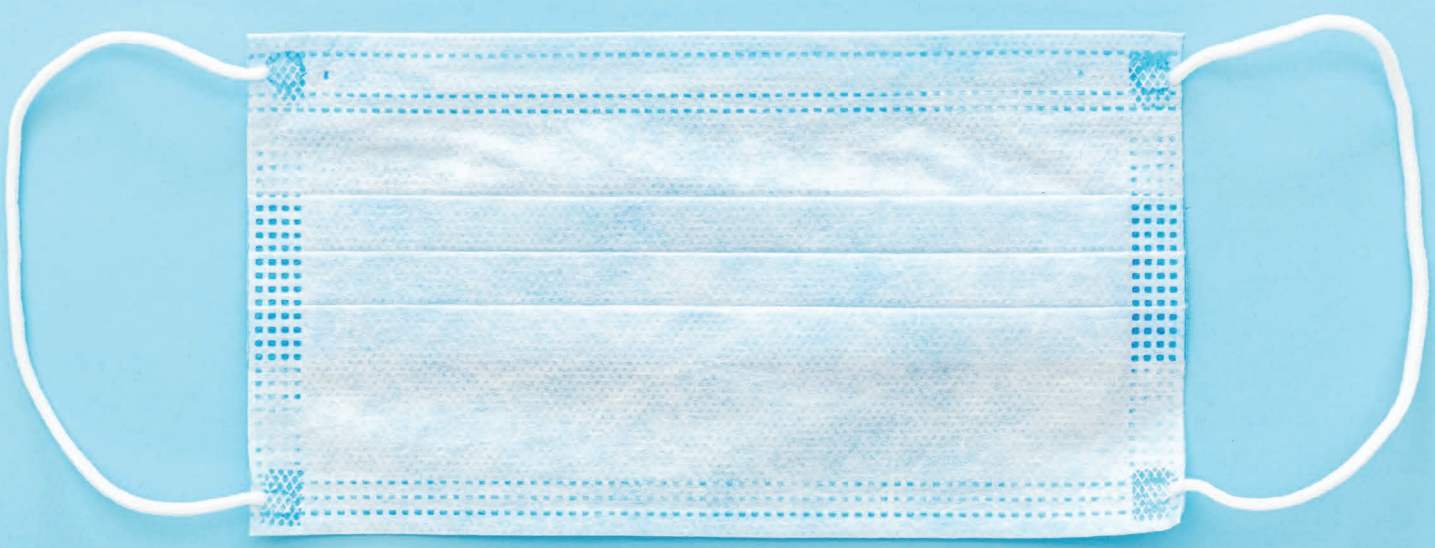
SUMMER 2021 | FACULTY OF ENGINEERING AND DESIGN

# Ingenious



## ANSWERING THE CALL

FROM EARLY RESPONSE TO PLANNING FOR THE FUTURE, CARLETON RESEARCHERS LOOK TO DEVELOP LASTING SOLUTIONS TO SOME OF COVID-19'S BIGGEST CHALLENGES

**RECLAIMING THE PAST**
Architecture students partner with Muskowekwan First Nation to transform residential school

**SUPPORTING WOMEN IN STEM**
Carleton launches industry and government supported Women in Engineering and IT Program

**GETTING THE GREEN LIGHT**
Undergrad team wins Project Arrow competition to design Canada's first zero-emissions vehicle

# Moving Forward Together

After pausing production on Ingenious throughout the tumultuous year that was 2020, we are delighted to share a new issue of the Faculty's alumni magazine for Summer 2021.

Looking back at the year we've left behind – and the now familiar challenges that have followed us into 2021 – it's important that we acknowledge and celebrate the dedication, resourcefulness and unity that continues to be put forth by our students, faculty and staff as members of the Carleton community.

Since the beginning of this global pandemic, Carleton researchers have devoted their efforts towards overcoming the impacts of COVID-19 on a number of fronts. From immediate response to adapting for pandemic life and planning for the future, this edition's cover story showcases some of the inspiring projects from professors and graduate-level researchers across our Faculty, as they work to develop lasting solutions to some of COVID-19's greatest challenges.

While we are unable to gather together on campus, there is still much to celebrate coming out of Carleton. This past October, a team of senior undergrads from Carleton's Industrial Design program won the Automotive Parts Manufacturers' Association (APMA) of Canada's Project Arrow design competition. Having placed first among more than 20 entries from across Canada, the team's original design will be used to create the first all-Canadian zero-emissions concept vehicle, projected to be road-ready by the end of 2022.

A long-term vision for our Faculty is also quickly on its way to becoming a reality, as Carleton University's all-new Engineering Design Centre looks to open its doors in late 2021. Connecting to Carleton's existing Mackenzie Building, the $16-million, 25,000-square-foot experiential learning facility will provide dedicated space for undergraduate students as they collaborate on fourth-year Capstone design projects.

Lastly, this past March, Carleton announced the launch of a ground-breaking new Women in Engineering and Information Technology (WiE&IT) Program – one of the first industry and government sponsored programs of its kind in Canada – which will provide learning and development opportunities for women students at all levels in Carleton's engineering and information technology (IT) programs. With financial support from more than a dozen external partners, the program will establish a comprehensive network of ambassadors and help to provide the necessary tools and knowledge for women students to successfully transition into the workforce.

Larry Kostiuk, PhD, P.Eng, FCSME, FCAE
Dean, Faculty of Engineering and Design

# Ingenious

**Editor:** Adam Landry

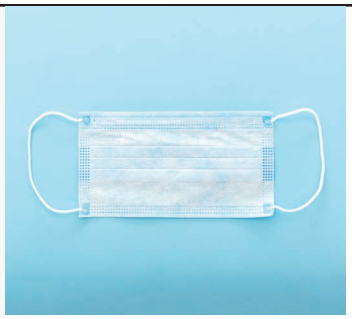
**Contributing authors:** Tyrone Burke, Leah Coppella, Elizabeth Howell, Karen Kelly, Adam Landry, Brenna Mackay, Joseph Mathieu, Dan Rubinstein, Dani Stock

**Photography by:** Mike Pinder, Chris Roussakis, Justin Tang, Fangliang Xu

**Additional photos and imagery courtesy:** Adobe Stock Images, Archives of the Missionary Oblate Sisters, Automotive Parts Manufacturers' Association of Canada, Carleton University - Department of University Communications, Diamond Schmitt Architects / KWC Architects, Ericsson, Jim Mountain, Madison Cohen-McFarlane

ON THE COVER
From immediate response, to adapting for pandemic life and planning for the future, professors and graduate-level researchers from the Faculty of Engineering and Design have rallied to the cause of combating COVID-19.

**Photo:** Adobe Stock Images



Newsletter Mission Statement
Ingenious is published for alumni, faculty, staff, friends, and partners of the Faculty of Engineering and Design. The newsletter is intended to communicate the Faculty's goals, strategic direction, and activities in order to connect alumni to each other and the university.



# Carleton Launches Women in Engineering and IT Program with Support from Industry and Government

*By: Leah Coppella*

While more women than ever are studying engineering and IT at university, it remains a hard truth that many women pursuing careers in science, technology, engineering and math (STEM) continue to face unique barriers both throughout their education and in accessing careers in the field after graduation.

While women repeatedly overcome systemic roadblocks in both academia and the workforce, there are enthusiastic efforts from allies in industry and institutions worldwide to oppose these unwarranted hurdles. Carleton's newly launched Women in Engineering and Information Technology (WiE&IT) Program is taking up that challenge.

As one of the first sponsored programs of its kind in Canada, the WiE&IT Program is being spearheaded by Carleton's Faculty of Engineering and Design, with financial support from more than a dozen industry and government partners. The program is another step toward closing the STEM gender gap, providing the necessary tools and knowledge for women students to successfully transition into the workforce.

The WiE&IT Program will provide learning and development opportunities for both undergraduate and graduate-level women within Carleton's wide range of engineering and IT programs. Starting in fall 2021, the program will host events that foster relationship building and mentorship, as well as a special fund to support allies in meeting equity, diversity and inclusion goals. The program will establish a comprehensive network of ambassadors and volunteers, roles that are crucial in challenging the public perception of women in STEM.

As a collaborative program, WiE&IT aims to unite individuals, community organizations and industry partners committed to supporting women in engineering and IT. Carleton knows the future of STEM requires equitable and competent professionals and that when we discourage women from the industry, we miss out on a wealth of knowledge and creativity.

Larry Kostiuk, Dean of the Faculty of Engineering and Design says Carleton is committed to developing and promoting an

As one of the first sponsored programs of its kind in Canada, the WiE&IT Program is being spearheaded by Carleton's Faculty of Engineering and Design, with financial support from more than a dozen industry and government partners.

engineering and IT culture that supports women.

"By collaborating with a variety of partners through this initiative, we will connect students to industry professionals, equip students with the tools and knowledge to succeed in the workplace, and foster inclusion in engineering and IT."

The program will provide women with access to industry tours, industry talks and "Candid Conversations," a safe space where students can ask about professional and personal experiences in the workplace. Networking sessions will also give external partners the opportunity to engage directly with students, encouraging the formation of meaningful professional networks. The program will also provide tangible resources that increase the visibility of women role models and ambassadors.

Banu Örmeci, Jarislowsky Chair in Water and Global Health and faculty adviser for Carleton University's Women in Science and Engineering (CU-WISE) chapter, says supporting women in engineering and IT "ensures more creative and viable solutions to the world's most pressing problems."

"By connecting our students with industry through the WiE&IT Program, we can enhance women's educational journeys and help to close the gender gap in STEM."

Industry and government partners supporting the program include Trend Micro, the Canadian Nuclear Safety Commission, CGI, Gastops, Leonardo DRS, Lockheed Martin Canada, Amdocs, BlackBerry QNX, CIRA (Canadian Internet Registration Authority), EllisDon, Ericsson, Nokia, Ross and Solace.

By fostering inclusion for educational journeys in STEM, the WiE&IT Program seeks to make roots in the community and industry. The program will work to increase diversity, inclusion and the visibility of women in the engineering and IT workforce by providing practical resources to women and fostering purposeful relationships with industry partners.

As Carleton's Faculty of Engineering and Design hosts some of the most comprehensive STEM programs in Canada, the faculty has a responsibility to work toward closing the STEM gender gap. While Carleton's innovative and unique programming is an important component towards gender equity in STEM, the implementation of the WiE&IT Program is a commitment to continue to inspire, encourage and include women for a more skilled and inclusive STEM future.

By helping women access some of the fastest-growing and highest-paid jobs of the future, we can ensure a diverse, talented workforce that can tackle the world's most pressing problems.

Carleton is committed to #CUEveryStep in closing the STEM gender gap with #WiEIT.

# **Reclaimed —** Saskatchewan's Muskowekwan First Nation plans to transform its residential school into a place of healing, with support from Carleton's Architecture program

*By: Dan Rubinstein*

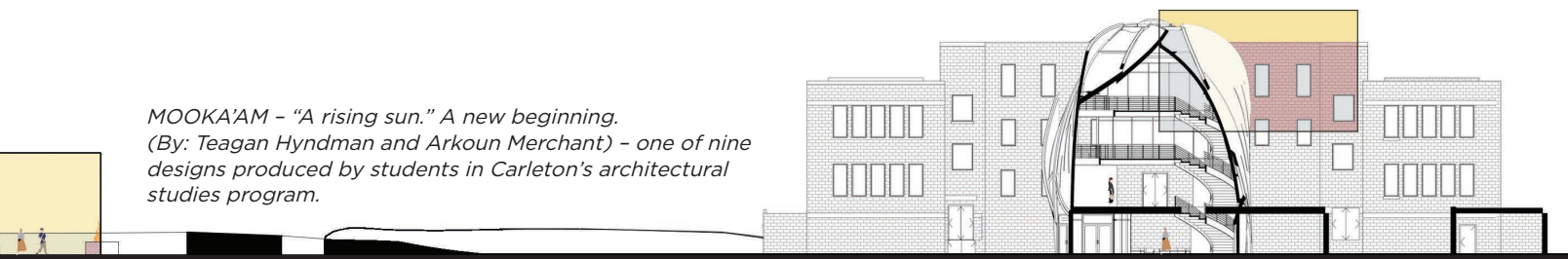
The colossal, three-storey red brick building is surrounded by farm fields and prairie wetlands, overshadowing everything else on the outskirts of the Muskowekwan First Nation, a Saulteaux community in southeastern Saskatchewan. A long, elm-lined driveway leads to the front door of the Collegiate Gothic structure, which features ornamental stone trims on the façade and is the last intact residential school standing in the province. Constructed in 1930 to replace an 1880s building that burned to the ground, it stopped operating as a government-run school in 1982, becoming a multi-purpose facility with a daycare, classrooms, a restaurant and transitional housing for youth, then closed for good in 1997.

"Horrific things happened inside," says Muskowekwan Band Councillor Cynthia Desjarlais, who lived across a field from the school when she was a student there in the early 1980s. "We were young, but still we knew." Desjarlais, whose mother had also attended the school and worked there as a janitor while Cynthia was a student, recalls a boy in Grade 7 who hanged himself. Several dozen children were buried in unmarked graves on the property, among the more than 3,000 students who died while attending residential schools across Canada, and she can name about 30 former classmates who are already dead, including one of her brothers — victims of physical, psychological and sexual abuse suffered at the school and of the intergenerational trauma that reverberates throughout the community.

Yet when the federal government offered money to tear down the building, all but four of the 339 Elders, residential school survivors and community members gathered in Muskowekwan voted to keep it standing.

"It's proof to future generations and to the rest of the country that these schools existed," says Desjarlais, "so this history is not swept under the rug. If people don't see things, they tend to forget them." Now, in collaboration with students and faculty from Carleton's Azrieli School of Architecture & Urbanism and the National Trust for Canada, a non-profit that strives to preserve the country's historic places, the Muskowekwan First Nation is planning to create a training and developing centre, museum, archive and memorial at the site — to transform the school's tragic legacy into something hopeful. "It's important to restore it, so the school can serve as a reminder," says Desjarlais. "Our Elders want to see it used for something good. For the children who never made it home."

In 2018, the National Trust put the Muskowekwan Residential School on its list of the Top 10 Endangered Places in Canada. National Trust Executive Director Natalie Bull and a pair of faculty members from Carleton's Azrieli School of Architecture & Urbanism — Adjunct Professor Lyette Fortin and Professor Stephen Fai, Director of the Carleton Immersive Media Studio (CIMS) — visited Muskowekan in November 2018. Following a moving and inspirational meeting with Elders and other community members, Fortin was determined to make the abandoned and deteriorating residential school the focus of a studio course in the Azrieli School of Architecture & Urbanism's Conservation and Sustainability



*MOOKA'AM – "A rising sun." A new beginning. (By: Teagan Hyndman and Arkoun Merchant) – one of nine designs produced by students in Carleton's architectural studies program.*

stream, and Fai hoped to use his lab to digitally document the building and make a detailed 3D model.

"How do you take a colonial Indian Act-era building and repurpose it into a place that reflects Indigenous values and culture?" asks Jim Mountain, an Adjunct Professor at Carleton and National Trust consultant who inherited the January 2019 studio course from Fortin when she fell ill after the trip to Saskatchewan. Mountain, who has worked on heritage conservation projects across Canada for four decades, including several with First Nations, talked from the start of the course to the 15 third-year students about the importance of listening to the community's vision and building relationships through four guiding principles: care, empathy, respect, compassion. "We spoke with Cynthia and other members of the Muskowekwan First Nation," says Mountain, "who told us the building was a dark place, both physically and with generations of bad memories, and that we needed to let light in. There's a lot of hurt, but the community doesn't want those stories to disappear."

Two months into the studio course, Desjarlais and Muskowekwan Chief Reg Bellerose came to Ottawa for a meeting with the Assembly of First Nations (AFN) National Chief Perry Bellegarde. They set up a presentation at AFN headquarters and met with the Carleton professors and the Studio ARCC3302 students, and a partnership with the university took root. The students did research on the history of the school, studied the surrounding landscape and climate, and compiled archival images and copies of the original architectural drawings. They visited the Douglas Cardinal-designed Wabano Centre in Ottawa — an Indigenous health centre — and a photo exhibit on residential schools at Carleton's MacOdrum Library. By the end of the term they had come up with nine designs for the Muskowekwan school site, based on Indigenous values they had been mentored on by the Muskowekwan First Nation. The design concepts suggested, among other changes, much larger windows, more curvilinear elements, better flow between and flexibility within rooms,

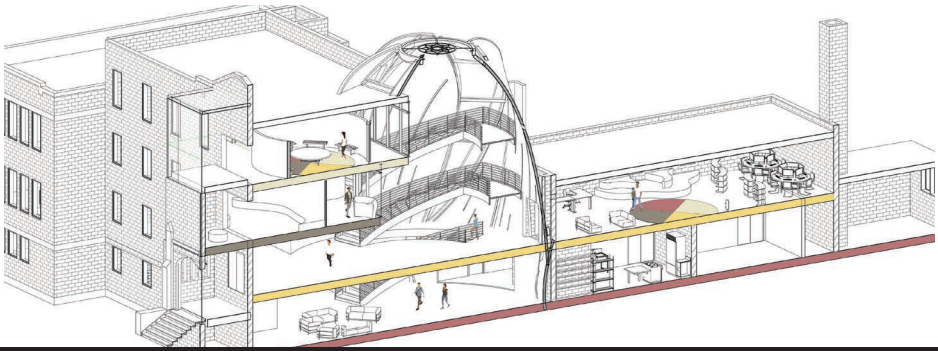
*Muscowequan School - 1946 - Grades 1, 2 and 3.*
*Archives of the Missionary Oblate Sisters - M19/40*

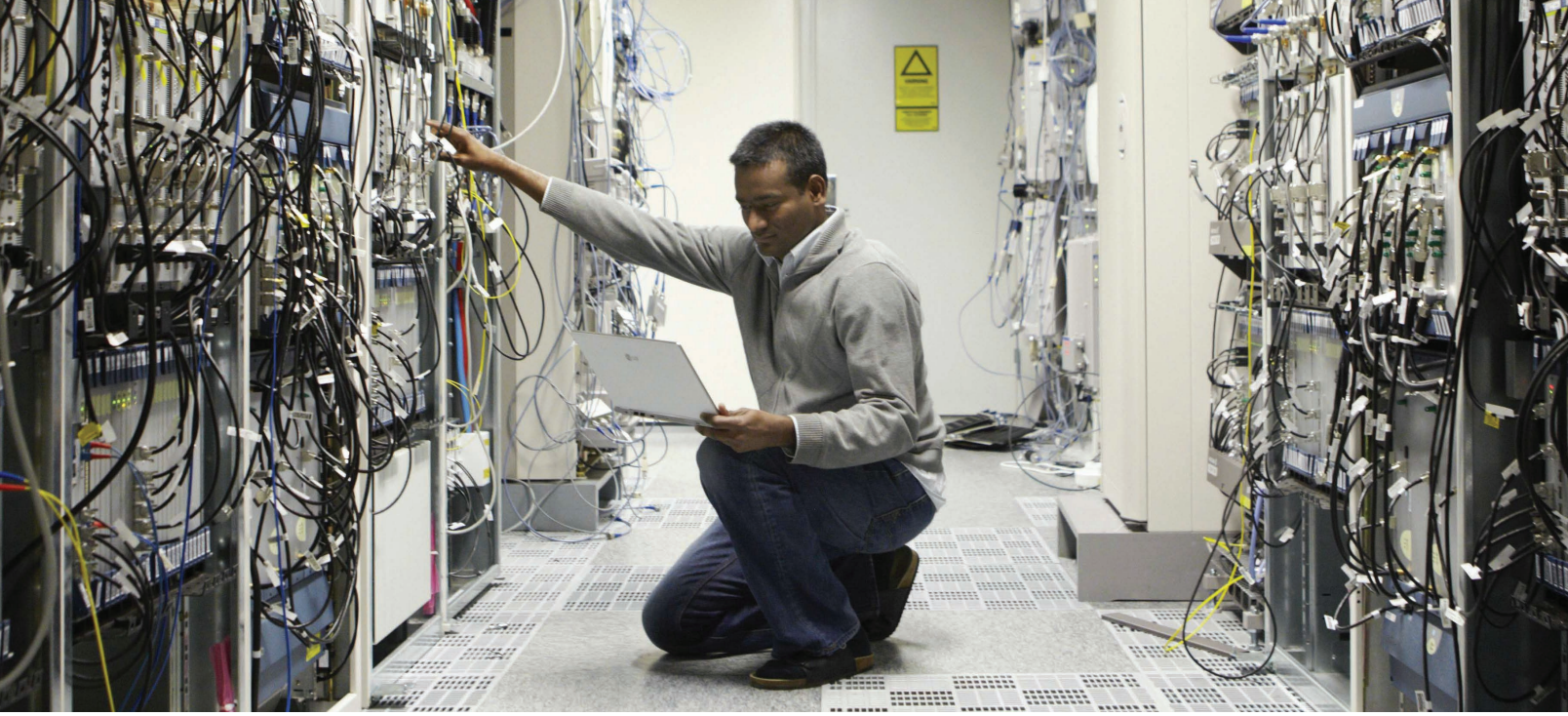
and a main entrance that no longer looked south but instead faced east, toward the sunrise.

"It was the most difficult and emotional project I've ever worked on," says Lauren Liebe, one of the students. "We wanted to put our hearts into it and make something meaningful." A couple months after the class, Liebe, who is from Regina and was back home for the summer working for a local architectural firm, went to Muskowekwan to give the designs and supporting material to Desjarlais and her fellow councillors. Professor Fai and a small crew from CIMS were also there, laser scanning and taking photos of the school for their 3D modelling. The student designs could inform the ultimate plans for the site, but in the meantime, along with the digital data, they will bolster a bid for National Historic Site status, which has already been submitted to Parks Canada and, if successful, could help raise awareness about and funding for the rehabilitation project. "Saskatchewan, like the rest of Canada, must work towards reconciliation," Ingrid Cazakoff, the CEO of Heritage Saskatchewan, wrote in support of the application. "Commemorative heritage projects such as this one, initiated by and through an Indigenous worldview, are critical."

"As a kid growing up in Saskatchewan, I was shocked that residential schools were part of our history," says Liebe. "As devastating as the stories are, I'll never really know what children there experienced. Now the community has an opportunity to reclaim the building and I feel privileged to have been part of this. It's something I'll think about forever."

The Muskowekwan Residential School already has new life. School groups and people from nearby cities and towns visit to learn more about what happened inside the building and the impact of those experiences on the long road toward reconciliation. "Like other historic sites, people come here to understand the past," says Desjarlais, explaining that the proposed training centre will help community members, while the museum, archive and memorial will have both ceremonial and educational roles. And this summer, just down the road from the school, several log homes will be raised for a new traditional, land-based healing and wellness centre. "Despite everything that happened to us, we lived through it and survived," says Desjarlais. "Now we have to help our people get better in any way we can."





# Carleton and Ericsson Collaborate to Shape the Next Generation of Telecommunications Technologies

*By: Tyrone Burke*

*5G is the fifth generation of cellular networks, bringing new capabilities that will create opportunities for people, businesses and society. 5G will do much more than improve your network connection. It provides new opportunities, enabling us to deliver groundbreaking solutions that reach across society. Imagine billions of connected devices gathering and sharing information in real-time to reduce road accidents; or life-saving applications that can take flight thanks to lag-free guaranteed connections; or production lines so predictive they can prevent interruptions well before they occur. There's no need to imagine. 5G can make this happen.*

"To perform remote surgery, with a surgeon in one place and the patient in another, we must have ultra-reliable and low-latency communication," says Dr. Rafik Goubran, a Chancellor's Professor of Systems and Computer Engineering and Carleton's Vice-President (Research & International).

"A surgeon needs to see what they are doing clearly, reliably and in real-time. 5G could enable that. It will open the door to new applications in health care, autonomous vehicles and many other fields."

There will be a new era in telecommunications innovation, but we are not quite there yet. To bring us closer, Carleton University is partnering with Ericsson, a Stockholm-based multinational telecommunications company that has a strong research and development footprint in Ottawa.

The four-year Ericsson-Carleton University Partnership for Research and Leadership in Wireless Networks launched in February 2020. It combines an ambitious research program with strategic talent development that will position both organizations to continue their leadership in 5G.

"5G opens the possibility of solutions we haven't even imagined yet," says John Luszczek, a Director at Ericsson.

"When the internet started, we didn't have applications like Netflix. They happened once broadband came in place. Now, a similar transformation is happening with 5G. We already see initial capabilities with higher speeds, but ultra-reliable, low latency communications will allow us to provide reliability for solutions like autonomous vehicles. These are the industries of the future. The technology itself is the enabler, and what we do with it will be really exciting."

The new partnership strengthens the ties between Ericsson and Carleton. The company employs 1,500 people at its research facility in the Kanata North Business Park and hires Carleton students as interns each year. There are a large number of Carleton graduates who work for the company, and the university's strengths in telecommunication align well with the company's business.

"There are professors at Carleton who are directly addressing some of the research challenges that Ericsson is dealing with. The university provides a strong set of professors and a strong curriculum," says Luszczek.

The communications infrastructure in Carleton's Advanced Research and Innovation in Smart Environments (ARISE) Building has been upgraded as part of the partnership. Students and researchers won't have to leave campus to test concepts and research projects using next generation communications technologies.

"They will be working collaboratively with Ericsson to co-create solutions that will be deployed in the real world," says Goubran.

"Our students will have leading-edge knowledge of telecommunications, and hands-on experience with equipment that will reach the market a few years from now. Working with Ericsson will help us promote Carleton's strengths in Information and Communications Technology (ICT). We consistently rank as one of the top universities in the world for telecommunications, and this partnership will make that excellence more visible. It will reflect our strengths and help us attract the best graduate students and postdoctoral researchers."

In 2020, The Shanghai Academic Ranking of World Universities placed Carleton 6th for telecommunication in North America, and third in Canada. This partnership will leverage that strength to probe a broad range of research challenges.

Ericsson is funding a research chair for Professor Ioannis Lambadaris, a Professor of Systems and Computer Engineering with expertise in the applied stochastic processes and control. Through a series of research projects, ten Carleton research teams will explore a diverse set of topics — from networking drone swarms to optimizing bandwidth with machine learning. Funded fellowships at the Master's and PhD levels will help attract the best students from around the world, and their education will be designed to help them succeed in industry.

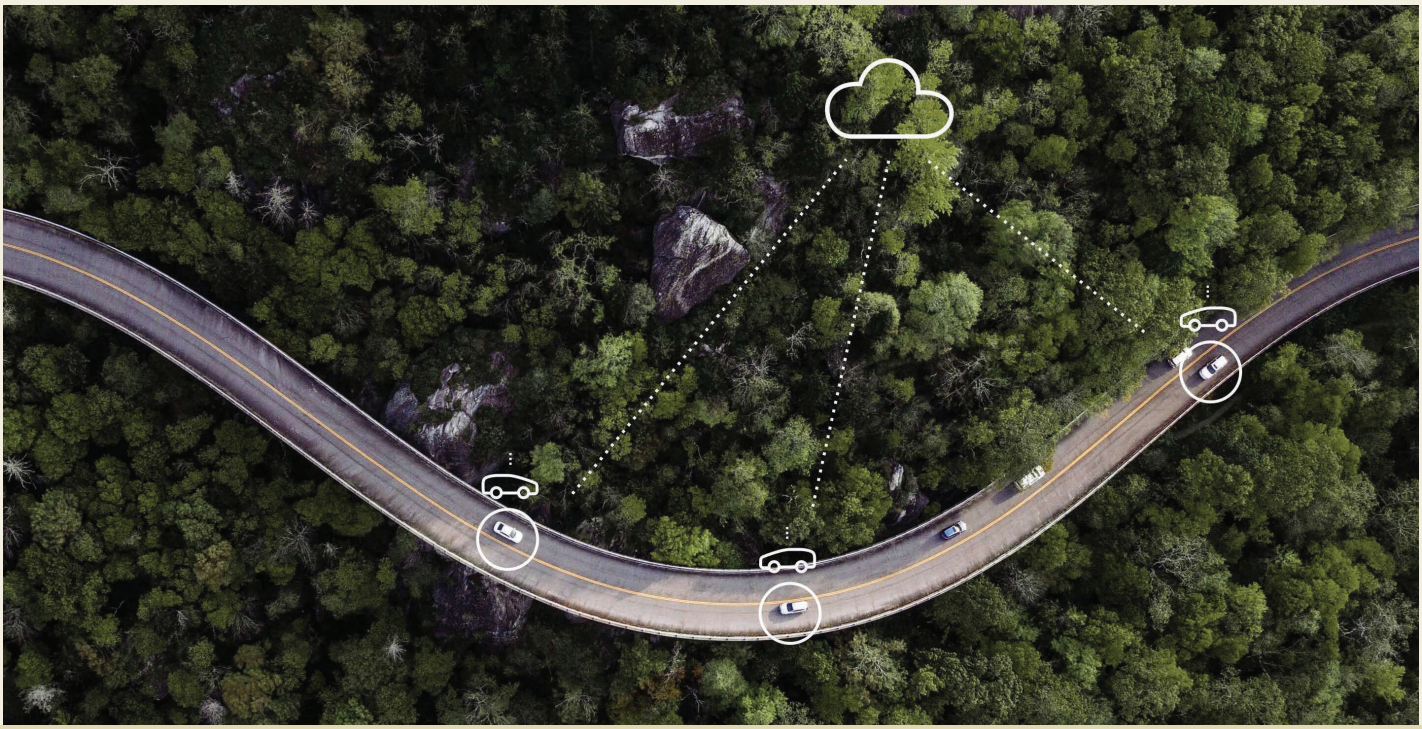
"The fellowships are a win-win-win for everybody. We will recruit talented researchers to work on these projects – the top talent locally, nationally and internationally," says Goubran.

"Working closely with a company like Ericsson will give our Fellows experience solving real-world problems. It is a kind of experiential learning that will be vital in delivering on the partnership's research projects, while also benefitting the researchers themselves."

For Ericsson, the partnership helps ensure it will have access to talented graduates who will help them tackle the technical challenges of the future.

"Recruiting talent is critical in the high-tech sector, and this is a strategic collaboration that helps us differentiate ourselves from the competition. We want people in the university ecosystem to know that Ericsson is a great place to work," says Luszczek.

"This is real-world research that addresses real-world problems. We want to be sure that we enable people to be successful in industry. Education is part of that, but education needs to be adapted to what industry needs. Ensuring that it is could be a success factor for Carleton."



# Carleton's Collective Effort to Fight **COVID-19**

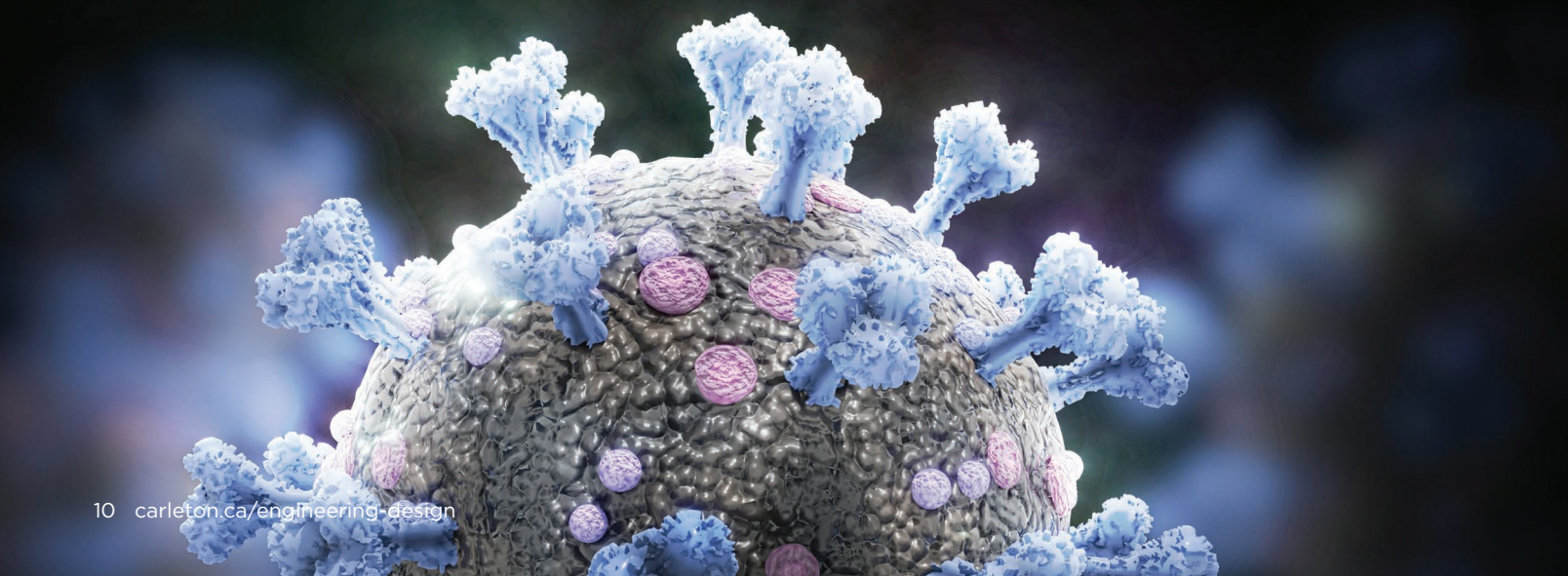
*By: Joseph Mathieu (with files from Tyrone Burke, Leah Coppella, Elizabeth Howell, Adam Landry and Dani Stock)*

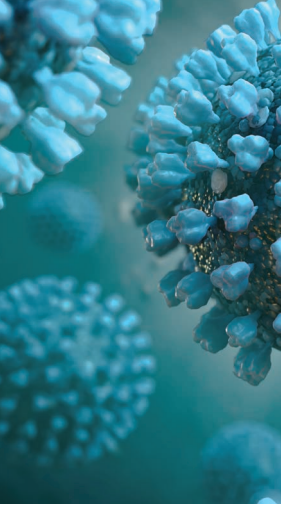
Keeping COVID-19 in check is a fight on many fronts. It involves the prevention of infection, the monitoring of community spread and a sweeping overhaul of how we live, work and play in our modern world.

Rallying to the cause, professors and graduate-level researchers from the Faculty of Engineering and Design have tackled several of these problems since the start of the global pandemic. Their projects vary widely in scope: from immediate response and mitigation of the continuing health impacts of COVID-19 to adapting for pandemic life and planning for the future.

What all these projects have in common is the goal to develop lasting solutions to COVID-19's biggest challenges. They are all globally-minded research initiatives that rethink society, medicine and technology and defend that which we hold most dear.

This inspiring showcase of projects from all departments and schools highlights the work of seven of our researchers, all of whom have made the future that much brighter through their diligent efforts.





# Drone Decontamination: Unmanned Aircraft Safety Takes Flight

Long-range cargo drones require only minimal human contact and could provide extra capacity for struggling supply chains during the COVID-19 pandemic. But to do so successfully means the uninhabited aircraft system (UAS) must not transmit the coronavirus as they deliver goods to remote and rural communities.

Mechanical and Aerospace Engineering Professor Jeremy Laliberté has launched an initiative to develop safe decontamination processes so large-scale drones only deliver vital supplies — and nothing else.

Laliberté has partnered with Canadian UAS firms Romaeris Corporation and Sky Canoe to research rapid decontamination strategies for aircraft that may have been exposed to SARS-CoV-2. With one of Carleton's CU COVID-19 Rapid Research Response Grants and an NSERC Alliance COVID-19 Grant, the project aims to demonstrate how UASs can be play a key role in ensuring communities have access to food, water and medicine during a global health crisis.

"In the very short term, this will enable both companies to safely clean and disinfect aircraft during ground testing, flight operations and maintenance," says Laliberté.

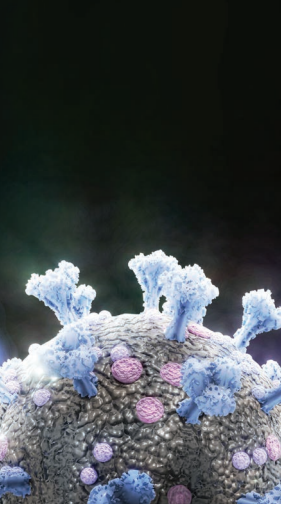
Each company will soon deploy drones capable of transporting cargo exceeding 250 kg that could deliver essentials to remote communities throughout the country. Because SARS-CoV-2 is known to be able to survive on metal and plastic surfaces for up to several days, the joint research initiative is integral to successfully and safely rolling out such deliveries.

Area X.O, originally named Ottawa L5 Connected and Autonomous Vehicle (CAV) test facility, will host test flights and decontamination processes. Open since May 2015, the cutting-edge facility accommodates research on autonomous vehicles and systems, UAS, 5G wireless networks and more to allow researchers to evaluate their project's prototypes.

Romaeris and Sky Canoe plan to integrate the newly developed decontamination processes into their respective operations as soon as they are finalized. Part of their work will be to ensure that decontamination won't pose any risk to the UAS airworthiness.

"In continuing our testing at Area X.O, the knowledge we gain will also enable the development of new drones that are designed for regular decontamination from the outset," says Laliberté.

More research is needed to determine how repeated exposure to decontamination chemicals may affect the safety and performance of UASs. The project will expand further once more restrictions are lifted to perfect processes and possibly develop new technologies.



# Better, Safer, Stronger: Rethinking Long-Term Care Home Design

Although the global health crisis has affected all segments of Canadian society, no group has been harder hit than people living in Long-Term Care (LTC) homes.

By the first anniversary of the World Health Organization's declaration of a novel coronavirus pandemic on March 11, over 22,000 Canadians had died from COVID-19. Approximately two thirds of those virus-related deaths were in LTC.

To protect this vulnerable population, Chantal Trudel, a Professor in the School of Industrial Design, launched an innovative project to rethink LTC spaces. Their design is complex because LTC homes need to be comfortable and inviting living spaces that also abide by infection prevention protocols necessary for clinical environments.

"Unlike hospitals, which are clinical in nature, long-term care environments are residents' homes," said Trudel.

Research-based long-term care planning and design will strengthen protection for residents and healthcare workers. It also has the potential to save lives, both during the current pandemic and during a future virus outbreak.

Infection prevention and control (IPAC) design is particularly hard to achieve in healthcare settings, where high-touch surfaces and shared spaces around daily care create many opportunities for transmission. To create IPAC design plans, Trudel and her partners at the Bruyère Research Institute and the Ontario Centres for Learning, Research and Innovation in Long-Term Care are remotely collecting data from five LTC homes.

They are in the process of expanding the study to 30 homes across Ontario. Their work to understand how LTC healthcare workers, residents and families of residents experience the design of the physical environment, equipment, supplies and technology was funded by a $40,000 grant from the Foundation for Health Environments Research in the United States in January 2021.

During the pandemic, healthcare workers are responsible for completing increasingly rigorous safety protocols and wearing cumbersome personal protective equipment, all while meeting their regular patient care duties.

The team will also work with future LTC homes and those undergoing renovations to create infection-prevention design strategies. While the experiences of healthcare experts and key construction stakeholders is essential, Trudel and her team will be seeking feedback from residents and their families as well.

Because even as LTC homes balance safety, efficiency and a high quality of life for their patients, they must keep in mind that patients are people. And they know how they want to live: in safety and with decency.

# Troubled Wastewater: Monitoring for Early Signs of COVID-19 on Campus

During the pandemic, Civil and Environmental Engineering Professor Banu Örmeci has kept a close eye on Carleton University by studying what is leaving its campus.

Because studies found that SARS-CoV-2's viral RNA can appear in feces within three days of infection — much sooner than the two weeks it takes for people to develop severe symptoms. And so, Örmeci, the Jarislowsky Chair in Water and Global Health and Director of the Global Water Institute, has tested the campus' wastewater for traces of COVID-19 since August.

The early-warning system can detect a rise in cases that might lead to outbreaks. Örmeci's team began to use it to test the City of Ottawa's sewer system last spring and will soon be assisting four additional cities with their wastewater monitoring.

"Our wastewater data indicate that the concentrations of the virus genetic material in wastewater show very good correlation with the number of COVID-19 cases and we can predict the trends earlier," she says.

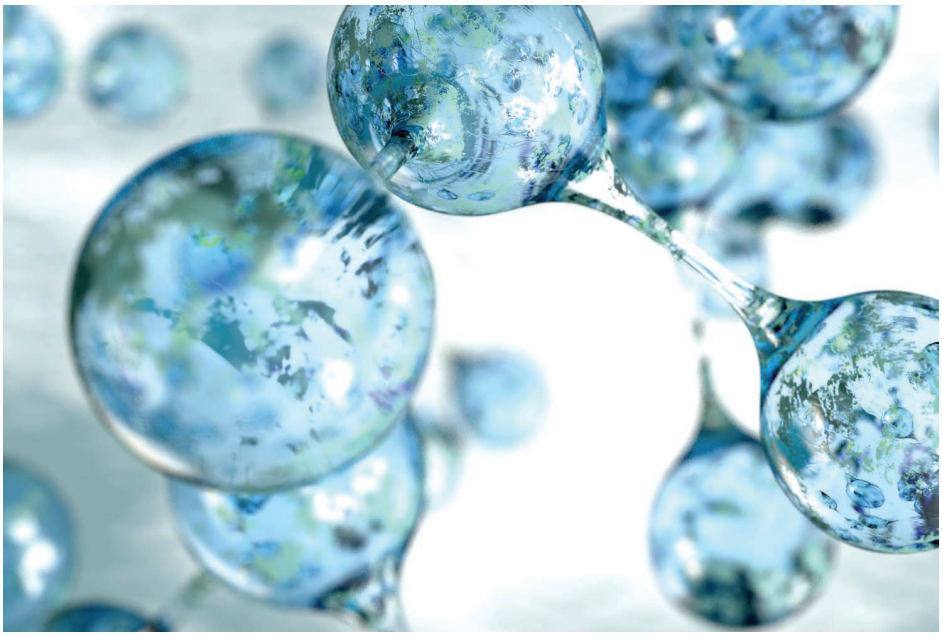
Currently, they are collecting on a weekly basis from the campus sewer and some of the residence buildings. If the monitoring indicates an increase in COVID-19 cases, Örmeci and her team would immediately inform campus administrators and public health officials, and they would sample from individual buildings to help identify the source of potential clusters.

Wastewater-based epidemiology (WBE) testing can identify the presence of the virus in the community before a case of the disease is confirmed. WBE is being used around the world, and Carleton was one of the first in Canada that began monitoring its campus wastewater. It makes for a discreet, precautionary alert system that can avoid outbreaks and warn healthcare practitioners of an increase in cases to come.

Örmeci is the Co-Chair of the International Water Association's (IWA) COVID-19 taskforce, a widespread global effort to share as much epidemiological information about SARS-CoV-2 as possible. The IWA is the world's largest international organization of water professionals and its taskforce provides the world's water sector with updates on state-of-the-art science, attributes of the virus, and any measures needed to protect both workers and public health.

Örmeci's research lab, one of the best-equipped wastewater and biosolids lab in Ottawa, plays a big role in tracing community infection. Because sooner healthcare professionals are aware of coming cases, the better equipped everyone will be in stopping the spread.


*Professor Banu Örmeci, Jarislowsky Chair in Water and Global Health and Director of Carleton's Global Water Institute.*



# The Hoarse Whisperer: Tracking COVID-19 One Cough at a Time

Biomedical Engineering PhD student Madison Cohen-McFarlane was already looking into possible ways to evaluate cough sounds when the coronavirus shut down the world.

As she listened to COVID-19 patients cough on the news, Cohen-McFarlane realized she could turn their varied cough sounds into a relevant database. Because coughing is an early recognizable symptom of COVID-19, being able to monitor more forceful or frequent coughing could be very helpful to healthcare providers as they make treatment decisions.

Working in collaboration with her PhD supervisors from the Department of Systems and Computer Engineering, she was able to create one of the first databases of COVID-19 cough sounds in the world: the Novel Coronavirus Cough Database (NoCoCoDa). Since their work was published in August, Cohen-McFarlane had added several new cough types to NoCoCoDa and has begun to work with crowdsourced datasets from other research groups.

"During our analysis, we discovered that the COVID-19 cough is initially dry, similar to a cough when you have a tickle in your throat," she says. "But in more severe cases it can become more wet or productive, such as the kind of cough you get when you have a cold or flu."

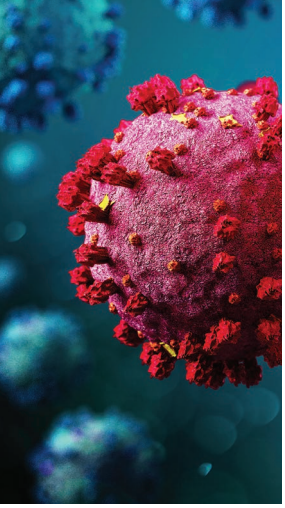
Since coughing is also a common symptom of a variety of other medical conditions, this presents a set of challenges for diagnosis. Many underlying factors — such as muscle strength, lung capacity, age and sex — can change how a cough presents itself.

While Cohen-McFarlane and her team are still investigating cough characteristics, specifically in regards to COVID-19 disease progression, they have also been experimenting with machine learning methods for the classification between different cough types. The goal is to evaluate the frequency and severity of cough sounds in an unobtrusive way using a rapid audio-based algorithm.

"Right now, we are trying to differentiate between wet coughs, dry coughs, whooping cough and wheeze sounds," says Cohen-McFarlane. "The ability to do this in real time could allow medical professionals to receive severe changes in health status within minutes rather than within hours or days."

*Biomedical Engineering PhD student, Madison Cohen-McFarlane.*

Potential real-time applications could include a system that identifies a cough sound, compares it to others, and makes a prediction of its type or characterization. In a smart-home device that could identify all kinds of restricted breathing sounds, this would ultimately allow older adults with respiratory health conditions to live independently at home.



# Going Viral: Point-of-Care Sensors Remain Essential for Early-Stage COVID-19 Detection

Monitoring community spread is essential to stopping the coronavirus in its tracks. But since over 50 per cent of carriers can be asymptomatic and infectious at the same time, managing the global pandemic will only be possible through rapid point-of-care (POC) testing.

"It's anticipated that COVID-19 will not be completely eliminated," says Electronics Professor Ravi Prakash. "It will end up becoming endemic, like the flu. Mortality rates will be low with the world's access to vaccines, but healthcare professionals will always need to test for COVID-19 at a high rate."

With funding from a CU COVID-19 Rapid Research Response Grant, Prakash has developed a novel POC nucleic acid test (NAT) that's both rapid and effective. In partnership with BioCoS, a Greek bioinformatics firm, Prakash's interdisciplinary team is testing a loop-mediated isothermal amplification (LAMP) assay that has proven to be highly specific to SARS-CoV-2 in preliminary assessment.

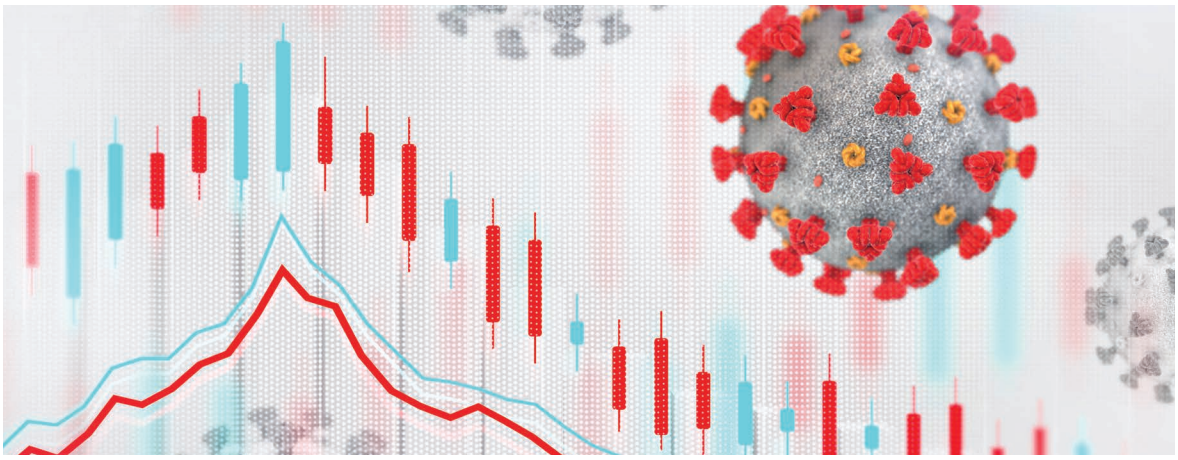
The new test will be adopted on a previously validated reverse transcription polymerase chain reaction (RT-PCR) micro-device, originally designed to detect influenza, and mosquito- and tick-borne diseases. The new POC NAT system developed for SARS-CoV-2 was improved to require less power and to send its results wirelessly, for a more rapid diagnosis.

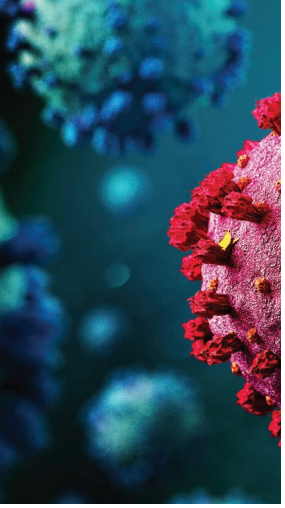
The final prototype is expected to be comparable to a smartphone in size and prepares and intakes a sample in about 10 minutes and extracts its total nucleic acid (RNA and DNA). These are mixed with a specific type of newly developed DNA polymerase enzyme that can amplify viral RNA molecules, the genetic signature of the coronavirus. The LAMP primers are designed to have minimal affinity to human or bacterial genome, which makes it suitable and accurate for detecting coronavirus in bacteria-rich wastewater samples.

As amplification of the RNA takes places, a biomarker changes colour to confirm the presence of SARS-CoV-2. In a typical RT-PCR sensor, a test can take anywhere between 30 to 60 minutes. With Prakash's LAMP POC sensor, test outcome could be available in close to 10 minutes.

If all goes well, Prakash hopes to start testing the prototype this summer with wastewater samples collected by Civil and Environmental Engineering Professor Banu Örmeci. Clinical testing with positive nasal swabs from Dr. Prameet Sheth at Kingston Health Sciences Centre could begin by late 2021 or early 2022.

"The need for reliable POC devices is not going anywhere," says Prakash. "They are essential for timely pandemic surveillance, and such devices will play a critical role in the years to come."





# Phone Contacts: Keeping People Safe, Data Secure through Contact Tracing System

Although conventional contact tracing is an essential public health tool to slow a virus' spread, high technology solutions can also help to alert Canadians of possible infection.

In April 2020, Wei Shi, a Professor with the School of Information Technology, created one such solution as a fully automated, efficient and secure contact tracing system (CTS). She received an NSERC Alliance Grant to develop the CTS using a smartphone's built-in Bluetooth technology. Shi then created a corresponding app, which she created with the help of a group of Carleton graduate students.

The Android app they completed by the end of May 2020 was designed to be as resilient to cyberattack as it was protective of user data. Like the COVID Alert app adopted by Health Canada in late July 2020, Shi's CTS uses Bluetooth because it only transmits data over a short range. There is no saved or exchanged location data, and it includes no information about a person's identity.

"Many of the CTS used in other countries collect your whereabouts and analyze this data at a central server to determine who could have been infected," says Shi. "But you don't need to do that. If everyone uses a cell phone with Bluetooth, we can establish contact between phones without recording their geolocations."

Whenever an app user tests positive for COVID-19, the app confirms that the test is legitimate and delivers a set of encrypted messages to all of its users. Each message can be decrypted only by the phones of those who have encountered this infected person's phone in the 14 days before and after the test date.

*Carleton's Wei Shi, Professor in the School of Information Technology.*

Although the arrival of vaccines suggests the pandemic's end is in sight, this also means that improving those CTS and remaining as vigilant as ever are still very important. Shi's research group has also been actively looking for a low-cost, Bluetooth-enabled sensor-based solution that could make the system available to people without phones, such as children, elders and the homeless.

"We are happy to see the light at the end of the tunnel of this pandemic," says Shi. "However, Canada should have a vision to better prepare for any future disaster. We need to be ready for the next one."


# Retail Re-Evaluation: Creating Safer Indoor Spaces for Pandemics

Because the inside of shops, restaurants and other shared spaces have become common sites for the spread of SARS-CoV-2, it's become unsafe to gather indoors as we once did.

Architecture and its standards, therefore, now play big roles in determining how we can continue to live our lives during a global pandemic.

Professor Zachary Colbert of the Azrieli School of Architecture & Urbanism is investigating architectural strategies to adapt to this new normal, and was awarded a CU COVID-19 Rapid Research Response Grant to help retail environments better follow physical distancing guidelines. His research will develop adaptive architectural design standards and recommendations, specifically for Canadian retailers.

Colbert is looking to take hygienic architecture concepts to the next level, such as implementing enhanced ventilation systems, redesigning doorways for touchless entry and incorporating antimicrobial surfaces. He's also focusing on integrated business models such as scheduling appointments for one-on-one personal shopping experiences, as well as "micro-climates" that could extend outdoor retail seasons in colder countries.

"Another thing we have to think about is the future ahead of this current crisis," says Colbert. "We can anticipate another pandemic in the future, so we must always be thinking about how we can adjust the built environment and the urban places that produce public life to be more adaptable."

While Colbert is developing recommendations to protect public health, he's also considering how changes can help support store owners and their employees, such as enabling distancing protocols that alleviate the psychological barriers of in-store shopping during a pandemic.



Colbert believes that architects have the ability to be leaders in thinking through the challenges associated with world-changing pandemics. He indicates the historical and contemporary precedent and notes that much of modern architecture can be read as a response to disease control.

"The aesthetics of modernism, such as clean and open interior environments were partly responses to tuberculosis outbreaks and the Spanish Flu pandemic, wherein the idea of hygienic architecture became universally desirable," he says.

Colbert hopes to do on-the-ground research with business owners in Ottawa while continuing to engage with historical research. He says cost-effective and safe adjustments are possible, and he'll work with retail partners in order to determine the best way to both implement physical distancing and bolster business traffic.


# PROJECT ARROW – Carleton Industrial Design Students Win National Competition for Zero-Emission Car

*By: Elizabeth Howell*

***The mission to produce the first all-Canadian, zero-emissions vehicle is kicking into high gear, thanks in part to a team of driven students from Carleton's industrial design program.***

This past October, senior undergraduates Kaj Hallgrimsson, Jun-Won Kim, Mina Morcos and Matthew Schuetz won the Automotive Parts Manufacturers' Association (APMA) of Canada's Project Arrow design competition, beating out 20 other entries from across Canada. The team's design will be used to create an original, full-build, zero-emission concept vehicle that is expected to be road-ready by the end of 2022.

The vehicle, based on a small sports utility vehicle (SUV), will be designed, engineered and built through a joint effort that includes Canada's world-class automotive supply sector. Answering Prime Minister Trudeau's call for a zero-emissions future by 2050, Project Arrow will bring together the best of the best of Canada's electric-drive, alternative-fuel, connected and autonomous and light-weight technology companies.

"We are all incredibly proud of this team and of the remarkable creativity, innovation and hard work they showed to win this competition," said Carleton President Benoit-Antoine Bacon. "This is a wonderful example of how Carleton strives for sustainability across our academic programs and research, as we state clearly in our new Strategic Integrated Plan."

The design portion of the competition was divided into two phases - the first being an ideation and concept phase that lasted 12 weeks, when the students needed to deliver photo-realistic images to the judges.

In the second phase. three shortlisted finalists, including Carleton, were given another 12 weeks to complete their final computer-aided design with assistance from Autodesk Technology Centres — where they were placed as part of the company's distinguished resident program.

"This is a proud and historic moment for Carleton and its students to have their design chosen as a lighthouse for Canada's shift into

zero-emission vehicle development," said Colin Singh Dhillon, CTO of the APMA. "The level of learning and growth must have been tremendous for all the students."

The AMPA plans for Project Arrow to encourage investments from manufacturers in Canada and beyond to develop their next-gen product and technologies within the Canadian automotive technology ecosystem. The organization's request for proposals closed in early March 2021, attracting submissions from more than 300 firms.

The Carleton team spent hundreds of hours thinking through usability and the best way to represent Canadian values in terms of product design semantics. They chose to adopt imagery reminiscent of the pathways carved through the rocks of the Canadian Shield that drivers see all over the country, including on the outskirts of Ottawa.

"We did some research on what Canadian values are and narrowed it down to three key words: freedom, stability and simplicity," says Morcos. "It wasn't just something we used when designing the aesthetics of the car, but also its usability and functions."

The Carleton team worked together remotely in their spare time, while continuing to complete courses and work on internships—all while the world was coping with quarantines related to the pandemic.

Carleton administrators also came together to support the students as they worked through the project, which ties directly to the university's new Strategic Integrated Plan that emphasizes preparing students for the future and addressing pressing social issues with a global and sustainable mindset.

"This was an extracurricular project the students did on their own accord, which makes it so impressive," said Bjarki Hallgrimsson, Director of the School of Industrial Design. "The team also emphasized holistic thinking – rather than just working on styling or manufacturing, they considered many other aspects in their design, including accessibility, general usability and sustainability."


APMA
LEAD. REACH. CONNECT.

# Carleton Breaks Ground on New Experiential Learning Facility

*By: Brenna Mackay*

A long-term vision for the Faculty of Engineering and Design (FED) is quickly on its way to becoming a reality, as Carleton University's new Engineering Design Centre looks to open its doors in late 2021.

With construction having first broken ground in fall 2020, the $16-million, 25,000-square-foot facility will connect to Carleton's existing Mackenzie Building on Library Road and will provide dedicated space for undergraduate students as they collaborate on fourth-year Capstone design projects.

Designed in a joint venture by Diamond Schmitt Architects and KWC Architects, the three-storey structure will feature a maker space, design studios, workshop bays, central atrium and meeting and lounge spaces.

"The best learning environments inherently combine both theory and practice," says FED Dean Larry Kostiuk. "By investing in this newly-established space for hands-on education, we look to expand Carleton's longstanding commitment to experiential learning."

FED is keen to collaborate with the community on this project. Alumni and partners can help enhance the long-term vision for the building, developing new collaborative opportunities and adding leading technology so that students and community can work together on shared challenges.

Following in-depth consultation with students and faculty, Kostiuk is now among many looking forward to additional on-campus space for students to construct their designs and work on research projects.

"The genesis of the idea for a dedicated student facility came from gathering feedback on the challenges that our undergraduates were facing in accessing collaborative workspaces," he says. "Once the idea was launched, we also began collecting responses from other stakeholders, and this helped create a larger, more tangible vision."

While engineering and design students at Carleton engage in hands-on projects throughout their programs, fourth-year students are required to work in teams to produce a design innovation that incorporates everything they have learned over the course of their studies.

Often considered the hallmark of an undergraduate engineering degree, fourth-year Capstone design projects provide a platform to integrate their knowledge with practical skills to develop a professional-level project. They also help foster an entrepreneurial spirit and passion for real-world problem solving.

"For students, fourth-year projects are much like working on a start-up – serving as an opportunity to explore new ideas that require sustained commitment, critical thinking and improvisational skill," says Kostiuk. "Having a dedicated physical space where students can work together towards a shared goal helps them gain valuable transferable skills for the future."

Collaboration is often cited as a fundamental soft skill for engineering students in terms of ensuring a successful transition to the workplace.

With that in mind, the building's interior has been intentionally designed to be open and inviting, with easily reconfigurable furniture and both formal and informal meeting space that encourages students to connect with one another, discuss projects and exchange ideas. Design rooms, which will serve classroom-like functions, will be outfitted with presentation technology, allowing for everything from small group discussions to formal meetings and presentations.

"As a purpose-built environment, the Engineering Design Centre will be the new hub of activity for our students and faculty," says Kostiuk. "It will not only support collaboration and provide students with space for experiential learning, but also help foster a sense of community within the faculty and on campus."

While the Engineering Design Centre will establish a new core for interaction within FED, the building's maker space

will serve as the heart of the facility — supporting students, technicians and faculty with access to vital equipment. Located on the ground floor, the maker space will feature laser and waterjet cutters, 3D printers, injection molders and vacuum, as well as standard drill presses, saws and routers upon opening.

The Engineering Design Centre will also serve as an example of Carleton's continued leadership in accessibility and sustainability. The entire building has been designed to be inclusive and accessible throughout, including barrier-free clearances for all workshop bays that meet or exceed the Ontario Building Code.

The facility will also incorporate energy-efficient building systems and strategies for electricity conservation and sustainability. The building itself will be instrumented and have the controls needed for graduate-level research to explore and test conservation and sustainability ideas.

# From Gadgets to Patents **A Lifelong Fascination with Machines**

*By: Karen Kelly*

*Rawan Alkurd completed her PhD in Electrical and Computer Engineering this past fall and was awarded a Senate Medal for outstanding academic achievement.*

As a child growing up in the United Arab Emirates, Rawan Alkurd's preferred birthday gift was always the latest gadget rather than the latest toy.

"I was not only fascinated with gadgets, but I wanted to learn how to build them," explains Alkurd. "I wanted to know how to communicate with machines and how to train them to understand things."

The only university path for Alkurd in the United Arab Emirates was electrical engineering, and she went on to earn a bachelor's and master's degree in the subject. But her search for a deeper understanding of machines continued.

"I didn't know much about data science, but I was always fascinated by physics and I loved coding," she explains. "When artificial intelligence and machine learning surfaced, I started reading about it and I became even more interested in these technologies."

Alkurd began searching for a PhD supervisor who could help her make the transition into data science and artificial intelligence. She was thrilled when Systems and Computer Engineering Professor Halim Yanikomeroglu invited her to study with him at Carleton.

"I was looking for a well-established research group with good support and the opportunity to interact with brilliant researchers,"says Alkurd, who arrived in 2015. "Professor Halim is a world-

renowned researcher in the wireless communications community, so I was extremely excited to work with him."

It's hard to imagine anything good arising from a frigid night at an Ottawa bus stop, but that is where Alkurd found the inspiration that has fuelled her success.

"It was February and I had just come to Ottawa. I was waiting for hours and it was confusing for me — I was trying to figure out which bus to take," she recalls. "I had no cellphone service while other people were watching videos. That led me to question why the network couldn't detect an urgent need for service."

Alkurd brought the idea to her supervisors, Yanikomeroglu and Sprott School of Business Professor Ibrahim Abualhaol.

The team had several brainstorming sessions to develop a proposal that would enable a network to personalize the delivery of network services and guarantee a certain quality of service for high priority usage. Then they had to convince others in the field that it was possible.

"The biggest challenge was that this idea was not defined; there was no solid background in the literature," recalls Alkurd. "We eventually managed to convince them that this was real, not science fiction."

As an electrical engineering graduate, Alkurd faced another hurdle — her own educational background.

"I had to reinvent myself as a data scientist," explains Alkurd. "I trained myself from scratch through online and in-person courses and hands-on projects."

This past fall, Alkurd earned her PhD in Electrical and Computer Engineering and was awarded a Senate Medal for outstanding academic achievement. Alkurd also won a Vanier Canada Graduate Scholarship in 2016, a prestigious award worth $50,000 per year for three years.

"The Vanier award made me financially independent from the industry and other organizations," says Alkurd. "It enabled me to own all of my inventions and hence, I have the right to commercialize them."

Alkurd and her supervisors have since secured two patents through Carleton's Innovation Transfer Office. They are also planning to launch a start-up up with the support of Carleton University.

Not only did Alkurd's PhD change the course of her career, it also changed the lives of her family, who were Palestinians living in the United Arab Emirates.

"We were stateless because we were not allowed to be citizens in the UAE. That was one of the reasons I wanted to come here, to build a life and be part of a community. Two years ago, I convinced my family to start a new life here, as well."

Alkurd says she is incredibly grateful that her parents, younger sister and two brothers have now joined her in Canada.

"I really appreciate all of the support I've received in Canada," says Alkurd. "From Carleton and my supervisors, and finally, the Canadian government for allowing my family to come. I have been so fortunate. I can't thank them enough."


# Dear Alumni,

# Help us share *your* stories.

# Reach out to us online!

## Are You Connected?

CarletonEngDesg

CarletonEngDesign

carleton_engdesign

Faculty of Engineering and Design - Carleton University

**Update your contact preferences at any time by contacting advancement@carleton.ca**
**Check out our upcoming events at carleton.ca/engineering-design/events**

Return undeliverable Canadian addresses to:

Department of University Advancement
Carleton University
1125 Colonel By Drive
Ottawa, ON K1S 5B6 Canada

Publication Mail Agreement
No. 40063314
ISSN 0226-5389

Mail To:

PM40063314