Dean's Report

Decarbonizing for a *Sustainable Future*

Conceptual Design of the BARN facility
BARN Team

Imagine if we could construct buildings entirely out of renewable materials such as trees, algae, and mushrooms. Or if we coordinated the ways we manage forests with the ways we manage the supply chain for the building industry.

This vision of an eco-responsible and sustainable architectural future is at hand. A new project called BARN (Building Architecture Research Node) is set to transform the ways we design, construct, and operate buildings. It brings together researchers in architecture, engineering, energy, ecology, landscape, forestry, and construction. Associate Professor Michael Jemtrud and Assistant Professor Salmaan Craig from the Peter Guo-hua Fu School of Architecture co-lead the project.

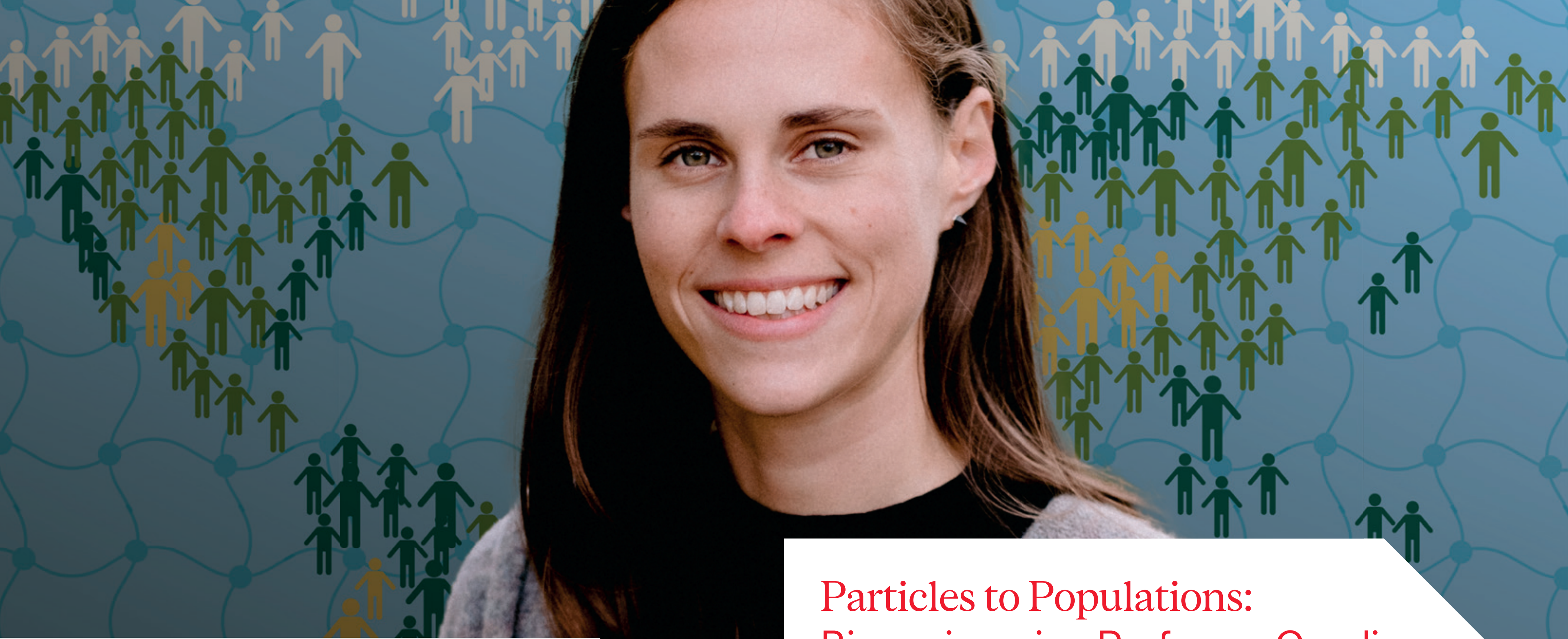
The innovative research laboratory will be built near the Morgan Arboretum on McGill's Macdonald Campus in Sainte-Anne-de-Bellevue, Quebec. It will house the School's DeCarbonized Architecture and Building (DeCARB) research group. This team looks at ways to reduce the environmental impact of building operations such as heating, ventilation and cooling. It also studies how to reduce the emissions embodied in the mining, harvesting, processing, manufacturing, transportation, and installation of building materials, in tandem with techniques to sequester carbon emissions in buildings for centuries to come.

The timing is right. Jemtrud argues there is an urgent need to deliver green building solutions now. "We have to move fast to address climate change." The project has generated enthusiasm and support across the country. It has more than $19 million in research funding: approximately $7.7 million through the Canada Foundation for Innovation's Innovation Fund (CFI-IF) and additional funds from the Government of Quebec.

The BARN building will be McGill's first mass timber construction. Walls and floors will be made from engineered wood, products created by compressing layers of wood through lamination, adhesives, and fasteners. Tall enough to allow the fabrication of two-storey-high wall panels indoors, the 18,000-square-foot laboratory is a state-of-the-art design-build facility. "Being on the Macdonald Campus also allows us to selectively harvest wood from the Arboretum to design and construct small demonstration buildings," says Jemtrud.

Researchers at BARN are already at work creating carbon-negative approaches to construction and community design. Ph.D. student Anna Halepaska is collaborating with Craig on using aerospace design techniques to create timber walls that work as water-to-air heat exchangers. The idea is to recycle heat and reduce the number of unique parts in building construction. "Designing structural, bio-based wall components as heat exchangers could be the step-change we need to integrate building systems with both fast- and slow-growing bio-materials," explains Halepaska. Ph.D. candidate Peter Osborne is collaborating with Jemtrud and Associate Professor Rosetta Elkin on ways to synchronize forestry and construction. The challenge, he says, is that forests face increasing pressures related to climate change. "I am linking what we design to what we harvest—and when we harvest—so we can reliably increase biodiversity and carbon storage in these complex ecosystems."

BARN supports a wide array of activities. For instance, the new laboratories will allow the production of full-scale prototypes, test buildings, and prefabricated building assemblies for new construction and retrofit. The research team can test untried passive heating, cooling, and ventilation technologies and monitor their performance over several years. "Sustainability has become a major trajectory of the School," adds Jemtrud. He says that many of the School's new professors have deep experience in ecological systems and eco-responsible building. "I hope that as many faculty members as possible can be involved with DeCARB and BARN. We want to accelerate the development and adoption of sustainable design and building technology."



Dean's Message

Prosperity by Design: *Creating a more sustainable and prosperous world.*

As I look back on 2021 and 2020, I am immensely proud of everything our students, professors and support staff have been able to accomplish, thriving and even excelling despite the challenges.

It is clear to me that the Faculty of Engineering's mission to create *globally-minded professionals equipped to solve problems that matter* is more relevant and urgent than ever.

The COVID-19 pandemic has only strengthened our commitment to training the next generation of engineers, architects, and urban planners able to tackle the increasingly complex problems we face, with an education that is purpose-driven, interdisciplinary, and forward-thinking. Two of the key challenges we face as a global society, are **sustainability**—learning to live within our means in respect of the planet and future generations; and **global health**—which involves guaranteeing access to quality of life that promotes positive health and prosperity for everyone, especially in developing countries. On both fronts there is a need for unprecedented levels of interdisciplinary collaboration. For that reason we equip the professionals we train not only to work together as teams in their fields, but to work with experts from other disciplines as well, in order to benefit society's common good.

Sustainability is one of our priorities at the Faculty of Engineering, across a range of areas, including climate change, renewable and efficient energy, sustainable infrastructure and manufacturing processes, among others. Building a more sustainable and prosperous future has become central to our research and teaching, and we are excited about our $19 million funded BARN project, led by professors in the Peter Guo-hua Fu School of Architecture, whose glorious (and humble) name stands for "Building Architecture Research Node." Read our cover story for more details about BARN's work to decarbonize construction at large. We are very proud of the School of Architecture's new cohort of sustainability hires, whose expertise will allow us to train new and future generations of environmentally-engaged architects.

When it comes to the future of energy, our newly-minted McISCE Centre (McGill Centre for Innovation in Storage and Conversion of Energy) will play a key role bringing together experts from across the world to share their knowledge in energy storage and conversion technologies, as we move toward carbon-free energy in light of Canada's commitment to net-zero emissions by 2050. Read our interview with Professor of Practice Karim Zaghib to find out more.

Alongside the development of new areas, there are also important developments in old areas, such as mining. 2021 is not only McGill University's 200th Anniversary, but it is also the 150th Anniversary of the founding our Mining Engineering program. Mining is of pivotal importance for the present and the future, not only for Canada but for the rest of the world. Sustainable technologies need critical minerals and materials, and we must ensure that mining continues to be not just more environmentally-friendly, but also inclusive and respectful of local and Indigenous populations, as we move further into the twenty-first century.

Sustainability also means rethinking our approach to global health. The COVID-19 pandemic has shown us how precarious health can be, individually and collectively. The importance of engineers in advancing biological processes, so as to improve the everyday lives of human beings, through healthcare, but also in many other fields such as energy, production systems, construction, and agriculture, is an area in which our work is expanding. The explosion of knowledge in the life sciences has given engineers a whole set of tools to solve major problems worldwide. Bioengineering, which applies the engineer's know-how and problem-solving approach to the very building blocks of life, is of critical importance not only for the production of vaccines and new treatments for diseases, but also for a whole range sustainable technologies that draw from and build on the biological world.

Our Department of Bioengineering is recently-founded yet already highly-regarded, and there is much room for growth. As you can read in this report, the Viral Vectors and Vaccines Bioprocessing Group, led by Bioengineering Professor Amine Kamen, is doing incredibly innovative work in the highly relevant sector of disease prevention. In our Q+A with recently hired Bioengineering Professor Caroline Wagner, she explains the vital importance of interdisciplinary research when it comes to helping public health planning and policy. Her work, like that of many of our professors, demonstrates the need to work across disciplines and adopt a big-picture mentality in order to tackle the complex problems we face.

The Faculty of Engineering's mission to create a more sustainable and prosperous world, which aligns with McGill University's two-centuries long commitment to discovery, innovation, and progress, is only possible with your help. Please join me in celebrating McGill's Bicentennial Anniversary! It is 200 years since McGill University was founded in 1821, thanks to a bequest by James McGill of £10,000 and his estate. From the beginning, philanthropic partnership has always been a central factor in our growth and development. We could not do it without you: it is your support and generosity that makes all these things possible. Thank you!

Jim A. Nicell, Ph.D., P.Eng., FCAE.
Dean, Faculty of Engineering

Particles to Populations: Bioengineering Professor Caroline Wagner researches disease spread

Recently hired by McGill's Department of Bioengineering, Professor Caroline Wagner studies the role of physical and biological processes in the spread and progression of diseases, in particular, how biological fluids like mucus interact with pathogens in the body, and affect their transmission between people at the level of populations.

Professor Wagner is part of a new cadre of researchers who take an interdisciplinary approach, and her work combines immunology, epidemiology, climate science, mathematical modeling, and engineering sciences, to tackle the global health challenges of the future.

You began your academic career as a mechanical engineering undergraduate student at McGill. How did you end up focusing on global health?

Caroline Wagner: By doing research with Professors John Lee and Andrew Higgins in Mechanical Engineering on combustion-related projects, I discovered I liked fluid mechanics. It turns out this field plays a big role in disease transmission. You need to understand fluid mechanics to model disease spread via emitted droplets in the air, and also to model the effect of all these biofluids we have in our bodies, like mucus and blood, in various disease contexts. My Ph.D. at MIT was spent thinking about the mechanical properties of biofluids and developing models to understand how changes in these properties might be related to various states of disease. I took classes in public health and development economics, and got interested in the bigger global health picture. I ended up doing a postdoctoral fellowship at Princeton developing mathematical models for how diseases spread within-hosts and at the level of populations. It became clear to me that biofluids play a big role in these processes. Many infectious diseases spread via droplets we emit, which contain mucus and its main protein components. Mucus also acts as a barrier within hosts, and can trap viruses, denying them access to the cells they would otherwise infect. I realized I would build my research program to incorporate these aspects of biofluids and bioengineering into thinking about modeling disease progression and transmission. Then the pandemic broke out a year and a half later. It was bizarre timing.

Have you learned anything from COVID-19 that we could use the next time there's a pandemic?

C.W.: I think having systems in place to rapidly mobilize data will be hugely important for the future, to help with public planning. Though ultimately there needs to be infrastructure connecting hospitals or public health agencies collecting these data with research teams. The pandemic has shown us that our responses need to be adaptable as we learn more about the disease in question—another strong reason to efficiently handle data. We can think about how to improve our baseline level of preparedness or ability to identify future threats. I didn't come up with this idea, but among my colleagues there is interest in setting up a system or observatory to monitor immunity levels to different diseases, say from random blood samples. Combining this with the monitoring of active infections could be very useful.

How is climate change going to affect public health?

C.W.: In lots of ways. During my postdoctoral fellowship I got to work with a team from Princeton that combines researchers from Ecology and Evolutionary Biology and the High Meadows Environmental Institute. We ended up combining both epidemiological and climatological data sets to think about the role of climate in a large Dengue virus outbreak in Sri Lanka in 2017. But it's not just mosquito-borne diseases that are impacted by climate. Aerosol-transmissible diseases, too: people get the flu more in the winter, for example. We don't necessarily know if that's because people are staying inside and staying close to each other, or if the weather is affecting either our immune system or the virus particles directly. That's an example of a big open question that engineers could play an important role in helping answer. If these seasonal disease patterns become different with climate change, that can have huge impacts on public health planning.

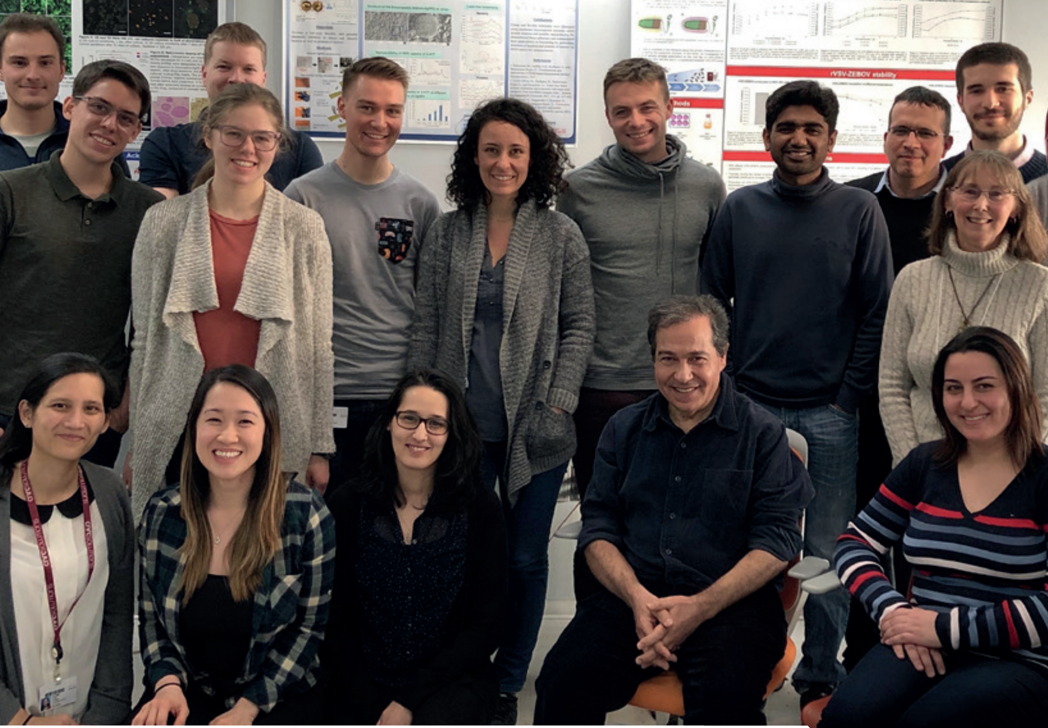
What is the role of universities and their researchers in helping to manage infectious disease?

C.W.: It's true that not all university researchers are directly involved in policy decisions. But many people at McGill work very closely with provincial and federal health agencies, in the generation of projections for case numbers and infections. When researchers publish their work, this is picked up and used by policy makers, and many of our public health researchers have devoted a lot of time, particularly during the COVID-19 pandemic, to communicating their knowledge to broader, non-academic audiences through various media and social media platforms.

Will your lab at McGill be an interdisciplinary one, then?

C.W.: Yes! The students who are keen on the biofluids side of the work will be from bioengineering, mechanical engineering, chemical engineering and so on. I'll also be recruiting people with a quantitative background who are interested in epidemiology. I think there's a lot to learn from connecting those two areas.

Photo above : Professor Caroline Wagner, Department of Bioengineering
Marlon Kuhnreich Photography



Technology to Transform Global Healthcare:

The Viral Vectors and *Vaccines Bioprocessing Group*

Viral vectors are the wonder tools that can deliver game-changing cell and gene therapies to treat serious conditions such as lymphoma, leukemia, multiple myeloma, and inherited blindness—and vaccines to prevent infectious diseases like COVID-19, Ebola, and influenza.

The Viral Vectors and Vaccines Bioprocessing Group, led by Bioengineering Professor Amine Kamen, develops cutting-edge bioprocessing technologies and techniques, to accelerate the development of and increase access to life-saving medicines and vaccines, improving health and quality of life for people globally.

Professor Kamen, a Canada Research Chair in Bioprocessing of Viral Vaccines, and Professor in the Department of Bioengineering, leads an interdisciplinary group that includes researchers from around the world with expertise across such fields as biotechnology, chemical engineering, microbiology, immunology, cell therapy, artificial intelligence and bioinformatics.

"Professor Kamen is a visionary, who has a deep and broad understanding of where the field is going," says Sascha Kiesslich, who recently completed a Ph.D. at McGill in biological and biomedical engineering. Professor Kamen has strong connections with industry, government and university partners and graduate students get the perfect training before going into the job market."

Kiesslich worked on a project to develop a more efficient and cost-effective manufacturing process for an Ebola vaccine candidate originally developed in Canada. African countries continue to experience severe Ebola disease outbreaks and this vaccine uses a recombinant Vesicular Stomatis Virus (rVSV)-based vector to protect against the disease. Kiesslich developed an efficient, scalable process for producing large quantities of Ebola vaccine in the widely used Vero cell line in bioreactors rather than the current roller bottle manufacturing process. "Improving production methods is super-important to reduce costs and enable the vaccine to be made in smaller facilities in African countries where it is most needed," Kiesslich says. He also used this innovative manufacturing process to efficiently produce similar rVSV vectors for novel HIV vaccine and COVID-19 vaccine candidates in Vero cells in bioreactors. "We demonstrated that the rVSV vaccine platform can be modified to be used as a vaccine for many different diseases and ultimately very economical manufacturing," he observes, noting that scalable, low-cost manufacturing of COVID-19 vaccines is urgently needed to meet the huge unmet demand in many developing countries.

"All the research in our lab has a practical application for the health and well-being of people," says Omar Farnos Villar, a research associate from Cuba. "By continually improving bioprocesses for making viral vectors and vaccines, we can help to make cell therapies, gene therapies and vaccines more affordable and available to people around the world."

Farnos is developing an improved vaccine against Newcastle Disease (ND), a critical threat to poultry in sub-Saharan Africa, where countries have an average of 10 outbreaks per year, with a major impact on local economies and food security. This innovative vaccine, which uses a non-replicating adenovirus vector to deliver an antigen against ND, can be produced much more efficiently using the group's cell culture manufacturing platform rather than traditional egg-based production.

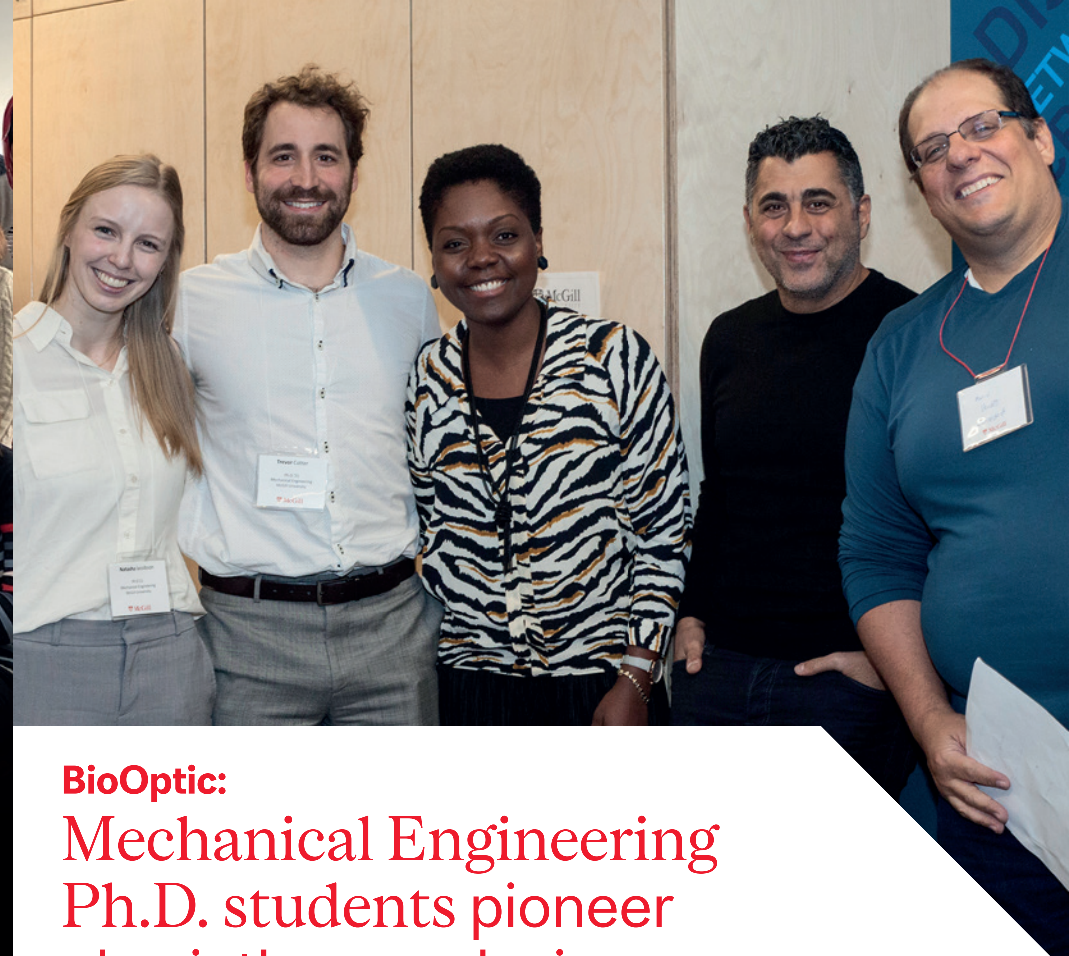
"Our vaccine is safer, superior and more cost-effective than the live ND vaccines currently produced in embryonic chicken eggs, which are expensive and imported from Europe. The transfer of our technology to the National Veterinary Institute (NVI) in Ethiopia can be expected to deliver cost-effective vaccine candidates against circulating ND viral strains, and be adapted to respond to other emerging avian viral threats to poultry in African countries," says Farnos.

Alina Venereo-Sanchez, a former McGill postdoctoral fellow from Cuba, launched the company VVector Bio to commercialize a unique process for high-yield, scalable biomanufacturing of viral vectors used in cell and gene therapies and vaccines. This leading-edge technology was developed in Kamen's lab. VVector Bio bridges the gap between research and the clinic by helping to meet the surging demand for large quantities of high-quality viral vectors for use in pre-clinical experiments and clinical trials of new cell and gene therapies. A key goal is to reduce high treatment costs. Cell therapy for leukemia costs about $500,000 USD per patient and gene therapy for spinal muscular atrophy, a leading genetic cause of infant deaths, is over $2 million USD for a single dose.

"The viral vector manufacturing market is expected to reach $815.8 million USD by 2023 and there are now more than 1,750 cell and gene therapy products in the pipeline for clinical approval that use viral vectors," says Venereo-Sanchez. "With our unique manufacturing process and proprietary methods, VVector can produce high-quality viral vectors faster to accelerate the translation of research into new treatments and help make therapies more affordable."

That is the global health challenge being undertaken by the Viral Vectors and Vaccines Bioprocessing Group: to transform global healthcare by developing technologies and techniques to produce a wide range of viral vectors and vaccines faster, on a larger scale, and at a lower cost.

Photo above : Viral Vectors and Vaccines Bioprocessing Group, 2019



BioOptic:

Mechanical Engineering Ph.D. students pioneer physiotherapy device

Mechanical Engineering Ph.D. candidates Natasha Jacobson and Trevor Cotter share a few traits: they are both from the Prairies, had each come across the hands-on research being done by McGill mechanical engineering Professor Mark Driscoll—the attraction to his research pulled her away from Winnipeg and him from Minnesota—and they come from families of engineers.

One other thing they share? First prize in last year's TechIdea competition after they pitched a physiotherapy innovation they developed together.

The novel device appears primed to replace what is now an invasive medical procedure for a difficult-to-broach condition. Doctors currently diagnose incontinence by inserting a catheter into the patient and filling the bladder with saline. Jacobson and Cotter have come up with a simple suction device that, when placed against the abdomen, outside of the body, measures intra-abdominal pressure and the elasticity of the abdominal wall.

The handheld machine, named BioOptic, houses a suction cup the size of half an orange that makes a seal on the stomach, sending out an LED light to measure how far the skin moves. Its pressure sensor gauges how much suction is being applied.

Jacobson's thesis has been built around this device, while Cotter has helped his fellow doctoral candidate actually build it. The idea for a device to diagnose incontinence came from Professor Driscoll, who had found that physiotherapists working on techniques to overcome the condition had no non-invasive ways in which to measure it. He brought the idea to Jacobson who got to work on the subject, delving into the literature and reading articles on bladder pressure measurement and the pervasiveness of incontinence. "It's something we never talk about. But it's so prevalent."

She came across a paper that showed a connection between the tension in the abdominal wall and how much pressure is behind it and, thanks to her grandfather, Waldemar Lehn, a professor emeritus in electrical engineering at the University of Manitoba, she took the research a step further. "He found a paper on a mathematical formula for determining that pressure."

Jacobson made her first prototype with help from the Department of Mechanical Engineering's 3D printer, but she was not happy with it. "I had a lot of parts that came together with screws, and I couldn't fit my hand into the device to get to them. It was a nightmare." she recalls. That's when she approached Cotter.

Cotter's mechanical inclinations has had him volunteering his services as a bike mechanic and joining his family in building most of an airplane in their garage. For the hardware problem, he brought in a small divot for easy access. But there were other difficulties. "We went through a bunch of iterations on how to seal our device," he recalls. "We also wanted to make sure it was reusable because most devices that come in contact with a person are used once and then thrown away." They have been looking at a durable resin for their final prototype, while Cotter's brother Anthony, a materials engineer, has suggested different adhesives and seals.

While Cotter and Jacobson won the 2020 TechIdea competition for BioOptic, they also did very well in the 2021 McGill's Three Minute Thesis Competition, with a first-place and third-place win, respectively. Cotter's winning thesis was on creating a simulator, akin to pilot training, for spine surgery. The two appreciate the work being done by Katya Marc, Associate Director of the McGill Engine Centre, who does much of the organizing of competitions at the Faculty of Engineering and helps shepherd entrepreneurial ideas.

The two hope that BioOptic will make an entrepreneurial splash and are already gaining interest from professionals in the field. "We're focusing on physiotherapists at this time," says Jacobson. "They've said 'You know, we can use this in our clinics.'"

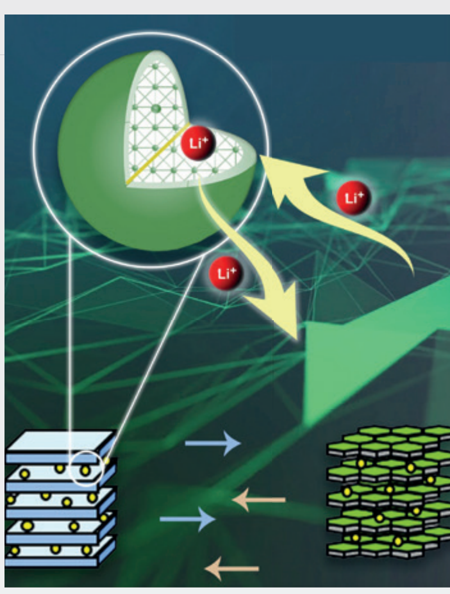
During the summer, Jacobson and Cotter welcomed other students' help on the final prototype. When it is completed they will be one step closer to getting their device into clinics and giving incontinence patients a more comfortable solution.

Photo above : Natasha Jacobson and Trevor Cotter (left) at the McGill Engine TechIdea Showcase, 2020

Antonella Fratino

Storing and Converting Energy: *For carbon neutrality in 2050*

The McGill Centre for Innovation in Storage and Conversion of Energy (McISCE) is a new research, training and innovation hub for the electrification of everything.



Artistic illustration of the movement of Li-ions during battery discharging and charging cycle.
Majid Rasool and George Demopoulos

One of the principal goals of engineers, architects and urban planners is to improve the everyday lives of people. But this objective has no meaning if the health of the planet is left out of the equation. Reducing adverse human impact on the environment is an imperative for which focused research at McGill Engineering is making a tremendous difference. This year, the Quebec government announced its 2030 Plan for a Green Economy, which calls for reaching carbon neutrality by 2050. Within this plan, the electrification of the transportation sector will dramatically increase demand for energy storage and conversion—from advanced batteries to green hydrogen and carbon-free fuels. To meet this demand, McGill University announced the launch of the McGill Centre for Innovation in Storage and Conversion of Energy (McISCE). The new centre will unite McGill's world-leading expertise in energy storage and conversion technologies, and forge new links between universities, industry and government.

Dr. Karim Zaghib, distinguished battery researcher and Professor of Practice in the Department of Mining and Materials Engineering, tells us why this new hub will become a world-leader in green, circular economy energy storage and conversion.

There's plenty of research going on at McGill in energy storage and conversion (hydrogen energy production and storage, battery research, mining and materials research). Why do we need a centre for it?

Karim Zaghib: You cannot work individually when you target a societal project like energy transition. It's like a pizza or a cake—you can't eat the whole thing yourself, but when you break it up into portions among friends, you can handle it. Global warming is here. The energy transition is happening now. We need to work together on many levels under an umbrella that encourages national and international collaborations to accelerate this energy transition.

Does Quebec's reliance on hydroelectric power make it an ideal place for green energy transition?

K.Z.: Certainly, in Quebec we have an abundance of green hydroelectric energy; but we also have critical minerals that we can transform right here, and we have human capital in the form of great students, great professors. McISCE can play a role to coordinate this ecosystem, to become a circular green economy. We can support a cycle of production from mine to mobility to recycling: for example, research in mining for processes like the electrification of mining operations, research on precursors for anodes, cathodes and cells, carrying out electric vehicle research, and recycling of raw materials from spent batteries. We cannot continually be taking materials from a mine.

What do you see as the major challenges of research of this green circular economy?

K.Z.: The challenges are to think about high performance materials, about non-toxic materials, and about what we have available in Quebec. It is very important to take care of the social impact, and to consider the traceability of the materials. And we have to make it the same price or lower than the market.

In addition to your involvement at McGill Engineering, you have worked with Hydro-Québec on their electrification programs, and for Investissement Québec. How will the work of McISCE unite these three sectors: academia, government, and industry?

K.Z.: Teaching students and doing research will be the basis of the Centre's work. But it will go beyond that, and it should be a hub for many satellites. There will be thirty members from many departments at McGill, but also collaborations with other universities, such as the Université du Québec en Abitibi-Témiscamingue (UQAT) and the Université du Québec à Trois-Rivières (UQTR). UQTR is a leader in hydrogen research. We should also think about jobs, about working with industry to create start-ups and new companies. These are the companies that will invest in universities in the future. For this we will coordinate with the McGill Engine as well. Beyond that, we are looking at international collaborations as well, with the European Community, or the US Department of Energy. The USA, Germany and Japan are more advanced in terms of hydrogen. Why not collaborate with them? We are interested to bring all actors together to work in concert and aggregate this research with national and international partners to produce results for Quebec government and industry.

McGill | Centre for Innovation in Storage and Conversion of Energy

Photo above : Professors George Demopoulos, Karim Zaghib, and Raynald Gauvin, Department of Mining and Materials Engineering

Mining the Future: The Next 150 Years of Mining at McGill

Our daily lives are dependent on the products of mining, and mining is essential to global economies. Mining is evolving rapidly as a discipline, becoming more socially and environmentally conscious, and using the most sophisticated technologies. McGill's Mining Engineering Program turned 150 years old in 2021: we now look ahead to another 150 years.

"We take mining for granted, but without it we cannot survive," says Professor Hani Mitri, former Director of Mining Engineering at McGill University. "If you look at green technology, for example, lithium for electric batteries has become one of the world's essential materials."

Adaptation to the developing needs of the industry has been the hallmark of the mining program at McGill Engineering for the last 150 years. Since its formation in 1871 in response to a call to modernize coal-mining operations in the new Dominion of Canada, the mining program has produced over 1,500 mining professionals who have occupied leadership positions in the industry.

In Canada, the industry is valued at over $100 billion and provides one in 30 jobs. The products of this industry are essential to every aspect of our daily lives: from the critical metals used in modern communication technologies to rare earth minerals that provide green energy solutions. As the longest-standing mining school in North America, McGill's program has matured to be number one in Canada and third in the world. But the program is refusing to rest on those laurels.

"Mining is a primary sector and receives the signals of economic and industrial changes earlier than the other sectors," explains Professor Mustafa Kumral, Director of Mining Engineering at McGill University. "Engineering as a profession emerged in the first industrial revolution, and mining engineering was one of the pioneers of this revolution. Now, as we discuss the fourth industrial revolution, mining engineering will continue its mandate in a new form to provide raw material to emerging disciplines."

"The discipline will be challenged in the next 150 years to diversify how we get our natural resources, from more difficult locales, through recycling, and even space mining," says Professor Richard Chromik, Chair of McGill's Department of Mining and Materials Engineering. "The future of our civilization is highly dependent on how we manage energy, food, water, and all natural resources used in technology. Huge technological innovations will be required to meet these challenges, including robotics and artificial intelligence, and I expect these to be applied in mining extensively."

Mining is a changing industry. Ask most of the Canadian population about their idea of mining, and you might drum up images of sooty-faced men creeping through dark, wood-trussed tunnels or ultra-heavy machinery spewing exhaust in open pit mines. The truth is, over the last two decades the mining industry has been evolving far beyond these old realities.

Mines have become much more sophisticated and complex as they are established at greater depths and in increasingly remote and challenging locations. As a result, the technology of mining has evolved immensely. Mining now uses robotics, artificial intelligence (AI), virtual reality (VR), and "big data" analytics to make its operations more efficient, safer, and less harmful on the environment. Mining operations are becoming greener. For example, the graphite mining company, Nouveau Monde, will inaugurate a carbon-neutral graphite mining operation this year in Saint-Michel-des-Saints, Quebec, whose operations are entirely electrified.

Along with these technological changes, mining is also undergoing a major shift in its social values. Mining professionals of the present and future must be actively involved in repairing and redesigning its reputation with populations worldwide. This means considering the social context of mining operations to understand the environmental and social context. This is essential to attract local workers (especially Indigenous peoples) who will not only provide support for local mining operations, but also establish trust and agency that would ensure responsible economic development and overall positive impacts for those communities.

"We will witness an intense transformation in the mineral industries in the coming years," adds Kumral. "As a result of the low-carbon or green economy, fossil fuel operations will decrease, and the transition to a green economy will demand more and more raw materials such as rare metals, rare earth elements, and some base metals. Mining operations will move to remote areas where extreme climate conditions prevail, such as the Arctic, and new social risk management and governance models will be required."

The mining professional of the future must thus be holistic, an active participant in creating a sustainable, prosperous future for humanity, and endowed with deep knowledge of the mining industry's international and financial dimensions, its social and environmental impacts, and its technological evolution.

"The overall goal is to create a new vision of mining that is environmentally-friendly, inclusive, and respectful of people and the planet," concludes Mitri. "Future mining will be safe, automated, efficient, generating little or no carbon footprint, and leaving a clean and restored environment. Mining will become not only economically and environmentally sustainable, but also socially sustainable."

Photo above : Canadian Malartic Mine, Quebec
Krishanu Dasgupta

The Dean's Report is published by the University Advancement Office at the Faculty of Engineering, McGill University.
Tel: 514-398-1371
ua-comms.engineering@mcgill.ca
3480 University Street West,
Montreal, QC, Canada, H3A 0E9

Prefer this as a PDF? or do you have a comment on a story? Get in touch with us at ua-comms.engineering@mcgill.ca We'd like to hear from you!

McGill | Faculty of Engineering

Design: Atelier Pastille Rose