

Ingenious

HIGH-STAKES TECH

CARLETON CREW AT CANOPY GROWTH LOOKS TO HELP SHAPE THE FUTURE OF CANADA'S BUDDING CANNABIS INDUSTRY

ELEVATING INCLUSIVITY

Design project celebrated for improving air travel for seniors

BRACING FOR IMPACT

Researchers target climate change effects on rural communities

RISE OF THE MACHINES

Carleton to host premier student robotics competition in 2020



Establishing New Horizons

Having recently begun a new chapter at Carleton this past summer in joining the Faculty of Engineering and Design, I find myself extremely fortunate to have been granted the opportunity to assume our Faculty's helm as we venture further and further into new territory.

While I find myself still settling in to my new role as dean, my first few months have already proven Carleton to be an extremely supportive and inclusive community. Looking at the vibrancy and ambition of our students and researchers alike as they work towards solving the challenges of today and tomorrow, I can see that I will be proud to call Carleton home for many years to come.

Following the national capital region's second bout of record-setting floods in the past three springs, Professor Shawn Kenny is working to assess the readiness of Ontario's rural municipalities and help these communities plan for further infrastructure challenges brought about by the impacts of climate change.

With Canada's cannabis industry recently passing the one year post-legalization mark, opening the market to an array of new cannabis-related products, an interdisciplinary group of co-op students have been working alongside Carleton grads at Canopy Growth Corporation to establish the worldwide standard for regulated vaporizer technology.

Having dedicated his final year at Carleton towards helping seniors prevent the onset of deep vein thrombosis during air travel, recent industrial design grad Rob Shudra has gone on to receive international acclaim for his fourth year project by winning gold at the Industrial Design Society of America's 2019 International Design Excellence Awards.

This past summer, our Faculty's not-for-profit youth outreach organization Virtual Ventures joined forces with the Department of Mechanical and Aerospace Engineering to establish an all-new aerospace camp for girls in Grades 3-9, with the aim of promoting greater gender balance among tomorrow's leaders in STEM.

Looking forward to 2020, I'm pleased to share that Carleton has teamed up with *FIRST* Robotics Canada to bring one of the country's premier STEM competitions for high school students to campus next spring. I invite each of you to join us from March 13-15, 2020 as we host over 800 students, volunteers, parents and sponsors at Ottawa's inaugural *FIRST* Robotics Canada District Competition.

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Ingenious

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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.

ON THE COVER

As Canada passes legislation on an array of new cannabis-related products, Carleton co-op students and grads at Canopy Growth have been working to develop the next generation of smart vaporizer technology.

Photo: Fangliang Xu



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All-New Drone Camp for Girls Takes Learning to New Heights



During the final session of this year's *She's Fly!* camps, students were given the unique opportunity to watch an air show performed by the Royal Air Force's elite Red Arrows aerial acrobatics team, before getting a close-up look at the planes and meeting the pilots themselves. (Photos courtesy Virtual Ventures)

Following a special on-campus celebration this past July to mark its 25th anniversary, Carleton's Virtual Ventures has already taken its next giant leap into the future – expanding its STEM-based programming for young girls.

This past summer, the not-for-profit organization run through Carleton's Faculty of Engineering and Design teamed up with the Department of Mechanical and Aerospace Engineering to launch *She's Fly!*, an all-new aerospace camp for female students in Grades 3-9. Over the course of seven weeks spanning July

and August, more than 100 campers engaged in specialized aerospace and drone-based learning activities designed to pique their interest in unmanned systems and aviation, as well as encourage more young women to pursue careers in STEM.

Junior camps, designed for students in Grades 3-5, featured an introduction to the basics of aircraft dynamics, focusing on topics such as propulsion, aerodynamics and space exploration.

"During each weeklong session, junior campers learned the essentials of drone technology by constructing and piloting drones using specialized

LEGO kits," says Christine Riddell, Director of Virtual Ventures. "Campers were also challenged with designing two rockets – one aimed at achieving maximum height or distance and another designed to serve as a spacecraft crew module capable of protecting an egg."

Senior camps for students in Grades 6-9 focused on the design and construction of more advanced drones, before shifting gears to flight simulation and outdoor line-of-sight piloting lessons. After learning how to master control of their drones, each student applied their knowledge by taking part in a mock search and rescue mission.

While Virtual Ventures already reaches over 5,000 youths annually through a wide variety of engineering and technology-based camps and programs, Riddell believes when it comes to engaging female youth through STEM, the sky's the limit.

“Changing perceptions about engineering and fostering an interest in STEM among younger girls is a strong priority for Virtual Ventures and the Faculty of Engineering and Design.”

“Changing perceptions about engineering and fostering an interest in STEM among younger girls is a strong priority for Virtual Ventures and the Faculty of Engineering and Design,” she says. “We know that introducing girls at a young age can make all the difference when it comes to considering STEM as career path later on.”

Professor Ron Miller, Chair of the Department of Mechanical and Aerospace Engineering, explains that *She's Fly!* was also partially inspired by Engineers Canada's '30 by 30' initiative, which looks to raise the number of newly licensed engineers who are female to 30 percent by the year 2030. With that target in mind, Miller looked to establish additional opportunities for STEM exposure – one of the simplest yet most frequently overlooked obstacles for children and youth of all ages when it comes to igniting long-term interest in engineering and technology.

“For youth to consider whether or not they might want to pursue something, they first have to understand what that something is,” he explains. “One of our main goals in putting together *She's Fly!* was to help dispel the idea that engineers just

fix engines or drive trains and instead raise awareness of what it really means to be an aerospace engineer.”

Miller hopes to build upon *She's Fly!*'s success in year two by expanding next summer's camps to include programming for girls in Grades 10-11. He and Virtual Ventures are also investigating the possibility of establishing additional drone-based clubs and enrichment programs for girls that could be run throughout the school year.

“What we want to help establish is a situation where girls have a way to feel connected to each other through their activities in STEM over their entire schooling,” says Miller. “If you happen to know 20 other girls who are also interested in STEM, you're much more likely to consider pursuing it as a career. By creating an array of opportunities for learning-based interaction, we hope to help form networks for like-minded youth.”





In performing background research for ELEVATE, Shudra visited the New Edinburgh Square location of Chartwell Retirement Residences to learn about the likes and dislikes of seniors regarding air travel. (Photo courtesy Rob Shudra)

Elevating Air Travel Inclusivity for Seniors

Cramped cabins and perpetually shrinking legroom have become all-too relatable experiences on today's airplanes for passengers travelling in economy class.

While we all may be feeling the pinch, recent industrial design graduate Rob Shudra (BID/18) has learned that, more often than not, it's seniors who have been left up in the air when it comes to modern-day commercial flights.


"Flying can be a stressful experience for any traveller, but older adults in particular often face a variety of added psychological and physiological challenges that complicate their ability to travel," he says.

During his final year at Carleton, Shudra chose to focus his fourth year design project on making air travel more accessible for seniors, leading to the development of ELEVATE, a specialized economy class active seating system that aims to reduce the risk of deep vein thrombosis (DVT) during flight.

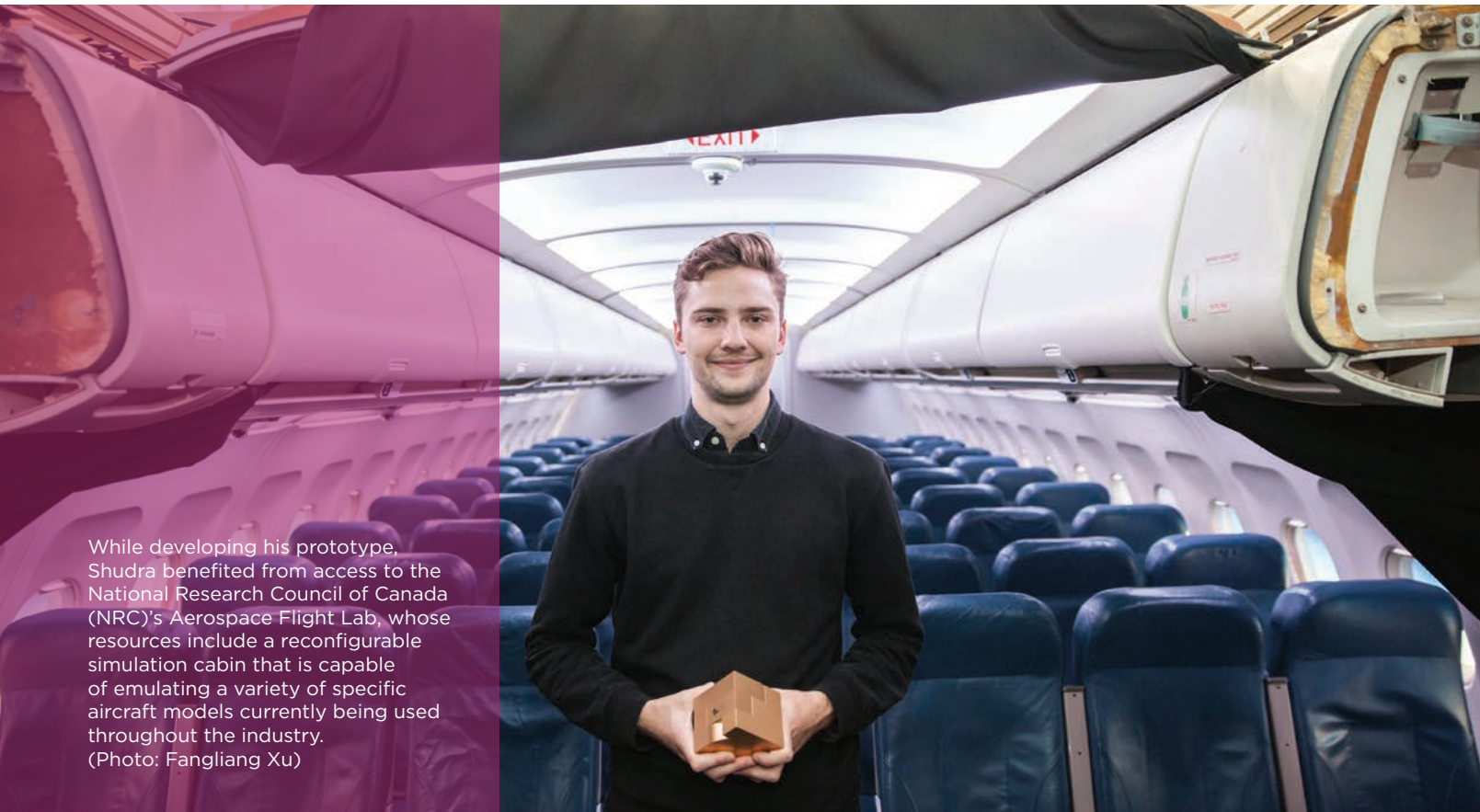
With space coming at a premium on today's planes, older passengers in particular are now facing an increased risk of developing DVT, a potentially life-threatening condition in which prolonged periods of sitting still results in improper blood circulation and leads to the formation of a blood clot in the lower leg or thigh region. While DVT can cause significant pain and swelling, it can also lead to serious health complications such as a pulmonary embolism in cases where the blockage breaks loose and travels to the lung.

As airlines continue to look for new ways to cut costs and remain competitive, legroom in economy class has plummeted for both long and short-haul flights throughout the industry. Multiple studies have shown seat pitch (used to describe the distance from any given point on a seat to the corresponding point of the seat in front of it) has dropped from an average of 34-35 inches in the early 2000s to only 30-31 inches today. As select low-fare carriers now provide as little as 28 inches of space between rows, the average width of seats themselves has also narrowed from about 18.5 inches to 17 inches over the past two decades.

While the onset of DVT is more prevalent during long-haul flights, the World Health Organization warns that passengers travelling in confined spaces can be at risk after as little as four hours. With the percentage of travellers over the age of 60 expected to rise in line with aging populations worldwide, Shudra understands how the needs of seniors must be better addressed moving forward.

A photograph of three people standing in front of a large white aircraft with red and blue stripes, likely a Conquest II business jet, inside a hangar. The aircraft's cabin door is open, and its airstair is extended. Two women are standing on the airstair steps, and a man is standing on the ground to the right, holding a small yellow object. The background shows the interior of a large hangar with various equipment and another aircraft's engine visible.

(From right) Recent Industrial Design grad Rob Shudra alongside his project supervisor, Professor Chantal Trudel, and Dr. Shelley Kelsey, Senior Research Officer at the National Research Council's Flight Research Lab.
(Photo: Fangliang Xu)



While developing his prototype, Shudra benefited from access to the National Research Council of Canada (NRC)'s Aerospace Flight Lab, whose resources include a reconfigurable simulation cabin that is capable of emulating a variety of specific aircraft models currently being used throughout the industry. (Photo: Fangliang Xu)

“ Flying can be a stressful experience for any traveller, but older adults in particular often face a variety of added psychological and physiological challenges that complicate their ability to travel. ”

“In many ways the airline industry has gone so far in the direction of efficiency that it's resulted in many populations with more specific needs being overlooked,” he says. “This project not only aims to help seniors who are affected by DVT, but also has the potential to make flying a more enjoyable and healthier experience for all travellers.”

Developed as part of a broader group of nine aerospace-focused design projects overseen by professors Chantal Trudel and Lois Frankel, ELEVATE aims to reduce the risk of DVT by tracking user motion, informing them about long periods of inactivity, and suggesting exercises ranging from simple stretches to interactive games controlled by a person's leg movements.

Early on in the development cycle, Shudra and his fellow students visited the New Edinburgh Square location of Chartwell Retirement Residences in order to engage with the target demographic for their projects. In hosting focus group discussions at the facility, residents were asked to identify their likes and dislikes regarding various aspects of air travel.

“The results from these focus groups were incredibly revealing,” says Shudra. “It was only by sitting down and talking with residents that the severity and prominence of DVT became apparent. Without this initial outreach, I never would have come to that realization.”

Following the consultation process, Trudel helped provide Shudra and his colleagues with access to the National Research Council of Canada (NRC)'s Aerospace Flight Lab in developing prototypes of their designs. Located right beside Ottawa's Macdonald-Cartier International Airport, the facility enabled students to benefit from key support and testing resources along with a behind-the-scenes look at the industry.

“Being able to test my design within the NRC's simulation cabin allowed me to get a better sense of how it would realistically interact with users, as well as how that interaction might ultimately affect other passengers in the vicinity,” says Shudra.



After constructing prototypes of their designs, Shudra and his classmates returned to Chartwell a second time in order to gather further feedback from prospective users.

“Our follow-up visit to Chartwell was an eye-opening experience that led to some very important refinements in my design,” he notes. “I had originally dedicated a considerable amount of time developing on-screen feedback that would be effective without being overly intrusive, but testing revealed that the residents preferred pop-up alerts over subtle notifications due to their directness.”

In learning to engage with older users about their unique needs, Trudel hopes her students can help reduce the prevalence of ageism in design, an issue where seniors are excluded from the development process because they are not viewed as a key demographic.

“When we work with real people, we can break out of our own assumptions and paradigms of how things should be done,” she says. “Including everyone in the conversation is a form of advocacy that supports a much needed movement towards responsible innovation.”

Shudra echoes his supervisor’s remarks on inclusive design, emphasizing how a lack of consultation with end-users can make it is easy to lose sight of the big picture.

“Very early on we grounded our work in consulting with the end-users, which meant that we were able to identify real problems faced by real people,” he says. “I think design is often seen to take place as a single ‘ah-ha!’ moment, but in reality, meaningful design takes a significant amount of research and collaboration to reach every small breakthrough, which then often presents its own new set of challenges.”

With Trudel’s newest group of fourth year students now exploring design solutions relating to cognitive issues such as dementia, she hopes to continue collaborating with Chartwell – an opportunity Leann Halpenny, Health and Wellness Manager at the New Edinburgh Square facility, believes residents would welcome.

“Seniors have so much to contribute to these kinds of projects because they’ve quite simply experienced so much more than anyone else,” says Halpenny. “Their wealth of insights, knowledge and opinions can be an extremely valuable resource in designing new technologies and it



This past August, Shudra’s ELEVATE won gold in the student design category at the Industrial Design Society of America (IDSA)’s International Design Excellence Awards. (Image courtesy Rob Shudra)

just makes sense for them to be consulted as part of the development process.”

This past August, Shudra’s ELEVATE rose to international acclaim, winning gold in the student design category at the Industrial Design Society of America (IDSA)’s International Design Excellence Awards.

“It was an incredible honour to have the IDSA recognize the value of my project,” he says. “It was an absolutely amazing experience to travel to Chicago and accept the award – there was a lot of design power in the room and it was very cool to rub elbows with them.”

While currently there are no plans on the horizon for a wide-scale deployment of ELEVATE on commercial aircraft, Shudra hopes the project can help demonstrate the possibilities of what can be done to push the boundaries of the economy class and inspire big players in the industry to do the same.

In Memoriam – Dr. A. O. Abd El Halim

It is with great sadness that the Carleton community acknowledges the loss of longtime professor Dr. A. O. Abd El Halim, who passed away on September 19, 2019 at the age of 69.

Throughout a storied career at Carleton spanning nearly four decades, Dr. Halim made many outstanding academic and professional contributions to the University, the Faculty of Engineering and Design, and the Department of Civil and Environmental Engineering.

Originally from Egypt, Dr. Halim obtained his Bachelor of Science in civil engineering from Alexandria University before first coming to Canada in 1977 to pursue a Master of Applied Science at the University of Toronto. In 1983, Dr. Halim joined Carleton as an assistant professor shortly after completing his PhD in transportation engineering at the University of Waterloo.

Since 1987, Dr. Halim had served as Director of Carleton's Centre for Geosynthetics Research Information and Development. In 1988, he was promoted to associate professor before ultimately being granted the rank of full professor in 1995. Dr. Halim also served as Chair of the Department of Civil and Environmental Engineering from 2003 until 2009 and was an integral member of Carleton's Centre for Advanced Asphalt Research and Technology.

Over the course of his career, Dr. Halim supervised more than 85 graduate students and received a total of 28 national and international awards including the Canadian Society for Civil Engineers' Sandford Fleming Award, as well as the American NOVA Award for Innovation in Construction, often referred to as the "Nobel Prize" in construction.

He also helped establish Carleton's unique undergraduate program in Architectural Conservation and Sustainability Engineering (in collaboration with the Azrieli School of Architecture & Urbanism), as well as the university's Master of Infrastructure Protection and International Security (offered jointly with the Norman Paterson School of International Affairs).

"Halim's vision was the pillar in establishing leading interdisciplinary graduate and undergraduate programs in civil and environmental engineering," notes current Department Chair, Dr. Yasser Hassan. "He also single-handedly put Carleton on the world map as a leading research institution in the area of pavement engineering."



After first developing the concept for his revolutionary Asphalt Multi-Integrated Roller (dubbed AMIR after his eldest son) in the early 1980s, Dr. Halim recently partnered with both the Ministry of Transportation of Ontario and Tomlinson Group to streamline the prototype's design. Having previously faced decades of funding roadblocks, AMIR's newest iteration has now begun production as a specialized conversion kit known as TRAK (Tomlinson-Russ-Amir-Kit) that can be added to conventional rollers, potentially facilitating its wide scale deployment throughout the industry.

On top of dedicating much of his professional career to the development of AMIR and TRAK, Dr. Halim also made critical research contributions in the areas of bridge management, highway economics and the environmental impacts of transportation. He was set to retire this coming December at the end of 2019, following more than 38 years of dedicated service at Carleton.

Dr. Halim will be greatly missed by friends and colleagues within the Carleton community, as well as by the countless students he has inspired over the course of his career. In honour of his lasting contribution to the university, his family has established a special graduate scholarship in transportation engineering in his memory. Those wishing to make a contribution to the fund are invited to visit futurefunder.ca or contact Jennifer Wolters, Assistant Director of Faculty Advancement for the Faculty of Engineering and Design, at jennifer.wolters@carleton.ca.



Bracing for Impact: Carleton Researchers Study Rural Municipalities' Readiness for Climate Change Effects on Infrastructure

On July 14, 2004, Peterborough, ON endured record amounts of overnight rainfall, and by the following morning, a state of emergency was declared. It was the city's second "100 year flood" in two years.


According to local reports at the time, over 80 per cent of the pipes in the city's stormwater system were undersized and many had been installed at the turn of the 20th century or earlier. On top of that, the paved-over downtown core which experienced the most intense rainfall was unable to withstand or appropriately displace the water. The damage was extensive.

More than 15 years later, the small city with a population of around 85,000 is integral to a study led by Carleton University professors Shawn Kenny from the Department of Civil and Environmental Engineering and Kathryne Dupré from the Department of Psychology.

Funded by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and Natural Sciences and Engineering Research Council (NSERC), Kenny and Dupré's study has two key objectives.

First, to develop a clear picture of the current state of readiness of Ontario's rural municipalities with respect to how they assess, measure and plan for climate change impacts on municipal infrastructure.

Next, to provide municipalities with guidance and resources (tools, standards, best practices) for updating



“ The Sustainable Peterborough community partnership is great example of people, businesses, governments and First Nations working strategically together towards defined visions and goals. ”

their asset management frameworks while keeping their communities informed and engaged.

For the purposes of the study, the term “rural Ontario municipality” is defined as a community with a population less than or equal to 100,000, or population density less than or equal to 100 people per square kilometre. The project’s steering committee includes the City of Peterborough, Peterborough County and the Township of Douro-Dummer.

For Peterborough, the 2004 flood was a catalyst for updating core infrastructure.

The city’s approach addressed technical issues, such as developing a flood reduction master plan and upgrading stormwater management infrastructure. But there was also keen insight that engagement with stakeholders, such as the council and public, would be key to raising awareness and achieving successful outcomes.

“The Sustainable Peterborough community partnership is great example of people, businesses, governments and First Nations working strategically together towards defined visions and goals,” says Kenny.

The city has specific programs aimed at educating and engaging the community to use stormwater as a resource and prevent pollution from entering waterways. These programs include Rethink the Rain which encourages the installation of rain gardens and rain barrels, Low Impact Developments (LID), and permeable pavement.

Earlier this year the city embarked on a watershed planning study in cooperation with neighbouring municipalities, First Nations, and community groups to establish a framework for the protection and management of water resources. This study will assess the cumulative impacts of activities across the watershed and ultimately help the city make decisions relating to planning for growth and land use within the watershed.

Unfortunately, not all Ontario rural municipalities have advanced into a leading position on addressing climate change impacts as in Peterborough.

An initial questionnaire sent to all 409 rural Ontario municipalities in the first stage of Kenny and Dupré’s study elicited 160 responses. The questionnaire explored four key elements of the asset management framework, including the state of local infrastructure, levels of service, asset management strategy and financing strategy. According to respondents, 77% of surveyed municipalities had not integrated climate change considerations into their asset management plans.

The study found that increased rainfall, snowfall, and ice accretion (build up), as well as erratic or cyclical temperature variation were the most commonly reported climate change effects. The observed impacts on core infrastructure include flooding, bridge deterioration, and damaged roadways (e.g. cracks and potholes).

Dupré’s findings from a second survey of rural community members has reinforced that when it comes to notions of climate change, it’s important that municipal decision-makers and community members are on the same page.

Overall, survey participants said they understand climate change, but most do not understand how climate change influences infrastructure or industry in their community, nor are many of them willing to pay more in taxes or reduce service levels to support adaptations.

For rural Ontario municipalities, the path forward may be best described as one of “collaborative engagement,” says Kenny.

“Smaller municipalities are constrained by resources, such as the responsible staff overburdened by multi-tasking or limited by the lack of training to be knowledgeable or proficient within certain skills sets,” he says. “We need to leverage their local knowledge and passion for community through bridged connections and engagements with other expertise, resources, technologies and partnership opportunities.”

As climate change is a complex, interdisciplinary subject area, rural municipalities can maximize engagement by sharing experiences, lessons learned, and best practices, while collaborating through shared resources and integrated studies across their network of municipalities, professional associations



Carleton PhD student Chelsie Smith and professors
Kathryne Dupré and Shawn Kenny.
(Photo: Ainslie Coghill)

(e.g. Federation of Canada Municipalities) and provincial (e.g. Ministry of Infrastructure, Ministry of Transportation) and federal (e.g. Environment and Climate Change Canada) governments.

Carleton PhD student Chelsie Smith joined this project when she was a Master's student in the Department of Psychology to assist with the data collection and analysis of community climate perceptions, and also to assist with knowledge translation of the various aspects of the research. She has been working to synthesize the study's findings into digestible Twitter threads with key takeaways and infographics.

"Determining effective solutions and adaptations to climate change requires interdisciplinary teams of both researchers and practitioners," says Smith. "However, within disciplines, we often rely on jargon that leaves our research inaccessible, not only to those studying and practicing in other disciplines, but to the general public, as well. Highlighting our key findings through straightforward language and infographics serves to ensure our research can reach, inform, and benefit as many individuals as possible."

Dupré says research from organizations suggests that if leaders adopt and model pro-environmental behaviours, then employees are more likely to adopt these behaviours as well. She says the evidence is less concrete in communities, but social comparison still plays a role.

"So, if municipal or community leaders engage in pro-environmental behaviours, provide evidence-based information in an unbiased, neutral manner, and encourage others to join them, there is reason to believe that the social perception could shift towards making these behaviours 'the new normal,'" she says, citing organizational environmental sustainability studies and a 2015 book called *The Psychology of Green Organizations*.

At present, Kenny is involved in two other Carleton-led research studies that explore related themes to the OMAFRA study: UTILI and PermafrostNet.

UTILI (the Uninhabited Aircraft Systems Training, Innovation and Leadership Initiative), a \$1.65 million NSERC CREATE program led by aerospace engineering professor Jeremy Laliberté, addresses technological challenges associated with the safe and effective operation of uninhabited aircraft systems. UTILI will train personnel and develop tools to identify and monitor the effects of climate change and geohazards on infrastructure performance.

PermafrostNet, led by geography professor Stephan Gruber, was the recipient of a \$5.5 million NSERC Strategic Partnership Grant for Networks, and unites key scholars and stakeholders from government agencies, industry and Indigenous communities with the common goal of boosting Canada's ability to adapt to permafrost thaw.

"Climate change in the north has had a profound, transformative impact with respect to the scale, magnitude and speed of deteriorating permafrost conditions," says Kenny.

He says the foundational knowledge on permafrost regions was established in the mid to late 20th century and may no longer be sufficient to maintain the north's infrastructure in a sustainable framework.

Municipalities and government agencies in the north have recognized the need to integrate climate change considerations within asset management practices and have been at the forefront of leveraging their experiences and traditional knowledge to develop policies and explore practical solutions for the natural and built environment.

In most rural Ontario regions, however, the need for adaptation has not been addressed, and the resources and buy-in have not been sufficiently developed. Kenny and Dupré offer a place to start.

"As academics, we need to be more proactive by understanding their questions, constraints and needs," says Kenny, "and enabling municipalities through the effective translation of research outcomes into guidance and recommended practices for practical use and benefit."

HIGH-STAKES TECH

CARLETON CREW AT CANOPY GROWTH
LOOKS TO HELP SHAPE THE FUTURE
OF CANADA'S BUDDING CANNABIS INDUSTRY



(Photo: Chris Roussakis)



Peter Popplewell (BEng/02, MAsc/04, PhD/10), Chief Technology Officer at Canopy Growth, also serves as Managing Director of Storz & Bickel, a German vaporizer manufacturer purchased by the company in late 2018. (Photo courtesy Peter Popplewell)

In December of 2017, slightly less than one year before Canada would become just the second country to legalize the recreational use of cannabis, Smiths Falls, ON based Canopy Growth Corporation hired Carleton electrical engineering alumnus Peter Popplewell (BEng/02, MAsc/04, PhD/10) as the company's first Chief Technology Officer and only dedicated technology research and development employee.

Fast-forwarding to today, with Canada having recently celebrated its one-year anniversary of cannabis legalization, Canopy Growth has since sprouted to become an industry giant as one of the largest pharmaceutical-grade cannabis producers worldwide. Having grown his team at the company's Kanata, ON location to include nearly 50 employees, Popplewell now oversees all of Canopy Growth's technology-based research and development for both recreational and medical markets.

With new legislation coming into effect this past October, launching the industry's next chapter by opening the door to an array of new cannabis-related products, Popplewell and his group look to get the jump on an emerging market by developing what is likely Canada's first and only line of vaporizers designed specifically for cannabis.

Battery-powered vaping devices differ from traditional methods of cannabis consumption in that they produce a combination of aerosol and vapour by heating either concentrated cannabis extracts or cannabis leaf (known as flower).

Having assembled his "dream team" at Canopy Growth, featuring an interdisciplinary group of Carleton co-op students and graduates, Popplewell is now ready to show the world that when it comes to the health of consumers, his newest devices aren't just blowing vapour.

As concerns mount south of the border surrounding growing reports from the U.S. Centers for Disease Control and Prevention on the number of confirmed cases involving vaping-related lung illnesses and deaths linked to heavy metals and other

toxic substances in nicotine based e-cigarettes and other unregulated vape products, Popplewell's team at Canopy Growth have dedicated immense time and resources towards ensuring these mistakes aren't replicated here in Canada, partly by helping to keep users informed.

"Imagine a device that's inherently been designed to be the world's smartest vaporizer," says Popplewell. "In pairing with an all-new companion app, consumers will now experience complete transparency in being able to view exactly what's in their product, along with where it originated from, right on their smartphone."

In responding to cases where substandard vaping devices from other

suppliers have caused fires and even explosions as a result of poor design quality and cheap components, Canopy Growth's new products will also adhere to currently optional UL 8139 standards, which evaluate the safety of electrical systems within electronic cigarettes and vaping devices, including batteries, chargers, protection circuits and more.

In continuing to grow his research group over the past several years, Popplewell has established deep-seated roots with Carleton, with roughly half of his team having connections to the university either as graduates or as part of Carleton's co-op program. Having previously worked with Carleton co-op students in a number of earlier roles before joining Canopy Growth,

Popplewell felt confident in turning to a relationship that has worked well in the past.

"Carleton has hands down provided me with the best talent over the years," he says. "In my experience, they tend to be a well-rounded group in that they have strong foundational skills, but are also eager to learn."

Canopy Growth's Vice-President of Hardware Development, Andrew Stewart (BEng/98), also an electrical engineering grad from Carleton, shares Popplewell's positive opinion on entrenching students with the research and development team.

"Our students are taking on responsibilities, driving key aspects of some programs and working hard to help us meet some tight deadlines," says Stewart. "We're having trouble finding enough qualified full-time staff and our Carleton students have been able to help fill that gap and keep us on track."

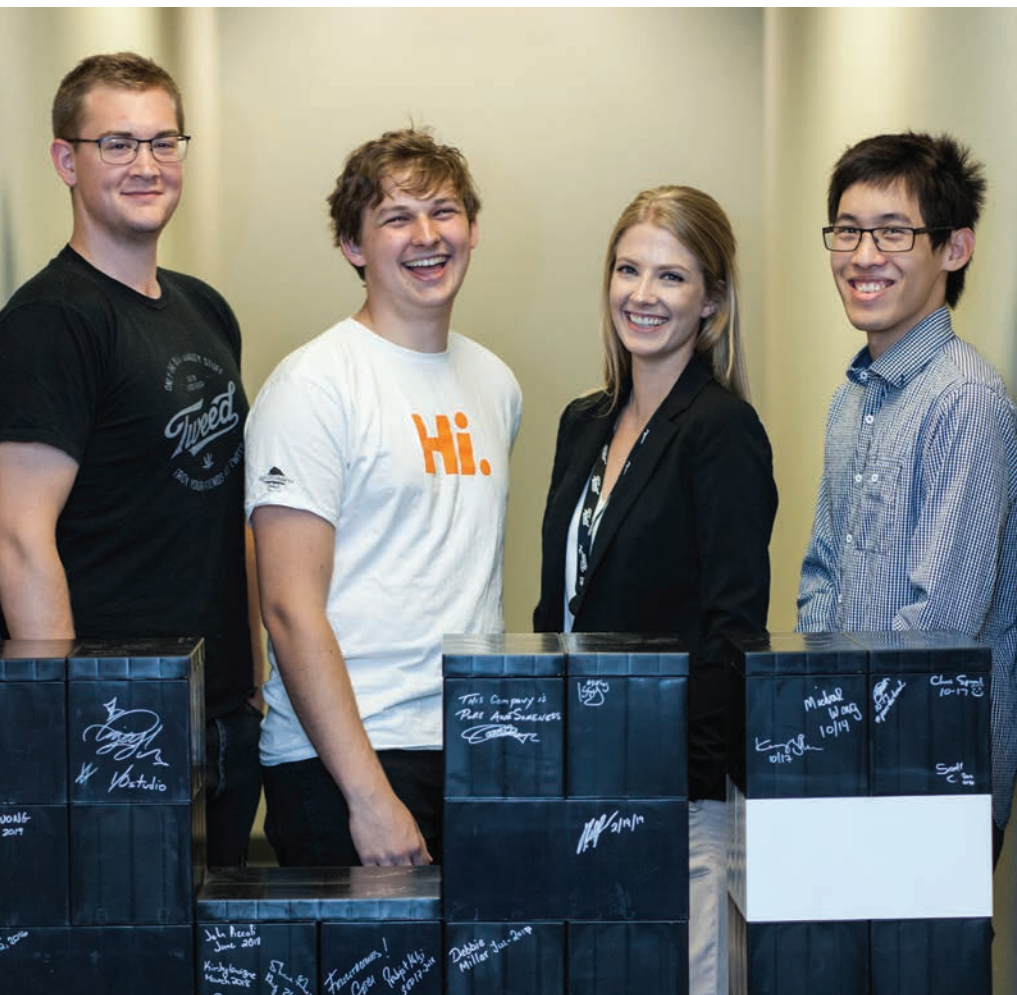
In looking back at his own time at Carleton, Stewart also notes how his undergrad experience helped lay a foundation for his career and current role at Canopy Growth.

"The coursework provided important technical training, but what truly helped me were the soft skills I learned," he says. "Things like time management, collaborative teamwork assignments, peer networking and the mentorship of some excellent professors really put me on the right track."

As part of Stewart's team, fourth year biomedical and mechanical engineering student Colin Tolls has been working on the mechanical design and prototyping of devices at Canopy Growth since May 2018. While he says his role typically involves mapping out ideas that have been developed by the hardware team, he notes that a few of his own original ideas have actually been patented during his time in co-op.

"In working with our lead mechanical engineer, my focus has been using computer-aided design to help figure out things like how our devices should look and feel, as well as how all of their internals can be held in place," he says.

Having had an insider's view on everything that's gone into developing the company's new technology,



Carleton students Colin Tolls (Biomedical and Mechanical Engineering), Will Brooks (Electrical Engineering), MacKenzie Brannen (Biomedical and Mechanical Engineering) and David Nguyen (Computer Science) have all worked as part of Popplewell's research team during their co-op placements. (Photo: Fangliang Xu)



Many of Canopy Growth's upcoming vaporizers will pair with a smartphone companion app that enables features such as location tracking and device locking. (Photo: Fangliang Xu)

he believes Canopy Growth's new vaporizers will likely create a ripple effect throughout the industry.

"If nothing else, this new line of products will force competitors to focus on quality in developing their own devices, which will ultimately benefit all consumers and lower the appeal of what's out there on the black market," he says.

Looking beyond the Canadian market, Popplewell's team has already designed its line of vaporizers to comply with the European Union's Restriction of Hazardous Substances Directive, which constricts the use of hazardous materials and heavy metals in electronic equipment. Each of Canopy Growth's new devices will also meet health and safety standards needed to receive a CE

certification mark from the EU, while those featuring wireless connected capabilities will adhere to U.S. Federal Communications Commission (FCC) regulations on electromagnetic interference.

By adhering to new and incoming regulations, Popplewell and his team look to set the bar for consumer expectations regarding safety and security of access. In addition to providing details on a product's origin, a number of the team's smart devices will also enable location tracking, allowing users to keep an eye on their devices and even lock them to help prevent misuse by children and youth.

Third year computer science student David Nguyen, who recently completed a total of 12 months with Canopy Growth's software development group,

was part of the team responsible for developing the company's mobile companion app, which will enable smart features on select devices. He believes the transparency offered by the app can help educate users on the nuances that exist throughout the company's upcoming line of consumable vaping products.

"Before I began working at Canopy Growth I never realized that cannabis had hundreds of different strains with varying degrees of intensity," he says. "Providing users with the ability to trace their product to the exact batch and see a full breakdown of its composition can help inform both casual and experienced consumers."

Nguyen also hopes the app will help to promote safe use and greater accountability among end-users.

“ As a newer industry there is so much that hasn't been done yet. By working with the research team here at Canopy Growth, I knew I would have the opportunity to take part in unique work that can help shape Canada's cannabis industry moving forward. ”



As a running joke poking fun at Popplewell's lifelong obsession with old British cars, each of the team's projects is given a code name featuring bygone sports car marques, which is then used until a product is ready to go to market. The team is waiting for just the right project to name after Popplewell's beloved Triumph TR6 pictured here, a model which he drove to and from Carleton throughout his years of study and still uses today. (Photo: Fangliang Xu)



Since its inception in 2013, Smiths Falls, ON based Canopy Growth has risen to become one of the world's leading producers of pharmaceutical grade cannabis. (Photo: Chris Roussakis)

"Being able to prevent your children or anyone else for that matter from accessing your device is something I think will really resonate with consumers," he says. "These kinds of features can help transform the industry by making it simpler to use cannabis products responsibly."

Fourth year biomedical and mechanical engineering student MacKenzie Brannen has been designing and 3D printing custom hardware components used in Canopy Growth's testing and research over the past six months. One of the things that first drew her to join Popplewell's team was the prospect of creating all-new developments as part of an industry still in its infancy.

"As a newer industry there is so much that hasn't been done yet," she says. "By

working with the research team here at Canopy Growth, I knew I would have the opportunity to take part in unique work that can help shape Canada's cannabis industry moving forward."

Brannen also explains how her time at Canopy Growth has aligned with her interest in working within the health and pharmaceutical industry.

"Since our vape devices have to meet strict regulations in order to make it to market, there is a lot of testing and consideration that goes into the development process," she says. "It's all been very relevant to my coursework so far at Carleton."

In looking at the breadth of devices currently being used by consumers, Popplewell believes his team's decision to build Canopy Growth's technology from the ground up will help separate

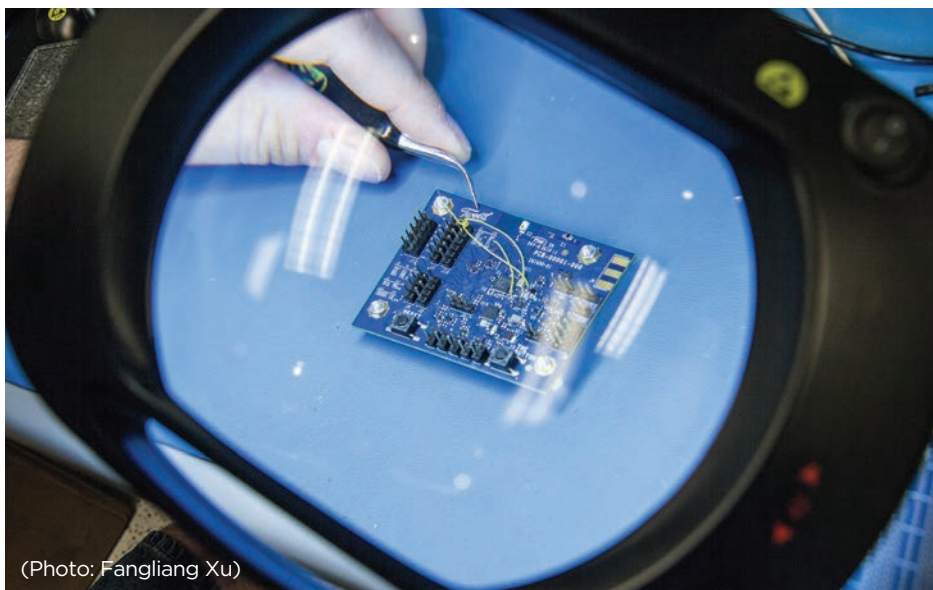
its vaporizers from that of both legal competitors and players within a heavily unregulated black market.

"When you look at all of these devices that can be found online, there's really no way to determine how they've been put together or where the products they use are coming from," he says. "Suppliers will always claim what they are selling is safe, but with absolutely zero oversight, these unregulated oils and extracts can include any number of harmful chemicals and impurities."

While it's a reality that many people are already using e-cigarettes and other unregulated devices to consume cannabis products, Popplewell notes that most of the current technology on the market has never actually been designed to process cannabis oils and extracts in their natural state.



Roughly half of Popplewell's research team at Canopy Growth consists of Carleton graduates and co-op students. (Photo: Fangliang Xu)



(Photo: Fangliang Xu)

"Pure cannabis extracts resemble molasses in that they typically have a very high viscosity," he says. "Since these devices aren't capable of heating something of that consistency on their own, unregulated suppliers have relied on the use of chemical thinning agents in order to make their products compatible."

Having instead focused on cannabis products from day one, Popplewell's team has developed devices that can either process oils and extracts in their original state, or make use of natural terpene flavourings found within the cannabis plant itself to provide thinning.

"Nobody is investing the time or money to do what we're doing," he says.

"At the end of the day, it's all about providing customers with a reliable product and being fully transparent with them about every aspect of what they are consuming and the technology they are using to do so."

In compliance with Canadian law, those of Popplewell's vaporizers that have been designed to be reusable feature unit-specific cartridges that can only be filled at Canopy Growth's Smiths Falls production facility, helping to prevent potential misuse and product tampering. While some black market devices do allow users to refill products on their own, yet another of the team's Carleton engineering graduates – Canopy Growth's Vice President of Software Development, Stephen Davis (BEng/86) – believes the company's added layer of security will appeal to a broader range of consumers.

"In developing this technology and the infrastructure that supports it, we will be able to guarantee individuals peace of mind that they're not about to inhale something unknown or counterfeit by giving them the ability to view genuine lab results of their product, down to the specific batch," says Davis.

Although the federal government's second round of cannabis legalization has technically enabled the sale of edibles and extracts (including vaporized concentrates), Health Canada requires any new cannabis-related products undergo a 60 day review period before being approved for sale. With that time frame in mind, Popplewell and his team expect Canopy Growth's vape products to be available to the public shortly before Christmas.

Until then, he intends to continue embedding Carleton talent within the company's research and development crew.

"Over my years managing engineering teams, Carleton has continually provided the best candidates and the most students that became full-time hires later on," he says. "We are planning to double our research staff in Kanata as the market continues expanding and I'm confident that Carleton will continue to be a part of our growth moving forward."



Carleton Welcomes *FIRST* to the Nation's Capital

(Photo courtesy FIRST Robotics Canada)

Next March, over 800 high school students, volunteers, parents and sponsors will descend on Carleton campus for Ottawa's inaugural *FIRST* Robotics Canada District Competition, hosted by the Faculty of Engineering and Design.

"It's still a ways off, but the excitement and planning for the *FIRST* Robotics competition is well underway," says Dean Larry Kostiuik. "The *FIRST* Robotics competition season is a pinnacle point in the year for these students, who are set to become leaders of our evolving world where advanced, non-stationary technologies are expected to play a larger role in our everyday lives."

FIRST (For Inspiration and Recognition of Science and Technology) is an international non-profit organization designed to inspire students to pursue further studies and careers in science, engineering, technology, and mathematics. *FIRST* Robotics Canada, the regional affiliate overseeing operations and competitions in Canada, now reaches 20,000 students.

Carleton's competition from March 13-15 will raise the number of *FIRST* Robotics district events in Ontario to eleven, held mainly at colleges and universities across the province. Though there are six robotics teams in the Ottawa area, more than three quarters of the competing teams will be travelling to town from outside the capital region.

Beginning in January 2020, teams will be tasked with building their competition robots in under six weeks, with help from industry sponsors, mentors, and a base starter kit of parts provided to all teams by *FIRST*.

During the three-day district event at Carleton, teams will lead their robots into a thrilling challenge that combines sport, science, teamwork and real-world engineering experience. Thanks to generous support from exclusive presenting sponsor General Dynamics Mission Systems-Canada and Ottawa-based MDS Aero Support Corporation, the whirlwind experience will be a weekend to remember.

"General Dynamics believes in empowering and engaging youth in STEM," said David Ibbetson, vice president and general manager of General Dynamics Mission Systems-International. "We support *FIRST* teams in Ontario and

Alberta, and we're very proud to play an integral part in this exciting event in our nation's capital."

To the delight of many, *FIRST* has a new partnership with Lucasfilm and parent company Disney as part of the Star Wars: Force for Change philanthropic initiative. Details of the theme for the 2020 challenge, called Infinite Recharge, have been trickling out since April of this year.

After competing at district events, teams with the highest rankings and awards will head to the Ontario Provincial Championships in Mississauga in April 2020. Rankings at this Championship will decide who moves onto the FRC World Championship in Detroit.

"We are excited to partner with Carleton University's Faculty of Engineering and Design to host an FRC event in 2020," says Mark Breadner, President of *FIRST* Robotics Canada. "We are looking forward to our partnership and giving Ottawa high school students and surrounding areas the unique opportunity to engage and excel in STEM through *FIRST* programs."

The *FIRST* Robotics community in Ottawa may be relatively small, but they are mighty. And many are current Carleton students and alumni.

Gabrielle Genereux, a 2018 software engineering graduate and mentor with local team 2706: Merge Robotics, currently volunteers as Lead Robot Inspector for *FIRST*. She says she likely wouldn't have pursued engineering if it wasn't for the *FIRST* community.

"The hands-on environment was monumental to my learning and development," says Genereux. "All through high school I struggled to find a hobby I enjoyed, and it wasn't until I started in *FIRST* that I found something I was truly passionate about."

Anyone who has witnessed a live competition knows just how passionate this community is. Touted as the "varsity sport for the mind," it is fitting that the competition will be held in the Ravens' Nest - home of the exceptional Ravens basketball program.

Mark your calendars for next March. The robots are coming to Carleton.

Q&A with Dean Larry Kostiuik

FORMER LONG-TIME UNIVERSITY OF ALBERTA PROFESSOR LARRY KOSTIUKE OPENS UP ON JOINING CARLETON AS NEW DEAN OF THE FACULTY OF ENGINEERING AND DESIGN

When did you first become interested in engineering? What drew you to consider it as a potential career path?

Growing up, my parents owned and ran a construction company in the Northwest Territories at a time where almost everything was well removed from professional support services, which largely left my father to his own devices when it came to problem solving. His solutions to getting jobs done were fascinating to me, partly because they tended to be bold, foolhardy, and often risked danger to himself and onlookers alike.

Only in retrospect has it occurred to me that he (perhaps unintentionally) inspired my inclination towards inventiveness, ingenuity, adaptation and, ultimately, engineering – though he did not use such words back then.

What are some of your main research interests?

The bulk of my research endeavours over the last three decades (not including watching my father's crude experiments) have revolved around combustion. Research

focusing on the industrial practice of flaring is actually what brought me to Carleton for the first time roughly four years ago, when I collaborated with Professor Matthew Johnson in the Department of Mechanical and Aerospace Engineering.

I've also worked in the field of microfluidics, especially in the area of electrokinetic power generation, as well as studying nanofluidic systems where matter is considered at the atomistic level.

What was it about Carleton that made you consider a move to the nation's capital?

After 26 years with the University of Alberta, my wife and I were keen to embark on a new adventure and Ottawa was one of the few cities that made the shortlist for possible destinations. We really enjoyed living here during the couple of months back when I was working with Professor Johnson, so there was already a degree of familiarity. I also already knew Carleton to be a very welcoming place with a beautiful setting, so that was certainly a draw as well. Throw in Carleton being home to a Faculty featuring both engineering

and design that was also actively seeking a new dean and it simply came down to a case of being the right place at the right time.

You spent some time in residence at Carleton during the summer before officially moving from Alberta. How did you benefit from your experience living on campus?

I ended up spending about three weeks here in residence during the summer term before the big move from Edmonton. It was a really positive experience for me and one that I felt was helpful in transitioning the idea of place and home. It also offered me the opportunity to just talk candidly with students (some in my Faculty, some in others) about life at Carleton. It was all part of building up an understanding of my new world.

Why is it so important to have these kinds of “hallway” conversations?

I find people are much more relaxed and expressive in a less formal setting and tend to feel more comfortable openly talking about what they really think or want or care about. This type of dialogue also provides me with the opportunity to reciprocate what’s on my own mind, which can be incredibly helpful when speaking with students, staff and faculty.

When the goal is to understand what kinds of things interest or bother students and colleagues, I prefer a casual conversation over an agenda-based meeting, because it allows for broader freedom in asking questions and exploring tangents that can ultimately help develop a more holistic level of understanding – without the added pressure of having to come to some formal agreement or plan of action. That sort of thing can then be developed later in a much more collaborative spirit.

You’ve previously mentioned how you were tempted to give yourself a class to teach at Carleton right away despite a slew of new responsibilities as Dean. What course would you have chosen and why?

Time permitting, I would have enjoyed teaching a class on applied energy systems because it has such a wonderful history and I think energy literacy is something we really need to work on expanding within our society. We are facing some monumental challenges with humanity’s growing energy needs and I think putting climate change into an historical perspective can be helpful for young engineers, providing you address the uniqueness of past and present eras.

Can you share some details about your own approach to teaching?

Perhaps the best way to describe my teaching style is that it’s deliberately inefficient and intentionally low-tech, at least on the surface. Most people don’t realize how much time goes into making my corny in-class demonstrations or narratives appear ad hoc and amateurish – using situations students can relate to – to ensure they are memorable while also relaying

important physical processes that are important for an engineer to know.

I also spend countless hours tracking and analyzing how and where students tend to make mistakes so that I can find patterns and hopefully make adjustments to help more students understand more of the material the next time I teach a specific course.

What opportunities do you see for the Faculty over the course of your term as Dean?

The biggest opportunity I see for our Faculty is to work more collaboratively on ambitious research programs, especially those that address society’s most relevant needs. While enhancing collaboration across the various disciplines of engineering and design will be fundamental in this regard, I also hope to increase our level of pan-university research involving faculty members from Science, Business, Arts and Social Sciences, and Public Affairs.

How have you been adjusting to your new role so far?

The transition to the role has been rather straightforward, but all the new faces, rules, committees and so on that come with joining a new institution have been a bit of a challenge admittedly. My immediate office staff has been extremely helpful in this regard, however, and everyone at Carleton has been very welcoming for that matter. University leadership has also been very supportive of my in-depth exploration into what the future of our Faculty might look like in the short and longer term.

The change has been an interesting adjustment for me on a personal level as well to some degree. I am probably an atypical dean in that I don’t really want to be seen as “the Dean.” I still very much want to be just like any other professor – just perhaps one who also happens to enjoy doing the types things deans are expected to carry out.

Will you be venturing into Carleton’s tunnel system this winter to keep away from the cold?

In Edmonton it is cold – certainly colder than in Ottawa and for longer periods of time. That kind of coldness naturally creates a sort of relationship between Albertans and snow. However, Edmonton’s subarctic temperatures make it that when a snowflake hits you, it simply bounces off and lands on the ground intact as a fluffy solid. In my previous experience with winter in Ottawa, I quickly discovered that when a snowflake hits you here, it instead sticks to your exposed skin, melts, drips down your shirt, and you find yourself in a new type of cold that we Albertans care little for . . . so, yes, I will definitely be wandering Carleton’s tunnels in the months to come relying on the kindness of strangers for directions.

Piecing Together the Future of Accessible Fashion

Fashion and function can co-exist, especially when you start from square one.



Carleton University Digital Media PhD student Lee Jones.
(Photo: Ainslie Coghill)

What's an e-textile? E-textiles, otherwise known as soft circuits, are electrical circuits created using flexible conductive material, like conductive thread and fabric, along with strategically placed electronics components, like batteries, lights and sensors. E-textile research is becoming more relevant because sewing e-textile threads into clothes is more practical than ever as certain e-textile threads and components can be put through the wash.

A Digital Media PhD student at Carleton University is working to expand the range of accessible clothing, facilitating a co-design approach that aims to break down the physical and social barriers of existing assistive technologies and smart clothing, and place more power in the hands of users.

Co-design allows for the user to be a partner in research, which can be complicated in the specialized field of wearable e-textiles. Lee Jones' PhD thesis project, Wearable Bits, helps position individuals with mobility disabilities in the design process early on at the prototyping stage.

"I want the wearers of e-textiles to design for themselves," says Jones. "It's about expression, and creating fashionable garments that provide support while reducing the stigma that often leads people to abandon their assistive devices."

Wearable Bits – the name for Jones' toolkit developed for prototyping wearable e-textiles – does not require any sewing or electronics knowledge.

Though it's appropriate for any beginner audience, the toolkit can also assist e-textile practitioners and adaptive fashion designers wishing to prototype garments alongside people with disabilities.

So what's in the kit? Primarily, a series of laser cut felt squares that can interlock. These modular bits allow for flexibility when producing garments for many different body shapes and assistive devices. Electronic components unique to the wearer's needs or requests are then machine-embroidered on to the felt pieces, and because of their modular design, the prototype garments can change over time, become other garments, and be adapted to different functions.



“You can think of them like textile puzzle pieces,” she explains. “Each piece has its own function such as lighting up, heating up, or changing colour, but when you put them together you create an interactive garment.”

So far, Jones says test participants have engaged with Wearable Bits’ prototyping tools in unique, unexpected ways.

“Essentially, my job is to be the facilitator,” she says. “The idea is that I help scaffold creativity. I’m not designing what the outcome will be. Instead, the participants with their life experience are the ones who are designing the end result, and we’re just providing the tools.”

At the end of her thesis, she plans for her Wearable Bits toolkit to be available online for anyone hoping to create their own e-textile garments.

“We can put out patterns, and anyone who has access to a makerspace can make whatever they want,” she says.

A natural extension of Jones’ thesis research, she recently took part in a fellowship at the non-profit accessible fashion organization Open Style Lab in New York City under the supervision of professor Grace Jun from the Parsons School of Art and Design.

The fellowship was an opportunity to learn more about the field of adaptive fashion. The co-design project linked Jones with fashion designers and occupational therapists to create wearable solutions in collaboration with clients from the NYU Langone’s Initiative for Women with Disabilities (IWD).

“We worked with young women who have cerebral palsy,” she says. “Most adaptive clothing is pretty expensive, and even if you can get it, it’s not always in your style. We worked on a toolkit so people can alter their own clothes, and do it accessibly.”

The process allowed teams to explore the client’s physical and social contexts, and ultimately meet the client’s needs. Her team’s end product: make-your-own pockets.

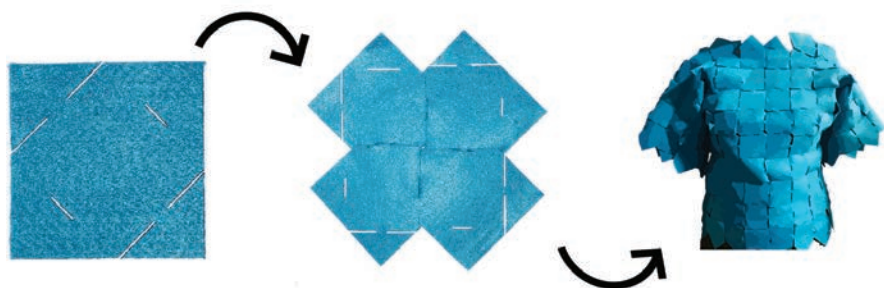
“A lot of people we worked with [from IWD] felt it was easier to have their belongings close to them, and didn’t want to have to ask others to get stuff for them,” says Jones. “So we developed various stitchless pocket hacks using laser cutting and 3D printing for stencils, fabric tape solutions instead of sewing, and came up with accessible tools to go with the pockets.”

“Working with people directly is where the innovation comes from. If you had asked me for accessible clothing ideas, or what the priorities are, I wouldn’t have thought pockets,” she adds.

Jones’ passion for wearable technology stems from an early interest in digital art during her Bachelor’s degree in art history and theory. Instead of writing about it, she wanted to make it.

Before Carleton, she completed a Master’s in Digital Futures at OCAD University in Toronto.

“When I started at OCAD, I was learning about code and about electronics in an artistic environment,” she says.



A single Wearable Bit, two joined Wearable Bits, and a wearable garment prototype.
(Photo courtesy Lee Jones)

Jones is now a member of the Creative Interactions Lab (CIL) at Carleton, led by Professor Audrey Girouard from the School of Information Technology.

Pursuing her PhD project at Carleton and working with the CIL team has taken Jones' knowledge of electronics, wearable technology, and accessibility practices even further.

Girouard, Jones' PhD supervisor, worked with her to find the perfect project for her skill set and their collective interests.

"Lee is passionate about working with textiles and making soft sensors, so she designed this project that has the potential to help people, especially those with accessibility needs, to design and adapt their own clothes," says Girouard. "She's driven and thriving, and it's wonderful to see her progress."

Along with her colleagues in the CIL, Jones names Hannah Perner-Wilson and Mika Satomi, the handmade wearable technology pioneers behind Berlin's KOBAKANT collective as great inspirations on the work she's producing.

"They're the first ones who started using handcrafted textiles, and I appreciate that they're open-source about it," says Jones.

In September, 2019, Jones attended the International Symposium on Wearable Computers in London, UK, where she shared her project's progress with a global network of peers and leaders in her field.

Jones says researchers were excited about the concept of using e-textiles to adapt and alter clothes that individuals already own.

"Today, there's a greater awareness of the amount of waste that fast fashion produces, so people are thinking of ways that we can be more sustainable," she says. "When creating any new technology, it's important to think about the lifecycle of what you're creating."



Wearable Bits with sewed on electronic components.
(Photo courtesy Lee Jones)



Lee Jones (third from right on stage), alongside her Open Style Lab team, present their adaptive pocket hack design. (Photo courtesy Open Style Lab)

Digital Mapping Puts Students at Forefront of Cyprus Heritage Conservation Efforts



(From right) This past August, Mary Chamberlain of the Department of Antiquities in Cyprus visited Carleton to receive training on Carleton Immersive Media Studio (CIMS) workflow, facilitated in part by graduate students Reem Awad and Michelle Duong. (Photo: Fangliang Xu)

In the land where mythical Aphrodite was born, the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site of Nea Paphos in Cyprus has enthralled visitors for centuries. However, conservators and local staff have never had a complete map of all the elements of the storied site. By the end of 2019, Carleton students will have created its first detailed digital map.

Two years ago, the Getty Conservation Institute, based in Los Angeles, asked Architectural Conservation and Sustainability Professor Mario Santana Quintero and his team of graduate students in the Carleton Immersive Media Studio (CIMS) to map the ancient site 8,544 kilometres from Ottawa in its entire current condition. Both the institute and the Department of Antiquities (DoA) in Cyprus will use the geographic information system of Nea Paphos to guide future conservation efforts and improve visitor understanding and experience.

Carleton graduate students Reem Awad and Michelle Duong have led a team of nine students in the complex digital mapping and geographic information system project. The two visited Paphos last June and used 3D scanning, drones and photogrammetry to record the information and map the site at a high level of detail.

Paphos is a city in the southwest of Cyprus and in ancient times there were two locations - Old Paphos and New (Nea) Paphos. Nea Paphos is the modern city that incorporates the harbour and ancient ruins of tombs, fortresses, theatres and villas with mosaics depicting scenes from Greek mythology.

The main archaeological site is more than 170 acres that includes the residential area with mosaics. A second area, known as Fabrika, is about 37 acres that includes 14 caves documented using terrestrial 3D scanning. The third area is known as Tombs of the Kings (dating back to the fourth century BC) and is more than 60 acres. The tombs vary in

size and Awad says the Carleton team documented more than 20 tombs through laser scanning and aerial photogrammetry.

The CIMS team captured more than 20,000 photographs and approximately 700 laser scans on site this past summer, documenting more than 60 mosaics in addition to a few wall paintings. The students have also been showing staff from the DoA how to use the specialized technological gear they brought to Paphos.

Now they are processing the data and, this November, Awad will return to Paphos with all of the maps ready for a quality check. She will continue to train DoA staff on using the geographic information system platform they have created. The final report will be submitted by the end of December to the Getty Conservation Institute.

Awad recently graduated with a master's in Architecture and will continue working full-time on this project until its completion.

"The reason I chose to come to Carleton is because of a heritage documentation training course Mario [Santana Quintero] gave in Palestine," says Awad who moved to Ottawa to complete her studies. "I was excited to learn from Mario and have the opportunity to work on one of his projects."

“ The amount of responsibility and trust given to the students (on Paphos) is unexpected,” says Friedman. “It’s a good model and great experience for them.” ”



As part of a Carleton Immersive Media Studio (CIMS) project led by Professor Mario Santana Quintero, nine graduate students travelled to the UNESCO World Heritage Site of Nea Paphos in Cyprus this past summer, where they captured more than 20,000 photographs and approximately 700 laser scans. (Photo courtesy Carleton Immersive Media Studio)

Duong is beginning her master's in Architecture, but is continuing to work on the project part time. "This project was an amazing opportunity," says Duong. "I don't know where else I would have had the opportunity to get intimate with such a historically and culturally significant UNESCO World Heritage Site."

"One area that we documented had never been studied."

Martha Demas and Leslie Friedman work in the Getty Conservation Institute's L.A. office and visited the CIMS lab at Carleton in August to get an update on the Paphos project and tour Carleton's facilities.

Demas says they came to meet the team in person and get a better sense of how CIMS works. "We've been so impressed by the students who have worked on Paphos," says Demas. "They are smart, quick, lovely human beings. It's been stellar to work with them on and off site."

For Friedman, the scale on which CIMS operates was very impressive.

"The amount of responsibility and trust given to the students (on Paphos)

is unexpected," says Friedman. "It's a good model and great experience for them."

Demas points out that the students are exposed to more than just mapping. They gain experience looking at the big picture of the project in dealing with local partners and getting to work with the DoA in Cyprus.

Santana Quintero is proud of the work his students have done in a place where no complete map had existed. Now the Getty Conservation Institute and DoA will receive a geographic information system platform that includes topographic maps, the slope of the site, sizes of the mosaics and an integrated database.

"We don't do these projects to make money," he says. "We do them for conservation purposes and to create opportunities for students so they can develop the skills and experience that the non-profit and private sectors require—and so they can help us advance the field."



More Than 300 Million Reasons to Say *Thank You*

On April 17, 2019, Carleton's Collaborate Campaign lived up to its name. The most ambitious fundraising effort in University history closed at \$308,139,166, a feat made possible through philanthropic partnerships with more than 29,000 donors from throughout the Carleton community.

Collaboration and partnership have been integral to Carleton's culture since its very founding. Through the Collaborate campaign, Carleton donors, alumni and friends furthered this legacy by investing in expanded learning opportunities and essential resources that support students, advance teaching and research, and serve the greater public good.

With every gift, supporters helped Carleton students access immersive experiences that enrich their learning and equip them to tackle the complexity of real-world challenges. Students in the Faculty of Engineering and Design (FED) have unprecedented access to collaborative and interdisciplinary opportunities to participate in design competitions, conferences, symposia and short courses, as well as mentoring and field trip interactions with professional engineers, architects and innovators. More than 248 donor-funded scholarships and bursaries are now available to undergraduate and graduate students across areas of study. These awards enable the University to attract and retain the very best students, and will award academic excellence and make higher education possible for students with limited means.

As change makers and risk takers, FED graduates are boldly forging new paths as leaders of industry and community. Through Collaborate, FED alumni champions mobilized to create meaningful connections with current students as engaged volunteers, guest speakers and mentors. As donors and fundraising ambassadors, FED alumni endorsed more than 30 student-led projects through FutureFunder.ca, Carleton's crowdfunding platform. These strengthened relationships support career and professional development, promote personal growth, inspire Ravens pride, and are leaving a legacy for future generations of proud Carleton students.

FED continues to be at the forefront of research excellence. Donor support and industry partnerships are propelling the discovery of new ideas and innovative approaches to addressing complex challenges with implications on a local and international scale. Building upon existing strengths in urbanism, biomedical devices, wastewater engineering, solar homes and the internet of things, Carleton researchers are helping to build sustainable communities and global prosperity. Embedded in this global context, FED students are poised to navigate the increasing complexity of real-world challenges and use their education as a force for good.

To learn more about the impact donor support can create, connect with Jennifer Wolters at jennifer.wolters@carleton.ca.



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