions consultées rapportaient avoir été victimes de cyberattaques au cours des 12 derniers mois. On y apprend aussi que la fréquence des attaques par rançongiciel serait en forte hausse dans le secteur.

La pandémie de COVID-19 n'est pas étrangère à ce constat. La crise sanitaire a forcé l'ensemble des universités canadiennes à transposer leurs activités en ligne. Jamais leurs infrastructures informatiques n'ont été aussi vitales à leur existence, ce qui en font des cibles attrayantes. « Le risque de cyberattaques était élevé avant mars 2020 ; il l'est encore tout autant. Cet épisode a conscientisé la communauté universitaire à sa vulnérabilité et à l'importance de développer un comportement numérique responsable », estime Mohammad Mannan, professeur agrégé à l'Institut d'ingénierie des systèmes d'information de l'Université Concordia.

Qui plus est, ces établissements doivent composer avec leur vocation particulière caractérisée par des pratiques axées sur la liberté universitaire, synonymes de vastes réseaux plus exposés par leur nature. « Cette culture d'ouverture et de transparence est une différence majeure avec les entreprises du secteur privé », souligne Nora Boulahia Cuppens, professeure au Département de génie informatique et de génie logiciel de Polytechnique Montréal. Selon elle, il faut arrêter de voir les pirates informatiques comme des fraudeurs malveillants cachés derrière leur clavier. « L'abus peut très bien provenir de l'intérieur. »

Des pirates si proches

Les travaux de recherche dépendent plus que jamais de partenariats nationaux et internationaux conclus entre une multitude d'acteurs – chercheurs, entreprises, centres de recherche. Or, sous le masque de collaborateurs se cachent peut-être des attaquants prêts à frapper. C'est justement « pour protéger la recherche et la propriété intellectuelle canadiennes contre l'interférence étrangère, l'espionnage et le vol » que le gouvernement du Canada a instauré en mars dernier des lignes directrices de sécurité nationale pour les partenariats de recherche du Canada.

Désormais, toute demande de financement soumise au titre du programme de subventions Alliance du Conseil de recherches en sciences naturelles et en génie du Canada (CRSNG) pour un partenariat de recherche auquel participent des organismes privés doit être accompagnée d'une évaluation du risque. « Les projets jugés à risque ou ceux pour lesquels les risques ne peuvent être atténués ne seront pas financés », annonçait par voie de communiqué le ministre de l'Innovation, des Sciences et de l'Industrie, François-Philippe Champagne.

> « Les équipes de recherche vont devoir répondre de leur gestion des risques, notamment en ce qui a trait à la cybersécurité. Les universités n'auront tôt ou tard pas le choix d'embarquer dans le train. »

Pour l'instant, ces lignes directrices ne concernent qu'un petit nombre de subventions relatives à des domaines de recherche considérés stratégiques, comme l'intelligence artificielle, les nanotechnologies et la biofrabication. Ce n'est toutefois qu'une question de temps avant qu'elles ne s'élargissent à plus de secteurs, prévoit M. Dupont. « Les équipes de recherche vont devoir répondre de leur gestion des risques, notamment en ce qui a trait à la cybersécurité. Les universités n'auront tôt ou tard pas le choix d'embarquer dans le train », anticipe-t-il.

Dans certains le cas, le retard à rattraper sera considérable. « Les moyens utilisés par les universités pour agir en faveur de la protection des données et de la cybersécurité sont limités. Il faut aller au-delà des simples campagnes de sensibilisation », pense celui qui a collaboré à la création du cours en ligne ouvert à tous *La cybersécurité en milieu universitaire*. Les universités peuvent dès maintenant investir dans des

mesures de prévention simples, comme l'authentification multifacteur de tous les usagers de ses infrastructures informatiques et l'emploi systématique de réseaux virtuels privés pour accéder à des données sensibles à partir de l'extérieur.

Et à plus long terme? La sécurité devra être l'affaire de tous les membres de la communauté universitaire, à commencer par ceux qui y sont le plus représentés : les étudiants. «Ce sont des agents de changement. Ce sont eux qui seront aux prises avec les menaces de demain, comme l'informatique quantique et le réseau 5G, qui augmenteront la surface d'attaque potentielle», met en garde Mme Cuppens, qui a d'ailleurs co-organisé la deuxième édition du concours de piratage éthique 24h@CTF, qui a eu lieu au début février. «C'est une manière d'initier nos étudiants aux enjeux de la cybersécurité», conclut-elle.– MAXIME BILODEAU

Science literacy

1 in 4 youth 'may ignore science,' leading to calls for improved communications

A new Canada Foundation for Innovation survey finds that while young people generally trust science, action is still needed to improve literacy

As Canada navigates the COVID-19 pandemic, science literacy has become more important than ever. This was one motivating factor behind the Canada Foundation for Innovation (CFI) Youth Science Survey, which was conducted last fall in partnership with Acfas (an association that represents francophone researchers). The survey examined the attitudes of 18- to 24-year-olds toward science, as well as the conditions and people who shape them.

Overall, the survey findings indicate that most Canadian youth use scientific information to guide their actions. For example, the majority of the 1,500 people surveyed believe that COVID-19 vaccines approved for use in Canada are safe (68 per cent); single-use plastics should be banned (63 per cent); curbing fossil fuels will reduce the impacts of climate change (55 per cent); and that Canadian politicians and governments should rely on science in making policy decisions (57 per cent).

That last finding struck Roseann O'Reilly Runte, president and chief executive officer of

CFI, as particularly telling. "This illustrates a level of sophistication in their thinking, and reflects their aspirations for society," said Dr. Runte. "They don't see [science] as just for them and their careers, but they see it as an important national issue."

" They don't see [science] as just for them and their careers, but they see it as an important national issue."

However, it wasn't all good news. The research separated Canadian youth into five cohorts, representing a spectrum of attitudes from pro-science to science hesitant. When split this way, the survey found that 25 per cent "may ignore science." This group was least likely to distinguish real news from fake news, and most likely to follow someone on social media who has anti-science views.

"We can't marginalize the 25 per cent who do not greatly pay attention to science," said Dr. Runte. "This is actually a challenge for us to reach out [...] and figure out how to best equip them so that they're able to make better decisions based on scientific information."

Anti-science views on social media
In line with many demographic groups across Canada, young people are relying on social media over more traditional news sources like newspapers and cable television. And, among those surveyed, 73 per cent report following at least one social media influencer who has expressed anti-science views.

"That absolutely does not surprise me," said Liam Mullins, a fifth-year science student and president of the microbiology student association at the University of Guelph. "I think the information that they're sharing, I might understand it to be misinformation and others might as well, but the individuals sharing it themselves do genuinely believe that it is accurate."

Mr. Mullins has seen misinformation proliferate on some of his social media channels since the start of the pandemic, mirroring an overall rise in inaccurate, false or misleading information about COVID-19 during the last two years. Anatoliy Gruzd, Canada Research Chair in privacy preserving digital technologies and co-director of the Social Media Lab at Ryerson University, confirmed that the pandemic has exaggerated trends towards misinformation.

"We are living in a period of uncertainty where scientific knowledge can change a lot as we learn about the virus, and information and instructions from our public health officials have also been changing frequently," said Dr. Gruzd, adding that this feeds into conspiracy theories and undermines trust in the scientific method. Going forward, he said, training at various levels should help students understand that science is not "one directional" and that as scientists learn more, things will change.

Is the medium the message?
While the CFI survey makes clear that there is a multiplicity of influences that could encourage anti-science views in youth – especially their peer group, family beliefs and religion – its authors emphasize that the complex information landscape online poses considerable challenges to science communicators and educators. Dr. Runte urged educators to be flexible and open to new mediums of communication.

"We have to continue trying to reach youth in ways that will be meaningful to them, and in the media that they access."

"We have to continue trying to reach youth in ways that will be meaningful to them, and in the media that they access," said Dr. Runte, who pointed to the TikTok account of Anna Blakney, a professor of bioengineering who gained over 250,000 followers by creating videos about vaccine science. "We must be versatile and open ourselves to new ways of communication."

A multi-stakeholder problem
While educators are uniquely positioned to deliver scientific information to students, improving science literacy among youth – and the general population – will require action from several stakeholders. Dr. Gruzd encourages universities to double down on efforts in information literacy, social media consumption and building critical-thinking skills in youth. Still, he admits "there is only so much we can do."

Dr. Runte said Canadian youth can be a key part of the solution. "In communicating with young people, [they] are our biggest allies – and we have the majority who believe in science," she said. "Why don't we help them have more discoveries and the ability to share it? And they'll teach us." – HANNAH LIDDLE

Littératie scientifique

Un quart des jeunes sont susceptibles de faire fi de la science : comment mieux faire passer le message?

D'après les résultats d'un sondage de la Fondation canadienne pour l'innovation, si les jeunes font généralement confiance à la science, il faut en faire plus pour améliorer leur compréhension

En ce temps de pandémie, la littératie scientifique est plus importante que jamais. C'est une des raisons pour lesquelles la Fondation canadienne pour l'innovation (FCI), en partenariat avec l'Acfas, a mené l'automne dernier une enquête sur les jeunes et la science. Son objectif : comprendre les perceptions des 18 à 24 ans en ce qui concerne la science, ainsi que les conditions et les personnes qui influencent cette relation.

Dans l'ensemble, les résultats indiquent que la plupart des jeunes canadiens se fient à la science. Par exemple, la majorité des 1 500 participants pensent que les vaccins contre la COVID-19 homologués au Canada sont sans danger (68 %), que le plastique à usage unique devrait être interdit (63 %), que s'éloigner des combustibles fossiles réduira les impacts des changements climatiques (55 %) et que les décideurs politiques canadiens doivent se fonder sur la science (57 %).

> **« Pour eux, [la science] ne touche pas que leur vie et leur carrière; c'est un enjeu national de premier plan. »**

Pour Roseann O'Reilly Runte, présidente-directrice générale de la FCI, cette dernière conclusion en dit long. « Elle témoigne d'une mentalité sophistiquée et reflète leur vision de l'avenir de la société, applaudit Mme Runte. Pour eux, [la science] ne touche pas que leur vie et leur carrière; c'est un enjeu national de premier plan. »

Cependant, les résultats ne sont pas tous aussi encourageants. Cette étude a divisé les participants en cinq cohortes, selon leur degré de confiance envers la science. D'après ce découpage, les résultats indiquent que 25 % des répondant.e.s « peuvent ignorer la science ». Ce groupe a montré la plus faible propension à distinguer les vraies informations des fausses, et la plus forte tendance à suivre une personnalité anti-science sur les réseaux sociaux.
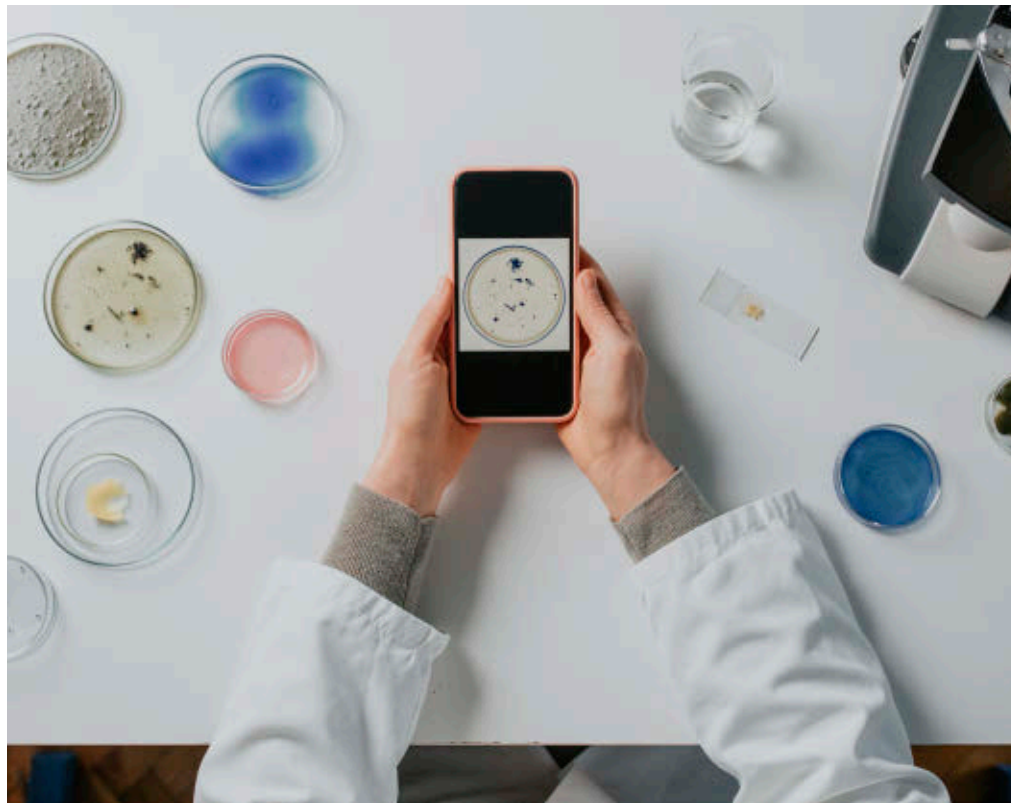
Les résultats d'un sondage mené par la Fondation canadienne de l'innovation, en partenariat avec l'Acfas, démontrent que la plupart des jeunes canadiens de 18 à 24 ans se fient à la science.

« Nous ne pouvons pas laisser de côté les 25 % de jeunes qui ne s'intéressent pas vraiment à la science, analyse Mme Runte. Nous devons plutôt trouver comment les atteindre [...] et leur donner les outils pour prendre des décisions éclairées par la science. »

Opinions anti-science sur les réseaux sociaux

Comme beaucoup de groupes sociodémographiques du Canada, les jeunes préfèrent les réseaux sociaux aux médias traditionnels, comme les journaux et la télévision. Parmi les participants à l'enquête, 73 % disent suivre au moins un influenceur ou une influenceuse ayant déjà exprimé des idées qui allaient à l'encontre de la science.

« Je ne suis pas surpris du tout », réagit Liam Mullins, étudiant de cinquième année et président de l'association étudiante de microbiologie à l'Université de Guelph. « Selon moi, même si nous considérons que l'information qu'ils diffusent est fausse, eux pensent sincèrement que ce n'est pas le cas. »

M. Mullins constate une prolifération de la désinformation sur certains des réseaux sociaux qu'il fréquente depuis le début de la pandémie. Une tendance qui reflète la montée globale des renseignements erronés ou mensongers sur la COVID-19 au Canada depuis mars 2020.

Anatoliy Gruzd, titulaire de la Chaire de recherche du Canada sur les technologies numériques de protection des renseignements personnels et codirecteur du Social Media Lab de l'Université Ryerson, confirme que la pandémie a aggravé la tendance à la désinformation. « Nous traversons une période d'incertitude au cours de laquelle les connaissances scientifiques évoluent rapidement au fur et à mesure que nous en apprenons sur le virus. Les autorités de santé publique changent aussi souvent leurs instructions et messages », explique M. Grudz, avant d'ajouter que ce phénomène alimente les théories du complot et sape la confiance envers la science. Selon lui, il faut maintenant enseigner aux étudiants de différentes manières que la science n'est pas une ligne droite, et qu'elle peut changer de trajectoire au fil des découvertes.

Le médium est-il le message?

Les résultats de l'enquête de la FCI montrent clairement que les raisons qui pourraient pousser les jeunes à ignorer la science sont multiples, en commençant par leurs fréquentations, leur famille et leur religion. Cependant, les auteurs insistent sur le fait que le paysage complexe de l'information en ligne complique énormément la tâche des vulgarisateurs et des éducateurs en science. Mme Runte exhorte les éducateurs à s'ouvrir aux nouveaux médias.

« Nous devons poursuivre nos efforts pour atteindre les jeunes sur les plateformes qu'ils utilisent », affirme-t-elle. Elle cite en exemple le compte TikTok d'Anna Blakney, professeure de bio-ingénierie à l'Université de la Colombie-Britannique, qui a plus de 250 000 abonnés grâce à ses vidéos sur la science derrière les vaccins. « Nous devons être polyvalents et rester ouverts aux nouvelles méthodes de communication. »

Une responsabilité partagée

Si les éducateurs sont les mieux placés pour transmettre l'information scientifique aux étudiants, plusieurs autres acteurs devront intervenir pour améliorer la littératie scientifique chez les jeunes et dans la population en général. M. Gruzd recommande aux universités de redoubler d'efforts pour apprendre aux jeunes à faire preuve d'esprit critique et de discernement dans le traitement de l'information qui leur vient de réseaux sociaux. « Il y a une limite à ce que nous pouvons faire », concède-t-il.

Selon Mme Runte, la jeunesse canadienne peut faire partie de la solution. « Dans le dialogue avec les jeunes, [ils] sont nos meilleurs alliés. La majorité d'entre eux font déjà confiance à la science, explique-t-elle. Pourquoi ne pas les aider à faire des découvertes et à les partager? Ils ont des choses à nous apprendre. »
– HANNAH LIDDLE

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Loleen Berdahl's The Skills Agenda column won the top prize in this category. Her column provides advice and techniques for professors who are looking to integrate career skill training into their academic programming.
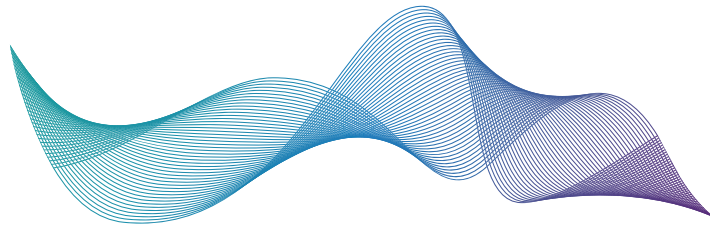
Best multicultural story
Silver
Tayo Bero's feature article "Addressing anti-Black racism on campus" from our September-October issue examines what universities are doing to make progress in their own institutions.

Best B2B website
Silver
The University Affairs / Affaires universitaires website was once again recognized for its breaking news, provocative commentary, and in-depth articles about university trends in both official languages.

Dale Kirby is an associate professor of education at Memorial University.

Can lower tuition fees grow a population?

The results of a recent study suggest it hasn't worked for Newfoundland and Labrador.

by Dale Kirby

"These findings should serve as a cautionary tale."

IN 1999, THE YEAR that introduced MSN Messenger, Napster, Bluetooth and the Euro, a tuition fee freeze came into effect at Memorial University. This past summer, Memorial announced the end of that fee freeze, starting in the fall of 2022.

Initial signs of a thaw began in 2018 when the fee freeze ended for Canadian non-residents at the university. That was met with public criticism, particularly from student groups. Some of those opposing tuition fee increases insisted that the fee freeze was an effective public policy instrument for increasing Newfoundland and Labrador's population – that lower university tuition fees were an incentive for individuals to settle in Newfoundland and Labrador, though no population data validated this argument.

Over the 22 years that Memorial's tuition freeze has been in effect, many justifications for its continuation have been provided by its supporters, though there has been little study of the impact for the university, its students, and the province of Newfoundland and Labrador, which has subsidized it.

Following a tenfold influx of students from the nearby Maritime provinces enrolling at Memorial in the 1990s, my research group initiated a study in 2010 to ask students what was behind this enrolment spike. Many of those in the 2010 Maritime student cohort confirmed that they chose Memorial, in part, due to lower costs, along with program availability and institutional reputation. Ten years later, in the fall of 2020, a follow-up study was conducted with the 2010 Maritime student cohort to a) investigate their persistence and graduation rates, b) ascertain whether this cohort continued to reside in Newfoundland and Labrador, and c) identify why some students stayed while others had left.

The results of the 2020 follow-up study, recently published in the Canadian Journal for Educational Administration and Policy, are inconsistent with claims that frozen tuition fees for out-of-province domestic students have substantively contributed to Newfoundland's population growth. Any contribution to the population growth would, in fact, appear to be minimal.

The analyses provided in the forthcoming paper show that 27 per cent of the students in our 2010 Maritime student cohort were no longer enrolled at Memorial in the fall of 2012, one year after their initial enrolment. This retention rate was more than 10 per cent below the national average for students in undergraduate degree programs. The two-year persistence rate for our 2010 Maritime cohort was 61 per cent, which was about 20 per cent below the national average. According to Statistics Canada data on graduation rates from undergraduate programs, 40 per cent of full-time students graduate within four years, and by the sixth year, the graduation rate increases to 74 per cent. For our 2010 Maritime cohort, the four-year graduation rate was much lower at 23 per cent, however, their graduation rate reached the national average by year five. By the sixth year, the graduation rate was 45 per cent – far below the national average.

Despite stakeholder claims to the contrary, results of the follow-up study showed 78 per cent of the 2010 Maritime student cohort were no longer residing in Newfoundland 10 years later. Respondents who remained in the province did so for employment, education, health and well-being considerations, and/or to be near a spouse/partner or friends. Survey respondents who left the province frequently cited employment opportunities, cost of living, and living closer to friends as their motivation. Living closer to parents was also frequently noted.

These follow-up study findings should serve as a cautionary tale. Contrary to the often-repeated claim that, as a result of lower, frozen tuition fees, out-of-province Canadian students were staying in Newfoundland and thus helping to provide a bulwark against population aging, the results of the follow-up study do not support such a notion. Because of attrition, nearly half of the students in the 2010 Maritime student cohort did not graduate from Memorial. Many of them returned home without completing a credential and compared to the national graduation rate, these students significantly underperformed.

If one of the primary aims of the former low tuition fee policy for out-of-province Canadians was to aid population growth, this study indicates that this objective failed. Considering the large drop-out rate, one must weigh these poor student outcomes against the costs borne by students and their families as well as the financial investment made by Memorial and the province of Newfoundland and Labrador. **UA**

Capilano University gets a new university librarian

Capilano University is welcoming Christina Neigel as its new university librarian. As part of the university's senior leadership, Dr. Neigel will lead the academic planning and development of the library and related academic learning services and supports. As university librarian, she will play a key role in maintaining and enhancing distinct learner experiences and scholarly activity through high-quality resources that support academic programming and activities. Previously, Dr. Neigel served as an associate professor and department head in information studies at the University of the Fraser Valley. She has also been actively involved in supporting academic faculty and the library profession through various roles, namely with the Federation of Post-Secondary Educators of BC, the BC Library Association and the Canadian Federation of Library Associations. Dr. Neigel holds a doctorate in education from Simon Fraser University.

Kristen Fisher has been appointed associate vice-president, people and talent at Brandon University. This new position will replace the previous chief human resources officer, and Ms. Fisher will be responsible for making the human resources division a strategic partner in institutional priorities and an advocate for employees. Ms. Fisher has worked at Brandon University for 14 years, having served as acting chief human resources officer for two years as well as manager of executive and board operations in the office of the president. The scope and title of this new position will allow human resources to serve as a strategic partner in institutional priorities as well as an advocate for employees – especially in areas of wellness, culture, and employee education and development.

MacEwan University has appointed **Maureen Lomas** as vice-president, finance and administration and chief financial officer. Ms. Lomas, who started her new position on Feb. 14, has 20 years of experience in progressive accounting and management, having recently served as vice-president, finance at Alberta Innovates, the research, business growth and innovation arm of the provincial government. Ms. Lomas has a diverse background across several sectors, including oil and gas, mining, manufacturing and health. She currently sits as a board member of the Primrose Place Family Centre and is a trustee for the Glenrose Rehabilitation Hospital Foundation. Ms. Lomas is a certified professional accountant and completed her bachelor of commerce from the University of Saskatchewan in 1997.

Le 1er juin prochain, **Pascale Lefrançois** accédera au poste de vice-rectrice aux affaires étudiantes et aux études de l'Université de Montréal. Doyenne de la Faculté des sciences de l'éducation (FSE) de l'établissement montréalais depuis 2018, Mme Lefrançois a auparavant occupé les fonctions de vice-doyenne aux études de 1er cycle de la FSE de 2010 à 2018 et de directrice du Centre de formation initiale des maîtres de 2010 à 2017.

Wilfrid Laurier University has appointed **Heidi Northwood** to a two-year term as senior executive officer: global strategy. Dr. Northwood, who previously served as senior executive officer of Laurier's Brantford campus, will lead the university's internationalization strategy, which aims to strengthen the institution's global reputation, build international partnerships, and increase opportunities for international exchange and recruitment. Dr. Northwood joined WLU in 2014 as dean of the faculty of liberal arts.

À compter du 1er juillet prochain, **Jason Carey** agira à titre de doyen du Campus Saint-Jean de l'Université de l'Alberta, et ce, pour un mandat de cinq ans. Titulaire d'un doctorat en génie mécanique de l'Université d'Ottawa, M. Carey s'est joint à l'université albertaine en 2004. Il y est actuellement professeur et vice-doyen de la Faculté de génie.

On Feb. 10, MacEwan University appointed **Jason Fung** as its new general counsel. Mr. Fung has served as a senior legal counsel with the department of justice and solicitor general at the Government of Alberta and has a strong background in providing strategic and legal advice on privacy, intellectual property and

risk management. Mr. Fung has served as lead counsel on a number of Alberta-wide initiatives, including the Calgary 2026 Olympic bid. He holds a bachelor of laws from Dalhousie University.

Depuis le 25 janvier dernier, **Michel Carrier** agit à titre de doyen par intérim de la Faculté de médecine dentaire de l'Université de Montréal. Son mandat prendra fin le 31 mai 2023. Ophtalmologiste de formation, Dʳ Carrier a précédemment été doyen de la Faculté de médecine vétérinaire de l'établissement montréalais pendant plus de huit ans et a exercé comme clinicien au Centre hospitalier universitaire vétérinaire rattachée à cette faculté.

Melanie Spence-Ariemma has been appointed as the vice-provost and chief academic officer at the University of Guelph-Humber. She will begin her new position on May 2. Dr. Spence-Ariemma currently serves as dean of student affairs for the Michener Institute of Education at the University Health Network and has previously held the role of provost and vice-president, academic at Sheridan College. She holds a PhD in leadership and policy and has taught at various universities in the U.S. and Canada.

Capilano University has appointed **Kartik Bharadwa** as the vice-president, people, culture and diversity. In this newly created position, Mr. Bharadwa oversees human resources activities and aids the university in achieving its goal of instilling a culture of equity, diversity, and inclusion throughout all operations. Prior to joining Capilano on Jan. 19, Mr. Bharadwa served as director, human resources, operations, and chief privacy officer for the BC Dental Association. He has extensive experience in labour relations, talent acquisition and retention, learning development, change management and organizational effectiveness.

Tina Chen is serving as the first executive lead, equity, diversity and inclusion, at the University of Manitoba, where she began a two-year term on Feb. 1. Dr. Chen will oversee the university's EDI initiatives to further the eradication of systemic inequities and biases. Dr. Chen was the first racialized person to be named head of the U of M's history department in 2013, a role she held until 2020. She has also demonstrated leadership outside of the university setting, most recently through her involvement in two national forums on anti-Asian racism. Dr. Chen has been named as one of Canada's Top 100 Most Powerful Women by the Women's Executive Network and is a highly regarded historian.

Depuis le 1ᵉʳ janvier dernier, **Gabriel Cormier** agit à titre de vice-recteur à l'administration et aux ressources humaines de l'Université de Moncton. Titulaire d'un doctorat en génie électrique de l'Université Carleton, M. Cormier était doyen de la Faculté d'ingénierie de l'Université de Moncton depuis 2020. Au cours de sa carrière d'une vingtaine d'années au sein de l'établissement acadien, M. Cormier a notamment été vice-doyen de la même faculté entre 2015 et 2019 ainsi que directeur du Département de génie électrique de 2014 à 2015.

Wilfrid Laurier University has appointed **Brent Wolfe** as the acting associate vice-president and dean of the faculty of graduate and postdoctoral studies. Dr. Wolfe will start his new position on July 1. Currently, he serves as associate dean for the faculty of geography and environmental sciences. He is a former northern research chair with NSERC and has trained more than 50 graduate and postdoctoral researchers in northern environmental science. Dr. Wolfe completed his PhD at the University of Waterloo in 1997 and has authored more than 110 peer-reviewed publications.

Vincent Beauséjour est vice-recteur à l'enseignement et à la réussite de l'Université du Québec en Outaouais depuis le 13 décembre dernier. Titulaire d'un doctorat en administration de l'Université du Québec à Montréal, M. Beauséjour a occupé les fonctions de vice-doyen au développement des programmes et de secrétaire de faculté à la Faculté de l'éducation permanente de l'Université de Montréal de 2015 à 2021. Il a également été directeur du Bureau d'études et développement de cette même faculté de 2013 à 2015.

On Jan. 31, Vancouver Island University announced **Carolyn Russell** as its new associate vice-president, international education. Ms. Russell has 25 years of experience in international education across the postsecondary sector in British Columbia and is the former executive director, global engagement at the University of Victoria. She has been a board member for the Canadian Bureau of International Education and received the BC Council for International Education Award for service excellence in 2012.

Nommée directrice générale des ressources humaines de l'Université de Montréal, **Karina Adam** est entrée en fonction le 6 décembre dernier. Auparavant vice-rectrice associée aux ressources humaines à l'Université d'Ottawa, Mᵐᵉ Adam compte plus de 20 ans d'expérience en gestion stratégique des ressources humaines. Au cours de sa carrière, elle a notamment été vice-présidente aux ressources humaines de l'Association des laboratoires régionaux de l'Est de l'Ontario.

L'Institut national de la recherche scientifique confie la direction de l'administration à **Isabelle Boucher**. Celle-ci a occupé le poste de façon intérimaire entre le 1ᵉʳ et le 28 février. Elle a officiellement entamé son mandat de cinq ans le 1ᵉʳ mars dernier. Avant d'accepter ce poste, Mᵐᵉ Boucher a œuvré pendant 10 ans à titre de vice-présidente à l'administration de l'Université du Québec. Elle avait auparavant exercé au sein de la même organisation les fonctions de conseillère principale à la présidence, d'adjointe au vice-président à l'enseignement et à la recherche et de coordonnatrice de projet.

Christopher Adams has been reappointed as rector of St. Paul's College at the University of Manitoba, where he will serve a new five-year term. Dr. Adams was first appointed rector in 2012, and under his leadership St. Paul's College joined Universities Canada (publisher of University Affairs) and became a founding partner of the National Centre for Truth and Reconciliation. Dr. Adams is a respected administrator and is a professor of political studies at the university. He holds a PhD in political science from Carleton University.

Depuis le 17 janvier dernier, **Carlos Alberto Castaño** agit à titre de directeur du Bureau du recrutement étudiant de l'Université du Québec à Rimouski (UQAR). Avant de se joindre à l'UQAR, M. Castaño a occupé le poste de directeur à la Direction des affaires étudiantes et du développement international au Cégep Marie-Victorin. Auparavant, il a été coordonnateur à la vie étudiante et aux services d'aide au Cégep du Vieux Montréal et intervenant auprès de personnes immigrantes dans le réseau des services sociaux.

Algoma University welcomed **Shannon Brooks** as its new vice-president, finance and operations on Jan. 10. Ms. Brooks is a certified professional accountant and holds an MBA from Laurentian University. She has over 22 years of experience in postsecondary education, most recently serving as associate vice-president, corporate services at Centennial College. She has previously overseen major construction projects at the college, including for a new $100 million campus building.

The University of British Columbia Okanagan has appointed **Rehan Sadiq** as vice-president, academic pro tem. He previously held the position of executive associate dean in the school of engineering, and was also the co-lead of the life cycle management laboratory at UBC. Dr. Sadiq is a world-leading researcher in the areas of asset management of water supply systems, environmental risk analysis and lifecycle assessment of the built environment. He holds a PhD in civil engineering from Memorial University and has been a registered professional engineer in B.C. since 2010.

Agissant par intérim à titre de vice-recteur aux études et à la recherche de l'Université de l'Ontario français (UOF), **Paulin Mulatris** a été nommé à ce poste en décembre dernier. Avant de se joindre à l'UOF en avril 2021 comme professeur titulaire et responsable du Pôle d'études et de recherche sur la pluralité humaine, M. Mulatris a eu diverses responsabilités au Campus Saint-Jean de l'Université de l'Alberta.

On Feb. 21, **Brad Storm** assumed the position of chief information officer at York University. Mr. Storm has more than 25 years of executive management experience and has proven leadership in digital strategy and information technology. Most recently, Mr. Storm served as vice-president and chief information officer of technology and security. He is a graduate of Carleton University as well as several professional development programs in leadership and information technology.

Depuis le 5 janvier dernier, **Jonathan Paquette** agit à titre de doyen de la recherche à l'Université du Québec en Outaouais. Avant d'entamer son mandat de deux ans, M. Paquette était professeur titulaire en administration publique à l'Université d'Ottawa. Détenteur d'un doctorat en gestion publique de l'École nationale d'administration publique, M. Paquette a été nommé titulaire de la Chaire de recherche en francophonie internationale sur les politiques du patrimoine culturel en 2019.

The University of Manitoba has extended the term of **Catherine Cook** as vice-president, Indigenous, where she oversees six Indigenous leadership projects. Dr. Cook has played an integral role in expanding Indigenous student representation and advancing reconciliation at U of M. She was one of the first Indigenous physicians trained in the province of Manitoba and has since been a leading voice on Indigenous public health and policy in the province's postsecondary education system. Dr. Cook's term is extended until June 30, 2023.

Depuis le 1ᵉʳ février dernier, **Hugo Cyr** agit à titre de directeur général de l'École nationale d'administration publique. Son mandat sera d'une durée de cinq ans. Expert en droit constitutionnel et en théorie du droit, M. Cyr était auparavant professeur titulaire à la Faculté de science politique et de droit de l'Université du Québec à Montréal, où il a également été doyen de 2015 à 2020. Au cours de sa carrière, il a été auxiliaire juridique auprès de l'Honorable Ian C. Binnie de la Cour suprême du Canada, Boulton Fellow à l'Université McGill, chercheur en visite à l'Académie européenne de théorie du droit et Schell Fellow à la Yale Law School.

Le 1ᵉʳ juin prochain, **Frédéric Bouchard** entamera son deuxième mandat consécutif à titre de doyen de la Faculté des arts et des sciences de l'Université de Montréal. Ce nouveau mandat prendra fin le 31 mai 2027. Professeur de philosophie des sciences, M. Bouchard a été élu membre de la Société royale du Canada en 2021.

Nommé doyen par intérim de la Faculté d'ingénierie de l'Université de Moncton en janvier, **Roger Boudreau** occupera ce poste jusqu'au 30 juin prochain. Titulaire d'un doctorat en génie mécanique de l'Université du Nouveau-Brunswick, M. Boudreau a débuté sa carrière à l'établissement acadien en 1986. Celui qui a accédé au rang de professeur titulaire en 1998 a également été directeur du Département de génie mécanique pendant plusieurs années.

York University has selected **Margaret Kierylo** as its new vice-president, institutional planning and chief data officer. Dr. Kierylo has had a 12-year career in higher education, most recently serving as associate vice-president, integrated planning and assessment at Athabasca University. She has also worked for the Canadian Museum for Human Rights as acting curator, Indigenous content. Dr. Kierylo holds a PhD in history from Queen's University.

Western University has appointed **David Muir** to serve as its inaugural associate vice-president, in charge of innovation and strategic partnerships. Dr. Muir previously served as director of research and development for the automotive and surface transportation portfolio at the Natural Science and Engineering Research Council, where he drove several strategic partnerships. He has two decades of experience in senior roles at 3M Canada, working in research, product development, manufacturing, commercialization, and business.

Depuis le 14 février dernier, **Alain Godmaire** agit à titre de vice-recteur à l'administration et aux ressources de l'Université du Québec en Outaouais. Titulaire d'une maîtrise en administration publique de l'École nationale d'administration publique, M. Godmaire a occupé plusieurs fonctions stratégiques au sein du Centre intégré de Santé et des Services sociaux de l'Outaouais. Jusqu'à tout récemment, il y était directeur de la direction des ressources humaines, des communications et des affaires juridiques.

Membre du conseil d'administration de l'Institut national de la recherche scientifique depuis 2020, **Yves Mauffette** en a été nommé président en janvier. Professeur retraité au Département des sciences biologiques à la Faculté des sciences de l'Université du Québec à Montréal (UQAM), M. Mauffette a été vice-doyen aux études et doyen de cette faculté de 2002 à 2009. Il a également occupé le poste de vice-recteur à la recherche et la création de l'UQAM de 2009 à 2015.

Greg Naterer will serve as vice-president academic and research at the University of Prince Edward Island, effective May 1. Dr. Naterer is currently the dean of the faculty of engineering and applied science as well as a professor in the department of mechanical engineering at Memorial University of Newfoundland. Dr. Naterer embraces diversity, equity and inclusion, and under his leadership Newfoundland and Labrador has had the highest percentage of female undergraduate engineering students in Canada.

Florentine Strzelczyk will be the new provost and vice-president, academic, at Western University. Her five-year term begins May 1. Dr. Strzelczyk has an extensive background in Canada's post-secondary education sector, and currently serves as provost and vice-president, academic at Memorial University. She has also previously held leadership positions at the University of Calgary.

James Culligan began his appointment as vice-president, finance and administration at St. Thomas University on March 1. A chartered professional accountant, Mr. Culligan has had a successful career with Service New Brunswick, where he served as executive director of finance and administration, responsible for a large operating and capital budget as well as forecasting and reporting.

En décembre dernier, **Pierrette Fortin** a été nommée vice-rectrice par intérim de l'Université de Moncton, campus d'Edmundston. Celle qui est doyenne des études au campus d'Edmundston depuis le 1ᵉʳ juillet 2013 cumulera les deux fonctions pour la durée de l'intérim. Titulaire d'un doctorat en philosophie de l'Université Laval, Mᵐᵉ Fortin avait également occupé ce poste par intérim de janvier à juillet 2018.

On Jan. 10, Concordia University named **Cherine Zananiri** as its new director of experiential learning and cooperative education. She is a talent and career strategist and former adjunct professor who has taught graduate and undergraduate courses at the John Molson School of Business. In her new role, Ms. Zananiri is responsible for fostering and maintaining strategic partnerships with industry, community organizations and all levels of government.

Ce n'est qu'un au revoir

Réflexions sur un engagement situé dans l'univers de l'éducation postsecondaire.

par Guy Laforest

« Les universités représentent une véritable colonne vertébrale pour notre société. »

À LA FIN JANVIER 2022, mon mandat s'est achevé à la direction générale de l'École nationale d'administration publique (ENAP). En complétant cette expérience extraordinaire, j'ai été saisi par une réalité incontournable : depuis quelque 60 ans, alors que j'étais étudiant en première année à l'école Ste-Claire d'Assise à Québec, l'éducation en général, et l'éducation postsecondaire en particulier, auront été les grands théâtres de ma vie active et professionnelle. Les lignes qui suivent résument l'essentiel de ce parcours et une certaine compréhension du sens de l'éducation.

Sur l'éducation, je crois avoir appris l'essentiel de penseurs comme Fernand Dumont, André Laurendeau, Jacques Grand'Maison et Pierre Vadeboncoeur. En les côtoyant, on en arrive à identifier les fins de l'éducation : la formation de la conscience individuelle, l'enracinement dans une société nationale distincte, le déploiement de la vigilance citoyenne, la cultivation du doute, l'ouverture à l'Autre et au monde.

En philosophie politique, j'appartiens au camp de celles et ceux qui se méfient des certitudes idéalistes, des multiples visages de la pensée doctrinaire. Mes références s'appellent Karl Popper, Hannah Arendt, Raymond Aron et Isaiah Berlin. C'est le courant de l'humanisme libéral. Pour paraphraser Berlin : loin de l'idéalisme, dans la société convenable, les règles, les normes et les principes sont toujours en train d'établir des compromis entre eux.

Cet engagement dans le monde de l'éducation, il a été situé au Québec et au Canada. J'aurai été

jusqu'à présent un politologue féru d'histoire intellectuelle et de droit constitutionnel, creusant sur ces terrains une compréhension de la maison constitutionnelle fédérale canadienne et de l'expérience historique et sociale du Québec. J'appartiens à une génération qui a été forgée par l'expérience traumatisante des vicissitudes entourant l'Accord du lac Meech entre 1987 et 1990. Alain-G. Gagnon, Alain Noël, François Rocher, Stéphane Dion, Linda Cardinal, Guy Lachapelle et Daniel Salée sont les principaux politologues de ma génération qui partagent cette expérience. D'autres creuseront cela avec plus de lucidité et de distance critique que moi. Pour plusieurs d'entre nous, la saga du lac Meech a été soit un point de départ ou un point tournant nous amenant à mener de nombreuses recherches sur le fédéralisme asymétrique et multinational, appuyées aussi bien sur la philosophie politique, le droit public, la sociologie politique, et toujours enrichies par une démarche comparative intégrant des expériences comme celles de l'Espagne, de la Belgique et du Royaume-Uni.

La démocratie libérale représentative, avec ses grandeurs et ses limites, a été plus qu'un investissement théorique pour moi. Au début des années 2000, j'ai été candidat défait dans le comté de Louis-Hébert pour l'Action démocratique du Québec (ADQ), après avoir été responsable de la commission politique et président du parti. Je me rappelle encore cette belle phrase, que l'on doit au philosophe Jacques Dufresne, au temps du rapport du Groupe Réflexion Québec, lequel mena à la fondation de l'ADQ :

« Dans les relations entre les citoyens et l'État, il est temps de passer du mode du cynisme et de la petite tricherie au mode de la responsabilité. » Dans le Québec contemporain au temps de la pandémie, le gouvernement de François Legault doit méditer à chaque jour le sens et la profondeur de ce défi. Au temps de la saga du lac Meech et encore aujourd'hui, je me reconnais dans un courant qui part de la légitimité du nationalisme autonomiste dans le présent et l'horizon d'avenir du Québec comme société nationale distincte, en trouvant un équilibre entre cet autonomisme et l'interdépendance dans le Canada.

Après quelque 30 ans au Département de science politique de l'Université Laval, je suis devenu directeur général de l'ENAP en 2017 et j'ai fait près de la moitié de mon mandat en contexte de pandémie. Pour moi, les universités représentent une véritable colonne vertébrale pour notre société, renforçant l'identité collective dans toutes les régions et renforçant l'espoir d'un avenir meilleur dans la tête de nos concitoyen.ne.s. Au Québec et à la grandeur du Canada, les universités ont raison d'être fières du travail accompli en pandémie. Et à l'ENAP, nous avons fait aussi de notre mieux pour contribuer à former une fonction publique dévouée, compétente et attentive aux besoins de la population.

Dans l'apprentissage des langues, je milite pour une approche combinant la passion, le cœur, et la discipline, telle que la rigueur requise pour approfondir les verbes irréguliers. Cœur et discipline me guideront pour l'avenir, lequel restera ancré dans des réflexions sur l'éducation. **AU**

Annonces de postes / Job listings

Careers/Carrières

Film Studies

Brock University - Brock University is located on the Traditional Territory of the Haudenosaunee and Anishinaabe peoples. This Territory is covered by the One Dish One Spoon Wampum Agreement and the Upper Canada Treaties. We express our gratitude and respect for the honour of living and working with Indigenous people. In all that we do, Brock University strives to honour and support the Indigenous peoples of whose Traditional Territory Brock University is located. Our commitment to Reconciliation and Decolonization are one of four strategic priorities of Brock's 2018-2025 Strategic Plan. These priorities include fostering a culture of inclusivity, accessibility, reconciliation and decolonization. At Brock, "we believe that a diverse and welcoming learning community is built upon the foundation of exceptional students, faculty, staff and alumni. This requires that Brock be attractive and welcoming to people of all identities and accepting of the unique histories and experiences of Indigenous people within the Canadian state." The Brock University experience is second to none in Canada. Located in historic Niagara region, Brock offers all the benefits of a young and modern university in a safe, community-minded city, with beautiful natural surroundings. With over 19,000 students and more than 100 undergraduate and graduate programs in seven diverse Faculties, Brock excels at providing exceptional experiential learning opportunities and highly rated student and campus life experiences. Brock University's main campus is situated atop the Niagara Escarpment, within a UNESCO World Biosphere Reserve, overlooking the city of St. Catharines, in the heart of Niagara wine country. The Niagara region is dotted with landmarks that recognize our nation's history and features breathtaking natural beauty and world-famous attractions. St. Catharines is home to vibrant arts and entertainment venues, and is a short drive from Toronto, Niagara Falls, and Buffalo, New York. With one of the warmest climates in Canada, clean, safe communities, and surprisingly affordable real estate, Niagara is an exceptional location to call home. Brock University offers competitive salary and benefits and support for research. Research resources include conference support, start-up funding, subscriptions to major databases

and access to various research funding vehicles. For candidates considering relocation, moving expenses will be administered according to the Faculty Association Collective Agreement. The Department of Communication, Popular Culture and Film at Brock University invites applications for a one-year Limited Term Appointment (LTA) in Film Studies at the rank of Assistant Professor to begin July 1, 2022. This position is subject to final budgetary approval. The Department of Communication, Popular Culture and Film offers four interdisciplinary undergraduate programs - Business Communication, Media & Communication, Popular Culture, and Film Studies - and is home to over 700 students. The Film Studies program is one of the oldest and most storied in Canada. The successful candidate must have a PhD in film studies, or a related discipline. The successful candidate will be required to teach four half courses - FILM 2P91 - Early Film Theory and FILM 2P99 - Film History II, plus two additional courses drawn from the following list: FILM 2P94 - Popular Cinema; FILM 3P20 - Television Studies; FILM 3P21 - Canadian Television; FILM 3P56 - Issues in Canadian Cinema; FILM 3P97 - Gender in Cinema Pre-1960s; FILM 4P31 - Theories of the Visible. Teaching experience and range are both of the essence for this position. Specific course assignments may vary in accordance with shifting staffing needs, and the successful candidates specific areas of strength. It should be noted that this position will require in-person instruction (Brock University and provincial and regional public health policies permitting). Notes: The closing date for the position is 12:01am on March 25, 2022. The last business day to apply is March 24, 2022. Applications should be submitted electronically via the online application system and include a cover letter, curriculum vitae, and a teaching dossier (including relevant course outlines, course evaluations, and a statement of teaching philosophy). Applicants should arrange for 2 confidential academic references to be sent to Dr. Anthony Kinik in the Department of Communication, Popular Culture and Film (at akinik@brocku.ca) before the closing date. Applications should be submitted electronically through the Brock Careers website at the following link: https://brocku.wd3.myworkdayjobs.com/brocku_careers/job/St-Catharines-Main-Campus/Limited-Term-

Appointment--Assistant-Professor--Film-Studies_JR-1010925. Brock University is actively committed to diversity and the principles of employment equity and invites applications from all qualified candidates. Women, Aboriginal peoples, members of visible minorities, people with disabilities and lesbian, gay, bisexual, transgender, and queer (LGBTQ) persons are encouraged to apply and to voluntarily self-identify as a member of a designated group as part of their application. LGBTQ is an umbrella category and shall be read to include two-spirited people. Candidates who wish to be considered as a member of one or more designated groups can fill out the Self-Identification questions included in the questionnaire at the time of application. Please note that Brock University requires all employees to be fully vaccinated against COVID-19 if they are working on campus and/or in-person with other employees, students or members of the public. As a condition of being hired, employees in these types of roles will be required to provide proof of full vaccination, or provide proof of a bona fide medical or Human Rights Code exemption. All qualified candidates are encouraged to apply; however Canadian citizens and permanent residents will be given priority. We will accommodate the needs of the applicants and the Ontario Human Rights Code and the Accessibility for Ontarians with Disabilities Act (AODA) throughout all stages of the selection process, as outlined in the Employee Accommodation Policy https://brocku.ca/policies/wp-content/uploads/sites/94/Employment-Accommodation-Policy.pdf. Please advise: talent@brocku.ca to ensure your accessibility needs are accommodated through this process. Information received relating to accommodation measures will be addressed confidentially. We appreciate all applications received; however, only candidates selected for an interview will be contacted. At this time, initial interviews will be conducted virtually. Learn more about Brock University by visiting www.brocku.ca. [56617]

Kinesiology

University of Victoria - The University of Victoria Campus is located on the traditional lands of the Coast Salish Peoples and we are privileged to do our work in a way that is inspired by their history, customs and culture. The School of Exercise Science,

Physical and Health Education (EPHE) is an academic unit within the Faculty of Education at the University of Victoria (http://www.uvic.ca/education/exercise/). Our mission is to advance knowledge and to prepare professionals in the area of physical activity and health through teaching, research and service. A collaborative research culture exists within the School. General research interests span exercise sciences, recreation, health, teacher education and inclusive pedagogies (Research profiles: https://www.uvic.ca/education/exercise/people/index.php). Our School, Faculty and University have a demonstrated commitment to equity and fairness. The School of EPHE is actively building a diverse, welcoming community of researchers, teachers, and learners. We invite applications for a tenure-track Assistant in the area of kinesiology to begin July 1, 2022 or as negotiated. We are seeking a collegial and energetic individual who has research experience in an area related to the physical rehabilitation of acute or chronic conditions. Applicants should have a strong record of research productivity commensurate with their experience. In accordance with the University's Equity Plan and pursuant to Section 42 of the BC Human Rights Code, preference will be given to Indigenous scholars. Candidates seeking preferential consideration, are asked to self-identify in their cover letter. Requirements: Doctoral degree in rehabilitation sciences, kinesiology, or equivalent, from a recognized institution by the time of appointment. Demonstrated ability to teach clinical skills in courses on exercise management of musculoskeletal or neurological conditions. Recent and relevant research experience in one or more of the following areas: musculoskeletal, neurological, cardiorespiratory, or metabolic conditions. Demonstrated commitment to service to the academic and professional community. Strong record of scholarly achievement, some of which may include community-engaged scholarship and/or clinical work, relative to stage of career. Evidence of a commitment to equity, diversity, inclusion, and the promotion of a respectful and collegial learning and working environment. The following will be considered assets: Successful supervision of the research activities of undergraduate honours students and graduate students. Evidence of engagement in academic collegial governance. Certification or eligible for certification as a Kinesiologist, Physical Therapist, Clinical Exercise Physiologist, or equivalent. Relevant clinical experience in Kinesiology or related rehabilitation health discipline. Experience with practicum-based learning. Evidence of contributions to curriculum and program development. Evidence of a commitment to equity, diversity, inclusion, and the promotion of a respectful and collegial learning and working environment. UVic is committed to upholding the values of equity, diversity, and inclusion in our living, learning and work environments. In pursuit of our values, we seek members who will work respectfully and constructively with differences and across levels of power. We actively encourage applications from members of groups experiencing barriers to equity, and for this particular search, preference will be given to Indigenous applicants. Read our full equity statement here: www.uvic.ca/equitystatement. The University acknowledges the potential impact that career interruptions can have on a candidate's record of research achievement. We encourage applicants to explain in their application the impact that career interruptions have had on their record. Persons with disabilities, who anticipate needing accommodation for any part of the application and hiring process, may contact Faculty Relations and Academic Administration in the Office of the VP Academic and Provost at FRrecruit@uvic.ca. Any personal information provided will be maintained in confidence. Faculty and Librarians at the University of Victoria are governed by the provisions of the Collective Agreement. Members are represented by the University of Victoria Faculty Association (www.uvicfa.ca). All qualified candidates are encouraged to apply; in accordance with Canadian Immigration requirements, Canadians and permanent residents will be given priority. Please indicate in your application package if you are a Canadian citizen or permanent resident. For candidates to be considered, please send: Cover letter outlining how the candidate meets the full scope of the job requirements; Curriculum vitae including appropriate evidence of research (publications or work in progress); Research statement (both traditional and community-engaged research interests are valued and welcomed); Teaching dossier (teaching statements, syllabi, evaluation data); A statement of diversity knowledge, experience and skills (maximum one page) describing past or potential contributions within research, service, and teaching; and The names and contact details of three referees. Please note that reference and background checks, including credential and degree verification, may be undertaken as part of this recruitment process. For questions regarding the position, please contact Sandra Hundza, PhD, Director of the School of Exercise Science, Physical and Health Education via email (ephe.director@uvic.ca) or phone (250-721-8382). In order to be considered, application packages must be received by April 8th 2022. Please send above documentation to: Rebecca Zammit, Assistant to the Director, Exercise Science, Physical & Health Education, University of Victoria, PO Box 1700 STN CSC, Victoria, BC, V8W 2Y2. Telephone: 250-721-8373; E-mail: epheadminasst@uvic.ca; Web: http://www.uvic.ca/education/exercise/ Only short-listed applicants will be contacted. The University of Victoria is consistently ranked in the top tier of Canada's research-intensive universities. Vital impact drives the UVic sense of purpose. As an internationally renowned teaching and research hub, we tackle essential issues that matter to people, places and the planet. Situated in the Pacific Rim, our location breeds a profound passion for exploration. Defined by its edges, this extraordinary environment inspires us to defy boundaries, discover, and innovate in exciting ways. It's different here, naturally and by design. We live, learn, work and explore on the edge of what's next—for our planet and its peoples. Our commitment to research-inspired dynamic learning and vital impact makes this Canada's most extraordinary environment for discovery and innovation. Experience the edge of possibilities for yourself. [56621]

Sparrow McGowan is a freelance journalist, writer and editor based in Charlottetown.

Establishing connections through the QES-Advanced Scholars program

One researcher shares the experience she gained conducting research with Indigenous groups in Canada and Ecuador.

by Sparrow McGowan

"This scholarship has shaped the way that I see things now."

IN EARLY 2020, Paulina Larreategui was planning to get to work after receiving funding from the Queen Elizabeth Scholarship Advanced Scholars program. "I wanted to do research in a different way, to be close to a community," she said. But then the pandemic hit. "I went straight into lockdown. It felt like nothing was going to be possible that year."

Ms. Larreategui, who has been working towards her PhD at the Johnson-Shoyama Graduate School of Public Policy at the University of Regina since 2018, is doing research that focuses on Indigenous actions in response to climate change. "My main idea was to compare one climate action or one environmental action from one community in Ecuador and one from Canada." She is also currently on leave from her lecturer position with the school of sociology at the Pontificia Universidad Catolica del Ecuador, a university based in Quito, Ecuador. She received her scholarship to do her research through the QES-Advanced Scholars program, which is administered by a partnership between the Rideau Hall Foundation, Community Foundations of Canada, Universities Canada (the publisher of University Affairs) and a group of Canadian universities.

Already having an established connection for her research in Ecuador's Sarayaku community, she turned her attention to finding a community in Canada. "Some people were afraid or were not confident about what I was going to do. Being [an unknown] researcher and trying to talk about Indigenous initiatives could be risky for people here, and I wanted to respect that," said Ms. Larreategui, noting there was also the added challenge of not being able to visit communities in person. "It took me a while, but I finally found a community that wanted to share their experience," Ms. Larreategui said. She was able to connect with a representative from the Kitchenuhmaykoosib Inninuwug First Nation in Ontario.

She attributes being able to navigate her research in the midst of the pandemic to the connections the scholarship helped her make, like the third-party partner she worked with. "One of the biggest outcomes from the research was being able to work with Amnesty International. I have not only supported the Regina group [...] but because of COVID we are connected with other groups [virtually]."
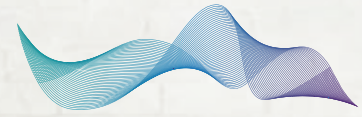
The themes of connection and knowledge-sharing run through much of Ms. Larreategui's research and activities since receiving the scholarship. "I have been embedded in some classes [in Ecuador] to share some of these ideas of how the Indigenous actions are connected, north and south. I share with them all the struggles that Indigenous peoples are facing here [in Canada] because that's something that you don't hear back home." She is also pushing for a new course at her university in Ecuador that will examine how Indigenous environment leaders are connected in the Americas and how non-Indigenous people can support their initiatives.

Similarly, students at the U of R will benefit from Ms. Larreategui's research. She said they are looking into an international course that connects students from U of R with students from other universities, including her own in Ecuador. "I will be the link between those two universities. It will be great if we can do that." She will also be teaching a course at U of R's Lifelong Learning Centre about Indigenous climate actions in the Americas.

Ms. Larreategui's experience exemplifies the goals of the QES-AS program. By providing enriched academic, professional and cross-cultural experiences and facilitating local and global community engagement, the program aims to develop the next generation of leaders and community builders while also strengthening the research capacity of universities and research institutes in low and middle income countries. Since 2015, over 2,000 scholars have been funded through 106 projects in 73 countries. The program is currently wrapping up a four-year longitudinal study, funded by the International Development Research Centre, to collect evidence on international scholarship programming as a mechanism for social change, and results are expected later in 2022.

For Ms. Larreategui, the insights and connections gained through her research have impacted her deeply. "Having this scholarship was amazing for me because it opened the door to learn more about my own community back home, in terms of climate change, environmental actions, Indigenous initiatives and Indigenous knowledge. This scholarship has shaped the way that I see things now." **UA**

CONNECTIONS MATTER

THE IMPACT OF CE ON UNIVERSITY INNOVATION, COLLABORATION, AND ACCESS

MAY 25 - 27, 2022

The CAUCE annual conference and meeting brings together professionals in university continuing education from across Canada to share ideas and best practices, deliberate on important topics, develop and strengthen networks, and to reflect on the place of continuing education in broader society.

Through guest speakers, panel discussions, conference presentations, and workshops, attendees engage with others for their own professional development and to spark ideas for new ways to improve, innovate or build upon their work in their respective institutions.

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CANADA'S TOP **100** CORPORATE R&D SPENDERS
CANADA'S TOP **50** RESEARCH UNIVERSITIES
CANADA'S TOP **40** RESEARCH HOSPITALS
CANADA'S TOP **50** RESEARCH COLLEGES

C I L CANADA'S INNOVATION LEADERS 2021

20/20 Innovation Vision:
Looking back and moving forward

Canada's decades-long effort to up its lacklustre innovation game has shown what works, and where bold action is still needed

By Debbie Lawes

It was probably the last thing many in Canada's research and innovation community wanted to see, yet there it was – another weighty tome with a buffet of options for improving the country's poor global performance when it comes to productivity, economic growth and competitiveness.

"I'm not sure I can read another innovation report. Maybe a stiff drink will reduce my resistance and then I'll read it and weep," quipped Dr. David Naylor, the former University of Toronto president who participated on expert panels in 2011 (*Innovation Canada*, aka the "Jenkins Report") and 2017 (Fundamental Science Review) that laid bare the challenges and potential solutions for addressing Canada's decades-old innovation conundrum.

This newest report was prepared by the Senate Prosperity Action Group, comprised of 12 federal Senators who saw the COVID-10 pandemic as an opportunity to tackle many of the country's pre-existing economic and social challenges. Released last fall, the 66-page document represents the latest in a long line of innovation-tackling reports that have attempted to steer both the public and private sectors towards policies and approaches that capitalize on the country's scientific and industrial strengths.

Many of its 15 recommendations are familiar – from reinvigorating the business environment and strengthening the talent pipeline to becoming a world leader in the digital economy and investing more in research and development (R&D). The big question is whether politics, jurisdictional wrangling and vested interests can be put aside to boldly act on a familiar laundry list of promising solutions.

"We keep commissioning reports, putting sector strategy tables together, putting councils together and then not completing the actions recommended by them," said Naylor. "Canada has been teetering on the brink of an outstanding transformation for at least 10 years but there continues to be this lack of resolve by government to make the hard decisions."

Naylor was one of 10 innovation thinkers Research Infosource interviewed for their perspectives on how far Canadian research and innovation has come over the past 20 years, and what further changes are needed to prepare the country for the next two decades.

"The Four Horses of the Economic Apocalypse"
Governments have struggled for decades to come up with the magic mix of policy sticks and policy carrots to encourage companies to invest more in the machinery, equipment and highly skilled talent needed to produce better strategies, capabilities, products, services or processes.

The statistics are stark. Canada's productivity growth has lagged below the Organisation for Economic Co-operation and Development (OECD) average for most of the last 20 years. We rank dead last among peer countries when it comes to government and business spending on R&D, despite having a highly educated work force and some of the world's top universities and research institutions. Canada's business R&D expenditures are over 50% below the OECD average, and our ranking among 60 countries in the 2020 Bloomberg Innovation Index fell to 22nd place, behind Slovenia. The Canadian government alone would need to invest an additional $22 billion per year in R&D just to get on par with the OECD average, according to an analysis by the Ottawa-based Global Advantage Consulting Group.

Diagnosing the problem isn't as difficult as one might think, according to Dr. Peter Nicholson, an innovation expert who has held senior posts in government, business, science, and academia. Necessity, as the saying goes, is the mother of innovation and for the past 150 years Canada's GDP growth rate on a per capita basis has generally matched that of the United States, fueled in large part by a gangbusters U.S. economy with an insatiable appetite for Canada's natural resources.

"Canadian business on the whole has never emphasized innovation in its business strategy because it has been profitable without doing so," explained Nicholson. "As such, there really hasn't been much motivation to change a formula that has worked for over a century."

That is until now. Rapidly shifting global headwinds are forcing Canadian companies to change how they operate in response to what Nicholson describes as "the four horses of the economic apocalypse": a world economic shift towards Asia; a digitally-driven industrial revolution; climate change and the transition to a green economy; and, an aging population and shortage of skilled labour.

While industry will continue to be the major driver of innovation, Nicholson said government has a role to play in developing a comprehensive innovation policy that motivates companies and promotes economic growth.

Attracting More Global Capital
As a first step, make Canada a more inviting place to invest, urged Dennis Darby, President and CEO of Canadian Manufacturers and Exporters (CME), whose members account for about 11% of domestic GDP and three-quarters of our exports.

Canada attracts less than 1% of the approximately USD$2.5 trillion invested annually in the manufacturing sector among OECD nations – a situation that has persisted for most of the last 20 years. CME's goal is for Canada to attract at least 2% of global capital which companies could use to invest in innovation.

"We call it the 2% challenge," said Darby. "If Canada could double its investment in technology and investment to become more efficient, to improve the resiliency of our supply chains, to become more greenhouse gas-efficient towards net zero, I think that would bode well."

A perception of Canada as "a complicated place to do business", combined with growing protectionism in the US, have convinced many global companies that the US is a safer bet for new investing. "New facilities there would get sited in a matter of weeks, compared to the months or years it would take in Canada to get all the different levels of approval", said Darby.

The other challenge is a lack of skilled labour, made worse when the pandemic put the brakes on most international students and immigration.

"We have to go back to the fundamentals," explained Darby. "We've got to get the people we need. We've got to stimulate investment in plant, equipment and technology so we can compete and improve our productivity and improve our output, and we have to find a way to improve our exports. In short, we need the government to commit to an industrial strategy that tries to grow the sector."

One big motivator, as Nicholson pointed out, is the transition to a net-zero economy. Darby said this will require policies that incent manufacturers, notably big greenhouse gas emitters like food, automotive, fertilizer and chemical producers, but also SMEs, to invest in energy-reducing technologies that make companies more competitive. For example, CME has called for the federal Strategic Innovation Fund to invest at least $2.5 billion annually to support large and small capital projects in manufacturing.

Another priority, added Darby, is for Prime Minister Justin Trudeau to rebuild our relationship with the US, which continues to be the single biggest market for Canadian exports.

"[US President Joe] Biden hasn't shown any particularly affinity for NAFTA or continental free trade. Right now it's all about the US," he noted. "We need a better understanding that we make things together, that we're integrated, because we haven't really been on the radar screen in the U.S."

What Canada is Getting Right
Economists often present an alarmist view of Canada's poor record of innovation and low productivity. But the good news is there is much Canada has got right over the past 20 years thanks in large part to a strong foundation of academic science.

Take the Networks of Centres of Excellence. Created in 1989 under the Progressive Conservative government of Prime Minister Brian Mulroney, the NCE provided the catalyst for a new era of multidisciplinary and multisectoral collaborative science that has transformed Canada's research culture.

The $240 million in funding – a staggeringly large public investment in research at the time – enticed academic researchers to step outside their disciplinary comfort zones to work in teams that transcend traditional scientific disciplines, institutional silos and geography. This made-in-Canada experiment also created new academic, private and public sector partnerships that mobilized a critical mass of resources, funding and expertise capable of addressing areas of strategic importance such as stem cells, stroke, the Arctic and automotive.

The goal was to help universities to produce more research that is needed, and to narrow the widening gap between research and commercialization. Towards this end, two spinoff programs were introduced: the Centres of Excellence for Research and Commercialization (CECR), and the Business-Led NCEs.

Unexpectedly however, and with little explanation, the government decided in 2018 to wind down the 30-year-old NCE program, and replace it with the New Frontiers in Research Fund, which supports high-risk, high-reward research. The Fundamental Science Report's expert panel had recommended that the NCE program be sustained and revised.

> **Canada has been teetering on the brink of an outstanding transformation for at least 10 years but there continues to be this lack of resolve by government to make the hard decisions.**
> **DR. DAVID NAYLOR**
> **President Emeritus, University of Toronto**

PARTNER PERSPECTIVE

Innovating for the post-pandemic future

Dr. Steven N. Liss
Vice-President, Research and Innovation
Ryerson University

The global COVID-19 pandemic has highlighted the numerous challenges faced by our society, from health-care inequities to skilled staffing shortages. As we move towards post-pandemic recovery, researchers are poised to address these issues and provide solutions, ensuring that we can build a beneficial future for everyone.

Throughout the COVID-19 pandemic, universities have demonstrated that they are agile and can adapt to changing conditions and situations. Building on our research expertise and strategic priorities, including community health and well-being as well as the future of work, Ryerson researchers were able to quickly respond to emergent challenges by pivoting projects and accelerating research to meet societal needs. That strong foundation and ability to be nimble is why Ryerson is well positioned to be at the forefront of recovery.

Excellence in research and innovation across many areas of health and wellness has established Ryerson faculty members as experts in fields ranging from community health, to biomedical devices, to health services policy.

As we move forward, our researchers' pandemic-driven health innovations span from

As we move beyond the pandemic, this work is making a difference in the lives of Canadians.

The pandemic has highlighted the vulnerabilities of Canada's seniors and Canada's health-care workers. The important policy work being done by our National Institute on Ageing (NIA) is having a positive impact in this space. Their work on the evolution and sustainability of systems such as long-term care is critical for the health and safety of our most senior citizens. And programs like the new Urban Health and Well-being Nexus are bringing together top talent from across disciplines to tackle challenges in nursing and patient experience in our communities.

technology development to community initiatives. Professor Mohammad Abdoli-Eramaki's team is designing wearable technology that monitors COVID-19 symptoms using embedded sensors and artificial intelligence. Professor Josephine Wong is leading Project PROTECH, an initiative that aims to reduce the negative psychosocial impacts of the pandemic on communities while also promoting resilience.

We've seen our engineering and science researchers at the Institute of Biomedical Engineering, Science and Technology (iBEST) swiftly adapt existing technology to respond to the diagnosis of SARS-CoV-2. Professors Bo Tan and Krishnan Venkatakrishnan adapted their nanosensors for molecule detection to rapidly test for COVID-19

in congregate settings such as schools, construction sites and airports.

Advancing and securing our digital future is critical as we look beyond this decade at our economy and at work, skills and industry. Since the emergence of COVID-19, organizations have moved their services online at an unprecedented pace. The demand for cybersecurity-skilled workers has grown exponentially, resulting in an undersupply of trained professionals. Institutions like the Future Skills Centre and the Rogers Cybersecure Catalyst were prepared to identify what skills are in demand now and what will be needed in the years ahead. This support extends beyond training to include small and medium-sized businesses, to provide the cybersecurity tools they

need to protect their enterprises. Research into a range of issues is being done by the Canada Excellence Research Chair (CERC) in Migration and Integration, such as workforce shortages and the decision-making of skilled migrant workers. Our organizations and partners are looking to lead the future of work and to shape inclusive workplaces.

Looking beyond the horizon is an integral part of undertaking research. It is this feature that has allowed universities to demonstrate that they have the knowledge and expertise to benefit Canada and facilitate post-pandemic recovery. At Ryerson, with our culture of innovation and our long history of collaboration, we are well prepared to respond to the challenges of today and tomorrow.

Canada's TOP 50 RESEARCH UNIVERSITIES 2021

Rank			Sponsored Research Income			Research Intensity			
2020	2019	University	FY2020 $000	FY2019 $000	% Change 2019-2020	$ per Faculty $000	$ per Grad Student $000	Tier*	Prov
1	1	University of Toronto+	$1,234,278	$1,089,287	13.3	$446.6	$61.0	M	ON
2	2	University of British Columbia	$652,637	$624,465	4.5	$267.7	$57.5	M	BC
3	3	McGill University	$628,642	$606,489	3.7	$344.1	$63.5	M	QC
4	4	Université de Montréal	$613,474	$597,168	2.7	$300.1	$36.1	M	QC
5	6	University of Calgary	$457,296	$487,805	-6.3	$298.5	$67.8	M	AB
6	5	University of Alberta	$446,013	$506,299	-11.9	$215.8	$54.6	M	AB
7	7	Université Laval	$426,628	$401,441	6.3	$273.0	$38.2	M	QC
8	9	University of Ottawa	$383,063	$346,406	10.6	$292.6	$50.3	M	ON
9	8	McMaster University	$353,530	$371,599	-4.9	$369.4	$68.9	M	ON
10	10	Western University	$230,407	$245,965	-6.3	$156.8	$34.1	M	ON
11	13	Queen's University	$228,092	$235,231	-3.0	$270.3	$40.7	M	ON
12	11	University of Saskatchewan	$223,328	$243,531	-8.3	$207.9	$65.0	M	SK
13	12	University of Waterloo	$211,213	$240,726	-12.3	$172.8	$34.0	C	ON
14	14	Université de Sherbrooke	$205,176	$169,319	21.2	$168.0	$19.9	M	QC
15	17	University of Manitoba	$193,138	$160,838	20.1	$159.2	$48.9	M	MB
16	16	Simon Fraser University	$167,256	$160,988	3.9	$188.6	$34.0	C	BC
17	19	Dalhousie University	$166,368	$151,334	9.9	$150.2	$43.4	M	NS
18	15	University of Guelph	$164,356	$164,591	-0.1	$196.6	$54.0	C	ON
19	18	Memorial University of Newfoundland	$162,922	$160,636	1.4	$173.9	$40.3	M	NL
20	20	University of Victoria	$124,972	$114,083	9.5	$176.8	$42.2	C	BC
21	23	Ryerson University	$105,605	$79,574	32.7	$123.2	$36.1	C	ON
22	21	York University	$100,416	$100,304	0.1	$72.7	$16.5	C	ON
23	22	Carleton University	$86,468	$81,760	5.8	$102.5	$20.5	C	ON
24	24	Université du Québec à Montréal	$83,567	$76,485	9.3	$74.7	$10.8	C	QC
25	25	Institut national de la recherche scientifique	$66,280	$71,889	-7.8	$419.5	$98.6	S	QC
26	26	Concordia University	$60,536	$61,899	-2.2	$70.3	$8.1	C	QC
27	27	University of New Brunswick	$50,609	$48,474	4.4	$111.7	$31.1	C	NB
28	28	Laurentian University	$37,794	$39,400	-4.1	$96.2	$37.9	U	ON
29	29	École de technologie supérieure	$35,570	$35,734	-0.5	$183.4	$16.5	S	QC
30	31	University of Windsor	$34,469	$30,067	14.6	$68.8	$8.3	C	ON
31	32	Université du Québec à Trois-Rivières	$33,297	$29,298	13.6	$71.5	$11.0	U	QC
32	30	Université du Québec à Rimouski	$31,204	$30,550	2.1	$151.5	$27.3	U	QC
33	34	University of Regina	$28,027	$24,357	15.1	$65.9	$13.8	U	SK
34	33	Université du Québec à Chicoutimi	$26,745	$25,257	5.9	$109.2	$16.8	U	QC
35	35	Lakehead University	$22,236	$22,820	-2.6	$65.0	$15.3	U	ON
36	37	Université du Québec en Abitibi-Témiscamingue	$18,132	$17,539	3.4	$127.7	$22.9	U	QC
37	40	University of Lethbridge	$17,911	$15,782	13.5	$51.6	$28.6	U	AB
38	39	Ontario Tech University	$17,638	$16,373	7.7	$80.9	$21.7	U	ON
39	36	Wilfrid Laurier University	$16,926	$18,160	-6.8	$31.7	$7.6	U	ON
40	38	Brock University	$15,592	$16,636	-6.3	$27.5	$8.0	U	ON
41	42	University of Northern British Columbia	$13,886	$12,943	7.3	$70.5	$23.2	U	BC
42	43	Royal Military College of Canada++	$13,750	$12,567	9.4	$70.9	$29.9	U	ON
43	45	Trent University	$13,532	$11,555	17.1	$52.4	$19.5	U	ON
44	44	University of Winnipeg	$13,169	$12,344	6.7	$43.9	$55.6	U	MB
45	41	Université de Moncton	$12,911	$12,946	-0.3	$37.8	$21.5	U	NB
46	47	University of Prince Edward Island	$10,987	$10,744	2.3	$41.6	$21.9	U	PE
47	48	Saint Mary's University	$10,103	$10,041	0.6	$39.8	$15.2	U	NS
48	46	Université du Québec en Outaouais	$9,411	$11,097	-15.2	$38.4	$6.6	U	QC
49	50	St. Francis Xavier University	$6,727	$7,335	-8.3	$26.5	$14.2	U	NS
50	49	Acadia University	$6,553	$7,347	-10.8	$32.9	$12.7	U	NS

Notes:
1. Sponsored research income includes all funds to support research received in the form of a grant, contribution or contract from all sources external to the institution.
2. Financial data were obtained from Statistics Canada, except where noted.
3. Fiscal 2019 figures may have been adjusted as more accurate information became available.
4. Faculty headcounts for academic year 2019-2020 were used to calculate Research Intensity-$ per Faculty. Includes full/part-time: full, associate and assistant ranks as provided/available. Data were obtained from Research Infosource's Canadian University R&D Database.
5. Graduate student enrollment headcounts for academic year 2019-2020 were used to calculate Research Intensity-$ per Graduate Student. Includes full and part-time students enrolled in graduate level (master's and doctorate) programs and courses leading to degrees, certificates or diplomas. Excludes students enrolled in health-related internships/residencies and first professional programs. Data were obtained from Maritime Provinces Higher Education Commission, Ministère de l'Éducation et de l'Enseignement supérieur, Ontario

Ministry of Advanced Education and Skills Development, Manitoba Advanced Learning Division, Alberta Advanced Education, BC HEADSet and some individual universities.
6. All data are provided for the main university including its affiliated institutions, where applicable.
7. All main institutions are members of the Canadian Association of University Business Officers (CAUBO).

*Tier: M - Medical, C - Comprehensive, U - Undergraduate, S - Specialized (not full-service)
+Sponsored research income administered by affiliated hospitals was reported one fiscal year in arrears
++Sponsored research income figures were obtained directly from the university

Research Infosource Inc. is Canada's source of R&D intelligence.
For further information, please visit **researchinfosource.com**

Research Universities of the Year 2021

Three universities gain Research Infosource's designation of *Research University of the Year* in their category for their performance on a balanced set of input and output measures. These full-service universities demonstrated superior performance on key measures of research success.

Rank	Medical	Score*	Rank	Comprehensive	Score*	Rank	Undergraduate	Score*
1	University of Toronto	98.9	1	University of Waterloo	93.9	1	Université du Québec à Rimouski	75.7
2	McGill University	69.5	2	University of Guelph	83.7	2	University of Regina	74.1
3	McMaster University	65.8	3	Simon Fraser University	75.1	3	Ontario Tech University	73.0

*The score in each category is out of a possible 100 points based on the following measures and weighting: total sponsored research income (20%), research intensity per faculty (20%), research intensity per graduate student (10%), total number of publications in leading journals (20%), publication intensity (20%) and publication impact (10%). For each measure, the top ranking institution is assigned a score of 100 and the other institutions' scores are calculated as a percentage of the first ranked institution. To be eligible to be included in the Research Universities of the Year Tier rankings, full-service universities must have ranked in the top 50% in their respective tier for 5 out of 6 measures. See www.researchinfosource.com for details.

CANADA'S TOP 50 RESEARCH UNIVERSITIES

CIL — CANADA'S INNOVATION LEADERS

McMaster University — BRIGHTER WORLD

uOttawa

Ryerson University

UNIVERSITY OF SASKATCHEWAN

Queen's UNIVERSITY

Carleton University

UNIVERSITY OF WATERLOO

YORK U — UNIVERSITÉ UNIVERSITY

University of Manitoba

Brock University

UNIVERSITY OF TORONTO

UNIVERSITY OF CALGARY

UDS Université de Sherbrooke

DALHOUSIE UNIVERSITY

Lakehead UNIVERSITY

UNIVERSITY of GUELPH — Improve Life.

Ontario Tech UNIVERSITY

INNOVATION — Canada Foundation for Innovation / Fondation canadienne pour l'innovation

MEMORIAL UNIVERSITY

CMC MICROSYSTEMS

OCI — Where Next Happens

20 YEARS — RESEARCH INFOSOURCE

CANADA'S TOP 50
Research Universities

University Research Income Keeps Pace

Research income at *Canada's Top 50 Research Universities* advanced by 3.0% to $8.27 billion in Fiscal 2020, building on gains of 5.7 % in Fiscal 2019, 3.6% in Fiscal 2018 and 6.8% in Fiscal 2017. Research income expanded at 31 universities and declined at 19 others. In Fiscal 2020, average faculty research intensity – research income per faculty member – was $202,900, which was a small 2.1% increase over Fiscal 2019. Graduate student research intensity – research income per graduate student – was $39,000.

The Fiscal 2020 result was mainly due to a -3.9% drop in Provincial Government funding ($1.20 billion), coupled with a -3.9% drop in NSERC funding ($873.5 million), and weak Foreign Government (3.4%) and Individual (-43.2%) research support. However, research funding rose at SSHRC ($329.6 million, up 10.9%) – much of that attributable to Tri-Council funding. CIHR ($975.9, million, up 10.2%) and CFI ($400.4 million, up 8.2%) rose considerably, while funding from Corporate sources also expanded by a healthy 6.7% to $1.14 billion in Fiscal 2020.

$100 Million Club

Research Infosource salutes the 22 universities that gained membership in the prestigious $100 Million Club – institutions that attracted $100 million or move of research funding in Fiscal 2020. New to the list this year is Ryerson University ($105.6 million). Club members accounted for $7.48 billion of research income, 90% of the Top 50 total, compared with $794.0 million for the 28 other institutions.

University Tiers

Sixteen Medical institutions posted a total of $6.60 billion of research income in Fiscal 2020, which was 80% of the Top 50 total and an increase of 3.2% over Fiscal 2019. Eleven Comprehensive universities posted $1.19 billion of research income, a growth of 2.6%, and accounted for 14% of all university research income. Twenty-one Undergraduate institutions reported a gain of 3.1% in research income, to $376.5 million, which was 5% of the total.

The top universities in each tier as measured by research income were: University of Toronto ($1.23 billion, 1st place overall), University of Waterloo ($211.2 million, 13th overall) and Laurentian University ($37.8 million, 28th overall).

Research Income Growth

In Fiscal 2020, a range of universities reported research income growth that was well above the national rate of 3.0%. Stand-outs included Université de Sherbrooke (Medical, 21.2%), Ryerson University (Comprehensive, 32.7%) and Trent University (Undergraduate, 17.1%).

Faculty Research Intensity

Fiscal 2020 faculty research intensity – research income per faculty position – was $202,900 overall, compared with $198,700 in Fiscal 2019. Top-placed full-service universities by tier were: University of Toronto ($446,600 per faculty) in the Medical tier, University of Guelph ($196,600) in the Comprehensive tier and in the Undergraduate group, Université du Québec à Rimouski ($151,500).

Graduate Student Research Intensity

Graduate research intensity is a measure of the amount of research income at each institution per graduate student. The top-ranked full-service universities by tier were: McMaster University ($68,900 per graduate student) in the Medical tier, University of Guelph ($54,000) in the Comprehensive category and University of Winnipeg ($55,600) led the Undergraduate tier.

Provincial Performance

In Fiscal 2020, 18 Ontario universities attracted 40% of the national research income total ($3.27 billion), up from 39% in Fiscal 2019. Quebec's 13 institutions garnered 27% of Top 50 research income ($2.24 billion), unchanged from Fiscal 2019. British Columbia's four institutions attracted 12% of all research income ($958.8 million), up from 11% in Fiscal 2019. Three Alberta universities had 11% of research income ($921.2 million), down from 13% of the total in Fiscal 2019.

Corporate and Not-for-Profit Research Income

Top 50 Corporate research income accounted for $1.14 billion or 14% of total university research income, down from 13% in Fiscal 2019. Not-for-Profit research income totaled $1.54 billion, accounting for 19% of the total, unchanged from Fiscal 2019. Corporate research income increased by 6.7% between Fiscal 2019 and Fiscal 2020 and Not-for-Profit by 3.4%.

Research Universities of the Year

Research Infosource has designated three institutions as Research Universities of the Year 2021 in their respective categories: University of Toronto (Medical), University of Waterloo (Comprehensive) and Université du Québec à Rimouski (Undergraduate). These institutions demonstrated superior performance on key measures of research success.

This Year and Next

Fiscal 2020 was a year of solid if unspectacular growth for research income. An overall rise of 3.0% basically keeps pace with inflation. And increases were evenly distributed among the three university tiers. Ryerson University gaining membership in the *$100 Million Club* represents enormous progress for what was once a polytechnic institution without degree-granting status.

This year's results are the last prior to the impact of COVID-19. As in other sectors of society and the economy COVID-19 has been a disruptive force on the research scene. As to how it has affected funding, we will need to wait for next year's data to know. One thing that COVID-19 has assuredly done is to reinforce the notion that a strong base of science – basic and applied – is absolutely critical for society to swiftly respond to emerging challenges – or in this instance, crisis. Not only in life sciences, natural sciences and engineering, but in social sciences and humanities, as we struggle to understand more about human behavior in the face of rapid social change.

In our 20th year Research Infosource salutes all the universities – and university funders – who have bequeathed us with a strong base of knowledge for the future.

Top Universities by Tier FY2020

Research Income

Rank	Medical	$000
1	University of Toronto	$1,234,278
2	University of British Columbia	$652,637
3	McGill University	$628,642
	Tier Average (16)	$412,812

Rank	Comprehensive	$000
1	University of Waterloo	$211,213
2	Simon Fraser University	$167,256
3	University of Guelph	$164,356
	Tier Average (11)	$108,133

Rank	Undergraduate	$000
1	Laurentian University	$37,794
2	Université du Québec à Trois-Rivières	$33,297
3	Université du Québec à Rimouski	$31,204
	Tier Average (21)	$17,930

Research Income Growth (% Change FY2019-FY2020)

Rank	Medical	%
1	Université de Sherbrooke	21.2
2	University of Manitoba	20.1
3	University of Toronto	13.3
	Tier Average (16)	3.2

Rank	Comprehensive	%
1	Ryerson University	32.7
2	University of Windsor	14.6
3	University of Victoria	9.5
	Tier Average (11)	2.6

Rank	Undergraduate	%
1	Trent University	17.1
2	University of Regina	15.1
3	Université du Québec à Trois-Rivières	13.6
	Tier Average (21)	3.1

Faculty Research Intensity ($ per Faculty)

Rank	Medical	$000
1	University of Toronto	$446.6
2	McMaster University	$369.4
3	McGill University	$344.1
	Tier Average (16)	$271.1

Rank	Comprehensive	$000
1	University of Guelph	$196.6
2	Simon Fraser University	$188.6
3	University of Victoria	$176.8
	Tier Average (11)	$123.0

Rank	Undergraduate	$000
1	Université du Québec à Rimouski	$151.5
2	Université du Québec en Abitibi-Témiscamingue	$127.7
3	Université du Québec à Chicoutimi	$109.2
	Tier Average (21)	$58.9

Graduate Student Research Intensity ($ per Graduate Student)

Rank	Medical	$000
1	McMaster University	$68.9
2	University of Calgary	$67.8
3	University of Saskatchewan	$65.0
	Tier Average (16)	$48.9

Rank	Comprehensive	$000
1	University of Guelph	$54.0
2	University of Victoria	$42.2
3	Ryerson University	$36.1
	Tier Average (11)	$23.2

Rank	Undergraduate	$000
1	University of Winnipeg	$55.6
2	Laurentian University	$37.9
3	Royal Military College of Canada	$29.9
	Tier Average (21)	$16.5

Note: Based on full-service universities on the 2021 Top 50 Research Universities list.

Corporate and Not-for-Profit Research Income by Tier FY2020

Corporate Research Income

Rank	Medical	$000
1	University of Toronto	$141,241
2	McMaster University	$112,137
3	Queen's University	$84,300
	Tier Average (16)	$53,895

Rank	Comprehensive	$000
1	University of Waterloo	$31,362
2	University of Guelph	$24,937
3	Simon Fraser University	$8,053
	Tier Average (11)	$8,905

Rank	Undergraduate	$000
1	Université du Québec à Chicoutimi	$7,566
2	Université du Québec en Abitibi-Témiscamingue	$6,213
3	Laurentian University	$3,519
	Tier Average (21)	$1,756

Corporate Research Income as % of Total University Research Income

Rank	Medical	%
1	Queen's University	37.0
2	Memorial University of Newfoundland	35.7
3	McMaster University	31.7
	Tier Average (16)	13.1

Rank	Comprehensive	%
1	University of Guelph	15.2
2	University of Waterloo	14.8
3	Concordia University	9.5
	Tier Average (11)	8.2

Rank	Undergraduate	%
1	Université du Québec en Abitibi-Témiscamingue	34.3
2	Université du Québec à Chicoutimi	28.3
3	Acadia University	27.5
	Tier Average (21)	9.8

Corporate Research Income Growth (% Change FY2019-FY2020)

Rank	Medical	%
1	Western University	51.4
2	University of Toronto	24.5
3	Memorial University of Newfoundland	16.1
	Tier Average (16)	4.7

Rank	Comprehensive	%
1	Carleton University	140.5
2	Simon Fraser University	65.2
3	University of Windsor	60.6
	Tier Average (11)	12.5

Rank	Undergraduate	%
1	Brock University	134.5
2	Trent University	96.7
3	University of Winnipeg	89.4
	Tier Average (21)	6.0

Not-for-Profit Research Income

Rank	Medical	$000
1	University of Toronto	$339,950
2	University of British Columbia	$120,407
3	Université de Montréal	$109,296
	Tier Average (16)	$74,319

Rank	Comprehensive	$000
1	Simon Fraser University	$26,183
2	University of Waterloo	$16,406
3	University of Victoria	$10,358
	Tier Average (11)	$10,006

Rank	Undergraduate	$000
1	Lakehead University	$6,875
2	Université du Québec à Trois-Rivières	$4,219
3	Université de Moncton	$2,931
	Tier Average (19)	$1,823

Not-for-Profit Research Income as % of Total University Research Income

Rank	Medical	%
1	University of Manitoba	36.4
2	University of Toronto	27.5
3	University of Ottawa	21.0
	Tier Average (16)	18.0

Rank	Comprehensive	%
1	University of New Brunswick	19.0
2	Simon Fraser University	15.7
3	University of Windsor	12.1
	Tier Average (11)	9.3

Rank	Undergraduate	%
1	Lakehead University	30.9
2	Université de Moncton	22.7
3	University of Prince Edward Island	21.7
	Tier Average (19)	9.7

Not-for-Profit Research Income Growth (% Change FY2019-FY2020)

Rank	Medical	%
1	University of Manitoba	24.4
2	University of British Columbia	18.5
3	McGill University	17.3
	Tier Average (16)	4.3

Rank	Comprehensive	%
1	University of Windsor	144.7
2	University of Guelph	76.2
3	York University	63.0
	Tier Average (11)	-0.6

Rank	Undergraduate	%
1	University of Northern British Columbia	94.6
2	Trent University	66.1
3	Ontario Tech University	63.1
	Tier Average (19)	3.5

Note: Based on full-service universities on the 2021 Top 50 Research Universities list, and reported research income from corporate and not-for-profit sources in the form of a grant or contract in Fiscal 2020.

Research for a future of endless possibilities

possibilities

possibilities

possibilities

A world of just societies, equal opportunity, universal health and wellness, sustainable technology and socially responsible prosperity is not wishful thinking. It's the world we dare to imagine—and create.

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LEADERS' CORNER

Waterloo researchers excel in a unique environment that integrates experiential education and entrepreneurship with disciplinary and interdisciplinary research. Our commitment to solving the most complex challenges of our time is shaped by fundamental and applied research excellence and our deep industry and community partnerships.
Vivek Goel, CM
President and Vice-Chancellor
University of Waterloo

Despite COVID-19, the Queen's community has continued research and collaboration to pursue not only new work prompted by the pandemic, but work towards other important priorities, including solutions for a low-carbon future, improved health outcomes, and fundamental discoveries that lead to innovation, shared economic prosperity, and a technologically advanced Canada.
Dr. Nancy Ross
Vice-Principal (Research)
Queen's University

The stellar continuous growth of Carleton's external research funding exemplifies our leadership and solidifies our reputation in corporate and partner engagement. Our research funding supports the training of the next generation of innovators, and ensures that our discoveries continue to make significant societal impacts both locally and internationally.
Rafik Goubran
Vice-President (Research and International)
Carleton University

York University is a leading international teaching and research University, and a driving force for positive change. York's 11 Faculties and Professional Schools conduct ambitious and groundbreaking interdisciplinary research that cuts across traditional academic boundaries, including areas such as global health, vision science, disaster risk management, liberal arts and social justice, and space exploration.
Amir Asif
Vice-President Research & Innovation
York University

The pace of change is accelerating, and universities have a key role in facilitating change in ways that benefit all Canadians. By leveraging our scholarly, research and creative activities and our collaborations, we are addressing pressing societal issues.

Together with our partners, Ryerson is driving innovation in critical areas such as health, community engagement, the future of work and advancing our digital future.
Dr. Steven N. Liss
Vice-President, Research and Innovation
Ryerson University

The pandemic has driven home the importance of collaborative research like never before and Canada's recovery will also depend on joining forces to innovate. Partnering with industry, governments and community organizations, the University of Ottawa dares to make a world of just societies, lifelong health and wellness and sustainable environments a reality.
Sylvain Charbonneau
Vice-President, Research and Innovation
University of Ottawa

We're incredibly proud of our number one ranking in research partnerships. Collaboration with community and industry partners is key in how we approach research at Sheridan, reflecting our deep commitment to radical engagement and intentional impact. Our research, innovation and entrepreneurship deliver social and economic benefits in our communities and provide transformational learning experiences for students.
Andrea England
Vice Provost, Research
Sheridan College

University of Manitoba researchers with international reputations in many areas of excellence are contributing to the cultural, economic and social wellbeing of Canadians and global citizens. I congratulate them on their accomplishments! I urge the federal government to enhance funding, to an internationally competitive level, for broad-based fundamental research in order to lay a solid foundation for a growth-focused economy as well as to tackle future pandemics.
Digvir S. Jayas, O.C.
Vice-President (Research and International) and Distinguished Professor
University of Manitoba

At Ontario Tech, we are delighted by the designation of 2021 Canada's Research Universities of the Year. As Canada's newest research intensive university, we have in two decades created an exemplary faculty complement, built extraordinary research facilities, and established deep relationships with industry partners, especially in the areas of sustainable and integrated energy systems, high performance computing, materials characterization, community wellness, and autonomous vehicles, which bodes for a bright future.
Prof. Les Jacobs, PhD, FRSC
Vice-President, Research and Innovation
Ontario Tech University

It's been a long two years. But amid all the lows we've witnessed some incredible highs, thanks to Canada's amazing research community. Indeed, research and innovation have been – and continue to be – the beacon of hope as we emerge from this pandemic. A huge shout-out to everyone – governments, business and healthcare workers – who have worked tirelessly to keep us all safe.
Karen Mossman
Vice-President, Research
McMaster University

The rankings continue to show that Lakehead University is the leader in research growth in our peer category over the past 20 years. In particular, our #1 ranking in not-for-profit research shows the importance and relevance of our university to the region we serve.

Diversity and partnerships with communities is key to our continued success in research.
Andrew P. Dean, PhD
Vice-President, Research and Innovation
Lakehead University

For 25 years, the Canada Foundation for Innovation has invested in the labs and equipment that allow researchers to chart a promising way forward, from new energy sources, to powerful medicines, to a more inclusive society. State-of-the-art research tools have never been more critical for attracting the best researchers and equipping the next generation to tackle today's challenges and bring benefits to citizens of the world.
Roseann O'Reilly Runte
President and CEO
Canada Foundation for Innovation

Through partnerships with industry, Brock research supports the economic and social vitality of Niagara, Ontario, and Canada. Our partners in the agri-food, bioproduct and biomanufacturing sectors understand the value that Brock researchers and highly trained graduates contribute, and they know we are here to work with them.
Tim Kenyon
Vice-President, Research
Brock University

Canadian Colleges play a critical role in supporting the County as we recover from the pandemic by providing research and development support to SMEs. Through applied research, Lambton College is collaborating with companies from all sectors including those from Canada's growing and emerging cleantech industries to establish and scale up new technologies with commercialization aspirations.
Mehdi Sheikhzadeh
Vice President, Research & Innovation
Lambton College

PARTNER PERSPECTIVE

The future of research must adopt a 360° approach

Amir Asif
Vice-President Research & Innovation
York University

York University conducts purposeful research that advances knowledge and creates positive change. York has experienced significant growth in areas that are having a transformative and positive impact on our communities, such as those identified by the United Nations 17 Sustainable Development Goals. Our success can be credited to our interdisciplinary and integrated approach to research, innovation, and creation.

One of the most pressing challenges we continue to face is COVID-19. Our researchers have been instrumental in the fight against COVID-19. York is the top ranked university in Canada for publications on COVID-19 and mathematical modeling. Researchers, such as **Jianhong Wu**, have been working with national and international bodies, using mathematical modeling to project COVID-19 cases and their burden on health care.

One of the most meaningful lessons we've learned from the pandemic is that such global events have the potential to disrupt every aspect of our lives, and often pose the highest risks to our most vulnerable communities. Our best bet is a 360°approach to transdisciplinary research and innovation that enables multi-pronged solutions to complex challenges. It not only enhances our ability to respond to global hazards such as climate change-induced extreme weather events, but it enables us to coordinate and collaborate in ways that can mitigate or prevent significant events that could have a dire impact on lives and livelihood, including our most vulnerable populations.

York's community of researchers are forging new areas that will help us to respond to global events, particularly through our leadership in Disaster Risk Management (DRM). **Ali Asgary** leads York's Advanced Disaster, Emergency and Rapid Response Simulation (ADERSIM) which brings together researchers from health, engineering, science and social sciences to conduct disaster research training, and to provide support to government, non-governmental and private sector partners. In collaboration with the United Nations Institute for Training and Research (UNITAR), York University is hosting Canada's first Centre International de Formation des Acteurs Locaux (CIFAL), focused on training new generations of global leaders to support a more sustainable world – socially, economically and environmentally.

In addition to DRM, our researchers in the social sciences and humanities are undertaking groundbreaking research around some of the most relevant issues facing humanity today, including COVID-19, anti-Black racism and Indigenous research, topics that underpin the fabric of an inclusive, diverse, and just society. **Christina Sharpe**, a Canada Research Chair in Black Studies in the Humanities, is leading a vibrant research hub rich with innovation research practices and projects that will advance knowledge of Black Studies.

Our researchers are game-changers in global health. Ranking number one in citation impact for health and nursing publications, they are identifying and treating diseases and developing novel solutions for complex communities, including children, aging populations and Indigenous Peoples. Our researchers are thinking outside the proverbial box to ensure global health is inclusive. **Sean Hillier** is researching the social, cultural and justice aspects of how First Nations people access health care services. Our researchers are collaborating with hospitals and mental health organizations to diagnose and treat diseases and develop tailored health care. They are examining the efficiency of vaccines, (**Catriona Buick**); investigating the molecular mechanisms underlying ovarian cancer (**Chun Peng**); and identifying biomolecular patterns and signatures of disease for use in diagnosis and prognostics (**Sergey Krylov**). Over the longer-term, York aspires for a new kind of School of Medicine to focus on integrated interdisciplinary care, family medicine, community health and wellness through the lifespan. York's community of gamechangers are committed to right the future.

York University is poised to experience exponential growth with the launch of the new Markham Campus, opening in 2023. Located in the heart of one of Canada's fastest growing tech hubs, the Markham Campus will catalyze opportunities for interdisciplinary researchers and industries to collaborate and translate innovative research across four areas experiencing technological disruption: Fintech, AI & Society, Digital Cultures and Public Policy research.

PARTNER PERSPECTIVE

HOW TO FIGHT A PANDEMIC:
Canada's Global Nexus

David Farrar
President and Vice-Chancellor
McMaster University

Being prepared for the next evolution of the COVID pandemic or another global health crisis has never been more important. How can we be ready for new variants or biological threats? How can we find more effective ways to deliver vaccines?

For starters, it requires a solid foundation of world-class infectious disease research, expertise and infrastructure; a robust hospital system with clinical trial management; and the trust and confidence of governments, academic, industry and international partners.

It requires an ecosystem of pandemic preparedness.

Canada's Global Nexus for Pandemics and Biological Threats is that ecosystem.

Based at McMaster, Canada's Global Nexus brings together experts and partners from academia, government and industry – across sectors, disciplines and borders – to develop solutions to protect communities and mitigate looming health threats.

And because of that ecosystem, our researchers were able to start clinical trials of two groundbreaking, inhaled, second-generation vaccines, with long-lasting protection against the original strain of SARS-CoV-2 and variants of concern.

The McMaster COVID vaccine – one of only a few developed in the country – is a huge development in the global race to fight the pandemic, and yet another proof of concept for Canada's Global Nexus for Pandemics and Biological Threats.

It's a remarkable achievement and one of many by researchers at Canada's Global Nexus, several of whom have been called upon to advise provincial and federal governments. They're lending their expertise in all areas: from medical and health related issues to the collateral social, economic and political ramifications of this pandemic. Our researchers are leading the way with made-in-Canada solutions.

Here's a recap of just some McMaster milestones:

• Millions of people worldwide owe their health and lives to McMaster molecular virologist Frank Graham's game-changing research on viral vectors. Indeed, his work on the Ad5 vector forms the platform for some of the COVID-19 vaccines people are receiving today.

• Shortly after the pandemic began our leading virologists were a part of the country's first team to isolate the agent responsible for COVID-19 from Canadian patients. Their discovery of this critical resource was shared with researchers across the country, paving the way for the development of vaccines and treatments.

• Experts in the McMaster Platelet Immunology Lab were called upon to combat vaccine-induced blood clots; rapidly identifying, diagnosing and treating the condition and saving the lives of Canadians and citizens around the world.

• Researchers in the McMaster Health Forum quickly established the COVID-19 Evidence Network to support Decision-making (COVID-END) – bringing together more than 50 of the world's leading teams to synthesize evidence, assess technologies and develop guidelines – to ensure decision-makers have ready-access to evidence to inform their policies.

• When panic set in over the availability of personal protective equipment (PPE) for healthcare and frontline workers, McMaster engineers, together with clinicians from our host hospitals, and our industry partners, created the Centre of Excellence for Protective Equipment and Materials – Canada's first research hub dedicated to developing, testing and validating PPE.

• Canada's Global Nexus researchers are working with diverse immigrant and Indigenous communities to better understand their immune responses and to increase vaccine confidence.

• As part of a multi-sector effort, our researchers are leading one of Canada's largest long-term care studies designed to protect our older population from COVID-19 and its impact on their physical, mental and social health.

• To help small businesses and not-for-profits recover and build resilience, McMaster-led research is examining how both sectors are navigating the pandemic and its eventual aftermath.

Our work is already having tremendous impact, yet there's so much more to do. I'm certain, with future investments from government and increased collaborations, we'll reach our full potential.

While COVID-19 is the first pandemic of our lifetimes, we expect it won't be the last. But we can be confident – thanks to the experts at Canada's Global Nexus for Pandemics and Biological Threats – that we will be much better prepared for the next.
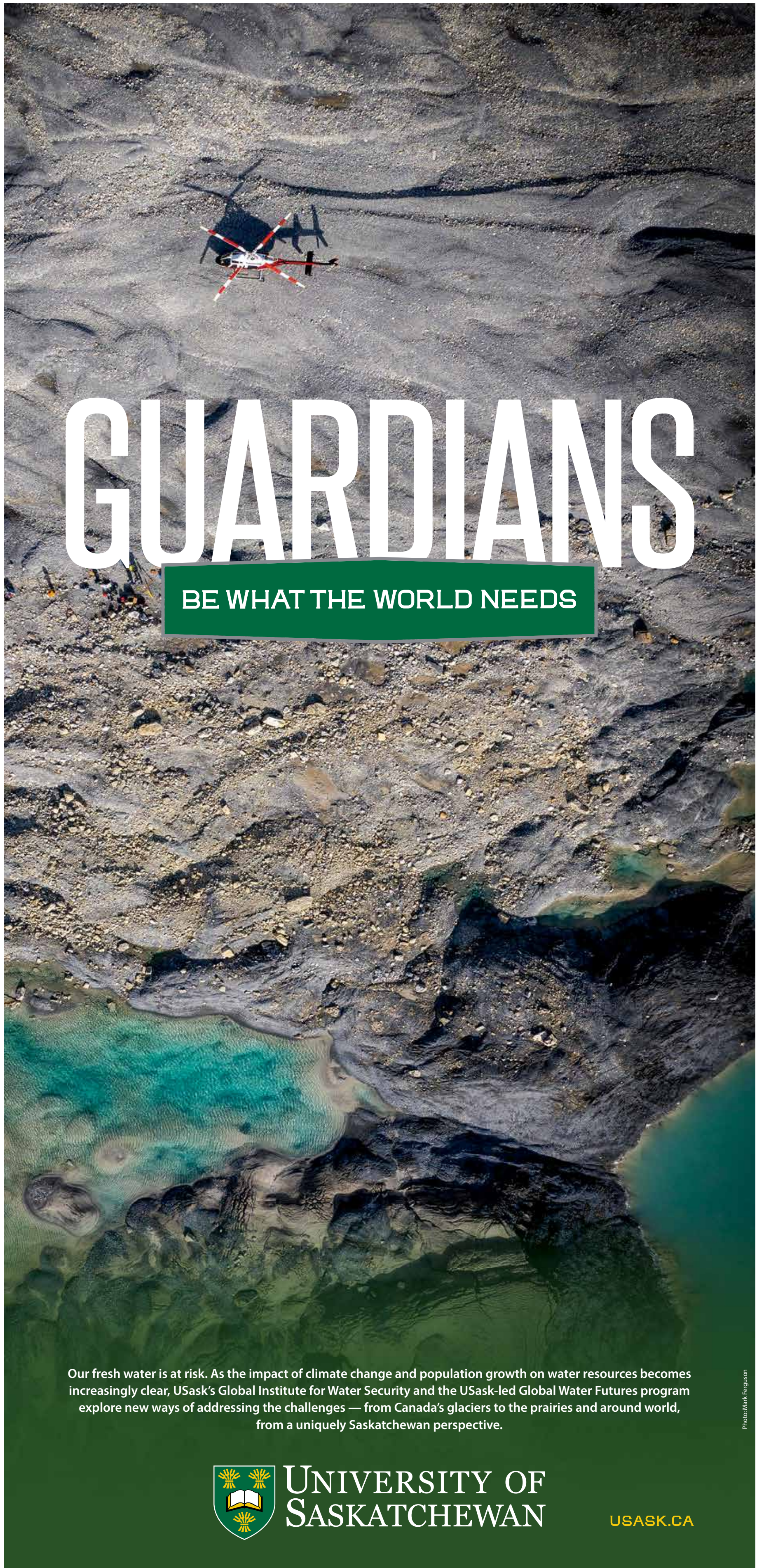
GUARDIANS

BE WHAT THE WORLD NEEDS

Our fresh water is at risk. As the impact of climate change and population growth on water resources becomes increasingly clear, USask's Global Institute for Water Security and the USask-led Global Water Futures program explore new ways of addressing the challenges — from Canada's glaciers to the prairies and around world, from a uniquely Saskatchewan perspective.
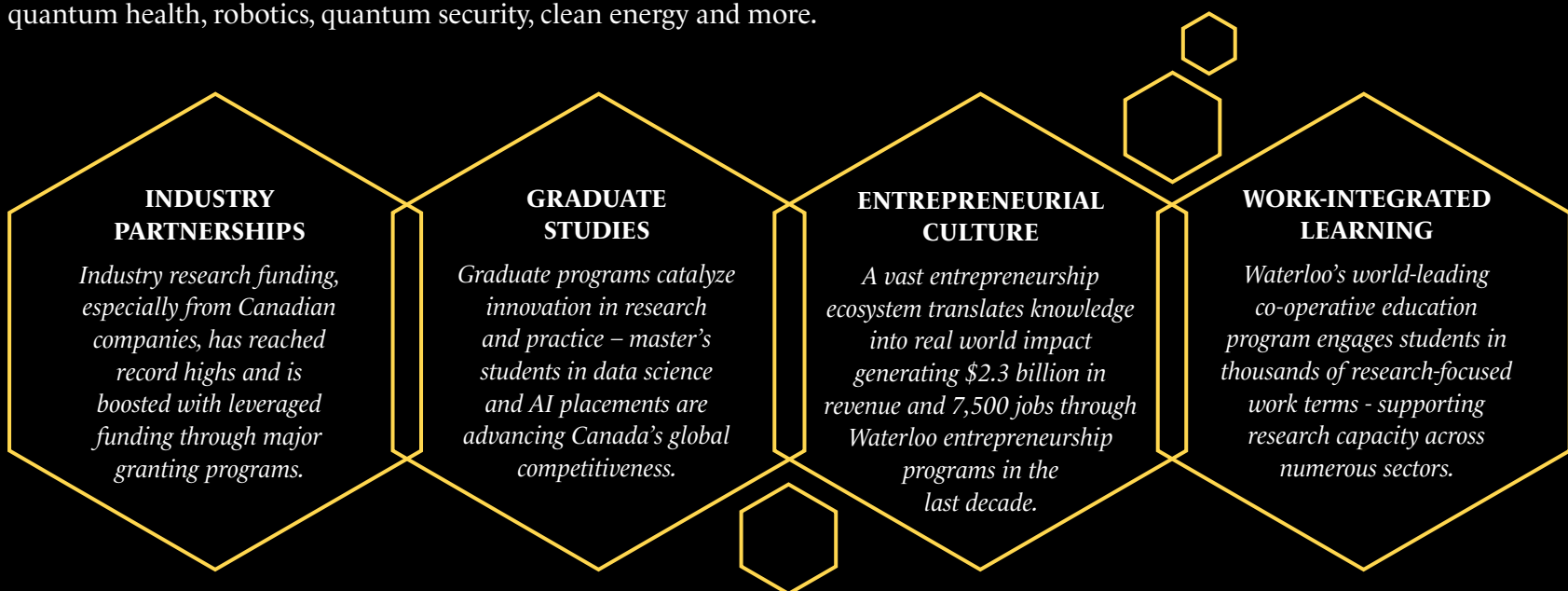
Photo: Mark Ferguson

UNIVERSITY OF SASKATCHEWAN

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PARTNER PERSPECTIVE

ADDRESSING A CRITICAL CLIMATE POLICY GAP:

Ocean Frontier Institute leading the charge for innovative ocean carbon monitoring

Dr. Anya Waite
Associate Vice-President Research (Ocean) at Dalhousie University, and Scientific Director and CEO of the Ocean Frontier Institute

Governments around the world are developing action plans, drafting policies, and setting emission targets in a collective push to address the climate crisis. In keeping with these efforts, we must also turn our attention to nature's most powerful carbon-absorbing tool: the ocean.

Sequestering more CO2 than all of the Earth's rainforests combined, the ocean is the greatest carbon sink on the planet, absorbing 40% of fossil fuel emissions to date. Current climate policy frameworks assume the ocean will continue to absorb carbon at the same rate it does now, however, scientists are warning there is evidence that the mechanisms which enable the ocean to perform this critical function are changing. While the scope of the changes and rate at which it is happening are still unknown, the fact remains that these biogeochemical processes have the potential to fail. This variable could jeopardize the credibility of global climate targets and move us further from Canada's goal of achieving net-zero emissions by 2050.

As a transnational hub for ocean research, the Ocean Frontier Institute (OFI) is bringing together experts from both sides of the North Atlantic to address this alarming information gap that has been described as "the most significant miscalculation of climate policy by nations". Established in 2016 and led by Dalhousie University in partnership, with Memorial University, and the University of Prince Edward Island, OFI's exceptional research teams are enhancing scientific understanding of our changing ocean and using the results to identify innovative solutions to complex ocean challenges.

As the deepest and most intense carbon sink in the world, the North Atlantic is particularly significant to the ocean carbon equation, accounting for roughly 30% of the total CO2 uptake in the ocean. OFI researchers are leading a project to deepen our understanding of how environmental conditions affect the Northwest Atlantic Biological Carbon Pump or BCP (the collective processes through which carbon is sequestered in the ocean), with the aim of improving decision-making around this key research area.

The evidence is mounting, both in the North Atlantic and beyond, that ocean carbon uptake is changing. In December 2021, a paper published in Nature Communications, co-authored by myself and a group of German colleagues, detailed evidence that melting sea ice can slow the biological carbon pump by as much as four months. In the Southern Ocean, there is data to suggest that this assumed sink might actually be releasing carbon back into the atmosphere, although more sampling is needed to reach a clear consensus on what is going on. The questions around ocean carbon are continuing to mount. What we need now are answers.

Building on our existing initiatives, Dalhousie and our partners are consolidating support for an ambitious solution to this critical climate policy gap: the creation of a North Atlantic Ocean Carbon Observatory (NACO). NACO would give researchers access to near real-time information on ocean carbon changes, which could then be shared with policy makers to ensure comprehensive climate calculations and targets.

Similar in concept to the International Space Station, the observatory would foster international collaboration and drive innovation by helping to create a scientific baseline which can be used to test the effectiveness of Ocean-Based Carbon Dioxide Removal technologies, while OFI's link to the Global Ocean Observing System provides an ideal foundation for developing the observatory. NACO represents an unparalleled opportunity for Canada to establish the global exemplar in ocean carbon observing, and Dalhousie is uniquely positioned to lead the charge.

FOCUS ON CANADA'S RECOVERY:
Research is key

Top research institutions are playing a critical role to ensure Canada's post-pandemic recovery is sustainable, resilient and equitable

By Debbie Lawes

What will Canada's economic recovery look like? That will depend in large part on what the science reveals.

Across the country, tens of thousands of academic researchers and their students are working with partners in industry, the public sector and civil society to develop and test the technologies, policies, and other innovative solutions that will prove critical in driving a post-pandemic recovery that is sustainable, resilient and equitable.

Research Infosource interviewed several leaders to learn what the country's top research institutions are doing to build a better Canada for future generations.

McMaster University

The speed at which research took us from the discovery of a deadly new virus to the creation of a tested vaccine is nothing short of a modern miracle. But fears remain that new variants will emerge that are more transmissible, able to evade current vaccines and lead to more severe disease.

As the pandemic transitions into an endemic phase, scientists at McMaster University are racing to develop more efficient vaccines that would cost less, have fewer side effects and be easier to store.

The research team led by Dr. Fiona Smaill received Health Canada approval in December to begin human trials for two next-generation booster vaccines specifically designed to combat variants of concern. The vaccines express three different SARS-CoV-2 proteins, including the distinctive spike protein.

"In building a vaccine against three different proteins it allows for a much broader immune response which will enable protection against new variants but also with other or similar coronaviruses," said McMaster virologist and Vice-President, Research Dr. Karen Mossman, who was part of a team of Canadian researchers who were among the first to isolate the agent responsible for COVID-19 from Canadian patients.

Unlike all first-generation COVID-19 vaccines, these new vaccines are inhaled directly into the lungs where respiratory infections begin. The research builds on two decades of R&D on a tuberculosis vaccine lead by Dr. Zhou Xing at the McMaster Immunology Research Centre.

"Another advantage," added Mossman, "is that you only need one-one hundredth of the dose, which addresses concerns about Canada's lack of biomanufacturing capacity."

The new vaccines were produced at McMaster's Robert E. Fitzhenry Vector Laboratory, one of the few facilities in Canada with the capacity to develop and produce viral vector vaccines for early phase clinical trials. The lab is part of Canada's Global Nexus for Pandemics and Biological Threats, a McMaster-based network focused on developing innovative treatments, vaccines and diagnostics, as well epidemiological models and evidence-based plans and protocols to neutralize threats.

"Canada's Global Nexus is focused on the greater good," explained Mossman. "It's great to have a vaccine but it needs to be affordable, with the right supply chain and delivered in an equitable manner. The pandemic is not going to end until those issues are addressed."

Queen's University

Cancer continues to have a significant impact on the Canadian population and health care system, driven in large part by an aging population and rising costs for treatment and care.

A new $5.2-million national partnership led by the Canadian Cancer Trials Group (CCTG) at Queen's University promises to significantly reduce these costs and save more lives using novel cell-based therapies, including CAR T-cells, that modify a person's own immune cells to detect and kill their cancer.

> " Instead of costing $400,000 or $500,000 per patient [to treat cancer] our goal is to reduce that by ten-fold.
>
> **DR. JANET DANCEY**
> Director, Canadian Cancer Trials Group, Queen's University

"It's about as personalized a therapy as you can get. It's your own white blood cells being trained to go after that cancer in you," said Dr. Janet Dancey, Director of CCTG, a national program of the Canadian Cancer Society which is collaborating with researchers and institutions across the country as part of a new network called ExCELLirate Canada.

Engineered immune cells are already being used in clinical trials to treat some forms of leukemia and lymphoma but many patients do not survive the month required to produce CAR T- cells using the current system, which often involves shipping cells to the U.S. for development.

ExCELLirate Canada is developing a revolutionary approach to locally manufacture immune cells to provide effective, low-cost therapies that can be produced in two weeks or less for clinical trials.

"It allows for all sorts of rapid innovation to develop new and better, more effective and less toxic types of approaches to treating cancer," said Dancey.

For example, CAR-T cell therapies could provide a single treatment for cancer that Dancey said "might improve survivability or even cure people", without the need for surgery, radiation or chemotherapy.

It would also save the healthcare system money. "Instead of costing $400,000 or $500,000 per patient our goal is to reduce that by ten-fold, so that the treatment itself and the trial costs may be $50,000 or $100,000 per patient," she said.

ExCELLirate Canada has already launched its first two trials, one in Ottawa and British Columbia, and a second in Alberta.

"Our group [in Kingston, Ontario] is also working on a trial that will test a new cell therapy approach for patients with multiple myeloma," added Dancey. "We hope to have that underway by the end of this year."

University of Ottawa

Ottawa is a global tech hub anchored by multinational giants, start-ups and scaleups as well as leading research institutions and large government labs. But until recently, the connection between these various players was limited.

That began to change in 2018 when Dr. Sylvain Charbonneau was named the University of Ottawa's Vice-President, Research and Innovation. It was the same year the federal government invested $2.8 billion to revitalize federal labs and facilitate closer links with academia and industry.

"Before 2017, little effort was made to reach out to this ecosystem. A big priority for me was to further link our university with the Ottawa ecosystem, including federal labs and the high tech sector," said Charbonneau, a former physicist with the National Research Council of Canada.

One key initiative was to establish a satellite campus in Kanata North, Canada's largest technology park located in the west end of Ottawa.

"We surveyed companies in Kanata North and learned they need three things: talent, reskilling of their workforce and help with advanced research," he said. "Talent is the new currency and is key to helping Canada build back better, which is why it's important for us to have a physical presence there."

Charbonneau said uOttawa is also putting the city's health innovation ecosystem "on steroids" by better connecting its medical school and six affiliated health research institutes and five local hospitals through a planned 32,516 square metre research and innovation, incubation and acceleration centre.

The Ottawa Health Innovation Hub will support smart health and precision medicine, from discovery science to the translation of that research into new health practices and procedures, as well as biotech, medtech and digital health startups. The hub will be anchored in the Advanced Medical Research Centre, scheduled to break ground in early 2023.

The next generation of mobile technology will take these linkages to the next level. In January, uOttawa and Telus announced a five-year partnership to transform its campuses into a 5G-connected innovation hub, propelling advances in areas like smart medicine, health and cybersecurity.

Said Charbonneau: "Having a more coordinated innovation ecosystem will help us build back better and be more resilient as we prepare for the next pandemic."

University of Guelph

Food security is a priority at the University of Guelph, where researchers are examining how climate change, and more recently the pandemic, are driving the need for more sustainable practices in the agri-food sector.

Much of this work is happening as part of a $76.6-million grant – the largest single federal research investment in U of G history – that supports 165 interdisciplinary faculty and more than 300 graduate students and post-doctoral fellows in the Food from Thought project. Its goal is to leverage big data to improve food production and biodiversity, both globally and locally.

"We're now looking at the next phase of that project. The pandemic has exposed, laid bare and/ or amplified challenges that exist within food systems," said Dr. Malcolm Campbell, Vice-President (Research) at U of G, known as Canada's Food University.

U of G is also helping public health units better track the spread of COVID-19 in communities, though that's not what the initial research intended. Food safety expert Dr. Lawrence Goodridge and his team had developed a way to use genomics to detect food-borne pathogens in sewage. That same technology is now searching for coronavirus variants in wastewater in several municipalities.

"This is a huge help right now in Ontario where we have pared back our individual testing to be able to have that population-level surveillance," said Campbell. "It was wonderful to see so many of our people that operate already in that safety space – food safety, food-borne pathogens and animal pathogens – pivot so quickly to use their research to help with the pandemic."

U of G works closely with industry and government to identify problems, and to develop evidence-informed, farm-tested innovations that can be put into practice. Key to this approach has been the Ontario Agri-Food Innovation Alliance, an approximately $90-million-a-year collaboration between the Ontario Ministry of Agriculture, Food and Rural Affairs and the U of G that supports research, training, and laboratory capacity.

"This partnership is about addressing real-life priorities that are set by the province but are coming from industry," said Campbell. "Moving research out in the real world is a point of pride for us. Our tag line is 'improve life', and we live that tagline. It's not just a platitude for us."

University of Manitoba

Much of Canada's post-pandemic recovery plans align with the United Nation's Sustainable Development Goals, including one to "reduce food losses along production and supply chains" by 2030.

Post-harvest losses have been a particular problem with grains such as wheat, barley and pulses, which suffer annual losses of about 20%, or 640 million tonnes, enough to feed nearly 1.5 billion people every year.

Dr. Digvir Jayas and other scientists at the University of Manitoba (UM) have already made significant progress in improving post-harvest storage and handling to minimize waste. Jayas, who is also Vice-President (Research and International), pioneered the concept of drying grain by forcing air horizontally rather than vertically to reduce energy costs during the drying process, resulting in more uniformly dried grains.

"Today, horizontal drying systems are being used in Canada and around the world, including Ukraine, the US and China. In 2018 when I visited China the engineers there estimated in that particular year more than two million tonnes of grain were dried using horizontal drying system," said Jayas, who currently leads the world in the development of 3-D mathematical models to predict heat, moisture and gas transfer, and movement of insets in stored grains.

UM has a long history of agri-food research successes, its most notable being the development in 1961 of canola by Baldur Stefansson, known as the "Father of Canola". Today, the canola value chain contributes nearly $30 billion to the economy annually, according to the Canola Council of Canada.

Researchers also focus on developing new grain varieties for winter wheat, canola and rapeseed, studying the impacts of climate change on crop yields, and developing healthier crops.

A more recent challenge is the vulnerabilities in Canada's food supply chains. One solution, according to a recent report by UM agricultural economist

Dr. Jared Carlsberg, is to lift barriers to interprovincial trade – such as transport and meat-processing regulations – that constrict the freer flow of goods and services in Canada.

"One thing the pandemic showed very clearly was the problems with the logistics," said Jayas. "Even if you have food, if you cannot distribute it to the consumer it has the potential to have a negative impact on society."

University of Waterloo

Passenger air travel has been one of the hardest hit global industries throughout this pandemic. Even before the arrival of COVID-19, the industry was facing personnel shortages and regulatory pressure from many countries to reduce its carbon and noise emissions.

"These issues have been in play for a long time. Now they've become even more acute because of the pandemic," said Dr. Charmaine Dean, Vice-President, Research & International, University of Waterloo, home of Canada's largest university-level aviation program.

In response, the university recently launched Canada's first research institute for sustainable aviation and aerospace. The Waterloo Institute for Sustainable Aeronautics (WISA) brings together 50 researchers from six faculties – science, environment, arts, mathematics, health and engineering – to work with industry and government to drive social, environmental and economic change. In addition to research to reduce CO2 emissions, researchers also address social factors like professional education, human-computer interaction and a diverse and inclusive workforce.

"The importance of the institute is that it's focused on a critical problem that the industry urgently needs to solve," said Dean. "Having industry partners directly involved with the institute increases the likelihood of the research being quickly adopted by industry."

Interdisciplinary research is becoming the go-to approach for addressing many complex issues, including how to help the elderly stay in their homes longer. COVID-19 exacted a heavy price on Canada's long-term care and retirement homes, especially during the first wave of the pandemic when residents accounted for more than 80% of all COVID-19 deaths, and staff at these facilities represented more than 10% of the country's total cases, according to the Canadian Institute for Health Information.

Coming up with technological solutions is the focus of researchers at the RoboHub and its Intelligent Technologies for Wellness and Independent Living Lab.

"Waterloo has focused for some time on how assistive devices like exoskeletons, a type of wearable device that helps with mobility, can make independent living a reality for more elderly citizens," said Dean. The research draws on fields such as materials science, medical imaging, engineering and the emerging field of social robotics, where human-centred robots can help ease the social isolation and loneliness experienced by many older adults.

Carleton University

Technology alone won't solve the challenge of reaching Canada's target of net zero emissions by 2050. At Carleton University, Dr. James Meadowcroft is studying how dramatic changes are needed to large-scale systems of social provisioning, including transportation, urban design and food production.

"We have had many similar changes in such systems in the past, such as the electrification of society, the rise of the internal combustion engine, indoor plumbing and, more recently, the digital revolution," explained Meadowcroft. "My research looks at what lessons we can learn from those historic episodes to help us navigate through the climate change issue. That will require multiple transitions in multiple systems."

Meadowcroft recently co-launched the Transition Accelerator, a not-for-profit that collaborates with targeted groups to solve major business or social challenges, and identify where greenhouse gas reductions can be built into the solutions. For example, it helped found an organization to unite the Zero Emission Vehicle industry supply chain.

"This includes mining companies through to battery and cell manufacturers and automotive manufacturing right through to charging stations" he said. "You also need to change regulations and insurance, get automobile dealers on board and build public acceptance. You need all these people working together to help build out this industry in Canada."

In Alberta, for example, the Transition Accelerator partnered with the Alberta Motor Transport Association to test the ability of hydrogen fuel cells to replace diesel for heavy-duty freight trucks. It also played a key role in setting up the Edmonton Hydrogen Hub.

"Now others have been calling us from other regions asking if they could be part of this too," said Meadowcroft. "You have to show that change is possible and then more people get involved and then more doors open that weren't open to you before."

In another initiative, The Transition Accelerator is working with government, companies and NGOs to decarbonize the building sector in ways that are affordable and equitable.

"People don't just want net-zero houses, they want houses that are comfortable and affordable. If they're in indigenous communities they don't want substandard housing," said Meadowcroft. "The challenge is how do we link this work to deal with these other social issues affecting the various sectors of the decarbonisation process?"

Baycrest

Most older adults in Canada want to remain at home for as long as possible as they age. That's a priority for governments across Canada and for Baycrest, a University of Toronto-affiliated research and teaching hospital for older adults.

"We want to help older people live their best possible lives, no matter where they live," said Dr. Allison Sekuler, President & Chief Scientist, Centre for Aging + Brain Health Innovation (CABHI) and Baycrest Academy for Research and Education at Baycrest Centre for Geriatric Care.

Scientific discovery at Baycrest, which also provides a range of elder-focused healthcare and residential living, is focused at the Rotman Research Institute (RRI), one of the world's top research institutes in cognitive neuroscience and aging. The RRI pairs novel behavioural and mental health assessments and neuroimaging with sophisticated analyses to answer fundamental questions about memory, aging, and the neuroscience of perception and cognition.

"Predictive neuroscience can drive new approaches to prevention, early detection, and care," said Sekuler. "We can prevent cognitive decline by detecting its behavioural and biological markers as early as possible, ideally before there are any memory symptoms. If we can slow down the progression of Alzheimer's by just five years, we will decrease its prevalence by 50 percent."

Researchers are also looking at how a person living with dementia can thrive in the community or in long-term care. For example, with support from the Baycrest-powered CABHI, a University of Toronto and Baycrest scientist developed a smartphone app, called HippoCamera, which assists those suffering from memory loss, including Alzheimer's.

Another Baycrest project, bringing together collaborators from Baycrest's Ontario Centre for Learning, Research and Innovation, the RRI, and CABHI, recently received $1.2 million from the Ontario government to develop the Learning Inter-Professionally Healthcare Accelerator (LIPHA) – a virtual training program that combines simulation and game-based learning to rapidly train personal support workers, nurses, and students working in long-term care.

"LIPHA, which is available for free in Ontario, is being used by long term care homes who want to upskill or retrain their staff," said Sekuler. "We're using it here at Baycrest's long-term care home as well, because whether older adults live at home in the community or in long term care, we want our research to help them age fearlessly."

Humber College

Social media, connected devices, sensor technology and other modern information systems collect an immense wealth of data that can be harnessed to help with Canada's post-pandemic recovery. But businesses and communities first have to understand what all this data means before they can use it.

Dr. Ginger Grant, Dean in the Office of Applied Research and Innovation at Humber College, is leading a $200,000 project to establish an Institute for Design Analytics, which is developing new ways to analyze data from the past to design a better future.

RESEARCHERS' CORNER

As part of the research team at Canada's Global Nexus for Pandemics and Biological Threats, headquartered at McMaster, I work alongside some of the country's best and brightest who are dedicated to keeping Canadians safe. Our unique ecosystem that fosters innovation through multidisciplinary and multi-sector collaboration has catalyzed made-in-Canada breakthroughs that will speed our path to recovery and enhance our preparedness for future infectious disease threats.

Matthew Miller
Associate Professor
McMaster's Michael G. DeGroote Institute for Infectious Disease Research

At the forefront of research on the emergence and spread of SARS-CoV-2 variants, Dr. Marc-André Langlois of the University of Ottawa's Faculty of Medicine leads the Coronavirus Variants Rapid Response Network (CoVaRR-Net). The network brings together interdisciplinary researchers in more than 90 teams across the country, whose rapid research findings help the Canadian government and public health authorities address the potential threat of emerging variants to keep Canadians safe.
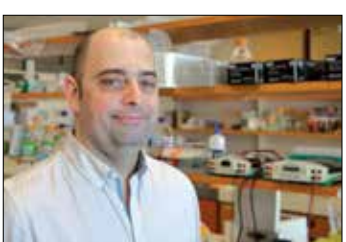
Dr. Marc-André Langlois
Faculty of Medicine
University of Ottawa

Dr. Karthik Tennankore is making great strides in kidney disease research and care. He played a key role in the establishment of a highly regarded nephrology research program and has also made a name for himself throughout Canada, and around the world. By identifying clinical issues that are impacting the health of patients with kidney disease and trying to better understand them, he is informing future treatments to better their health.

Dr. Karthik Tennankore
QEII Foundation Endowed Chair in Transplantation Research
Nova Scotia Health

Modelling disease with novel software tools
By harnessing powerful tools like machine learning and artificial intelligence for medical images, at Ryerson University, Dr. April Khademi is furthering our understanding of diseases such as dementia and breast cancer.

At the Image Analysis in Medicine Lab, she is leading the development of novel software tools to extract insights from magnetic resonance and digital pathology images, investigating the causes and progression of neurodegeneration and breast cancer.

This critical work offers an innovative approach to disease modelling.

Dr. April Khademi
Assistant Professor
Department of Electrical, Computer, and Biomedical Engineering
Ryerson University

COVID-19 has heightened inequities faced by many groups. Dr. Katrina Milaney is a local and national advisor on the relationship between the pandemic and growing vulnerabilities and is leading several innovations to bridge systemic gaps. One national project is focused on healing and reunification for at risk families. Lessons from the pandemic are being used to re-imagine homelessness prevention as a strategy towards inclusion and equity, necessary to break multi-generational marginalization for children and youth.

Dr. Katrina Milaney, PhD
Associate Professor, Department of Community Health Sciences
Cumming School of Medicine
University of Calgary

The skilled trade industry expects a significant labour shortage in the next ten years. Drs. Amin Yazdani and Marcus Yung of the Canadian Institute for Safety, Wellness, & Performance (CISWP) are leveraging their interdisciplinary applied research expertise and network of industry partners to develop job specific data-driven solutions to support a rapidly aging and increasingly diverse workforce and reduce the risk of disabling injuries. Collectively, these solutions will address challenges related to recruitment and retention of skilled trade workers and will ultimately ensure Canadian businesses succeed and prosper.

Amin Yazdani, PhD, CSP
Director, CISWP

Marcus Yung, PhD, CPE
Research Manager, CISWP

School of Business
Conestoga College

Saskatchewan Polytechnic's Digital Integration Centre of Excellence Technology Access Centre (DICE-TAC) has achieved its five-year revenue goal in two years. Dr. Terry Peckham leads the 40 person DICE-TAC team to work with industry partners across Canada. Terry's area of expertise involves data analytics, artificial intelligence and data storage. The vast majority of his current research projects involve the industrial application of machine learning (especially with sensor-based systems), data integration and migration for machine learning across data silos.

Dr. Terry Peckham, PhD
Director and Research Chair,
Digital Integration Centre of Excellence Technology Access Centre (DICE-TAC)
Saskatchewan Polytechnic

Can we use artificial intelligence to detect patients at risk for Alzheimer's disease? York Research Chair and VISTA member Shayna Rosenbaum studies the relationship between brain and behaviour. She is collaborating with Baycrest Health Sciences and VISTA researcher James Elder to harness AI to characterize and correct spatial navigation difficulties in older adults. The research could help health care providers detect and treat individuals who are at risk of developing Alzheimer's.

Shayna Rosenbaum
Professor, Faculty of Health
York Research Chair in Cognitive Neuroscience of Memory

A ground-breaking optical imaging system is reducing wait times for diagnosis of cancer and eye disease. Photoacoustic Remote Sensing (PARS®) microscopy, invented by Professor Parsin Reza, has replicated the gold-standard histology from fresh unprocessed cancerous human tissues shrinking diagnosis from weeks to seconds while enabling complete cancer removal during surgery. PARS non-contact eye-imaging has captured the attention of top ophthalmologists internationally by showing promise in detecting blinding diseases *before* vision is affected.

Parsin Haji Reza
Assistant Professor, Systems Design Engineering
University of Waterloo

Amal Driouich
Program Manager

Gordon Maretzki
Centre Manager

Walker Advanced Manufacturing Innovation Centre
Niagara College

Niagara College research teams are recognized for their ability to move forward with agility, responding to industry needs. For example, team leaders Amal Driouich and Gordon Maretzki led their innovation centre to acquire materials, design and produce more than 35,000 face shields to overcome supply-chain issues for healthcare facilities in the early months of the pandemic. For their efforts, the team earned a 2021 Everyday Heroes Award of Excellence from the Ontario Minister of Colleges and Universities.

CANADA'S Innovation

Canada's innovation community continues to be at the forefront of research and discovery

Through entrepreneurship, commercialization and social innovation, researchers in our universities, hospitals, colleges and companies are turning their leading-edge research into products, technologies and services that advance our economy and improve the lives of citizens the world over. Take a look at how their work is transforming society

The **CCNB-INNOV** Network is one of Atlantic Canada's premier resources for applied research and innovation. Its three divisions support businesses in agriculture, bioprocesses, advanced manufacturing, robotics, artificial intelligence, and advanced materials.

CCNB-INNOV's agriculture and biotechnology division is certified by Health Canada as a cannabis research institution, has extensive research experience in the brewing and distillery industry, and is proficient in agriculture and watershed management research.

It's advanced manufacturing division is specialised in fields such as prototype development, robot welding and robotics applications.

CCNB-INNOV's advanced materials division works hand in hand with the naval industry in composite material, including infusion molding.

With our cutting edge equipment and personnalised and flexible service, our experts offer assistance in a wide range of areas such as feasability studies, scientific and technical support, and integration of existing and emerging technologies.　🛈 **ccnb.ca/innov**

Carleton University's Institute for Advanced Research and Innovation in Smart Environments (ARISE) is a hub for interdisciplinary thinking and world-class training of the next generation. More than just a building, ARISE embodies the university's leadership and commitment to corporate partnerships. The flexible work environments foster collaboration between students across faculties so they can gain marketable skills while working on solutions to emerging challenges. It also serves as a space for industry to pursue their R&D needs and attract investors to exploit their intellectual property across the university. Relationships fostered here inspire entrepreneurial thinking, facilitate industry-driven research, and fuel growth.　🛈 **research.carleton.ca**

ARISE Building at Carleton University.

Nova Scotia's New Health Innovation Hub: The first of its kind in Atlantic Canada, Nova Scotia Health's Innovation Hub is a centre of excellence for health research and innovation. By offering an agile, adaptable, and creative space for researchers, clinical teams, partners and investors to come together, we are focused on providing high-impact solutions that address healthcare's biggest challenges. We are discovering, innovating and implementing solutions that contribute directly to the betterment of Nova Scotians.

Future Nova Scotia Health Innovation Hub collaboration space, as part of the QEII Health Sciences Centre redevelopment.

Nova Scotia Health is proud to be further strengthening our culture of continuous quality improvement that seeks out data, experience and evidence to improve practice. It is truly a new era of collaboration with our partners and building capacity in the healthcare system. This is how we are propelling healthcare in Nova Scotia to new heights.

🛈 **nshealth.ca/research-innovation-discovery**

York University is a world-leader in vision science, including computer vision and biological vision. York was recognized for its contributions to vision research with $33 million in funding from the prestigious **Canada First Research Excellence Fund** to launch Vision: Science to Applications (VISTA) led by York Research Chair Doug Crawford.
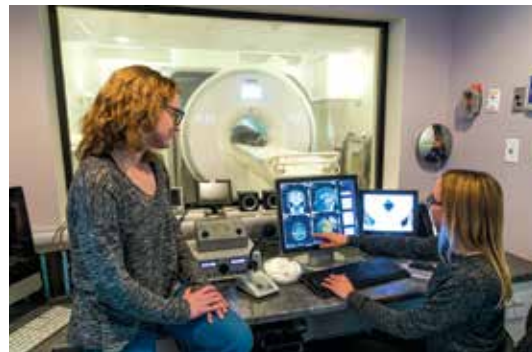
VISTA realizes the potential of disruptive technologies and real-world applications to impact both human and machine vision. VISTA brings together interdisciplinary researchers to help solve global challenges. **Laurence Harris**, **Michael Jenkin** and **Lauren Sergio** are advancing virtual-reality displays to treat patients with vision-related health limitations. **James Elder** and **Michael Jenkin** are applying computer vision techniques to improve machine vision for autonomous vehicles and field robotics. **Shital Desai** is developing inclusive design solutions in assistive adaptive technologies, and **Mary Bunch** is researching the intersection of political imagination and its visual/sensory expressions.　▶ **yorku.ca/research**

Humber College has established Canada's first Broadcast-Broadband *Convergence B²C* Lab to explore multisectoral data delivery applications enabled by the new Advanced Television Systems Committee (ATSC) 3.0 television broadcast standard. ATSC 3.0 runs on an IP (internet protocol) backbone and integrates with other global data delivery standards, including Wi-Fi and 5G. Offering enhanced audio-visual features and full broadcast mobility, ATSC 3.0 is currently the world's most efficient one-to-many data delivery system.

The *B²C* lab fosters partnerships between Humber and the private sector leading to business innovation at local, regional and national levels.

The *B²C* lab is housed in the Barrett Centre for Technology Innovation. Phase one of the lab is now operational. Phase two is expected to be completed by the summer and will include a multiple transmitter/antenna test bed set up across Humber North and Lakeshore campuses to form a broadcast inter-tower communication network with Single Frequency Network capabilities.　🛈 **B2convergence.ca**

Photo: Oakville Beaver

Sheridan's Centre for Elder Research (CER) translated its expertise on issues facing older adults by responding to urgent needs brought on by the pandemic. CER's Putting Food on The Table project brought together Sheridan researchers, students, and local community organizations to better understand and improve the food and social needs of older adults living in community housing who were affected by COVID-19 restrictions. In response to the pandemic, a local community organization created a Senior's Healthy Food Package delivered to the door of older adults who were unable to access fresh food. The Centre researched how well the package met client needs, and what gaps remained to address food security and isolation during COVID-19. After the package was enhanced based on CER's findings, high levels of satisfaction with the package jumped from 8% at initial baseline to 66% at the end of the project.

🛈 **elderresearch.sheridancollege.ca**

Achievements

The **University of Ottawa**'s new Smart Connected Vehicles Innovation Centre has teamed up with tech industry partners to accelerate the future of connected and autonomous vehicles. Located at the University's Kanata North campus, in the heart of Canada's largest technology hub, the cutting-edge research facility offers cost-effective experimentation for connected and autonomous vehicles, including self-driving car prototypes, drones and robots. Led by engineering professor Burak Kantarci and staffed with a team of researchers, the centre focuses on AI-based solutions to problems related to the connectivity, cyber-physical security, and sustainability of vehicular networks. A unique open access lab, it draws together experts, from computer scientists and engineers to social scientists, economists, and ethics and compliance specialists, to maximize innovation in this rapidly growing sector. For such transformative research collaborations with industry, Professor Kantarci was recently awarded the Ontario Minister of Colleges and Universities' Award of Excellence for innovation and entrepreneurship.   *i* **uOttawa.ca/research-innovation/**

Cambrian R&D, the applied research arm of **Cambrian College**, helps industry and community partners in Sudbury, Ont. innovate by connecting them with student researchers and our expert staff and faculty. Drawing from the department's suite of specialized equipment and engineering staff, along the college's range of academic programs, Cambrian R&D has what you need to tackle any challenge.

We are especially suited to take on mining innovation projects. In 2019, Cambrian was awarded its first Technology Access Centre (TAC), a specialized research hub, from the Natural Sciences and Engineering Research Council of Canada.

Cambrian's Centre for Smart Mining is the only one in Canada with a focus on facilitating technology adoption in the mining sector. The Centre demystifies new technologies in the industry by creating strategic R&D partnerships and access to specialized equipment.

Learn more about how Cambrian R&D and the Centre for Smart Mining can accelerate your business.   *i* **cambriancollege.ca/rd**

Ontario Tech University's Brilliant Energy Institute (BEI) harnesses the university's energy research, labs and expertise to lead a just and timely transition to meet Canada's vision for net zero by 2050. As a change agent for decarbonization of energy systems, BEI is helping Canada meet climate change goals with infrastructure that will strengthen prosperity, quality of life and equality for Canadians and people, worldwide. Home to Canada's new International Atomic Energy Agency Collaborating Centre, BEI leverages Ontario Tech's research strengths in hydrogen, traditional-scale nuclear and small modular reactors, solar, thermal power, geothermal, life-cycle analysis, and related fields including cyber security, transportation, aerodynamics and data sciences. Through an inter-disciplinary approach, BEI advances and connects technologies to build clean energy systems; provides relevant data and context to inform policy and strengthen energy literacy; and creates inclusive collaboration across academia, industry, government and a diversity of communities to spark innovation. BEI is tech with a conscience and a vision for a brilliant future.

i **research.ontariotechu.ca/discover-research/welcome-message.php**

Ryerson University: Collaborating to drive responsible innovation in artificial intelligence

From our homes to our city streets, artificial intelligence (AI) has become embedded in almost every aspect of our lives. Launched in fall 2021, Responsible Artificial Intelligence (RAI) is led by Ryerson's Dr. Ebrahim Bagheri and a team of academic collaborators, with stakeholders from industry, government and civil society groups such as advocacy organizations. This innovative initiative has students engage with topics like policy and AI governance, civic responsibility and justice, and equality while offering emerging talent the opportunity to acquire the skills and knowledge they need to create responsible and beneficial AI.

As one of the first formal, multi-institutional training initiatives of its kind in Canada, RAI will help the next generation of AI experts learn about the critical importance of the social, legal and ethical implications of the technology as well as its unintended byproducts, such as biases, discrimination and invasion of privacy.   *i* **ryerson.ca/research**

Dr. Ebrahim Bagheri
Associate Professor and Canada Research Chair in Social Information Retrieval
Department of Electrical, Computer and Biomedical Engineering
Ryerson University

Scientists at **McMaster University** have developed an inhaled vaccine that delivers long-lasting protection against SARS-CoV-2 and variants of concern.

The team – all members of Canada's Global Nexus for Pandemics and Biological Threats – demonstrated the benefits of inhaled vaccines over traditional injections. In addition to being needle- and pain-free, an inhaled vaccine is so efficient at targeting the lungs and upper airways that it can achieve maximum protection with a small fraction of the dose of current vaccines – possibly as little as one percent – meaning a single batch of doses could go 100 times farther.

Such an alternative delivery method could be game-changing, given the challenges with vaccine supply.

The second-generation vaccine – one of only a handful developed in Canada – is effective against highly transmissible variants because it targets three proteins, two of which don't mutate, which is why it works.

Researcher Michael D'Agostino demonstrates use of the inhaled vaccine system.   Photo: Georgia Kirkos

The McMaster vaccine is now in clinical trials to evaluate its effectiveness in healthy adults who have received two mRNA vaccine doses.   *i* **globalnexus.mcmaster.ca**

RRC Polytech is Manitoba's largest institute of applied learning and research. Working alongside industry we find innovative solutions to real-world challenges, while also providing students with the applied knowledge to succeed in their future careers. Home to three Technology Access Centres and two active research capacity building programs, the scope of research spans sectors from aerospace to early childhood development to zero-emission vehicle technology and beyond.

Our Vehicle Technology & Energy Centre collaborated with Frontiers North Adventures, one of Canada's top three sustainable tourism operators, on a proof-of-concept project to convert their Tundra Buggy® – a 40-seat off-highway vehicle – from diesel-powered to a state-of-the-art battery electric vehicle. The result: a new zero-emission vehicle technology application that will reduce greenhouse gas emissions by 8.3 tonnes in one tourist season, achieving their goal of reduced environmental impact as well as creating new clean tech jobs.   *i* **rrc.ca/research**

Photo supplied by Frontiers North Adventures

IT COVERS 70 PERCENT OF THE PLANET BUT

THE OCEAN IS MISSING

The world's ocean stores 50 times more carbon than the atmosphere. But it is changing rapidly, and Professor **Anya Waite** says we need to know how if we're to meet Canada's goal of net-zero emissions by 2050.

Dr. Waite, Scientific Director and CEO of the Ocean Frontier Institute at Dalhousie University, is leading a global conversation to improve ocean carbon absorption monitoring. Together with colleagues across Canada and around the world she's ensuring the science of the changing ocean isn't missing when we calculate global climate targets.

13 CLIMATE ACTION   **17 PARTNERSHIPS FOR THE GOALS**

It's work that supports Dalhousie's commitment to the **United Nations' Sustainable Development Goals**.

DALHOUSIE UNIVERSITY | LEARN MORE AT **OCEANFRONTIERINSTITUTE.COM**

SPOTLIGHT ON

Two decades of university research progress
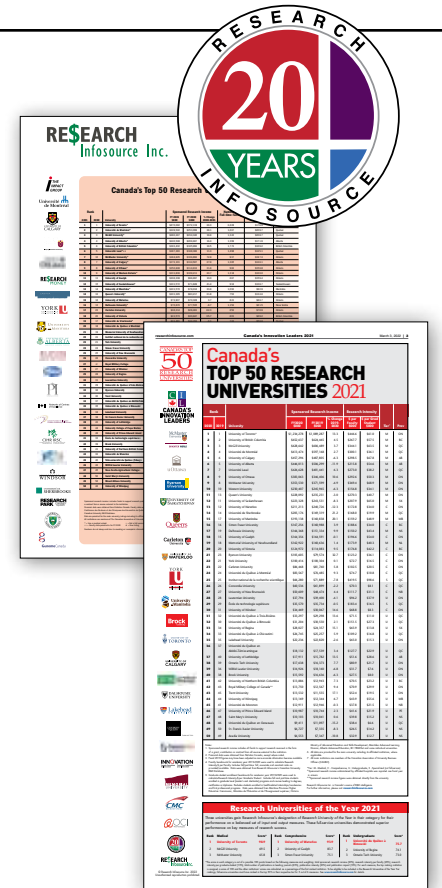
2020

2001

In association with its 20th anniversary, Research Infosource shines the spotlight on two decades of university research progress in terms of attracting research income and producing peer-reviewed academic publications

20-Year Spotlight - Research Income Growth   % Change FY2001-FY2020

Total Research Income			Corporate Research Income			Not-for-Profit Research Income		
Rank	**Medical**	**%**	**Rank**	**Medical**	**%**	**Rank**	**Medical**	**%**
1	**Université de Sherbrooke**	**394.6**	**1**	**Memorial University**	**715.1**	**1**	**Université de Sherbrooke**	**541.6**
2	Memorial University of Newfoundland	375.3	2	Université de Sherbrooke	279.4	2	University of Toronto	278.0
3	University of British Columbia	237.4	3	Queen's University	220.7	3	University of British Columbia	272.3
4	University of Calgary	165.7	4	University of Saskatchewan	122.2	4	University of Manitoba	265.3
5	University of Toronto	162.6	5	University of Toronto	102.4	5	University of Alberta	251.9
	Base (16)			Base (14)			Base (14)	
Rank	**Comprehensive**	**%**	**Rank**	**Comprehensive**	**%**	**Rank**	**Comprehensive**	**%**
1	**Ryerson University**	**1,071.3**	**1**	**Concordia University**	**247.4**	**1**	**Concordia University**	**6,589.6**
2	Simon Fraser University	558.1	2	Simon Fraser University	236.0	2	Ryerson University	1,589.3
3	York University	260.4	3	Ryerson University	228.8	3	University of Windsor	1,347.7
4	University of Victoria	200.6	4	York University	222.8	4	Simon Fraser University	670.1
5	Concordia University	192.8	5	University of Waterloo	134.4	5	Carleton University	426.3
	Base (11)			Base (11)			Base (11)	
Rank	**Undergraduate**	**%**	**Rank**	**Undergraduate**	**%**	**Rank**	**Undergraduate**	**%**
1	**Université du Québec à Rimouski**	**407.1**	**1**	**Lakehead University**	**467.3**	**1**	**Lakehead University**	**7,712.5**
2	Wilfrid Laurier University	325.1	2	Trent University	278.0	2	Trent University	3,363.6
3	Lakehead University	283.2	3	Royal Military College	261.8	3	University of Northern British Columbia	1,045.1
4	University of Lethbridge	239.2	4	Université du Québec à Rimouski	223.8	4	University of Regina	887.3
5	Laurentian University	221.3	5	University of Regina	168.0	5	Université du Québec à Rimouski	698.3
	Base (15)			Base (14)			Base (13)	

Notes:
1. Based on full-service universities on the Top 50 Research Universities list for all 20 years; and reported research income from both corporate and not-for-profit sources in FY2001 and FY2020.
2. Total Research Income: funds to support research received in the form of a grant, contribution or contract from all sources external to the institution.
3. Corporate and Not-for-Profit Research Income: funds to support research received in the form of a grant or contract from corporate and not-for-profit sources respectively.
4. Financial data were obtained from Statistics Canada.

20-Year Spotlight - Research Publication Growth   % Change 2000-2019

Total Research Publications			International Collaboration Publications			Cross-sector Collaboration Publications		
Rank	**Medical**	**%**	**Rank**	**Medical**	**%**	**Rank**	**Medical**	**%**
1	**University of Ottawa**	**264.3**	**1**	**University of Ottawa**	**579.3**	**1**	**University of Calgary**	**522.3**
2	Memorial University of Newfoundland	241.3	2	Memorial University of Newfoundland	552.9	2	University of Ottawa	486.1
3	University of Calgary	226.2	3	University of Calgary	433.1	3	Queen's University	467.6
4	University of British Columbia	199.2	4	University of Alberta	406.2	4	Université de Sherbrooke	448.1
5	University of Alberta	181.0	5	University of British Columbia	401.0	5	Dalhousie University	364.9
	Base (16)			Base (16)			Base (16)	
Rank	**Comprehensive**	**%**	**Rank**	**Comprehensive**	**%**	**Rank**	**Comprehensive**	**%**
1	**Ryerson University**	**1,084.0**	**1**	**Ryerson University**	**2,523.5**	**1**	**Ryerson University**	**2,066.7**
2	Concordia University	258.0	2	University of New Brunswick	569.2	2	York University	759.6
3	University of Waterloo	228.8	3	Concordia University	498.3	3	University of Victoria	637.5
4	Simon Fraser University	202.3	4	Université du Québec à Montréal	495.1	4	Simon Fraser University	614.5
5	Carleton University	200.0	5	Simon Fraser University	472.5	5	University of Waterloo	548.6
5	Université du Québec à Montréal	200.0		Base (11)			Base (11)	
	Base (11)							
Rank	**Undergraduate**	**%**	**Rank**	**Undergraduate**	**%**	**Rank**	**Undergraduate**	**%**
1	**Lakehead University**	**321.3**	**1**	**Wilfrid Laurier University**	**1,255.6**	**1**	**University of Northern BC**	**1,000.0**
2	Wilfrid Laurier University	312.2	2	Brock University	826.9	2	Université du Québec à Trois-Rivières	790.9
3	Brock University	308.3	3	Laurentian University	639.1	3	Université de Moncton	583.3
4	University of Regina	213.7	4	University of Northern British Columbia	628.6	4	Lakehead University	555.6
5	University of Northern British Columbia	208.2	5	Lakehead University	603.1	5	Brock University	480.0
	Base (14)			Base (14)			Base (12)	

Notes:
1. Based on full-service universities on the Top 50 Research Universities list for all 20 years; and reported research, international and cross-sector publications in both 2000 and 2019.
2. Total University Research Publications: publications by researchers affiliated with Canadian universities or research hospitals. To be included a university had to have more than 50 publications in 2000.
3. University International Collaboration Publications: publications that were co-authored with researchers outside of Canada. To be included a university had to have more than 10 international collaboration publications in 2000.
4. University Cross-sector Collaboration Publications: publications that were co-authored with researchers from a Canadian non-university institution. To be included a university had to have more than 5 cross-sector collaboration publications in 2000.
5. Publications with multiple authors from different institutions were counted once for each university listed on the authored publication.
6. Publication data were obtained from Observatoire des sciences et des technologies (Clarivate Analytics – Web of Science) publications data 2000-2019 (latest final year available).

20/20 Innovation Vision

"It's left a gap across Canada," stated Dr. Martha Crago, Vice-Principal (Research and Innovation), McGill University and one of the Fundamental Science Review's panel members. "We saw that during the pandemic. We had no programmatic way to get funding out there rapidly; instead it was done in a kind of rapid fire panicky mode. In the absence of the NCE, we need to look at how we can network multiple universities and their combined talents to respond quickly to the next crisis."

The government also decided to consolidate the CECR and BL-NCE programs under the federal Strategic Innovation Fund, managed by Innovation, Science and Economic Development Canada. One concern with this move, cautioned Naylor, is that funding decisions once guided by independent peer reviewers are now made by a government department, "which opens the door to political interference".

A Commercialization Powerhouse

One of the biggest successes to emerge from the CECR program is the 10-year-old Centre for Commercialization of Regenerative Medicine, which is capitalizing on Canada's pioneering work in the discovery of stem cells in the early 1960s to revolutionize the treatment of chronic diseases. CCRM is building a sustainable cell and gene therapy ecosystem by catalyzing manufacturing capability, access to capital and talent development to ensure Canada's leadership in the USD$38.7-billion global regenerative medicine market.

Health Canada has already approved five gene therapies developed by CCRM, and with more in the pipeline, the Centre expects 10-20 new gene therapy products will be approved every year for the next few years. CCRM has also co-founded one company (AvroBio), incubated a second and supported the launch of nine more that together have raised over CAD$770 million.

Dr. Christopher Paige, a Senior Scientist at the University Health Network in Toronto, credits CCRM's success in large part to its industry-heavy board of directors, along with a network that includes researchers as well as companies, investors and entrepreneurs. CCRM's long-term sustainability is based on a fee-for-service model – called a Contract Development and Manufacturing Organization – that helps companies to scale-up production of cells and viral vectors needed for a growing number of clinical trials.

"CCRM is building an ecosystem at the interplay between research, academia and industry," said Paige, who also sits on CCRM's board. "For example, CCRM partnered with the University Health Network to build and operate a GMP [Good Manufacturing Practices] compliant facility to produce cells and viral vectors for Phase I and II clinical trials, which is helping keep companies in Ontario."

Overcoming Jurisdictional Barriers

Canada is also pioneering a new approach to cancer research and care that overcomes many of the jurisdictional barriers that limit cooperation between provincial health authorities and with the federal government.

Led by the Terry Fox Research Institute (TFRI), the new Marathon of Hope Cancer Centres Network is using $300 million in public and private sector money to unite cancer centres across Canada for the first time. This Team Canada approach will embed research in the cancer clinic, uniting the top-tier cancer researchers and clinicians throughout Canada. Each time a cancer is treated anywhere in the system, clinicians will

FROM THE CEO'S DESK

Celebrating 20 years of research excellence

Ron Freedman
CEO
Research Infosource Inc.

For the past 20 years Research Infosource has had the privilege of reporting on the state of research in our universities, hospitals, colleges and corporations. And what a 20 years it has been. For instance, two decades ago total university research income in Canada was about $3.4 billion. Today it is nearly $8.3 billion.

Research income inputs are of course only one part of the equation. In terms of the quantity and quality of university publication outputs our institutions compete with the best anywhere. Furthermore, in human terms, they have equipped hundreds of thousands of graduates who have gone on to enrich the economy and society, with research knowledge and skills. Progress has taken place across the board, not only in our large institutions, but in smaller universities as well, where research activity has grown by leaps and bounds in the past two decades.

In 2011 we launched our Top 40 Research Hospitals list in recognition of the important – and often overlooked – role that our health delivery organizations play. This list now encompasses very diverse organizations; hospitals, hospital networks and health authorities. Together with their university counterparts they lie at the heart of the country's health research and innovation ecosystem. Their combined research activity on our inaugural list was nearly $2.1 billion. This year health institutions reported just under $3.1 billion of research expenditures. Suffice to say that these past two challenging years have underscored the importance of the research they conduct.

Our Top 50 Research Colleges list debuted in 2013. This year colleges reported $270.9 million of sponsored research income, demonstrating the rapid research growth of this key partner in the national system of innovation. Colleges' strength is their closeness to the local and regional industry and social organizations that are able to rapidly take up the fruits of their research. Among them, colleges complete thousands of collaborative research projects annually and train the workforce of the future.

> **For 20 years Research Infosource has been proud to be associated with Canada's top innovators in our universities, hospitals, colleges and companies who have continued to step up, especially during this global crisis**

Research Infosource actually launched with our Top 100 Corporate R&D Spenders list, which we continue to publish. This list has been an ongoing effort to track the R&D spending of Canada's leading companies. Over time it has been a record of the waxing and waning of corporate R&D in Canada. Many companies have come and gone from the list and a few have been constants – R&D champions – demonstrating their commitment to performing research in Canada.

Throughout our journey of 20 years, we have striven to provide independent and accurate data and analysis on the state of Canada's research ecosystem. By and large I think we have succeeded.

For 20 years Research Infosource has been proud to be associated with Canada's top innovators in our universities, hospitals, colleges and companies who have continued to step up, especially during this global crisis. Individually and collectively, they remind us of the value of our prior investments in research and innovation and the importance of linking our research capacity to those who can put it to its best use. We salute and thank them all.

I offer my gratitude to the many organizations that have supported our work through their participation in our Canada's Innovation Leaders print and online publications.

Finally, I have to thank the Research Infosource team who have been with us from the start and to whom we owe our success. Today, they are under the outstanding leadership of our managing director, Arlene Dwyer. Providing research support is Annlee Chad. Our online guru is Andrew St. Denis. Caroline Bowker is our creative director. To them I offer my heartfelt thanks.

DEMENTIA:
Tackling the next urgent public health crisis

Dr. Allison Sekuler
Sandra A. Rotman Chair in Cognitive Neuroscience, Rotman Research Institute President & Chief Scientist, Baycrest Academy for Research and Education at Baycrest Centre for Geriatric Care President & Chief Scientist, Centre for Aging + Brain Health Innovation (CABHI)

More than 500,000 Canadians currently live with Alzheimer's disease and other forms of dementia, affecting one out of every four Canadians over the age of 85. Before COVID-19, this number was expected to nearly double by 2030, and the pandemic is likely speeding that growth due to both the direct and indirect effects of COVID-19 on the brain. Thus, addressing the public health crisis of dementia has become even more urgent.

Currently, there is no effective medication on the market to prevent, treat, or reverse the course of Alzheimer's disease and related dementias. However, we may be able to predict dementia years before its onset, intervene early, develop better models of care, and change the future. If we can delay the onset of dementia by just five years, we will decrease its incidence by 50 per cent.

Predictive Neuroscience for Healthy Aging
Baycrest's Rotman Research Institute (RRI) is a preeminent international centre for the study of aging and human brain function. Scientists at the RRI are paving the way toward the new field of **predictive neuroscience** to optimize aging and tackle the dementia crisis. This emerging field brings together artificial intelligence, neuroinformatics, physical and digital biomarkers, neuroimaging, environmental and societal data, and clinical and cognitive neuroscience to model and predict how people will age in the future.

With predictive neuroscience, we can drive new approaches to prevention, early detection, and care. We can prevent cognitive decline by detecting its behavioural and biological markers as early as possible, ideally before there are any memory-related symptoms. Additionally, we can guide people toward the right lifestyle choices to reduce their risk of dementia.

Preventing Dementia with Brain Health Prescriptions
For decades, Baycrest researchers have made critical contributions to our understanding of lifestyle factors that can reduce our chances of developing dementia. Recent research suggests that we can reduce our risk of dementia by up to 40 per cent by modifying such factors as managing stress, addressing hearing loss, maintaining a brain-healthy diet, and exercising regularly.

As the scientific headquarters of the Canadian Consortium on Neurodegeneration in Aging (CCNA), a network of over 300 leading scientists and clinicians across Canada, the RRI is working collaboratively to enhance our understanding of how these lifestyle factors interact to prevent dementia. Baycrest's Kimel Family Centre for Brain Health and Wellness focuses exclusively on dementia prevention and serves as the flagship living laboratory for the CCNA's National Dementia Prevention Program. Kimel members will participate in research and receive individualized assessments and interventions to address their dementia risk profile,

> **For decades, Baycrest researchers have made critical contributions to our understanding of lifestyle factors that can reduce our chances of developing dementia.**
> DR. ALLISON SEKULER

including diet, exercise, cognitive training, stress reduction, social interaction, and brain stimulation. The aim is to create personalized brain health prescriptions to help older adults live longer and better.

Harnessing the Power of Big Data and Artificial Intelligence to Defeat Dementia
At Baycrest's Sam and Ida Ross Memory Clinic, research is embedded in clinical care, allowing clinicians and researchers to identify factors that may influence the development of cognitive decline and dementia. Predictive neuroscience in the clinic combines artificial intelligence with clinical data to optimize care, for instance, to enhance client triaging for services that are urgently needed, as well as to develop personalized client care planning in the form of precision medicine.

We Must Tackle the Complex Challenges of an Aging Population Together
To accelerate brain health research and predictive neuroscience across the province and globally, open science is crucial as it makes knowledge and discovery open to researchers around the world. By adopting open science principles, Baycrest is creating a pathway to accelerate research, discovery, and innovation that will benefit older adults everywhere and help them age fearlessly.

Whether it is including Baycrest's unique data in international, online databases accessible by other researchers; sharing research materials so other research groups do not have to "reinvent the wheel;" or publishing results in open access sources, the RRI is working to bring aging and brain health science to the world. Our groups are also developing methods to democratize science, bringing neuroimaging and cognitive assessment techniques into the community, and creating mobile testing labs to increase community engagement and diversify research participants for maximum societal impact. Finally, we are actively training the next generation of scientists to continue pushing the boundaries of aging, brain health, and predictive neuroscience research.

Developing Solutions for and with Older Adults
It is crucial that older adults be involved in all aspects of the process of optimizing aging. Recently launched by the Baycrest-led Centre for Aging + Brain Health Innovation (CABHI), Leap is a revolutionary new platform that puts older adults and their care partners right at the centre of innovation. Leap creates meaningful opportunities for participants across Canada to share stories; raise awareness of their lived experiences; and learn about brain health, technology, and innovations. In Leap, older adults and caregivers can test the concept, design, and usability of solutions and provide innovators, researchers, and policymakers with critical feedback.

As we enter a new phase of the COVID-19 pandemic and keep learning about its long-term impacts on brain health, we must continue to work to defeat dementia and provide everyone with the tools they need to make their later years the best years of their lives, so that every older adult can *Fear No Age*™.

Canada's TOP 40 RESEARCH HOSPITALS 2021

Rank		Hospital/Hospital Network/ Health Authority	Research Spending			Research Intensity		Prov	Main Affiliated Research Centre(s)/Institute(s)
2020	2019		FY2020 $000	FY2019 $000	% Change 2019-2020	Researcher $ per Researcher $000	Hospital $ as % of Total Hospital Spending		
1	1	University Health Network (UHN)	$489,966	$408,300	20.0	$610.9	20.0	ON	PM Cancer Centre, Krembil, TGHRI, McEwen Institute, Techna, KITE@UHN, TIER@UHN
2	2	Hospital for Sick Children	$281,939	$254,093	11.0	$734.2	28.4	ON	SickKids Research Institute
3	3	McGill University Health Centre (MUHC)	$206,101	$203,660	1.2	$507.6	15.5	QC	Research Institute of the MUHC
4	4	Hamilton Health Sciences	$171,115	$184,739	-7.4	$376.1	10.7	ON	Population Health Research Institute, Thrombosis and Atherosclerosis Research Institute, Escarpment Cancer Research Institute
5	5	Vancouver Coastal Health Authority	$164,736	$181,029	-9.0	$388.5	4.1	BC	Vancouver Coastal Health Research Institute, Providence Health Care Research Institute
6	7	Provincial Health Services Authority	$155,246	$136,167	14.0	$186.4	4.0	BC	BC Cancer Research, BC Children's Research Institute, Women's Health Research Institute
7	6	Ottawa Hospital	$144,848	$145,703	-0.6	$378.2	9.3	ON	Ottawa Hospital Research Institute, Ottawa Heart Institute Research Corp
8	8	London Health Sciences Centre/ St. Joseph's Health Care London [a]	$121,888	$118,796	2.6	$618.7	7.0	ON	Lawson Health Research Institute
9	9	CHU de Québec - Université Laval	$112,855	$110,450	2.2	$366.4	8.5	QC	Centre de recherche du CHU de Québec - Université Laval
10	10	Sunnybrook Health Sciences Centre	$107,616	$102,128	5.4	$311.9	9.0	ON	Sunnybrook Research Institute
11	12	Sinai Health	$93,376	$85,084	9.7	$718.3	14.7	ON	Lunenfeld-Tanenbaum Research Institute, Bridgepoint Collaboratory for Research and Innovation
12	11	Unity Health Toronto	$88,948	$86,724	2.6	$400.7	7.0	ON	Li Ka Shing Knowledge Institute, Keenan Research Centre for Biomedical Science
13	14	Centre hospitalier de l'Université de Montréal (CHUM)	$83,216	$77,546	7.3	$204.0	5.9	QC	Centre de recherche du CHUM
14	13	Centre for Addiction and Mental Health	$75,615	$78,835	-4.1	$510.9	15.9	ON	Campbell Family Mental Health Research Institute, Krembil Centre for Neuroinformatics, Azrieli Centre for Neuro-Radiochemistry
15	15	CIUSSS de la Capitale-Nationale	$74,817	$76,755	-2.5	$233.8	4.8	QC	CERVO, VITAM, CIRRIS, CRUJeF
16	16	Alberta Health Services - Edmonton Zone	$57,002	$55,316	3.0	$170.7	na	AB	
17	17	CIUSSS de l'Estrie - Centre Hospitalier Universitaire de Sherbrooke (CHUS)	$56,659	$55,277	2.5	$122.9	3.5	QC	Centre de recherche du CHUS, Centre de recherche sur le vieillissement, Institut universitaire de première ligne en santé et services sociaux
18	18	CIUSSS du Centre-Ouest-de-l'île de Montréal	$51,536	$52,275	-1.4	$233.2	4.5	QC	Lady Davis Institute
19	19	CHU Sainte-Justine	$50,551	$44,655	13.2	$209.8	9.3	QC	Centre de recherche du CHU Sainte-Justine
20	20	Montreal Heart Institute	$43,636	$41,592	4.9	$445.3	19.4	QC	Montreal Heart Institute Research Center
21	21	Institut universitaire de cardiologie et de pneumologie de Québec - Université Laval	$34,458	$35,565	-3.1	$478.6	11.2	QC	Centre de recherche de l'Institut universitaire de cardiologie et de pneumologie de Québec - Université Laval
22	23	CIUSSS de l'Est-de-l'Île-de-Montréal	$33,915	$32,272	5.1	$187.4	2.5	QC	Centre de recherche de l'Hôpital Maisonneuve-Rosemont, Centre de recherche de l'Institut universitaire de santé mentale de Montréal
23	24	Alberta Health Services - Calgary Zone	$33,070	$29,060	13.8	$403.3	na	AB	
24	22	CIUSSS de l'Ouest-de-l'Île-de-Montréal	$30,295	$32,456	-6.7	$488.6	3.0	QC	Douglas Hospital Research Centre
25	30	Baycrest	$26,920	$18,301	47.1	$997.0	14.1	ON	Rotman Research Institute
26	27	St. Joseph's Healthcare Hamilton	$26,870	$24,519	9.6	$126.2	4.3	ON	Research Institute of St. Joe's Hamilton, Firestone Institute for Respiratory Health, Michael G. DeGroote Centre for Medicinal Cannabis Research
27	25	Children's Hospital of Eastern Ontario	$26,783	$26,874	-0.3	$100.7	7.7	ON	Children's Hospital of Eastern Ontario Research Institute
28	29	CIUSSS du Centre-Sud-de-l'Île-de-Montréal	$26,497	$22,653	17.0	$102.7	1.6	QC	Centre de recherche de l'Institut universitaire de gériatrie de Montréal, Institut universitaire sur la réadaptation en déficience physique de Montréal, Institut universitaire sur les dépendances
29	28	Nova Scotia Health Authority	$25,700	$23,988	7.1	$84.8	1.0	NS	
30	26	Kingston Health Sciences Centre	$25,266	$24,842	1.7	$67.9	4.1	ON	Kingston General Health Research Institute
31	36	Health Sciences Centre Winnipeg	$20,210	$11,701	72.7	$149.7	3.4	MB	
32	31	Women's College Hospital	$17,606	$14,825	18.8	$352.1	10.2	ON	Women's College Research Institute, Women's College Hospital Institute for Health System Solutions and Virtual Care
33	32	The Royal	$15,336	$14,515	5.7	$182.6	8.3	ON	University of Ottawa Institute of Mental Health Research
34	33	Holland Bloorview Kids Rehabilitation Hospital	$14,000	$13,475	3.9	$700.0	13.7	ON	Bloorview Research Institute
35	35	St. Boniface Hospital	$13,475	$13,046	3.3	$364.2	3.8	MB	Albrechtsen Research Centre, Asper Clinical Institute
36	34	IWK Health Centre	$12,374	$13,051	-5.2	$112.5	4.2	NS	Canadian Centre for Vaccinology, Biomedical Translation Imaging Centre, MicroResearch International
37		Vitalité Health Network	$11,626	$6,843	69.9	$135.2	1.6	NB	Atlantic Cancer Research Institute, Centre de formation médicale du Nouveau-Brunswick, New Brunswick Centre for Precision Medicine
38	38	Bruyère	$10,401	$10,376	0.2	$297.2	6.2	ON	Bruyère Research Institute
39	37	Hôpital Montfort	$9,732	$10,493	-7.3	$100.3	4.0	ON	Institut du Savoir Montfort
40	39	Health Sciences North	$9,237	$10,317	-10.5	$105.0	1.8	ON	Health Sciences North Research Institute

Notes:
1. Research spending includes all funds (direct and indirect) spent on all sources (internal and external) to support research.
2. Data were obtained through a survey or from financial statements. Information for Ontario was coordinated in part through the Ontario Hospital Association (OHA).
3. Fiscal 2019 figures may have been adjusted as more accurate information became available.
4. Researcher headcounts include full/part-time researchers/scientists/investigators/ clinician-researchers with a faculty appointment who actively conducted research.
5. Data are provided for the main hospital/health network/health authority including their affiliated hospitals and research centres/institutes, where applicable.

na = Not available
[a] Research spending amounts were combined as these hospitals have one research institute.

Canada's Top 40 Research Hospitals

CIL CANADA'S INNOVATION LEADERS

nova scotia health

Baycrest

INNOVATION
Canada Foundation for Innovation
Fondation canadienne pour l'innovation

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CANADA'S TOP 40
Research Hospitals

Hospital Research Spending Forges Ahead

In Fiscal 2020, *Canada's Top 40 Research Hospitals* posted a substantial gain of 5.8% over Fiscal 2019. Their combined research spending increased to $3.06 billion from $2.89 billion in Fiscal 2019. Research spending expanded at 28 Hospitals, Hospital Networks and Health Authorities and declined at 12 others. The number of health researchers was 9,698, a 3.6% increase over Fiscal 2019.

University Health Network (UHN) led the national ranking, with outlays growing to $490.0 million in Fiscal 2020, a gain of 20.0%. Hospital for Sick Children ranked in second spot ($281.9 million, up 11.0%), followed by McGill University Health Centre (MUHC) in third ($206.1 million, up 1.2%). Hamilton Health Sciences maintained fourth spot ($171.1 million, down -7.4%) and

Vancouver Coastal Health Authority followed in fifth place ($164.7 million, down -9.0%). With a 14.0% increase in their research spending in Fiscal 2020 to $155.2 million, Provincial Health Services Authority moved into 6th spot, up from seventh last year. New to the Top 40 this year is Vitalité Health Network, which debuted in the 37th position.

$100 Million Club

In Fiscal 2020, 10 institutions – the same group as in Fiscal 2019 – each recorded research spending in excess of $100 million. This elite group in the *$100 Million Club* recorded a combined research spending of $1.96 billion and accounted for 64% of total national research spending.

Provincial Performance

In Fiscal 2020, Ontario's 19 health research organizations on the Top 40, accounted for $1.76 billion of total national research spending, or 58% of the total (up 7.6%). Quebec's 12 institutions accounted for $804.5 million, representing 26% of the national total (up 2.5%). Two health organizations from British Columbia posted $320.0 million of research spending, or 10% of the national total (up 0.9%).

Research Spending Growth

Compared with an overall gain of 5.8% in national research spending, 10 organizations recorded increases of more than 10% in their research activity in Fiscal 2020. Health Sciences Centre Winnipeg posted an impressive 72.7% gain in research spending, followed closely by Vitalité Health Network (up 69.9%). Research spending at Baycrest rose by 47.1%. Other top institutions that reported increased research spending in Fiscal 2020 were University Health Network (up 20.0%), Women's College Hospital (up 18.8%), CIUSSS du Centre-Sud-de-l'Île-de-Montréal(up 17.0%) and Provincial Health Services Authority (14.0%).

Researcher Intensity

Research Infosource measures research intensity in two ways: by researcher (research spending per researcher), and by hospital (research spending as a percent of total hospital spending). In Fiscal 2020, at the national level, researcher intensity expanded by 2.1% to an average of $315,100 of spending per researcher, and the national hospital intensity was 7.2%.

At $618,700 of spending per researcher, London Health Sciences Centre/St. Joseph's Health Care London led its Large hospital peers, followed by University Health Network ($610,900 per researcher) and McGill University Health Centre ($507,600). Among the Medium hospital category, Hospital for Sick Children ($734,200 spending per researcher) was the most researcher-intensive institution, followed by Sinai Health ($718,300 spending per researcher) and in third spot, Centre for Addiction and Mental Health ($510,900 spending per researcher). In the Small category, Baycrest ($997,000 spending per researcher) was the most researcher-intensive and also led the national results. In second place in this Small category was Holland Bloorview Kids Rehabilitation Hospital ($700,000 spending per researcher), followed in third by Institut universitaire de cardiologie et de pneumologie de Québec - Université Laval ($478,600 spending per researcher).

Measured by hospital intensity (proportion of total hospital spending accounted for by research), University Health Network led the Large hospital category, devoting 20.0% of its total hospital spending to research. However, Hospital for Sick Children (28.4%), the leader for the Medium category also posted the highest portion of research spending nationally. Montreal Heart Institute topped the Small category (19.4%).

This Year and Next

Fiscal 2020 was a strong year for health research spending. Many institutions posted large gains in

their research activities. The 5.8% national increase signals a robust health research sector. This year's results pre-date COVID-19 and it will be interesting to see what effect government, private sector and donor spending will have on next year's results. Fiscal 2020 is also a powerful reminder that research capacity cannot be built overnight. Today's health research forms the basis for tomorrow's success. Without a strong base of research and researchers, society would be unable to address emerging challenges such as COVID-19.

Top 40 – Leading Provinces

Province	% of Total
Ontario (19)	58
Quebec (12)	26
British Columbia (2)	10

$100 Million Club

2020 Rank	Hospital	Research Spending $000
1	University Health Network (UHN)	$489,966
2	Hospital for Sick Children	$281,939
3	McGill University Health Centre (MUHC)	$206,101
4	Hamilton Health Sciences	$171,115
5	Vancouver Coastal Health Authority	$164,736
6	Provincial Health Services Authority	$155,246
7	Ottawa Hospital	$144,848
8	London Health Sciences Centre/ St. Joseph's Health Care London	$121,888
9	CHU de Québec - Université Laval	$112,855
10	Sunnybrook Health Sciences Centre	$107,616

Spotlight on Hospital Research Activity FY2020

Top Researcher-Intensive Organizations (Research Spending per Researcher)

Rank	Large	$000	Rank	Medium	$000	Rank	Small	$000
1	London Health Sciences Centre/St. Joseph's Health Care London	$618.7	1	Hospital for Sick Children	$734.2	1	Baycrest	$997.0
2	University Health Network (UHN)	$610.9	2	Sinai Health	$718.3	2	Holland Bloorview Kids Rehabilitation Hospital	$700.0
3	McGill University Health Centre (MUHC)	$507.6	3	Centre for Addiction and Mental Health	$510.9	3	Institut universitaire de cardiologie et de pneumologie de Québec - Université Laval	$478.6

Top Hospital-Intensive Organizations (Research Spending as % of Total Hospital Spending)

Rank	Large	%	Rank	Medium	%	Rank	Small	%
1	University Health Network (UHN)	20.0	1	Hospital for Sick Children	28.4	1	Montreal Heart Institute	19.4
2	McGill University Health Centre (MUHC)	15.5	2	Centre for Addiction and Mental Health	15.9	2	Baycrest	14.1
3	Hamilton Health Sciences	10.7	3	Sinai Health	14.7	3	Holland Bloorview Kids Rehabilitation Hospital	13.7

Note: Hospital size tiers were based on Fiscal 2020 total hospital spending:
Large = more than $1 billion; Medium = $400 million to $1 billion; Small = less than $400 million.

Top 10 Research Hospitals by Research Spending Growth

2020 Rank	Hospital	% Change 2019-2020
1	Health Sciences Centre Winnipeg	72.7
2	Vitalité Health Network	69.9
3	Baycrest	47.1
4	University Health Network (UHN)	20.0
5	Women's College Hospital	18.8
6	CIUSSS du Centre-Sud-de-l'Île-de-Montréal	17.0
7	Provincial Health Services Authority	14.0
8	Alberta Health Services - Calgary Zone	13.8
9	CHU Sainte-Justine	13.2
10	Hospital for Sick Children	11.0

20/20 Innovation Vision

have access to that data and how the cancer responded to a specific drug or therapy.

Anchoring this pan-Canadian network will be the Digital Health and Discovery Platform, a $150-million initiative led by TFRI and Montreal artificial intelligence (AI) startup Imagia that brings together nearly 100 partners, including AI institutes, hospitals, researchers and industry partners. The platform will overcome the jurisdictional, cultural and geographic barriers to sharing and analyzing the enormous amounts of genetic, clinical and imaging data available in provincial health systems.

"The digital platform allows you to link all that information while still maintaining patient privacy," said Paige, who chairs TFRI's board of directors. "It means researchers will be able to use AI to analyze and make sense of all that data, without it ever leaving the hospital. The goal is to create 15,000 shareable datasets of cancer cases within five years."

Putting Health Research into Practice

One of the most transformational shifts in how research is conceptualized and funded happened in 2000 when new federal legislation replaced the Medical Research Council (MRC) with the Canadian Institutes of Health Research. Whereas the MRC primarily supported basic research, CIHR focuses on both basic research as well as putting that knowledge into practice. Its 13 institutes target every aspect of human health, from aging, disease and gender to health policy, nutrition and indigenous people's health.

"CIHR has a broader mandate than MRC and is very interdisciplinary and cross-cutting", explained Dr. Jeannie Shoveller, Chair of the CIHR Governing Council. "It is focused on investing in biomedical, but also clinical research, health systems and services research and policy research and research that focuses on social, cultural, environmental and population health [CIHR's "Four Pillars"]."

This ability to work across scientific disciplines proved critical throughout the COVID-19 pandemic. Beyond the obvious need for better diagnostics and treatments, CIHR rallied researchers from across the country to address a rapid escalation in mental health cases, domestic violence and opioid overdoses.

"When you think of that fourth pillar which is very focused on the socio-cultural determinants of health, we also funded work that looks at the impact and incidence of anti-Asian racism and finding ways to counter those wild, very detrimental of pieces of misinformation that circulate on social media," said Shoveller.

CIHR recently released a 10-year strategy, the most forward-looking roadmap

it's ever produced. A significant new priority, and a sign of the times, is a strengthened focus on health equity.

"Our plan was very much informed by society's reckoning of systemic racism, the pandemic and everything that gets laid bare when you think of the inequalities and inequities that have arisen and continue to arise in this country," said Shoveller.

Health equity, she added, also means dismantling barriers applicants for research funding face because of their sex, gender, age, disability, ethnicity, or even where they live in Canada.

"I'm a strong believer that diversity and inclusion are good for science. It's all about multiple perspectives being unleashed on what seem to be intractable problems," said Shoveller.

Understanding Human Thought and Behaviour

Over the past 20 years, those multiple perspectives have increasingly included greater participation from the social sciences and humanities (SSH), a chronically underfunded area of research that will be critical to solving some of today's most complex problems.

"I think everyone understands intuitively that if you want to understand almost anything important in the world today you really need to understand human thought and behaviour in the past, present and thinking about the future," said Dr. Chad Gaffield, Research Chair in Digital Scholarship at the University of Ottawa, incoming president of the U15 Group of Canadian Universities, and past President of the Social Sciences and Humanities Research Council (SSHRC) (2006-14).

The science of human behaviour has become paramount during this pandemic as politicians and public health experts navigate difficult questions around vaccine hesitancy, mask mandates, retail lockdowns and private gatherings. Gaffield said there is growing consensus on the importance of SSH research, particularly when it comes to tackling complex "wicked problems" such as climate change and the transition to a net-zero economy.

SSH research has also received greater recognition as a competitive tool in business where human behaviours and motivations can often be more important than the technology itself.

"Having the best technology is

nowhere near enough," stressed Gaffield. "Successful IT companies are the ones that understand the market the best, and who understand the interface between technology and human beings."

On the academic side, he said more work is needed to ensure that all disciplines – from history to chemistry – understand how their individual area of science fits into big picture problems, what he refers to as "discipline-based interdisciplinarity".

The research granting councils are also embracing this more holistic approach with monthly meetings to discuss how they can support grant applications that bridge traditional disciplinary divides.

"Having that improved coordination across the funding agencies in a horizontal way has been one of the great transformations of recent years, and it's not over yet," he said.

A Bigger Role for the College Sector

Canada's college sector – which includes colleges, polytechnics and cégeps – was a relatively minor R&D player until 2003 when the Natural Sciences and Engineering Research Council (NSERC) launched a pilot program to strengthen innovation at the community level. The College and Community Innovation (CCI) program became permanent five years later, and with additional support from CIHR and SSHRC.

Since 2008, the CCI has invested close to $740 million in 4,400 applied research projects at colleges, polytechnics and cégeps.

"That initial policy decision nearly 20 years ago now has led to greater community and industry engagement with the college sector," said Ray Hoemsen, head of the Manitoba-based consultancy NEXUS Manitoba and the former Executive Director of Research Partnerships & Innovation at RRC Polytech in Winnipeg. "There's many applied research partnerships that weren't there before."

With activities in more than 670 urban, rural and remote locations across Canada, colleges and institutes have a more pervasive regional presence than universities, making them a logical partner for local companies, particularly small- and medium-sized enterprises (SMEs) looking for fast turnarounds to solve immediate challenges.

"Depending on the province you might have a few universities but there's a college in almost every reasonably

sized city across the country," said Hoemsen.

CCI also funds 60 college- or cégep-affiliated Technology Access Centres. Each year, TACs provide about 4,200 mostly SMEs with access to the highly specialized facilities, equipment and expertise needed to develop new prototypes, scale-up processes and solve unique business challenges.

For example, companies working with the TAC for Aerospace & Manufacturing at RRC Polytech can tap into over $40 million of facilities. This includes two "industrial campuses" – the Centre for Aerospace Technology & Training (with StandardAero) and the Centre for Non-Destructive Inspection (with Magellan Aerospace), where college-owned equipment is maintained and operated by industry, and made available to other companies, including competitors. The investment also supports three other manufacturing-related facilities – the Model Factory Machine Shop, the Smart Factory (emerging technologies) and the Composites Model Factory.

"The model allows governments to maximize their investment because the equipment is getting more use," explained Hoemsen, a recent board member at Tech-Access Canada, the organization that supports TACs. "The companies are using it for limited development and sometimes production purposes while the college is able to use the equipment for applied research and education, which helps support that industrial sector."

"Innovation Walks on Two Legs"

The old adage "innovation walks on two legs" reflects the central role that highly trained people play in the research itself and in putting that research into practice. One of Canada's most successful programs for doing just that has been Mitacs and its suite of internship programs for aspiring researchers.

Founded over 20 years ago initially as a mathematics-focused Network of Centres of Excellence, Mitacs has evolved to become one of Canada's largest programs for industrial research internships and postdoctoral fellowships. Over its history, it has supported more than 20,000 research projects and trained more than 33,000 students and postdocs working in all research fields, from aerospace systems to childhood literacy. In 2018, Mitacs expanded its internships to include colleges and polytechnics.

Both Naylor and Nicholson credit the program for providing companies with a job-ready pipeline of skilled researchers, as well as its more recent move to place more interns in civil society, government policy shops, and the non-profit sector.

"MITACS has improved career opportunities outside of academe for young Canadians with advanced research degrees, and in the process, strengthened the brain trust and innovation capacity of a wide spectrum of Canadian enterprises," said Naylor.

Set an R&D Spending Target

Money isn't the solution to all of our innovation woes, but it can certainly provide a healthy pipeline of scientific talent and discoveries that companies need to be more productive and competitive.

The return to federal budget surpluses in the late 1990s was a turning point for Canada. It signalled unprecedented new investments in scientific discovery, including the establishment of the Canada Foundation for Innovation (CFI) ($800 million), Canadian Millennium Scholarships ($2.5 billion), 2,000 Canada Research Chairs (CRCs) ($900 million), and Genome Canada ($160 million).

"Those four investments were absolutely transformative," said Dr. Gilles Patry, Executive Director of the U15 Group of Canadian Research Universities, and former president of the CFI

> **"Having the best technology is nowhere near enough. Successful IT companies are the ones that understand the market the best, and who understand the interface between technology and human beings.**
> **DR. CHAD GAFFIELD**
> Research Chair in Digital Scholarship, University of Ottawa and incoming President, U15 Group of Canadian Universities

> **"That initial policy decision nearly 20 years ago has led to greater community and industry engagement with the college sector.**
> **RAY HOEMSEN**
> Principal, NEXUS Manitoba

Canada's TOP 50 RESEARCH COLLEGES 2021

Rank 2020	Rank 2019	College	Sponsored Research Income FY2020 $000	FY2019 $000	% Change 2019-2020	Researchers 2019-2020 #	Research Intensity $ per Researcher $000	Prov	Main Affiliated Research Centre(s)/Institute(s)
1	1	Cégep de Trois-Rivières	$19,521	$15,827	23.3	119	$164.0	QC	Centre de Métallurgie du Québec, Innofibre, C2T3
2	6	Humber College	$15,034	$8,471	77.5	450	$33.4	ON	Barrett Centre for Technology Innovation
3	8	Niagara College	$13,917	$7,828	77.8	38	$366.2	ON	Walker Advanced Manufacturing Innovation Centre
4	2	Lambton College	$12,527	$12,420	0.9	186	$67.3	ON	Centre of Excellence in Energy & Bio-Industrial Technologies
5	3	NAIT - Northern Alberta Institute of Technology	$12,252	$11,754	4.2	62	$197.6	AB	
6	7	Southern Alberta Institute of Technology (SAIT)	$11,726	$8,445	38.9	129	$90.9	AB	Centre for Innovation and Research in Advanced Manufacturing and Materials (CIRAMM)
7	12	Cégep de la Gaspésie et des Îles	$9,761	$7,058	38.3	123	$79.4	QC	CIRADD, Merinov, Nergica
8	15	George Brown College	$9,199	$6,255	47.1	109	$84.4	ON	Food Innovation and Research Studio (FIRSt)
9	13	Cégep de Thetford	$8,639	$6,456	33.8	80	$108.0	QC	COALIA, Kemitek
10	4	Mohawk College	$8,493	$10,884	-22.0	246	$34.5	ON	IDEAWORKS
11	14	Sheridan College	$8,237	$6,412	28.5	158	$52.1	ON	Centre for Mobile Innovation
12	40	Saskatchewan Polytechnic	$7,023	$1,736	304.6	95	$73.9	SK	Digital Integration Centre of Excellence (DICE)
13	10	Cégep de La Pocatière	$6,939	$7,358	-5.7	114	$60.9	QC	Solutions Novika
14	5	RRC Polytech	$6,874	$9,303	-26.1	150	$45.8	MB	Technology Access Centre for Aerospace & Manufacturing (TACAM)
15	25	Cégep de Shawinigan	$6,513	$3,796	71.6	40	$162.8	QC	Centre national en électrochimie et en technologies environnementales (CNETE)
16	18	Conestoga College	$6,348	$4,629	37.1	222	$28.6	ON	SMART (Smart Manufacturing and Advanced Recycling Technologies) Centre, Canadian Institute for Seniors Care
17	9	British Columbia Institute of Technology	$6,171	$7,531	-18.1	110	$56.1	BC	Centre for Applied Research and Innovation (CARI)
18	24	Cambrian College	$5,561	$3,933	41.4	68	$81.8	ON	Glencore Centre for Innovation & Centre for Smart Mining
19	21	Collège de Maisonneuve	$5,527	$4,442	24.4	62	$89.1	QC	Centre d'études des procédés chimiques du Québec (CÉPROCQ)
20	19	Centennial College	$4,959	$4,480	10.7	69	$71.9	ON	Wearable Interactive Mobile Technologies Access Centre / Aerospace Innovation
21	22	Seneca College	$4,494	$4,112	9.3	149	$30.2	ON	Seneca Centre for Innovation in Life Sciences (SCILS)
22	16	College of the North Atlantic	$4,264	$6,151	-30.7	47	$90.7	NL	Centre for Innovative Mining Solutions (CIMS), Newfoundland and Labrador Workforce Innovation Centre
23	42	La Cité	$4,001	$1,619	147.1	22	$181.9	ON	Centre d'accès à la technologie en bio-innovation (CAT-B), Centre d'expertises en prototypage intelligent (CEPI)
24		Cégep de Sainte-Foy	$3,931	$3,292	19.4	79	$49.8	QC	CIMMI, Centre d'enseignement et de recherche en foresterie (CERFO)
25	32	Collège d'Alma	$3,813	$2,742	39.1	33	$115.5	QC	Agrinova
26		Cégep André-Laurendeau	$3,569	$3,335	7.0	82	$43.5	QC	OPTECH
27	37	Algonquin College	$3,552	$1,837	93.4	96	$37.0	ON	Data Analytics Centre, Social Innovation Lab, Victimology Research Centre
28	28	Collège communautaire du Nouveau-Brunswick	$3,507	$3,466	1.2	33	$106.3	NB	Réseau CCNB-INNOV
29	26	Lethbridge College	$3,479	$3,538	-1.7	42	$82.8	AB	Integrated Agriculture Technology Centre (IATC), Spatial Technologies Applied Research & Training (START) Centre
30	31	Cégep de l'Abitibi-Témiscamingue	$3,325	$2,873	15.7	34	$97.8	QC	Centre technologique des résidus industriels (CTRI)
31	47	Cégep de Lévis	$3,003	$875	243.2	42	$71.5	QC	Centre de robotique et de vision industrielles (CRVI), TransBIOTech
32	27	Cégep de Saint-Jérôme	$2,957	$3,481	-15.1	61	$48.5	QC	CDCQ, IVI
33	39	Selkirk College	$2,799	$1,769	58.2	28	$100.0	BC	Applied Research and Innovation Centre
34	29	Aurora College	$2,789	$3,102	-10.1	22	$126.8	NT	Aurora Research Institute
35	46	Loyalist College	$2,735	$943	190.0	15	$182.3	ON	Centre for Natural Products and Medical Cannabis
36	20	Nova Scotia Community College	$2,661	$4,451	-40.2	63	$42.2	NS	SEATAC
37	34	Holland College	$2,622	$2,260	16.0	27	$97.1	PE	Canada's Smartest Kitchen
38	23	Fleming College	$2,601	$4,000	-35.0	25	$104.0	ON	Centre for Advancement of Water and Wastewater Technologies, Centre for Sustainable Municipalities
39	41	Durham College	$2,562	$1,655	54.8	62	$41.3	ON	CCBI, The AI Hub, Centre for Cybersecurity Innovation, MRC Studio
40	38	Cégep de Rimouski	$2,532	$1,833	38.1	45	$56.3	QC	SEREX, Innovation maritime
41	35	Fanshawe College	$2,468	$2,087	18.3	42	$58.8	ON	Centre for Applied Research in Biotechnology (CARIB)
42	33	Olds College	$2,364	$2,297	2.9	27	$87.6	AB	Olds College Centre for Innovation (OCCI)
43		Cégep du Vieux Montréal	$2,256	$573	293.7	26	$86.8	QC	Centre de recherche pour l'inclusion des personnes en situation de handicap (CRISPESH)
44	44	Bow Valley College	$2,229	$1,437	55.1	32	$69.7	AB	
45	17	Cégep de Jonquière	$2,051	$4,712	-56.5	47	$43.6	QC	
46		Cégep de Saint-Laurent	$1,981	$1,843	7.5	32	$61.9	QC	Centre des technologies de l'eau (CTE), Centre Artenso
47	45	Cégep de Rivière-du-Loup	$1,919	$1,385	38.6	25	$76.8	QC	GREB, LLiO
48	49	Georgian College	$1,775	$770	130.5	51	$34.8	ON	
49		Collège Lionel-Groulx	$1,746	$1,342	30.1	28	$62.4	QC	Centre d'innovation en microélectronique du Québec (CIMEQ)
50	43	Camosun College	$1,695	$1,463	15.9	35	$48.4	BC	Camosun Technology Access Centre

CANADA'S TOP 50
Research Colleges

College Research Accelerates

The combined sponsored research income of the colleges and cégeps on *Canada's Top 50 Research Colleges List* reached $270.9 million in Fiscal 2020, a substantial gain of 20.8% over Fiscal 2019. Research income was in the form of research grants, contracts and contributions (cash and in-kind) from third parties. In Fiscal 2020, government funding accounted for $160.4 million, or 59% of the total. Federal government sources accounted for 35% of total funding ($94.3 million), while provincial governments contributed 24% ($64.4 million) to the government total. Industry funding was responsible for 32% ($86.8 million) of all funding, while Non-Industry sources provided 6%.

Cégep de Trois-Rivières once again led the national Top 50 Research Colleges ranking, reporting sponsored research income in Fiscal 2020 of $19.5 million, a 23.3% increase over Fiscal 2019. Humber College moved into second place with a substantial increase of 77.5%, posting research income of $15.0 million. Niagara College also moved up in the ranking, to 3rd position, with $13.9 million and a gain of 77.8%. Overall, 39 institutions posted research income gains against 11 where research income declined.

Provincial Performance

In Fiscal 2020, 17 Ontario colleges accounted for 40% of the Top 50 total ($108.5 million, up 31.7%) and 18 Quebec cégeps accounted for 33% ($90.0 million, up 22.9%). Alberta's five colleges were responsible for 12% of the national total ($32.1 million, up 16.7%) and British Columbia's three institutions contributed 4% ($10.7 million, down -0.9%).

Average per-college provincial research income was highest in Saskatchewan, where Saskatchewan Polytechnic reported $7.0 million of sponsored research income, followed by Manitoba, where RRC Polytech received $6.9 million. Among larger provinces, Alberta averaged $6.4 million of sponsored research income per institution. Ontario colleges garnered an average of $6.4 million, Quebec cégeps received an average of $5.0 million and British Columbia colleges attracted $3.6 million per institution on average.

Research Income Growth

In Fiscal 2020, six of the institutions on the Top 50 reported triple-digit growth in sponsored research income. Among the top gainers were Saskatchewan Polytechnic (304.6%), Cégep du Vieux Montréal (293.7%), Cégep de Lévis (243.2%), Loyalist College (190.0%), La Cité (147.1%) and Georgian College (130.5%).

Research Intensity

A number of colleges stood out in terms of research intensity – research income per researcher in Fiscal 2020. The top three were Niagara College ($366,200 per researcher), NAIT - Northern Alberta Institute of Technology ($197,600 per researcher) and Loyalist College ($182,300 per researcher). The national average research intensity in Fiscal 2020 was $68,000 per researcher.

Research Partnerships and Projects

Measuring a college's or cégep's volume of research partnerships and completed research projects provides a good indication of its levels of activity and output. In Fiscal 2020, the Top 50 Research Colleges engaged in a total of 4,847 research partnerships and 3,655 completed research projects. A number of institutions stood out on these measures. Among Large institutions, Sheridan College led reporting 388 research partnerships in Fiscal 2020. Cégep de Trois-Rivières (456) was the leader in the Medium category, while Cégep de la Gaspésie et des Îles headed the Small tier with 234 partnerships.

In terms of completed research projects the leaders by tier were: Algonquin in the Large tier completed 286 projects, Cégep de Trois Rivières in the Medium tier completed 421 projects and Cégep de la Gaspésie et des Îles in the Small tier completed 153 projects.

Students provide a large element of the college research workforce and receive experience and payment in return. A total of 3,784 students engaged in some kind of paid applied research projects. The top institutions by tier were: Centennial College in the Large tier employed a total of 474 students on its research projects, while Lambton College in the Medium tier employed 234 and Cégep de la Gaspésie et des Îles in the Small category hired 46.

Industry Research Income

In Fiscal 2020, total research income provided by industry via grants and contracts – a combination of cash and in-kind – was $79.4 million. A number of institutions stood out in terms of the research income they received from industry sources to work on research projects. In Fiscal 2020, leaders in each category included Humber College (Large tier, $6.4 million of industry research income), Niagara College (Medium tier, $9.8 million) and Cégep de La Pocatière (Small tier, $4.6 million).

Industry research income comprised a high proportion of total sponsored research income at a number of institutions. Industry research income was highest at Mohawk College (Large tier, 50.3% of the total), Niagara College (Medium tier, 70.3%) and Cégep de La Pocatière (Small tier, 66.6%).

This Year and Next

Fiscal 2020 was a stand-out year for college research. A research income increase of 20.8% is noteworthy. Gains were made across the board in many income, activity and output categories. Nearly 80% of institutions reported increases in research income. This comes in the wake of a previous strong year in Fiscal 2019. It seems that college research has established a solid foothold in the national innovation scene. Industry funding of research is robust, although governments still account for the plurality of funding. At a time when many commentators decry the shortfall in national R&D spending, college research is a bright spot.

Next year will be something of a litmus test for colleges. Fiscal 2021 will be the first year to be affected by a COVID-19 economy. It will be interesting to see whether and to what extent COVID-19 has disrupted – or perhaps spurred – college research; especially industry involvement.

Spotlight on College Research Activity FY2020

Research Partnerships*

Rank	Large	#	Rank	Medium	#	Rank	Small	#
1	Sheridan College	388	1	Cégep de Trois-Rivières	456	1	Cégep de la Gaspésie et des Îles	234
2	Mohawk College	254	2	Lambton College	246	2	Collège d'Alma	182
3	Humber College	159	3	Niagara College	188	3	Cégep de Thetford	124

Completed Research Projects*

Rank	Large	#	Rank	Medium	#	Rank	Small	#
1	Algonquin College	286	1	Cégep de Trois-Rivières	421	1	Cégep de la Gaspésie et des Îles	153
2	Saskatchewan Polytechnic	245	2	Niagara College	278	2	Cégep de La Pocatière	110
3	Sheridan College	238	3	RRC Polytech	104	3	Cégep André-Laurendeau	90

Paid Student Researchers**

Rank	Large	#	Rank	Medium	#	Rank	Small	#
1	Centennial College	474	1	Lambton College	234	1	Cégep de la Gaspésie et des Îles	46
2	Sheridan College	372	2	Durham College	220	2	Cégep André-Laurendeau	42
3	Mohawk College	349	3	Cambrian College	109	3	Selkirk College	41

Industry Research Income+

Rank	Large	$000	Rank	Medium	$000	Rank	Small	$000
1	Humber College	$6,446	1	Niagara College	$9,790	1	Cégep de La Pocatière	$4,618
2	Southern Alberta Institute of Technology (SAIT)	$5,525	2	Cégep de Trois-Rivières	$6,345	2	Cégep de Shawinigan	$2,137
3	NAIT - Northern Alberta Institute of Technology	$4,842	3	Lambton College	$4,715	3	Cégep André-Laurendeau	$1,832

Industry Research Income+ as % of Total Research Income

Rank	Large	%	Rank	Medium	%	Rank	Small	%
1	Mohawk College	50.3	1	Niagara College	70.3	1	Cégep de La Pocatière	66.6
2	Southern Alberta Institute of Technology (SAIT)	47.1	2	Durham College	42.8	2	Cégep André-Laurendeau	51.3
3	Humber College	42.9	3	Lambton College	37.6	3	Cégep de Lévis	49.6

Notes: College size tiers were based on Fiscal 2020 total college income:
Large = $250 million or more; Medium = $75 million to less than $250 million; Small = less than $75 million.
*Research partnerships and completed research projects with external organizations governed by formal written agreements. Excludes technical services agreements.
**Students that were involved in applied research projects that were paid for their work.
+Includes research income reported from industry sources in the form of a grant, contribution or contract. Excludes all funds from technical service agreements and entrepreneurship operations/activities.

Top 50 – Leading Provinces

Province	% of Total
Ontario (17)	40
Quebec (18)	33
Alberta (5)	12
British Columbia (3)	4

Top 10 Research Colleges by Research Income Growth

2020 Rank	College	% Change 2019-2020
1	Saskatchewan Polytechnic	304.6
2	Cégep du Vieux Montréal	293.7
3	Cégep de Lévis	243.2
4	Loyalist College	190.0
5	La Cité	147.1
6	Georgian College	130.5
7	Algonquin College	93.4
8	Niagara College	77.8
9	Humber College	77.5
10	Cégep de Shawinigan	71.6

Top 10 Research Colleges by Research Intensity

2020 Rank	College	$ per Researcher $000
1	Niagara College	$366.2
2	NAIT - Northern Alberta Institute of Technology	$197.6
3	Loyalist College	$182.3
4	La Cité	$181.9
5	Cégep de Trois-Rivières	$164.0
6	Cégep de Shawinigan	$162.8
7	Aurora College	$126.8
8	Collège d'Alma	$115.5
9	Cégep de Thetford	$108.0
10	Collège communautaire du Nouveau-Brunswick	$106.3

Research is Key

"Think of it as taking an artistic approach to data called design-driven analytics (DDA)," explained Grant. "We're focused on data storytelling because data is massive. If you can't explain why you collected the numbers and what you're trying to do with the numbers, then it doesn't matter how much data you have."

Humber has already pioneered several new approaches to data-driven storytelling at its StoryLab where an interdisciplinary team of experts works journalists to turn raw data into news stories. The Institute for Design Analytics will take a similar approach to help small and mid-sized companies develop DDA practices and products that predict trends, improve innovation and make productivity-boosting, fact-based decisions.

This approach to understanding data can be used for social innovation as well, where metrics like improved health and wellbeing are viewed as important as profits.

"I try to focus on return on impact, more so than return on investment. This is part of social innovation. You could use this approach, for example, to look at diverse demographic data – age, gender, and ethnicity, children at home – to identify patterns that allow people to revision retirement or the value systems that drive behaviour," said Grant, an experienced researcher in designing new research methods for open innovation and co-creating solutions with communities.

Social innovation is a major research thrust at Humber, where identifying the problem and developing the solution starts with partnering with communities.

"It starts from the problem, not from theory, and finding ways to fix the problem," explained Grant. "If we're going to recover from this pandemic we have to take an open innovation approach to developing solutions, and that means co-creating solutions with partners."

University of Toronto

Global challenges, from pandemics and climate change to plastic pollution, have expedited the need to develop new materials with improved performance that are more affordable and eco-friendly. The University of Toronto is spearheading a revolutionary solution, led by Professor Alán Aspuru-Guzik, the inaugural Director of the Acceleration Consortium.

This new international consortium brings together 80 scientists from 11 countries, along with industry and government partners, to make next-generation materials faster, cheaper and smarter using self-driving laboratories driven by automation, robotics and artificial intelligence.

"It typically takes 20 years and $100 million to develop and bring to market new advanced materials. The consortium's goal is to reduce this to more like one year and $1 million," said Dr. Christine Allen, U of T's Associate Vice-President and Vice-Provost of Strategic Initiatives.

Allen is also a pharmaceutical scientist whose own lab began to rely on artificial intelligence and automation during the pandemic. "Alán helped us integrate artificial intelligence and automation into our work. Using a liquid handling robot, for example, allowed just one person to get so much more work done. It also enabled us to get around some of the COVID-19 related physical distancing requirements."

The design of advanced materials with superior performance characteristics is seen as vital to driving a range of innovations, including clean energy storage, development of sustainable packaging for consumer products, drug discovery, quantum computing, clean transportation solutions and the creation of stronger, lightweight, low-carbon building materials.

"What makes this consortium unique internationally is that the research is precompetitive, sector agnostic and focused on commercialization," she said. "All the tools, approaches and methods can be adapted for other sectors."

Attracting talented scientists and graduate students to Canada and training the next generation of researchers are top priorities for the Acceleration Consortium. It plans to open a training facility in Mississauga, in partnership with the National Research Council of Canada, in addition to offering workshops, conferences, hackathons, post-doctoral fellowships, a master's degree program and training on self-driving labs.

"Every industry partner we speak with tells us about the importance of highly qualified personnel who are industry ready," said Allen. "That talent will be critical in supporting Canada's post-pandemic economic recovery."

Sheridan College

Two years of fighting the COVID-19 pandemic has exposed many economic and social vulnerabilities that institutions like Sheridan College are working to address.

"We're taking more of a holistic perspective to economic recovery and how we support businesses and communities," said Dr. Vicki Mowat, Sheridan's Director of Research. "That means taking a broader view of research to consider the more human aspects of supporting organizations in pandemic recovery."

20/20 Innovation Vision

Continued from page 19

(2010-17). "And I would add a fifth one: the indirect costs of research," which includes operational costs like technical support and administration. In 2000, the government awarded $225 million towards indirect costs, an amount that is now close to $430 million annually. However, that investment represents less than 23% of the research expenditures. In comparison, public universities that are members of the Association of American Universities (AAU) received 53% on average in 2014.

Maintaining that investment momentum has been a challenge. The 2017 Fundamental Science Review expert panel recommended that spending across the four research granting agencies (CFI, CIHR, SSHRC and NSERC) increase from approximately $3.5 billion to $4.8 billion. To date, only two-thirds of that amount has been invested, said Naylor.

"The granting councils need generous support for open inquiry. That's the upstream feeder for a lot of the made-in-Canada innovation that will matter," he explained. "A classic discovery is mRNA technology where Canada played a pivotal role in developing that whole area with the nanoparticles and mRNA vaccines for COVID-19. That core work owes a lot to Canadian science."

Despite these successes, Canada continues to lags peer countries when it comes to investing in R&D. Both the Senate Prosperity Action Group and the U15 have recommended that the government invest 2.5% of GDP into R&D over

the next few years to bring it up to the OECD average.

The U15 also wants the government to increase the talent pipeline by tripling the number Master's-level students and doubling the number of PhDs and postdocs who receive Canada Graduate Scholarships through the three research granting councils. Other recommendations include funding the full costs of indirect research, and adopting immigration policies that make Canada "the first-choice destination" for international students.

"It's a chicken and egg situation," said Patry. "Our industrial investments in R&D are quite low compared with other countries, but our number of PhD graduates is also quite low, so bootstrapping those two is critically important."

Feeding the Innovation Pipeline

"We're always bemoaning the fact that we're no good at innovation in this country. I beg to differ," said Dr. Alan Bernstein, President and CEO of the Canadian-based global research organization, CIFAR.

In the field of artificial intelligence, for example, the Nature Index ranked Canada sixth out of 25 countries in the number of scientific papers related to AI. Toronto and Montreal are also among the top 10 cities leading the way in AI, according to the AI blog Re-Work.

Canada has come a long way since 2002 when CIFAR launched one of the earliest AI programs, comprised

of an unlikely mix of neuropsychologists, physiologists, neurobiologists and computer scientists. These researchers are credited with pioneering the field of deep learning, a market now poised to reach USD$93.34 billion by 2028, according to Vancouver-based Emergen Research.

"Twenty years ago the private sector did not fund AI research. The risks were too high," said Bernstein. "Only government can fund long-term, high-risk research which occasionally will lead to transformative breakthroughs, and only industry can turn those ideas into companies and products.

"Today," he added, "the private sector in Canada and worldwide is investing hundreds of millions of dollars into

> " AI has turned into a great Canadian research and innovation success story and is a textbook example of how innovation works best – when the public and private sectors complement, not duplicate, each other's strengths and roles in the R&D ecosystem.
>
> **DR. ALAN BERNSTEIN**
> **President and CEO, CIFAR**

AI R&D. AI has turned into a great Canadian AI research and innovation success story and is a textbook example of how innovation works best – when the public and private sectors complement, not duplicate, each other's strengths and roles in the R&D ecosystem."

Those companies rely on the discoveries emerging from academia, as well as researchers and their students. "If you don't have talent you don't have ideas, and if you don't have talent and ideas you don't have knowledge-based companies or innovation," said Bernstein.

For example, Yoshua Bengio, Geoffrey Hinton, and Yann LeCun – sometimes called the 'godfathers of AI' – are all current or former CIFAR fellows who straddle both academia and industry. Hinton works at both Google and the University of Toronto; Bengio is a professor at the University of Montreal and co-founder of AI startup Element AI; and LeCun is Facebook's Chief AI scientist and a professor at New York University.

Supporting more "godfathers" of this calibre, added Bernstein, requires ongoing public support of fundamental research.

"We are still not internationally competitive in terms of the level of public funding that goes into fundamental research. Innovation is a pipeline that goes from fundamental research to innovation to product. There's no point building that pipeline unless there's oil in the ground and putting that oil in the ground – the talent and ideas – is the role of government."

Don't Skimp on the Peanut Butter

Trying to please everyone often ends up pleasing no one. This has too often been the approach to funding Canadian research and innovation.

"An unreasonably broad distribution creates the 'peanut butter problem': by spreading funds too thinly, it rewards mediocrity and handicaps excellent researchers by giving them unduly small grants," the expert panel wrote in its 2017 Fundamental Science Review.

The Canada Research Chairs program exemplifies this problem, said McGill's Crago. The CRC has had success in retaining and attracting top-notch scientists, but funding has stayed flat since the program was created over 20 years ago. Tier 1 chairs receive $200,000 annually over seven years while Tier 2 chairs receive $100,000 over five years.

"This program was initially seen as leading the way internationally, but the funding hasn't kept pace with inflation, which means more money is going to salary and less is available for research," said Crago. "And now we hear the Liberal government is going to create a thousand more CRCs. But they won't be

terribly competitive unless the funding levels change."

The government has taken a similar approach to another successful program, Genome Canada. What started 20 years ago with a laser-beam focus on health has expanded to include agriculture and agri-food, forestry, fisheries and aquaculture, as well as the environment, energy and mining.

Crago suggests picking just a few areas where Canada can excel, such as health, the environment and food, and then allow researchers to apply to just one, rather than separately to multiple funding agencies.

"It's a lot of labour trying to knit pieces together that should be coherently and integratively put together in programs that work side by side with each other," she said. "The government needs a clear strategy on this."

Thinly spread funding has also limited the government's ability to encourage more industrial R&D, said Darby from CME. For example, rather than following Korea or Germany's lead in investing big in advanced manufacturing, "we did the Canadian thing," he said, in reference to the $950-million federal program that created Innovation Superclusters in multiple sectors, including advanced manufacturing, digital technology, proteins, oceans and artificial intelligence.

"We have a hard time picking something and saying this is what we're good at," said Darby. "We're good at energy, at transportation, and food/bio production. Let's focus on being globally competitive in a few areas instead of opting for the usual peanut butter approach."

Getting there, most experts agree, will require a national strategy that focuses on science, innovation and prosperity. The report by the Senate Prosperity Action Group called for a "whole of Canada" approach, as well as a "grand alliance" among governments, business, labour, civil society and communities that usher in a new era of constructive and cooperative federalism.

"Crises like the [pandemic] we are enduring," the Senate group writes, "can provide opportunities for creative responses, just as the Second World War provided the impetus for the United Nations and the Great Depression changed the way in which Canadians thought about the economy. This is just such an inflection point."

Debbie Lawes, Debbie@dovercourteditorial.ca, is an Ottawa-based writer specializing in science, technology and innovation.

SHERIDAN COLLEGE:
Collaborative partnerships are vital to research

In an ever-changing world, the delivery and approach of Sheridan's research, innovation and entrepreneurship (RIE) continues to evolve into newer, more impactful ways of working with industry and community partners.

Throughout the COVID-19 pandemic and beyond, Sheridan has leveraged innovative thinking and methods around practical and sustainable RIE solutions. This has helped the college forge new and diverse partnerships across different sectors, particularly with community-based and not-for-profit organizations. Sheridan's increasing priority on social innovation has supported partners with outside-of-the-box thinking to deliver meaningful societal and economic benefits in the community.

"Research has experienced an incredible transformation at Sheridan over the past couple of years, largely due to the partnership growth we've seen with community and industry organizations," said Dr. Vicki Mowat, Director, Research at Sheridan. "Sheridan has always had a strong reputation in the community. Our partners continue to approach us for high-tier innovation support with our amazing faculty, students and facilities, but they also know we're the right partner to help them imagine and incubate these big ideas that can one day make an impact in our world."

Sheridan's recent top ranking for research partnerships in the 2021 edition of Research Infosource Inc.'s annual summary, Canada's Top 50 Research Colleges, is strong evidence that industry and community partners continue to look to Sheridan for innovation support. With cutting-edge RIE activities across five Faculties and six renowned Research and Incubation Centres, Sheridan continues to respond to its partners, bringing valued interdisciplinary expertise to develop practical and novel solutions.

A few recent highlights of research projects and partnerships at Sheridan over the past year:

Virtual Life Skills Development
In partnership with Halton Region, the Oakville Community Foundation and 14 not-for-profit community organizations, Dr. Sara Cumming, professor from the Faculty of Humanities and Social Sciences, is leading a three-year project that will design, develop, and implement a virtual life skills program for marginalized or precariously housed individuals in Halton. The program will teach life skills including financial literacy, food literacy, health, wellness, and more.

Integrating Creative Content and Digital Technology
With the Canadian Opera Company, the National Ballet of Canada and the UK's Royal Opera House, Sheridan's Screen Industries Research and Training Centre (SIRT) provided expertise in the integration of creative content and digital technologies within the arts. SIRT's Digital Stage project is exploring new, collaborative approaches to digital technology to deepen engagement with audiences, share performance art with the world, and innovate business processes.

Building Resilience in Small Business Owners
Garrett Hall and Dr. Sujinda Hwang-Leslie, professors from Sheridan's Pilon School of Business, partnered with Sheridan's EDGE Entrepreneurship Hub on the Building Small Business Resilience (BSBR) research project. The BSBR project enhances the digital marketing capabilities of small business owners who pivoted online due to the COVID-19 pandemic. The project also aims to create a research-informed digital marketing program prototype to increase equitable, diverse, and inclusive participation in small business sectors.

Interested in partnering with Sheridan? Please connect with us by visiting **research.sheridancollege.ca**.

Research is Key

Mowat, who has a Ph.D. in psychology, uses her social sciences background and Sheridan's increasing priority on social innovation as the lens to help shape the college's research, innovation and entrepreneurship approach to partnerships, which now includes more community and not-for-profit partners.

> **We're taking more of a holistic perspective to economic recovery. That means taking a broader view of research to consider the more human aspects of supporting organizations in pandemic recovery.**
>
> **DR. VICKI MOWAT**
> Director of Research, Sheridan College

For example, Sheridan's Centre for Elder Research partnered with Food for Life and Community Development Hamilton to help hundreds of older adults living in community housing who faced increased social isolation and loneliness during the pandemic. The Putting Food on the Table Project changed a simple food basket into more of a wellness package which, in addition to food, also included valuable resources and information to connect older adults to social supports.

Sheridan is home to faculty-led research and six research centres that include screen industries, advanced manufacturing and mobile innovation.

The centres are increasingly working across disciplines and faculties, in what Mowat describes as "that intersection of technology and social innovation".

The diversity of new partners is also reflected in those supported by Sheridan's Entrepreneurship Discovery and Growth Engine (EDGE) social innovation hub. In 2020, RBC Future Launch donated $435,000 to support social entrepreneurship at Sheridan, including an expansion of EDGE's Social Impact Catalyst program which supports youth entrepreneurs to pursue social venture ideas supporting equity, inclusion and justice.

The 14-week program has so far supported 23 new social ventures targeting climate change and environmental sustainability, with a particular focus on supporting BIPOC (Black, Indigenous and People of Color) entrepreneurs.

"One venture that was supported is BLK-Owned Hamilton. It organized an online directory that lists over 160 Black-owned businesses on Instagram," said Mowat. "They also developed a social media strategy that specifically targets and supports black-owned businesses to continue to support the success of these new companies."

Lakehead University
Long before COVID-19, there was an affordable housing crisis in Canada. Today, some 12% of households struggle to access affordable, suitable and adequate housing.

Two research projects led by Lakehead University's Dr. Rebecca Schiff are working with local communities to produce the evidence that will persuade governments to invest more in proven approaches that improve the availability of affordable housing across Canada.

"The National Housing Strategy identifies the need for more research into housing and homelessness," said Schiff, Chair and Professor in the Department of Health Sciences. "As a result, Canada Mortgage and Housing Corporation partnered with the Social Sciences and Humanities Research Council to fund research that address priorities, including our projects on community housing and northern housing," with each project receiving more than $1.3 million.

Current strategies to address chronic housing need and homelessness have primarily been developed outside of the North, making them disconnected from northern needs, priorities and strengths, said Schiff.

The At Home in the North: Partners in Housing in Home project addresses that gap by bringing together academic researchers and community partners to inform the development of programs, services and models for housing and homelessness, developed by and centred in northern communities.

"A one-size-fits-all approach to housing won't work in the North where we need affordable housing that this both culturally safe and culturally appropriate," she explained.

The second project, Community Housing Canada, focuses on households with low and modest incomes across Canada and how cooperatives and other forms of community housing can offer a sustainable solution that also improves people's physical and mental health.

"Co-op housing hasn't been appreciated enough in terms of federal policy and federal funding priorities for the impact it can make in people's lives," said Schiff. "For example, the pandemic showed how people living in housing cooperatives were less socially isolated than those living in independent market rental housing."

The project is finding several other benefits of co-op housing, including children who do better in school and adults who are more successful in terms of employment.

Said Schiff: "We call this the social return on investment, those impacts that go beyond the bottom line of an accounting book."

CANADA'S TOP 100 CORPORATE R&D SPENDERS

CANADA'S INNOVATION LEADERS

Canada's
TOP 100 CORPORATE R&D SPENDERS 2021

Rank			R&D Spending			Revenue	R&D Intensity	
2020	2019	Company	FY2020 $000	FY2019 $000	% Change 2019-2020	FY2020 $000	R&D Spending as % of Revenue**	Industry
1	1	Magna International Inc.*	$1,113,445	$849,216	31.1	$43,795,951	2.5	Automotive
2	3	Constellation Software Inc.*	$808,925	$701,930	15.2	$5,324,414	15.2	Software & Computer Services
3	11	Shopify Inc.*	$740,678	$471,069	57.2	$3,929,912	18.8	Software & Computer Services
4	5	Bausch Health Companies Inc.*	$606,358	$624,970	-3.0	$10,768,221	5.6	Pharmaceuticals/Biotechnology
5	4	Pratt & Whitney Canada Corp. (fs)	$597,783	$629,533	-5.0	nd		Aerospace
6	8	TELUS Corporation	$553,000	$530,000	4.3	$15,463,000	3.6	Telecommunications Services
7	7	BCE Inc.	$535,000	$532,400	0.5	$22,883,000	2.3	Telecommunications Services
7	2	Suncor Energy Inc.	$535,000	$830,000	-35.5	$25,052,000	2.1	Energy/Oil & Gas
9	12	Rogers Communications Inc.	$500,104	$442,412	13.0	$13,916,000	3.6	Telecommunications Services
10	14	Open Text Corporation*	$496,906	$427,044	16.4	$4,171,711	11.9	Software & Computer Services
11	9	IBM Canada Ltd. (fs)	$482,300	$512,000	-5.8	nd		Software & Computer Services
12	13	AMD Canada (fs)	$426,844	$429,819	-0.7	nd		Electronic Systems & Parts
13	15	Ericsson Canada Inc. (fs)	$350,000	$381,000	-8.1	nd		Comm/Telecom Equipment
14	10	Canadian Natural Resources Limited	$340,670	$473,000	-28.0	$16,893,000	2.0	Energy/Oil & Gas
15	18	Huawei Canada (fs)	$319,159	$261,611	22.0	nd		Comm/Telecom Equipment
16	17	CGI Group Inc.	$304,103	$302,781	0.4	$12,164,115	2.5	Software & Computer Services
17	16	BlackBerry Limited* ++	$288,423	$343,667	-16.1	$1,197,960	24.1	Software & Computer Services
18	19	BRP Inc.++	$242,300	$238,400	1.6	$5,952,900	4.1	Other Manufacturing
19	20	CAE Inc.	$241,200	$232,100	3.9	$3,620,000	6.7	Aerospace
20	23	Zymeworks Inc.*	$226,088	$153,934	46.9	$52,253	432.7	Pharmaceuticals/Biotechnology
21	22	Cisco Canada (fs)	$172,832	$166,267	3.9	nd		Comm/Telecom Equipment
22	6	Bombardier Inc.*	$162,322	$577,202	-71.9	$8,702,311	1.9	Aerospace
23	26	Sanofi (fs) (a)	$145,278	$144,321	0.7	$792,887	18.3	Pharmaceuticals/Biotechnology
24	21	Imperial Oil Limited	$140,000	$170,000	-17.6	$22,388,000	0.6	Energy/Oil & Gas
25	25	Hydro-Québec	$133,800	$132,000	1.4	$13,594,000	1.0	Electrical Power & Utilities
26	29	Novelis Inc.* (fs)	$112,686	$95,537	18.0	$15,047,606	0.7	Mining & Metals
27	27	Sierra Wireless, Inc.*	$110,432	$115,077	-4.0	$601,781	18.4	Comm/Telecom Equipment
28	39	Teck Resources Limited	$97,000	$67,000	44.8	$8,948,000	1.1	Mining & Metals
29	31	Evertz Technologies Limited	$90,827	$85,823	5.8	$436,592	20.8	Comm/Telecom Equipment
30	43	Enghouse Systems Limited	$79,757	$59,049	35.1	$503,778	15.8	Software & Computer Services
31	50	Northland Power Inc.	$74,615	$44,200	68.8	$2,060,627	3.6	Electrical Power & Utilities
32	33	EXFO Inc.*	$73,198	$76,923	-4.8	$356,280	20.5	Comm/Telecom Equipment
33	36	Descartes Systems Group Inc.* ++	$72,530	$71,006	2.1	$467,733	15.5	Software & Computer Services
34	37	Aurinia Pharmaceuticals Inc.*	$67,514	$70,148	-3.8	$67,233	100.4	Pharmaceuticals/Biotechnology
35	30	Linamar Corporation	$66,950	$87,149	-23.2	$5,815,573	1.2	Automotive
36	34	Arbutus Biopharma Corporation*	$63,696	$76,431	-16.7	$4,721	1,349.2	Pharmaceuticals/Biotechnology
37	49	Kinaxis Inc.*	$63,614	$45,280	40.5	$300,750	21.2	Software & Computer Services
38	82	Canopy Growth Corporation	$61,812	$15,238	305.6	$439,626	14.1	Pharmaceuticals/Biotechnology
39	41	Canadian Solar Inc.*	$60,592	$62,424	-2.9	$4,663,718	1.3	Energy/Oil & Gas
40	40	GlaxoSmithKline Inc. (fs)	$60,501	$65,165	-7.2	$890,578	6.8	Pharmaceuticals/Biotechnology
41	35	Liminal BioSciences Inc.	$58,594	$75,686	-22.6	$3,317	1,766.5	Pharmaceuticals/Biotechnology
42	42	AstraZeneca Canada Inc. (fs)	$58,076	$62,296	-6.8	$874,440	6.6	Pharmaceuticals/Biotechnology
43		Repare Therapeutics Inc.*	$54,989	$28,654	91.9	$181		Pharmaceuticals/Biotechnology
44	44	Dorel Industries Inc.*	$53,956	$52,671	2.4	$3,705,874	1.5	Other Manufacturing
45	60	Ballard Power Systems Inc.*	$47,649	$35,731	33.4	$139,351	34.2	Machinery
46	46	Ontario Power Generation Inc.	$47,000	$51,000	-7.8	$7,240,000	0.6	Electrical Power & Utilities
47	65	Lightspeed POS Inc.*++	$46,268	$27,171	70.3	$161,835	28.6	Software & Computer Services
48	32	Syncrude Canada Ltd.	$45,786	$78,207	-41.5	nd		Energy/Oil & Gas
49	45	Novartis Pharmaceuticals Canada Inc. (fs)	$45,000	$51,800	-13.1	nd		Pharmaceuticals/Biotechnology
50		D2L Inc.* ++	$42,390	$36,053	17.6	$169,528	25.0	Software & Computer Services
51	47	Martinrea International Inc.	$41,215	$48,782	-15.5	$3,375,286	1.2	Automotive
52	56	Pharmascience Inc.	$40,893	$38,458	6.3	nd		Pharmaceuticals/Biotechnology
53		AbCellera Biologics Inc.*	$39,431	$13,419	193.8	$312,777	12.6	Pharmaceuticals/Biotechnology
54	72	Aptose Biosciences Inc.*	$39,290	$22,338	75.9	$0		Pharmaceuticals/Biotechnology
55	57	Celestica Inc.*	$38,635	$37,684	2.5	$8,898,438	0.4	Electronic Systems & Parts
56	58	Thales Canada Inc. (fs)	$37,863	$36,374	4.1	$533,947	7.1	Electronic Systems & Parts
57	53	L3Harris WESCAM (fs)	$34,664	$41,359	-16.2	nd		Aerospace
58	48	Optiva Inc.*	$34,258	$46,650	-26.6	$101,841	33.6	Software & Computer Services
59	59	Trillium Therapeutics Inc.*	$34,004	$36,358	-6.5	$199		Pharmaceuticals/Biotechnology
60	63	Cascades Inc.	$32,021	$30,231	5.9	$5,157,000	0.6	Forest & Paper Products
61	66	BELLUS Health Inc.*	$31,832	$26,119	21.9	$20		Pharmaceuticals/Biotechnology
62	69	Héroux-Devtek Inc.	$30,650	$24,194	26.7	$612,996	5.0	Aerospace
63	61	Westport Fuel Systems Inc.*	$28,139	$33,401	-15.8	$338,725	8.3	Other Manufacturing
64	68	Mediagrif Interactive Technologies Inc. +	$27,870	$25,397	9.7	$75,428	36.9	Software & Computer Services
65	62	Pason Systems Inc.	$26,977	$30,439	-11.4	$156,636	17.2	Software & Computer Services
66	79	IMV Inc.	$26,605	$18,986	40.1	$3		Pharmaceuticals/Biotechnology
67	51	Eli Lilly Canada Inc. (fs)	$26,396	$43,946	-39.9	nd		Pharmaceuticals/Biotechnology
68	85	Aurora Cannabis Inc.	$26,070	$14,778	76.4	$328,203	7.9	Pharmaceuticals/Biotechnology
69	88	Theratechnologies Inc.*	$24,570	$14,385	70.8	$88,610	27.7	Pharmaceuticals/Biotechnology
70	67	Absolute Software Corporation*	$24,547	$25,507	-3.8	$140,416	17.5	Software & Computer Services
71	74	Sangoma Technologies Corporation	$23,913	$20,748	15.3	$131,418	18.2	Computer Equipment
72	77	Vecima Networks Inc.	$22,862	$19,040	20.1	$96,416	23.7	Comm/Telecom Equipment
73	71	Winpak Ltd.*	$22,150	$22,425	-1.2	$1,143,619	1.9	Rubber & Plastics
74		Magnet Forensics Inc.*	$21,779	$19,379	12.4	$68,724	31.7	Software & Computer Services
75	54	Acasti Pharma Inc.*	$21,709	$38,961	-44.3	$0		Pharmaceuticals/Biotechnology
76	52	Resverlogix Corp.*	$21,288	$42,917	-50.4	$0		Pharmaceuticals/Biotechnology
77	73	Computer Modelling Group Ltd.	$20,751	$21,206	-2.1	$75,786	27.4	Software & Computer Services
78	70	Resolute Forest Products Inc. (fs)	$19,200	$24,000	-20.0	$2,877,000	0.7	Forest & Paper Products
79	78	Neo Performance Materials Inc.*	$18,411	$19,009	-3.1	$465,087	4.0	Mining & Metals
80	76	Lockheed Martin Canada (fs)	$18,158	$19,761	-8.1	$570,542	3.2	Aerospace
81		Docebo Inc.*	$17,440	$11,383	53.2	$84,403	20.7	Software & Computer Services
82	87	TECSYS Inc.*	$17,276	$14,392	20.0	$104,855	16.5	Software & Computer Services
83		Coveo Solutions Inc.*	$16,993	$13,561	25.3	$74,421	22.8	Software & Computer Services
84	100	Essa Pharma Inc.*	$16,294	$8,885	83.4	$0		Pharmaceuticals/Biotechnology
85	86	TC Energy	$16,168	$14,423	12.1	$12,999,000	0.1	Energy/Oil & Gas
86	81	Intertape Polymer Group Inc.*	$15,019	$16,622	-9.6	$1,627,277	0.9	Rubber & Plastics
87	80	Baylin Technologies Inc.	$13,272	$16,803	-21.0	$119,739	11.1	Comm/Telecom Equipment
88	89	AcuityAds Holdings Inc.	$13,157	$13,834	-4.9	$104,894	12.5	Telecommunications Services
89	95	Oncolytics Biotech Inc.	$12,945	$11,135	16.3	$0		Pharmaceuticals/Biotechnology
90		Knight Therapeutics Inc.	$11,725	$3,913	199.6	$199,519	5.9	Pharmaceuticals/Biotechnology
91		Tetra Bio-Pharma Inc.	$11,655	$6,199	88.0	$0		Pharmaceuticals/Biotechnology
92	93	DiaMedica Inc.*	$11,148	$11,618	-4.0	$0		Pharmaceuticals/Biotechnology
93	84	Servier Canada Inc. (fs)	$10,836	$14,838	-27.0	$116,599	9.3	Pharmaceuticals/Biotechnology
94	38	Titan Medical Inc.*	$10,647	$68,227	-84.4	$26,830	39.7	Medical Devices & Instrumentation
95	90	ShawCor Ltd.	$10,517	$12,647	-16.8	$1,178,482	0.9	Other Manufacturing
96		Cardiol Therapeutics Inc.	$10,515	$3,530	197.9	$0		Pharmaceuticals/Biotechnology
97		Stingray Group Inc.	$9,919	$8,551	16.0	$306,721	3.2	Telecommunications Services
98		Blackline Safety Corp.	$9,241	$7,117	29.8	$38,377	24.1	Software & Computer Services
99	97	POET Technologies Inc.*	$8,900	$10,298	-13.6	$0		Electronic Systems & Parts
100		Q4 Inc.*	$8,773	$4,342	102.0	$54,171	16.2	Software & Computer Services

Notes:
1. Data were obtained through annual reports, financial statements, securities commission filings, other company issued documents, or through a survey.
2. We have attempted, whenever possible, to provide gross R&D spending before deduction of investment tax credits or government grants.
3. We have attempted, wherever possible, to provide revenue net of interest and investment income.
4. FY2019 R&D spending figures may have been adjusted as more accurate information became available.
5. Canadian-owned company results include worldwide revenue and R&D spending; foreign subsidiaries (fs) for their Canadian operations only.

*Converted to CDN$ at annual average 2020 = 1.3415; 2019 = 1.3269 (Bank of Canada)
**Based on companies with $2 million or more of revenue
+Not current name/acquired/merged
++Fiscal 2021 figures were used for year-ended January or February
fs = Foreign subsidiary (includes revenue and R&D spending for Canadian operations only)
nd = Not disclosed
(a) Sanofi Pasteur Limited and sanofi-aventis Canada Inc. (including Sanofi Genzyme Canada)

CANADA'S TOP 100
Corporate R&D Spenders

R&D Spending Stalls

Total research and development (R&D) spending growth by *Canada's Top 100 Corporate R&D Spenders* was flat in Fiscal 2020. Combined Top 100 R&D spending was $13.23 billion in Fiscal 2020 compared with $13.22 billion in Fiscal 2019. R&D spending increased at 55 companies and declined at 45. Combined revenues of 89 of the Top 100 that disclosed this data was $326.15 billion. This led to R&D intensity (R&D spending as % of revenue) of 3.3%.

The leading R&D spender was Magna International Inc., which devoted $1.11 billion to R&D (up 31.1%), followed by Constellation Software Inc. ($808.9 million, up 15.2%) and Shopify Inc. ($740.7 million, up 57.2%. Bausch Health Companies Inc. was in 4th spot with $606.4 million of R&D (down-3.0%) and Pratt & Whitney Canada Corp. rounded out the top five R&D spenders with $597.8 million (down -5.0%).

$100 Million Club

Twenty-seven Top 100 firms each reported R&D spending in excess of $100 million in Fiscal 2020, thus qualifying for membership in Research Infosource's *$100 Million Club*. In Fiscal 2020, total Club members' R&D spending was $10.69 billion, accounting for 81% of total Top 100 R&D spending.

R&D Spenders Tiers

Grouping the Top 100 companies into three R&D spending tiers (Tier 1 = $100 million or more of R&D spending, Tier 2 = $30 million-$99.9 million, Tier 3 = less than $30 million), three firms emerged as the respective tier leaders: Tier 1 – Magna International Inc. ($1.11 billion), Tier 2 – Teck Resources Limited ($97.0 million) and Tier 3 Westport Fuel Systems Inc. ($28.1 million).

R&D Spending Growth

In Fiscal 2020, the leading firms for growth in R&D spending in Tier 1 were Shopify Inc. (57.2%), Zymeworks Inc. (46.9%) and Magna International Inc. (31.1%). The Tier 2 leaders were Canopy Growth Corporation. (305.6%), AbCellera Biologics Inc. (193.8%) and Repare Therapeutics Inc. (91.9%). Tier 3 R&D growth leaders were Knight Therapeutics Inc. (199.6%), Cardiol Therapeutics Inc. (197.9%) and Q4 Inc. (102.0%).

R&D Intensity

Combined Top 100 R&D intensity (R&D spending as a percent of revenue) was 3.3% in Fiscal 2020. Among the 89 firms for whom complete data were available, a number of companies bucked the trend by posting very strong gains in R&D intensity. In Tier 1, the leading firms were: Zymeworks Inc. (432.7%), BlackBerry Limited (24.1) and Shopify Inc. (18.8%). Tier 2 leaders were: Liminal BioSciences Inc. (1,766.5%), Arbutus Biopharma Corporation (1,349.2%) and Aurinia Pharmaceuticals Inc. (100.4%). Heading Tier 3 were Titan Medical Inc. (39.7%), Mediagrif Interactive Technologies Inc. (36.9%) and Magnet Forensics Inc. (31.7%).

Regional Performance

In Fiscal 2020, 45 companies headquartered in Ontario reported combined R&D spending of $7.06 billion, representing 53% of the Top 100 total, followed by 29 Quebec-based companies ($3.61 billion, 27% of the total) and 25 firms located in Western Canada ($2.52 billion, 19% of the total). Overall R&D growth jumped by 12.0% in Ontario and dropped in both Quebec (-10.2%) and Western Canada (-12.2%). Quebec's drop was largely due to a continued decline at Bombardier Inc.

Industry Performance

In Fiscal 2020, a number of industry sectors posted the most R&D spending: 22 companies in the Software & Computer Services sector accounted for 28% of total Top 100 R&D spending, 29 Pharmaceuticals/Biotechnology firms accounted for a combined 14% of Top 100 R&D spending, five Telecommunications Services companies accounted for 12% of the top 100 total, three companies in Automotive sector with 9% of the total and eight companies in the Comm/Telecom Equipment sector also accounted for 9% of the total.

R&D spending growth was strongest in Fiscal 2020 in the following sectors: Automotive (up 24.0%), Software & Computer Services (up 13.5%), Pharmaceuticals/Biotechnology (up 7.2%) and Telecommunications Services (up 5.5%).

Bucking the Trend

Normally, Research Infosource expects R&D spending trends to broadly align with revenue trends. In Fiscal 2020 several industry sectors performed counter to expectations: the Automotive sector experienced a combined drop in revenue of -16.7%, but posted an overall increase in R&D spending of 24.0% and the Telecommunications Services sector posted a combined loss of -2.5% in revenue with an overall gain in R&D spending of 5.5%. Firms in the Software and Computer Services sector posted revenue gains of 11.3% and their R&D spending increase was even higher at 17.2% and the Pharmaceuticals/Biotechnology sector posted revenue gains of 2.6% and their R&D spending growth expanded by 9.2%.
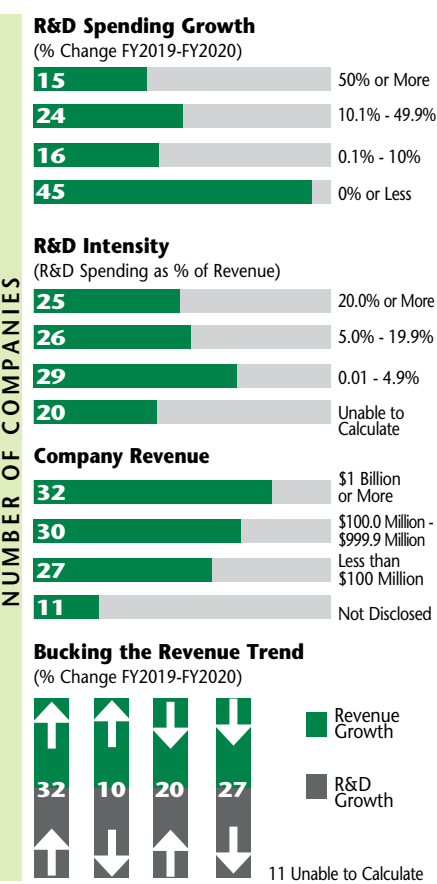
This Year and Next

There is no getting around the fact that Fiscal 2020 was a disappointment for corporate R&D spending. Overall R&D spending flatlined. While many companies did report healthy levels, the overall result was poor. What is troubling is that this year's results predate a slowing economy resulting from COVID-19 disruptions. Thus, it is entirely possible that Fiscal 2021 results could be worse.

It is tempting to blame companies alone for the poor state of corporate R&D. Equally, though, there is an urgent need for a serious re-think of government incentives and programs. Clearly, decades of "gap-filling" public policy measures and much-promised but little-delivered program consolidations are not having the desired effect.

Let's hope that Fiscal 2020 was an anomaly and that corporate R&D spending will return to a positive trajectory in the coming years.

Top Corporate R&D Spenders by Tier FY2020

R&D Spending			R&D Spending Growth (% Change FY2019-FY2020)			R&D Intensity* (R&D Spending as % of Revenue)		
Rank	**Tier 1**	**$000**	**Rank**	**Tier 1**	**%**	**Rank**	**Tier 1**	**%**
1	Magna International Inc.	$1,113,445	1	Shopify Inc.	57.2	1	Zymeworks Inc.	432.7
2	Constellation Software Inc.	$808,925	2	Zymeworks Inc.	46.9	2	BlackBerry Limited	24.1
3	Shopify Inc.	$740,678	3	Magna International Inc.	31.1	3	Shopify Inc.	18.8
Rank	**Tier 2**	**$000**	**Rank**	**Tier 2**	**%**	**Rank**	**Tier 2**	**%**
1	Teck Resources Limited	$97,000	1	Canopy Growth Corporation	305.6	1	Liminal BioSciences Inc.	1,766.5
2	Evertz Technologies Limited	$90,827	2	AbCellera Biologics Inc.	193.8	2	Arbutus Biopharma Corporation	1,349.2
3	Enghouse Systems Limited	$79,757	3	Repare Therapeutics Inc.	91.9	3	Aurinia Pharmaceuticals Inc.	100.4
Rank	**Tier 3**	**$000**	**Rank**	**Tier 3**	**%**	**Rank**	**Tier 3**	**%**
1	Westport Fuel Systems Inc.	$28,139	1	Knight Therapeutics Inc.	199.6	1	Titan Medical Inc.	39.7
2	Mediagrif Interactive Technologies Inc.	$27,870	2	Cardiol Therapeutics Inc.	197.9	2	Mediagrif Interactive Technologies Inc.	36.9
3	Pason Systems Inc.	$26,977	3	Q4 Inc.	102.0	3	Magnet Forensics Inc.	31.7

Notes:
1. R&D Spending Tiers: Tier 1 = $100 million or more of R&D spending, Tier 2 = $30 million-$99.9 million, Tier 3 = less than $30 million.
*Based on companies with $2 million or more of revenue

Top 100 Corporate R&D Spenders Key Demographics FY2020

R&D Spending Growth (% Change FY2019-FY2020)
- 15 — 50% or More
- 24 — 10.1% - 49.9%
- 16 — 0.1% - 10%
- 45 — 0% or Less

R&D Intensity (R&D Spending as % of Revenue)
- 25 — 20.0% or More
- 26 — 5.0% - 19.9%
- 29 — 0.01 - 4.9%
- 20 — Unable to Calculate

Company Revenue
- 32 — $1 Billion or More
- 30 — $100.0 Million - $999.9 Million
- 27 — Less than $100 Million
- 11 — Not Disclosed

Bucking the Revenue Trend (% Change FY2019-FY2020)
- 32 ↑↑ | 10 ↑↓ | 20 ↓↑ | 27 ↓↓
- Revenue Growth / R&D Growth
- 11 Unable to Calculate

FOCUS ON CANADA'S RECOVERY:

Research is key

Continued from page 23

Cambrian College

Supply chain bottlenecks for critical minerals throughout the pandemic have reinforced the need for a reliable and sustainable domestic mining industry. Getting there will rely in large part on a long overdue technological retrofit, particularly in the adoption of clean energy and digitalization.

Cambrian College is helping with this transition. In 2019 it established the Centre for Smart Mining (CSM), one of 60 national Technology Access Centres in Canada and the only one focused on driving technology adoption in mining – a sector where deviation from established practices is often viewed as unduly expensive.

Based in the international mining capital of Sudbury, Ontario, CSM works on industry-driven problems to de-risk technologies through proof-of-concept, pilot studies, prototyping, and customized technology training. Its areas of expertise include underground communications, alternative tailings treatment technologies, and battery-powered and connected mining vehicles.

"Mining companies face financial and operational risks with working underground so they need to know that a new technology will solve their problem and work in this type of environment," said Dr. Mike Commito, Director of Cambrian R&D, Cambrian College's applied research division.

> **This is no longer my grandfather's industry … there are now enticing career pathways for students in mining that they wouldn't never have even thought of 10 or 15 years ago.**
>
> **DR. MIKE COMMITO**
> **Director of Cambrian R&D, Cambrian College**

"The industry has entered this sort of renaissance where they're recognizing that a lot of these new innovations and technologies can help them be safer, more efficient and ultimately be more profitable," he added.

For example, CSM is working with companies to accelerate the adoption of battery electric vehicles which will replace diesel-fueled equipment. The benefits include lower fuel costs, reduced ventilation costs and reduced exposure of underground workers to diesel emissions.

Proven technologies that can work in rugged conditions aren't the only thing mining companies need. Cambrian is also training both students, as well as heavy equipment mechanics already working in the sector, on how to work on electric vehicles and other new technologies.

"With the advent of all these new technologies, mining companies are looking for students with IoT [Internet of Things] skills, who are programmers, who are coders, mechatronic engineers," said Commito. "This is no longer my grandfather's industry … there are now enticing career pathways for students in mining that they would never have even thought of 10 or 15 years ago."

RRC Polytech

Battery-powered electric vehicles (EVs) are becoming more commonplace in rugged environments, including Canada's north.

Frontiers North Adventures, a family-owned tourism business in Churchill, Manitoba, needed to know if it was possible to convert its Tundra Buggy® fleet from diesel-powered to battery electric. The goal was two-fold: to lessen their environmental footprint and reduce the vehicle's sound pollution, providing tourists with a silent experience when viewing polar bears and other wildlife on the sub-Arctic tundra.

For assistance the company turned to the researchers, engineers and students at RRC Polytech's Vehicle Technology & Energy Centre (VTEC), which has testing and validation experience in shifting transportation fleets from diesel to electric. VTEC's 5,574 square metre centre is also home to two facilities unique to Western Canada: MotiveLab™ and the Vehicle Technology & Research Centre.

"VTEC supports on- and off-highway vehicle innovation and most of our applied research activities have been related to EVs, starting from the electric bus prototype to some cold-weather performance testing, and looking into the future of having EV vehicles for other heavy duty vehicle sectors," said Jojo Delos Reyes, Research Program Manager at VTEC.

That research laid the foundation for the 2019 launch of the Future Skills Centre, a pan-Canadian initiative led by Ryerson in partnership with The Conference Board of Canada and non-profit Blueprint ADE to support real-world tests of promising skills development solutions and contribute to a growing evidence base on what works, why, and how.

For example, the pandemic has many workers looking for new careers, but a recent report from the Future Skills Centre found that most Canadians don't have the information they need to decide which training program – from the tens of thousands that are available – is the right one for them.

"I'm concerned about the proliferation of lifelong learning programs," said Liss. "Micro-credentials, for example, are the flavour of the month but you have to understand the supply and demand side of that, which is why we need strong evidence to support and evaluate them."

VTEC initially conducted a feasibility study in 2018 showing it was technically possible to convert the Tundra Buggies to electric. That was followed in 2021 by a proof-of-concept project using a repurposed battery from an electric bus. VTEC experts also provided training materials on safe handling and operation of the repurposed batteries.

Frontiers North put the prototype into full operation in November 2021, and plans to convert their entire fleet of 12 Tundra Buggies to electric by 2030. The company estimates the switch to green energy will reduce its carbon dioxide emissions by more than 3,600 tonnes over the next 25 years.

"We validated that the conversion could be done," said Delos Reyes. "One of the reasons we participated in this project was to prove that electrification of a wide range of heavy duty vehicles, including tractors, snow moving and mining equipment, is possible and they can work in extreme cold temperatures."

Ryerson University

One of the biggest post-pandemic challenges will be finding enough skilled people, particularly in emerging sectors like cybersecurity. It's an issue Ryerson University has been working on well before the pandemic started, whether it was identifying labour market disruptions and government policies at the Brookfield Institute or working with the Ontario Chamber of Commerce to develop an intelligent matchmaking portal, called Magnet, which connects qualified jobseekers with potential employers.

"Ryerson has been at the forefront of many of the important policy discussions. Now, looking to the future of Canada, we're at an important juncture with respect to issues like urban renewal and how immigration will be key to maintaining and sustaining our standard of living in the face of changing demographics," said Dr. Steven N. Liss, Ryerson's Vice-President, Research and Innovation.

Dr. Anna Triandafyllidou is leading several projects examining migration and integration, including how the pandemic is influencing decisions by highly-skilled immigrants to come to Canada and their difficulty in obtaining jobs commensurate with their experience.

"Where there continues to be a huge gap is in the area of cybersecurity," said Liss. "Several years ago we identified that pathways to the labour market through accelerated training could be an innovative way to do things. But that had to be coupled with research, innovation and with public policy and engagement."

Saskatchewan Polytechnic

The government of Saskatchewan has an ambitious plan of tripling the province's tech sector over the next decade by adding 100,000 new jobs. Saskatchewan Polytechnic is doing its part to fill the talent pipeline for this growing labour market through its Digital Integration Centre of Excellence.

Launched in 2018 with funding from both the federal and provincial governments, DICE is Saskatchewan's only Technology Access Centre. It has proven particularly popular throughout the pandemic, with demand for its services up 50% compared to previous years, "and it's still going up exponentially," said Dr. Susan Blum, who helped establish DICE and other applied research centres when she joined Sask Polytechnic as its first-ever Vice President of Applied Research and Innovation.

DICE's highly qualified specialists and technologists – several of whom hail from industry – provide digital solutions focused on data, including data integrity, data transmission and data analysis and storage. Many of the students who work on DICE projects end up being hired by the industry partners.

> **The nice thing about [Digital Integration Centre of Excellence] is it crosses all industry sectors, including mining, agriculture, health, education and transport.**
>
> **DR. SUSAN BLUM**
> **Vice President, Applied Research and Innovation, Saskatchewan Polytechnic**

"There wasn't really anyone else providing that service to the industry sector, especially for the large number of startups and small companies in the province," said Blum. "The nice thing about DICE is it crosses all industry sectors, including mining, agriculture, health, education and transport."

In one project, for example, DICE partnered with VeriGrain, an agriculture technology company, to enhance an app that gives farmers the ability to accurately determine grain quality and optimize grain utilization and reduce spoilage, which increases the quantity and quality of food available.

DICE also works with social ventures and the not-for-profit sector. The Restorative Action Program, which helps high school youth in Saskatoon outside the classroom, worked with DICE to develop a new database to allow fast data analysis to identify which practices and services work best for helping youth sort through conflicts like bullying, crime and mental health needs.

Now Sask Polytechnic is in the process of developing another applied research centre, the Sustainability-Led Integrated Centre of Excellence, or SLICE.

"It's bringing the other areas of expertise that we have in alternative energy, agriculture, manufacturing and forestry sectors together to deliver solutions to companies in the circular economy," said Blum.

Seneca College

The impact of the pandemic on food supply chains, combined with a growing trend to buy local, has fueled a voracious appetite for urban gardening. Seneca is leveraging its expertise in science, business and sustainability to help build local businesses that address food insecurity and increase access to healthy food in urban communities.

With $360,000 in funding from the Natural Sciences and Engineering Research Council of Canada (NSERC), Seneca and Ryerson University launched a three-year project in collaboration with community partners Greenest City and Toronto Urban Growers, a network of more than 1,000 urban growers and supporters. What makes the project unique is that it brings science, business and sustainability together in one package.

"The objective of our program is to help existing and potential urban farmers create a sustainable urban agriculture business. One of the biggest barriers urban farmers face is in accessing start-up capital so we will also be helping with microfinancing, as well as business planning, mentorship and training," said Ben Rogers, Dean, Seneca Innovation. Once piloted and proven the training modules will be packaged to be implemented in communities across Canada.

In another project funded by NSERC, Seneca's School of Software Design & Data Science and School of Nursing combined their research strengths to address the immediate and pressing need for qualified personal support workers (PSWs). During the COVID-19 pandemic, many PSW positions went unfilled due to bottlenecks in validating staffing requirements, despite qualified candidates looking for work.

TriNetra Systems Inc., a Markham, ON-based software company, collaborated with Seneca to create a new online portal to better connect PSW employers with PSWs seeking work. The partnership soon expanded to include Octochain Inc., which develops blockchain software products, and ConnexHealth, an agency that connects healthcare users with healthcare professionals through their online portal.

Together, the team developed OctoMatchAI, an online system that confirms PSW credentials in a fast, easy and reliable way.

"They then used artificial intelligence and machine learning to optimize the assignment of PSWs to different healthcare settings," said Rogers. "This not only helps recruiters find ideal candidates faster, it also helps PSWs find their ideal jobs."

University of Calgary

The pandemic has triggered a massive shift in global work patterns, with more people working from home. Empty office buildings have been a particular problem in Calgary which was already experiencing high vacancy rates because of an economic downturn that began after oil prices crashed in late 2014.

The University of Calgary and the City of Calgary are working on solutions,

> **The objective of our [urban farming] program is to help existing and potential urban farmers create a sustainable urban agriculture business.**
>
> **BEN ROGERS**
> **Dean, Seneca Innovation**

building on their longstanding collaboration through Urban Alliance which expedites the transfer of research to address important policy issues.

The new the Civic Commons Catalyst brings together faculty and students from architecture, landscape planning and public policy, along with urban environmental charity Evergreen, to help reinvent downtown Calgary's vacant public spaces and spur economic recovery and investment. Ideas include a hyperloop station, a waste-to-energy facility, a Calgary Airport-Downtown-Banff Rail, crypto-mining farms, hydroponic facilities, an innovation district and an artist/rainbow village.

> **Strong research universities create a mix of talent, ideas, intellectual property, and then having those well-oiled pathways to get into company creation and innovation creation is really necessary.**
> **DR. WILLIAM GHALI**
> Vice-President (Research), University of Calgary

"Coming out of the COP26 climate change conference, there's no question that we are now challenged as a province and country to produce innovative solutions and technologies. Yes, this is daunting in some ways, but it's also a very exciting opportunity to reimagine our future," said Dr. William Ghali, Vice-President (Research).

The United Nation's Sustainable Development Goals are guiding more of the research these days at UCalgary, from urban planning to developing better health systems, societies and public policies.

"The SDGs provide a compass and a sense of urgency for us to channel our scholarship to have impact on the things that really challenge us in society," he said. "That's a philosophy we are embracing as a university and it's making a difference in terms of how we operate."

UCalgary already had a strong reputation as an entrepreneurial university. The AUTM recently ranked it number one for creating startup companies compared to all Canadian research institutions. Ghali attributes this success to UCalgary-affiliated incubators (Innovate Calgary and CDL Rockies), a strong innovation ecosystem, and the Hunter Hub for Entrepreneurial Thinking, which provides seed funding for startups and social enterprises.

"Strong research universities create a mix of talent, ideas, intellectual property, and then having those well-oiled pathways to get into company creation and innovation creation is really necessary," added Ghali.

Niagara College

Many Canadians are consuming more alcohol during this pandemic – but not all. A growing number of health conscious consumers is fueling demand for non-alcoholic beverages, which is providing an opportunity for companies like DistillX Beverages.

But the Toronto firm needed a beverage that had both the taste and "mouthfeel" of real alcohol and that's where Niagara College was able to help. Led by Dr. Ana Cristina Vega-Lugo, a senior food scientist at Niagara's Canadian Food and Wine Institute Innovation Centre (CFWI IC), faculty and students were instrumental in the flavour development and proprietary distillation process for the company's new product, Sobril 0-Gin. The company recently landed a major Dragon's Den deal for the product, which is made with all natural ingredients, and no sugar, calories or hangovers.

DistillX soon returned to Niagara for help in developing non-alcoholic tequila, which hit the market last October.

"Our industry partners often come back," said Dr. Marc Nantel, Vice-President, Research and External Relations, Niagara College. "They see the value we bring to them in de-risking the development process."

That de-risking involves more than technology development. Niagara's Business and Commercialization Solutions team provides expertise in human resources, international business, operations management and sales and marketing. The services are available to industry partners in the college's three innovation centres – the Walter Advanced Manufacturing Innovation Centre, the Agriculture and Environmental Technologies Innovation Centre and the CFWI IC, which also specializes in cannabis-infused drinks and edibles.

"We not only give companies a technology solution, but also a commercialization solution," said Nantel

"What's the market, who is their competition, what's the supply chain look like, what's the go-to-market strategy? That added layer enables them to be more successful."

Niagara's newest capability is the beverage production facility which can manufacture enough units to get a company into the market.

"We recently received certification from the Canadian Food Inspection Agency to make thousands of litres," said Nantel. "It enables small companies like DistillX to put some product on the shelves so that when they get that massive deal with a large grocery chain we've already debugged the scaling up process and they can go to a co-packer [large-scale manufacturer] to make 20,000 or 50,000-litre batches."

Brock University

Brock University has a long history of partnering with the agri-food and biomanufacturing sectors to support research and talent development in southern Ontario's agricultural heartland.

Its most recent initiative is the new Brock-Niagara Validation, Prototyping and Manufacturing Institute (VPMI). The $6.1-million facility targets the bioproducts, bioscience and bioagriculture sectors, as well as chemical manufacturers. VPMI works to support the agrifood sector alongside two other Brock research institutes – the Niagara Community Observatory (NCO) and the Cool Climate Oenology and Viticulture Institute (CCOVI).

"These three institutes offer an entire suite of scientific and business expertise, problem solving, policy recommendations and partnership support," said Dr. Tim Kenyon, Brock's Vice-President, Research.

He describes the VPMI as a "one stop shop" for a wide range of analytic, prototyping and early stage biomanufacturing services. "Many of these services existed already but they were scattered in different locations around southern Ontario."

In one project, VPMI experts partnered with Toronto-based CanBud, which grows and distributes hemp cannabinoids (CBD) products, to study how different fungi can provide an organic alternative to chemical fertilizers.

Another Brock research centre, CCOVI, was established in 1996 in partnership with the Grape Growers of Ontario, the Winery & Grower Alliance of Ontario, and the Wine Council of Ontario. One current project is studying the use of a hand-held hyperspectral imaging system to detect grapevine viruses before symptoms are visible in the vineyard.

"CCOVI is seen as a trusted and credible problem solver by grapevine farmers and wine makers not just in Niagara but across the country," said Kenyon.

Brock is also home to the NCO, a think tank established in 2009 to explore public policy issues related to several sectors, including transportation and agriculture. It recently received funding through the federal-provincial Canadian Agricultural Partnership program to investigate the barriers and drivers to the adoption of automation and robotics in Ontario's agriculture sector.

"That research has already identified two significant barriers to technology adoption: farmers' lack of in-house expertise and a lack of government funding and support," said Kenyon. "The next step will see a full report released this year that offers some strong policy recommendations and concrete action items to address these barriers."

Ontario Tech University

Canada's transition to a green economy will inevitably include a role for high-energy, low carbon technologies like nuclear and hydrogen. But how will these technologies, along with renewables like hydro, solar and wind, be integrated into existing energy systems?

That's one of several challenges being tackled by the new Brilliant Energy Institute (BEI) at Ontario Tech University.

"Canada doesn't have a single energy system; we have different regions with different systems," explained Dr. Les Jacobs, Vice-President, Research and Innovation. "A net-zero economy needs to figure out how all these pieces are integrated. It's a policy issue, a technology issue and a data science issue."

Ontario Tech is a national leader in clean energy and environmental sustainability research, including hydrogen, nuclear, small modular reactors (SMRs), thermal power, advanced data analytics and software development.

About 30% of its faculty work on energy-related research, including clean energy and hydrogen researchers Dr. Marc Rosen and Dr. Ibrahim Dincer, who are in the top 1% of the world's most cited researchers. Ontario Tech also accounts for about 40% of all research done on hydrogen in Canada.

"We had all these disparate pieces but prior to BEI had never tied them together before to show how strong we were in this space," said Jacobs.

That strength was formally recognized last year when the International Atomic Energy Agency designated Ontario Tech as the first Collaborating Centre in Canada to support IAEA activities on advanced nuclear power technology, including SMRs as well as advancing integrated energy systems relying on diverse sources from hydro dams and renewables to nuclear.

"Our research strengths also line up with national priorities on clean energy," added Jacobs, notably Canada's SMR Action Plan as well as the Hydrogen Strategy for Canada.

In the shorter term, BEI is working with trusted industry partners on issues ranging from battery storage and the deployment of electric vehicle fast charters to lifecycle analysis of renewables. The university will also help Ontario Power Generation with its first SMR deployment later this decade at the Darlington Nuclear Generating Station, along with the skilled workforce needed to operate this new system.

"This is an important niche for Ontario Tech in building the workforce of the future," said Jacob.

University of Saskatchewan

Putting academic research to work solving local problems is also a priority at the University of Saskatchewan, where collaborations with both the province and the City of Saskatoon have a long history dating back over a century.

"The University of Saskatchewan was established nearly the same time as the province and the city, so those connections have been there since the beginning," said Dr. Baljit Singh, Vice-President Research at USask.

A three-year-old initiative to further link city staff and USask researchers and students is taking an even more strategic approach to help Saskatoon overcome barriers to contemporary urban issues like employment, transit and sustainable energy.

Research Junction has so far provided about $350,000 to 15 projects, including a wastewater monitoring project that measured levels of human pharmaceuticals such as antibiotics in Saskatoon's wastewater to assess potential risks these chemicals might pose to the downstream environment. The award-winning project pivoted with the COVID-19 pandemic, when in 2020 the city and the Saskatchewan Health Authority began using this surveillance system to measure traces of SARS-CoV-2 in wastewater.

Another project is applying geophysical methods to monitor the east riverbank of the South Saskatchewan River, where slope failures have occurred.

> **We are leveraging our technology and the skillsets of our faculty and students to help businesses adapt to doing business in the pandemic.**
> **DR. MICHELLE CHRÉTIEN**
> Associate Vice-President, Research & Innovation, Conestoga College

"They're looking at where and why these mudslides happen and how they can be prevented. It has implications for the houses that are built there, as well as city infrastructure and public space," said Singh.

The city and university also have a data licensing agreement that provides USask researchers with secure access to city data via the university's library. For example, researchers are designing fast, reliable, and explainable algorithms using Saskatoon Transit data that allow the city and transit planners to make data-driven decisions, optimize service at different times and better handle emergencies such as road closures and the COVID-19 pandemic.

"These types of collaborations make universities less of an ivory tower," said Singh. "It creates a valuable support system for the city to do research they need, and it creates great experiential learning opportunities for students to become aware of these complex problems and what is needed to build robust communities."

Conestoga College

Thinking about how to grow their business post-pandemic is still a luxury for many small companies struggling to make their next payroll or rent payment. The struggle has been particularly tough for restaurants.

Inspired by large fast food chains like McDonalds, students from Conestoga College's School of Applied Computer Science & Information Technology worked with Ottawa-based CPOS Inc. to develop a web-based kiosk style system that allows restaurant customers to avoid long lines by ordering and paying based on a QR code.

"This technology was previously only available to larger retailers," said Dr. Michelle Chrétien, Associate Vice-President, Research & Innovation, Conestoga College. "We are leveraging our technology and the skillsets of our faculty and students to help businesses adapt to doing business in the pandemic."

Another project is taking aim at the tens of thousands of tonnes of personal protective equipment (PPE) waste that has been generated over the last two years. Kitchener-based MEA Health Corp. and the college's Smart Manufacturing and Advanced Recycling Technologies Centre are developing a process to recycle masks and other PPE. That reprocessed material can then be sold to the plastics industry for non-woven and plastic injection molding manufacturing.

"MEA plans to reintroduce the recycled plastic into the value stream so we can reduce the amount of waste we're generating with our increased use of PPE. It's opening a new market for them," said Chrétien.

Another Conestoga research centre, the Canadian Institute for Seniors Care (CISC), unfortunately had to put some of its research on hold when the pandemic hit in March 2020 as several faculty and students shifted to the front lines to assist with a shortage of nurses and personal support workers in hospitals and long-term care homes. Among them was Dr. Veronique Boscart, the CISC's Executive Director and CIHR/Schlegel Industrial Research Chair for Colleges in Seniors Care.

"She is also a registered nurse and started working night shifts at the Village of Winston Park when it was experiencing an outbreak," said Chrétien. "This speaks to the agility of colleges, and their strong connection with the community, to pivot quickly in times of need."

York University

A York University-led research team is employing big data and artificial intelligence (AI) to help governments and local communities contain and manage the spread of COVID-19.

Launched in 2020, the Africa-Canada Artificial Intelligence and Data Innovation Consortium (ACADIC) brings together more than 50 researchers from data science, epidemiology, physics, mathematics, software engineering and AI, as well as disaster and emergency management, clinical public health, citizen science, and community engagement experts. Countries represented include Botswana, Cameroon, Canada, Eswatini, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Zambia and Zimbabwe, with more expected to join.

ACADIC collaborates with expert stakeholders in Africa to analyze epidemiological data in a locally nuanced way to identify emergent outbreaks, prioritize individuals at higher risk, and develop highly targeted and staged vaccine delivery plans that are equitable and effective, said Dr. Jude Kong, ACADIC founding director and Assistant Professor in York's Department of Mathematics & Statistics. The consortium also developed COVID-19 monitoring dashboards that visualize data that is locally relevant to the public and policy makers.

"With these tools, we're able to assess the impact of different vaccine distribution strategies given the limited quantity Africa is receiving and identify hotspots to ensure vaccines go where they're most needed," he explained. "Working with local authorities is key to developing strategies that are unique to each community, rather than a one-size fits all approach."

Armed with this data, communities can respond quickly when deciding whether to close schools and businesses. Authorities can also see the impact of an outbreak on local economies and whether public health interventions are equitable and effective.

"We're in discussions to build on this success by using these tools to fight diseases like malaria, cholera, sleeping sickness and emerging diseases," said Kong. "We are equally thinking about how we can apply these tools to identify women with high risk pregnancies and how health authorities can respond."

Canada could also benefit as a warming climate threatens to bring infectious diseases normally only seen in warmer countries.

"Some of these modelling tools could be brought back to Canada to help us understand the dynamics of these diseases so when or even before they arrive we'll know what it is and how to respond at the local level," said Kong.

Debbie Lawes, Debbie@dovercourt-editorial.ca, is an Ottawa-based writer specializing in science, technology and innovation.

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> **DR. LES JACOBS**
> Vice-President, Research and Innovation, Ontario Tech University

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Fiona Smaill
Professor, Pathology and Molecular Medicine

Zhou Xing
Professor, Medicine

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