President's Update 2021

GLOBAL IMPACT

UNIVERSITY OF WATERLOO

THE POWER OF CO-OPERATION TO CHANGE THE WORLD

FERIDUN HAMDULLAHPUR
President and Vice-Chancellor

For centuries our global community grew closer – trading together, working together and exchanging ideas. The global pandemic upended that world, physically separating us more than ever and forcing us to shift our focus.

The physical distance can make it feel like we are more apart than ever before. But in fact, I think the opposite is true.

We are coming together, showing great resiliency in the face of complex issues. We have seen global co-operation on solutions to the COVID-19 pandemic, including the rapid development of a vaccine.

WATERLOO WAS BUILT FOR CONNECTION

This collaboration across nations, industries and the political spectrum is changing the world. We are coming together to protect not only ourselves but one another. These connections push us forward every single day.

The University of Waterloo was built on connection and co-operation. It is deep within our institutional DNA, beginning with our dedication to blending academics with real-world experience through our **renowned co-operative education program**.

OUR GREATEST IMPACT HAPPENS TOGETHER

Our founders believed that Waterloo's deep connections with partners in industry and the community would mean richer education for all and a stronger national economy. It has imbued our University with a unique, entrepreneurial spirit that looks to find solutions to critical problems and partner with those who can help achieve the biggest impact. We need those relationships more than ever if we are to tackle disruptive, global challenges that require complex solutions.

This report is filled with stories of connection: There are collaborations with industry and non-profit groups for everything from better health care to improved security and stronger communities.

These stories demonstrate that **Waterloo was built for co-operation and impact**. That legacy propels us forward and we're only just getting started.

> ❝
> **We are coming together to protect not only ourselves but one another.**
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> # THESE CONNECTIONS PUSH US FORWARD EVERY SINGLE DAY.
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> Feridun Hamdullahpur,
> President and Vice-Chancellor

We need connections and partnerships more than ever if we are to tackle disruptive, global challenges that require complex solutions.

Explore the numbers behind what makes the University of Waterloo a dynamic community where connections to industry, government and community organizations help us develop the next generation of talent.

We are harnessing the strengths of humans and machines to optimize everything from operating rooms to factory floors and farmers' fields.

HUMAN– MACHINE INTERACTION

85M

jobs may be displaced by a shift in labour between humans and machines by 2025.

WORLD ECONOMIC FORUM FUTURE OF JOBS, 2020

97M

new roles may emerge by 2025 that are more adapted to the division of labour between humans and machines.

WORLD ECONOMIC FORUM FUTURE OF JOBS, 2020

HOW THE PANDEMIC WILL OPEN THE DOOR TO AN

AI AND ROBOTICS REVOLUTION

Canada has a historic opportunity to emerge from the public health crisis stronger than before with innovative policies and investments that embrace change.

While many people hope to get back to normal after the pandemic, economics professor Joel Blit (MASc '99) sees an unprecedented opportunity for Canada to transform its economy.

The pandemic has forced businesses to do things differently and often better. Firms have digitized processes and automated workflows to survive the economic crisis and address its health risks.

"We are in the midst of a historic opportunity. The artificial intelligence and robotics revolution that we have been expecting is now at our doorstep," Blit says. "We must start shifting from COVID-19 economic policies that aim to maintain the status quo to policies that embrace change."

The harsh reality of the pandemic is that millions of people have lost their job, and due to automation, many of these jobs will never come back. But trying to restore the old normal is a losing proposition that would only ensure Canada's loss of global competitiveness, Blit says. Instead, we must promote this economic transformation, while supporting people through the transition and beyond.

THE COVID-19 RECESSION: WHY IT'S DIFFERENT

With a background in computer engineering, business and the economics of innovation, Blit is an integral part of the conversation about the future of work. He's advised senior policy-makers such as the G7 Sherpas and has been invited to speak at high-profile events including the OECD Global Forum on Productivity.

JOEL BLIT

Professor, Faculty of Arts
Waterloo.ai
Centre for International Governance Innovation

When the COVID-19 pandemic shut down the economy, Blit's work shifted to examining the impact that this health crisis would have on an economy on the threshold of an artificial intelligence and robotics revolution.

"In every recession since the beginning of the information and communications technology revolution, the Canadian economy has undergone significant technological automation and resource reallocation," Blit says. Historical data shows that each recession saw a permanent drop in routine jobs – jobs that typically involve a lot of structure, repetitive tasks and predictable routines that can therefore more easily be replaced by machines. Meanwhile, non-routine jobs were less likely to be affected by a recession, and if they were, typically bounced back quickly after the recession.

"This COVID-19-induced recession will be no different, and in fact, will trigger an even bigger economic transformation due to the added health-related incentives to automate. If you are a manager, the best way to protect your people and operations is to replace worker-worker interactions with worker-machine interactions, or better yet to replace workers altogether," Blit says. "The transformation is likely to be greatest in the retail and hospitality sectors, because these industries have strong health incentives to automate and automation is feasible given current technologies."

We're already seeing how businesses of all sizes are changing, from family-owned bricks-and-mortar shops going online to retail giants such as Walmart piloting stores without cashiers, and wholesalers replacing warehouse workers with robots.

"Even sectors such as health and education, that have historically seen relatively little technology-driven transformation, are seeing rapid changes because these industries face the most significant health risks," Blit says, adding that advances in telehealth and online education will endure after the pandemic and catalyze further waves of innovation.

While some people view this trend toward automation negatively, Blit sees it as an opportunity to bolster flagging productivity and increase the standard of living of Canadians. "We should embrace this revolution by removing barriers to technological change, by helping to finance investments that make our firms more competitive, and by mobilizing the knowledge that resides in our universities and institutes."

MAKING SURE EVERYONE BENEFITS

Innovation may be the silver lining to the COVID-19 recession, but Blit's research also considers how to avoid the inequalities that can arise from technological change. We've already seen how the COVID-19 recession disproportionately affected low-income earners, and a massive wave of technology adoption could make things worse.

"Not only will their jobs be disproportionately impacted, they are also less likely to have the skills to easily transition to the new economy," Blit says. "Retraining is part of the solution and universities have a crucial role

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> ## WE ARE IN THE MIDST OF A HISTORIC OPPORTUNITY. THE ARTIFICIAL INTELLIGENCE AND ROBOTICS REVOLUTION THAT WE HAVE BEEN EXPECTING IS NOW AT OUR DOORSTEP.
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>
> Joel Blit

CAN ROBOTS LEVEL THE PLAYING FIELD?

Kerstin Dautenhahn
Professor, Faculty of Engineering
Social and Intelligent Robotics
Research Laboratory (SIRRL)

A new robot named MyJay that lights up when it scores a basket is just part of Kerstin Dautenhahn's vision for building robots that give all children the ability to play games regardless of their abilities.

"I really believe social robots can make a positive contribution to society," says Dautenhahn, a professor in Waterloo's Faculty of Engineering and Canada 150 Chair in Intelligent Robotics.

Children with very limited mobility, who can perhaps only move their fingers, can direct MyJay to pick up a ball and shoot a basket. Dautenhahn and her team in the Social and Intelligent Robotics Research Laboratory (SIRRL) – Hamza Mahdi, Shahed Saleh and Omar Shari – are particularly interested in having children with special needs play games with friends and siblings who don't have disabilities. ▢

to play. But the reality is that we also need to consider other programs such as a guaranteed basic income. Fortunately, COVID-19 also presents a historic opportunity to reimagine our social contract."

"Recessions' periods of rapid automation and reorganization are important to long-term productivity and growth," Blit says. "Change is coming. Our choices are twofold: how quickly to make the transition, and what governance to put in place so that all Canadians benefit." ▢

Everything from our privacy, economy, health care and education is shaped by advancements in data science and computing.

NEXT-GENERATION COMPUTING

41.6B

devices will be capturing data on how we live and operate machines by 2025.

WORLD ECONOMIC FORUM, 2019

53%

of the global population is using the internet.

WORLD ECONOMIC FORUM, 2020

PAYING IT FORWARD FOR

THE NEXT-GENERATION OF WOMEN IN COMPUTING

Waterloo Computer Science student dreams of being a tech leader and building bridges for marginalized groups in tech.

KEER LIU

Student, Faculty of Mathematics
David R. Cheriton School of Computer Science

Keer Liu was 18 years old when she left China to study Computer Science at the University of Waterloo with a dream of becoming a leader in the tech industry. She wanted an exceptional foundation in computing but her real dream has always been to lead.

This year, Liu will have an undergraduate degree in Computer Science, experience building a successful startup with her classmates, and six co-op work terms at some of the world's best-known technology companies.

Working in companies such as Apple, Uber, Slack and Coinbase transformed her education, but Liu says the connections she made – and the female role models she met – while working in an industry still dominated by men have inspired her to not only lead but to build bridges for other young women in computing.

"I was able to get a co-op term with Apple on the basis of a recommendation from my supervisor at Slack," Liu says, who starts full-time at Apple after graduating. The recommendation came from a female engineering colleague. Liu says the experience of reporting to three women during co-op terms in San Francisco, Toronto and Vancouver shaped her vision of leadership.

"Female software engineers and managers have empathy for younger women just entering the field," Liu says. "They have the engineering skills but they also know how to mentor young students like me. I want to be able to do that for others."

THE POWER OF A NETWORK OF WOMEN IN TECH

For Liu, the power of connection and community started early in her studies when she became involved in the Women in Computer Science group in Waterloo's Faculty of Mathematics. There she was introduced to other women studying computer science who shared their own stories of experiencing unconscious bias, feeling like imposters in the workplace, and the fear of speaking up in meetings. Liu, who speaks three languages, said she had to push herself to be more assertive, in part because she was a woman, but also because English is her third language.

> According to Statistics Canada, only 18 per cent of people working in engineering or computer and information systems jobs are women. In the U.S., software developers, with a median annual wage of $103,000, continue to be in high demand but only 18 per cent of those jobs were filled by women in 2017.

The disparity persists despite research that shows diverse teams perform better. A recent analysis by McKinsey & Company found that organizations in the top quartile for gender diversity on executive teams were 25 per cent more likely to have above-average profitability than companies in the fourth quartile. In the case of ethnic and cultural diversity, McKinsey's 2020 report, Diversity Wins: How Inclusion Matters, found that companies in the top quartile for ethnic and cultural diversity outperformed those in the fourth quartile by 36 per cent in profitability.

As of fall 2019, women represented 36.5 per cent of the undergraduate population in the Faculty of Mathematics and 24.4 per cent in the David R. Cheriton School of Computer Science. The numbers have been increasing over the past decade, thanks in large part to the work of Women in Computer Science (WiCS), Waterloo Women's Impact Network (WWIN), the Centre for Education in Mathematics and Computing (CEMC) and Women in Mathematics (WiM).

AN ASPIRING FEMALE ENTREPRENEUR

Part of Liu's journey at Waterloo included time on Tutturu, a startup that won $50,000 in the University of Waterloo's Velocity Pitch competition in 2020. Liu is currently supporting the Tutturu team as a marketing lead but the time she spent learning to pitch an idea and the connections she made with other entrepreneurial students in Velocity has expanded her network. Beyond the Velocity community, Liu met other students interested in starting ventures in an entrepreneurship course offered through Waterloo's Conrad School of Entrepreneurship and Business.

Liu is taking everything she's learned about entrepreneurship into another role as fellow for MiraclePlus, an incubator based in China. She is building connections between people with promising startup ideas in Waterloo and MiraclePlus, the incubator founded by global tech leader Lu Qi, the former chief operating officer at Baidu and a former executive vice president at Microsoft.

As an international student, Liu hopes to continue to build a global community of women and other marginalized groups who are as passionate about tech and transforming the world as she is. "I've watched women who lead and they really know their engineering and computing, but they are also very smart about building teams. My dream is to one day be as good as they are." ▾

> "I'VE WATCHED WOMEN WHO LEAD AND THEY REALLY KNOW THEIR ENGINEERING AND COMPUTING, BUT THEY ARE ALSO VERY SMART ABOUT BUILDING TEAMS. MY DREAM IS TO ONE DAY BE AS GOOD AS THEY ARE."
>
> Keer Liu

David Jao
Professor, Faculty of Mathematics
Chief Cryptographer, evolutionQ Inc.
Waterloo Cybersecurity and Privacy Institute

The Canadian Space Agency recently awarded Waterloo spinoff company, evolutionQ a research grant to help bring satellite-based quantum key distribution into a future world where economic security will very much depend on computer security.

David Jao, chief cryptographer at evolutionQ and a professor in Waterloo's Faculty of Mathematics, says Canada needs such a system because of numerous cyber threats ahead. ▾

QUANTUM-SAFE SECURITY

Find out more about why Waterloo is widely regarded as a world-leading research centre in quantum and post-quantum cryptography.

uwaterloo.ca/news/evolutionQ

STAY CONNECTED AND PROTECTED

As the pandemic drove people online to work, study and connect with loved ones, Leah Zhang-Kennedy doubled down on her commitment to making digital spaces safer for everyone.

"We are at a very critical crossroad right now. New and emerging technologies that rely heavily on our private information are becoming more ubiquitous," says Zhang-Kennedy, a professor at Waterloo's Stratford School of Interaction Design and Business. "The seamless convenience of these tools poses significant security concerns." ▾

Leah Zhang-Kennedy
Professor, Faculty of Arts
Waterloo Cybersecurity and Privacy Institute

Find out more about how Zhang-Kennedy partnered with industry, non-profit groups and scholars to support students who want to be privacy-conscious professionals.

uwaterloo.ca/news/cyberheroes

Global crises of health and racial equity have accelerated a shift in thinking about how society can create sustainable jobs and communities for all.

SOCIAL AND ECONOMIC PROSPERITY

1.2B
children were out of school in 2020 as a result of COVID-19.

WORLD ECONOMIC FORUM, 2020

32%
of all jobs are at "significant risk" of automation.

WORLD ECONOMIC FORUM, 2020

WHEN YOU'RE A GIG WORKER DURING A GLOBAL PANDEMIC AND

YOUR BOSS IS AN APP

Gig work is transforming our global economy and public health as workers weigh risks every day in precarious, low-wage jobs to deliver us food and parcels.

When the pandemic hit and workers retreated to the safety of their homes, Ellen MacEachen knew the risks of being infected with COVID-19 and transmitting it to others would be high for the gig workers delivering our food and parcels and for the drivers helping us avoid public transportation.

"There are some interesting opportunities out there and it all works great until you have an illness or an injury or a pandemic," says MacEachen, a professor in Waterloo's School of Public Health and Health Systems. "All of a sudden, you start to appreciate even more strongly the work and health protection differences between a gig and a more traditional job."

A few months after Canada went into lockdown, MacEachen and her research teams began exploring how to reduce the risk of gig workers getting and transmitting the coronavirus, and how sick leave policies and practices can protect workers and the community. MacEachen is hoping the research will help protect gig workers and others in low-income, precarious jobs who are helping to keep the rest of us safe in our homes.

CONSEQUENCES FOR WORKERS AND COMMUNITY

"We want to know what risks these workers take when they don't have paid sick leave and what are the consequences for public health," MacEachen says.

Through in-depth interviews, her research teams are hearing from personal shoppers who are delivering groceries to people with COVID-19 who refuse to wear masks. They may refuse to finish a grocery order because a store employee is coughing, but that work refusal increases their "cancellation rate," which could get them kicked off the app for which they work.

ELLEN MACEACHEN

Professor, Faculty of Health
School of Public Health and Health Systems

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> MacEachen's research teams are finding there are unique dilemmas for workers employed through app-mediated online platforms such as Uber Eats, Amazon Flex and Lyft. While each app works differently, gig workers can wake up one morning to discover they've been kicked off the app by an algorithm because their customer score went too low. It's why drivers are anxious about asking passengers to wear a mask and risk a poor review.

"They are very insecure workers and anxious about wanting to maintain their jobs," MacEachen says. "They don't really have a manager. These companies see themselves as technological interfaces so workers don't really have a manager to go to."

There are ride-hail drivers, says MacEachen, who buy disposable masks for passengers with their own money. While some drivers may worry about getting infected by passengers, they continue to work and often can't even afford to take time away from driving to get tested for COVID-19. "They may say, 'I have a sore throat but I need to pay the rent, so I'm going to work,' " MacEachen says.

GIG WORK BEFORE THE PANDEMIC

Before the pandemic, MacEachen says there had already been a significant shift around the world and in Canada, with about 30 per cent of workers engaged in low-wage, temporary work. This global shift has impacts that go beyond the health and wellness of individual workers.

"These gig firms don't pay employment insurance. They don't pay into a pension plan. They don't pay payroll taxes," MacEachen says. "They don't contribute to our national well-being in the same way that other employers do ... so they are free riders in a way."

The costs, however, impact all Canadians: "If these workers do get ill, if they can afford to be ill, instead of a workers compensation claim – it will be a hospital visit," MacEachen says. "Workers aren't signed up for employment insurance, so they end up on social assistance."

MacEachen says the pandemic has highlighted the critical importance of supporting vulnerable workers and may force society to make changes for those who currently have almost no workplace health support or guidance. She hopes her research team's findings will guide workplace interventions that combat misinformation and fear while reducing illness and disease transmission.

The Canadian Emergency Response Benefit (CERB) is one example of a government intervention that has supported gig workers during the pandemic. "It's really exciting to see this change on the part of the government, MacEachen says. "This is the time when we are re-evaluating our society and the types of supports we want." ◗

> ## WE WANT TO KNOW WHAT RISKS THESE WORKERS TAKE WHEN THEY DON'T HAVE PAID SICK LEAVE AND WHAT ARE THE CONSEQUENCES FOR PUBLIC HEALTH.
>
> Ellen MacEachen

Iyinoluwa "E" Aboyeji
Alumnus (BA '12), Faculty of Arts
Co-founder, Future Africa

Iyinoluwa "E" Aboyeji (BA '12) is a serial entrepreneur who doesn't consider his ventures a success unless they improve society.

"That's the ethos that guides my work," says Aboyeji, co-founder of Future Africa – a company dedicated to providing African innovators with a community of coaches, capital investors and a network of business connections. ◗

AFRICAN CAPITAL FOR AFRICAN INNOVATION

Find out more about how Aboyeji is turning Africa's biggest challenges into opportunities.

uwaterloo.ca/news/future-africa

BEING INDIGENOUS AND HAVING "RECONCILIATION" IN YOUR JOB DESCRIPTION

Savanah Seaton wants to help employers create workplaces where Indigenous employees can feel a sense of belonging and fully contribute their untapped knowledge, skills and abilities.

Seaton, a graduate student in Industrial and Organizational Psychology in the Faculty of Arts, hopes her research journey will help employers create more genuinely supported "reconciliation" jobs and authentic welcoming spaces. ◗

Find out more about how the history of Canada's relationship with Indigenous peoples throws serious roadblocks in the paths of Indigenous scholars.

uwaterloo.ca/news/reconciliation-jobs

Savanah Seaton
Graduate student, Faculty of Arts
Waywayseecappo First Nation

Researchers are finding new ways to save lives through everything from robotics to artificial intelligence and new, evidence-based preventative health policies.

TECHNOLOGY AND HUMAN HEALTH

2B
of the world's population will be 60 years and older by 2050.

WORLD HEALTH ORGANIZATION, 2020

50%
of all mental health conditions start at 14 but most are untreated.

WORLD HEALTH ORGANIZATION, 2020

A SEARCH ENGINE FOR BETTER

DISEASE DIAGNOSIS AND TREATMENT

Waterloo Engineering researcher sought early support from alumnus company to develop technology he hopes will revolutionize health care.

Hamid Tizhoosh was looking for a new idea, a fresh start, when he began talking to doctors about how they do their jobs and how they might do them better.

Six months into his consultations, with his engineering lab at the University of Waterloo reduced to a one-man show by a failed artificial intelligence (AI) startup, he heard something that almost floored him.

Pathologists in the 21st century still rely on atlases – books of images from biopsy samples – and flip through them for potential matches to help diagnose new cases.

Really? Books of old images? That was it, the spark that sent the systems design engineering professor roaring down a productive new research path.

"They were using a very Stone Age type of search," he recalls. "When I learned that, I said, 'For heaven's sake, we should do this automatically. It is image search. Computers can do it.'"

Seven years later, Tizhoosh has turned that basic concept into new technology he hopes will revolutionize health care by giving doctors a simple, powerful tool to help diagnose, treat and research disease via search in large medical image archives.

PARTNERING WITH INDUSTRY TO SECURE $3.14 MILLION

To help realize that goal when his early work started showing promise, he approached a local company, Huron Digital Pathology of St. Jacobs, for support in return for commercialization rights.

> " I BELIEVE THIS IS DISRUPTIVE TECHNOLOGY THAT WILL EVENTUALLY TOUCH EVERY AREA OF THE MEDICAL FIELD. "

HAMID TIZHOOSH

Professor, Faculty of Engineering
KIMIA Lab

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Huron later became the industrial partner in a consortium led by Tizhoosh and researchers in his Laboratory for Knowledge Inference in Medical Image Analysis (KIMIA Lab) that secured $3.14 million in funding through the Ontario Research Fund: Research Excellence program in 2018.

The technology at the heart of the project is essentially a specialized search engine that allows doctors to comb archives of digital images of tissue samples for the closest matches to new cases.

The original images contain massive amounts of digital data, so search is only possible because Tizhoosh came up with a way of using AI to identify key features and convert them into bunches of barcodes.

That reduces the size of images to a tiny fraction of the originals and indexes them, enabling the search engine to find matches in archives of millions of images in a split second using ordinary computers.

"We designed the search from the beginning to be super-efficient, to do this without heavy-duty computational power," Tizhoosh says.

By finding similar images, the search engine instantly connects doctors to a treasure trove of information on old cases – the diagnosis report, the treatment plan, the eventual outcome – that is now just sitting in archives.

WATERLOO TECH WILL MODERNIZE WORLD'S LARGEST TISSUE ARCHIVE

A hint of its potential came last fall when the KIMIA Lab was selected by the World Health Organization to contribute to a global research project on cancer categorization using its image-retrieval technology.

Around the same time, the United States military signed on as Huron's first paying customer to modernize the Joint Pathology Centre, home to the largest collection of preserved tissue samples in the world.

That deal put the project two years ahead of schedule in terms of commercialization, but Tizhoosh is convinced they have still only scratched the surface.

He looks forward to the day the system is used everywhere – including areas of the developing world where pathologists are especially scarce – to virtually eliminate diagnostic error, personalize treatment plans and fuel drug development.

"I think we're only at the very beginning, to be honest," Tizhoosh says. "I believe this is disruptive technology that will eventually touch every area of the medical field."

"Even we don't know what the full impact of image search in medical archives will be. Every time we talk to doctors, they give us new ideas."

# THE MATHEMATICS OF LIFE AND DEATH IN A GLOBAL PANDEMIC

Never before have our lives been so fraught with life-and-death questions. The COVID-19 pandemic has left leaders and ordinary people asking: Will lockdowns work? Can schools be opened? When can we visit our loved ones?

Some of the best answers to these questions have been found in mathematical modelling and now, with COVID-19 vaccines being distributed, mathematicians like Chris Bauch are tuning into the question: Who should get vaccinated first?

Chris Bauch,
Professor, Faculty of Mathematics
Waterloo.ai

Find out more about how Bauch and his research team have developed a social-epidemiological model with four COVID-19 vaccine strategies.

uwaterloo.ca/news/modelling
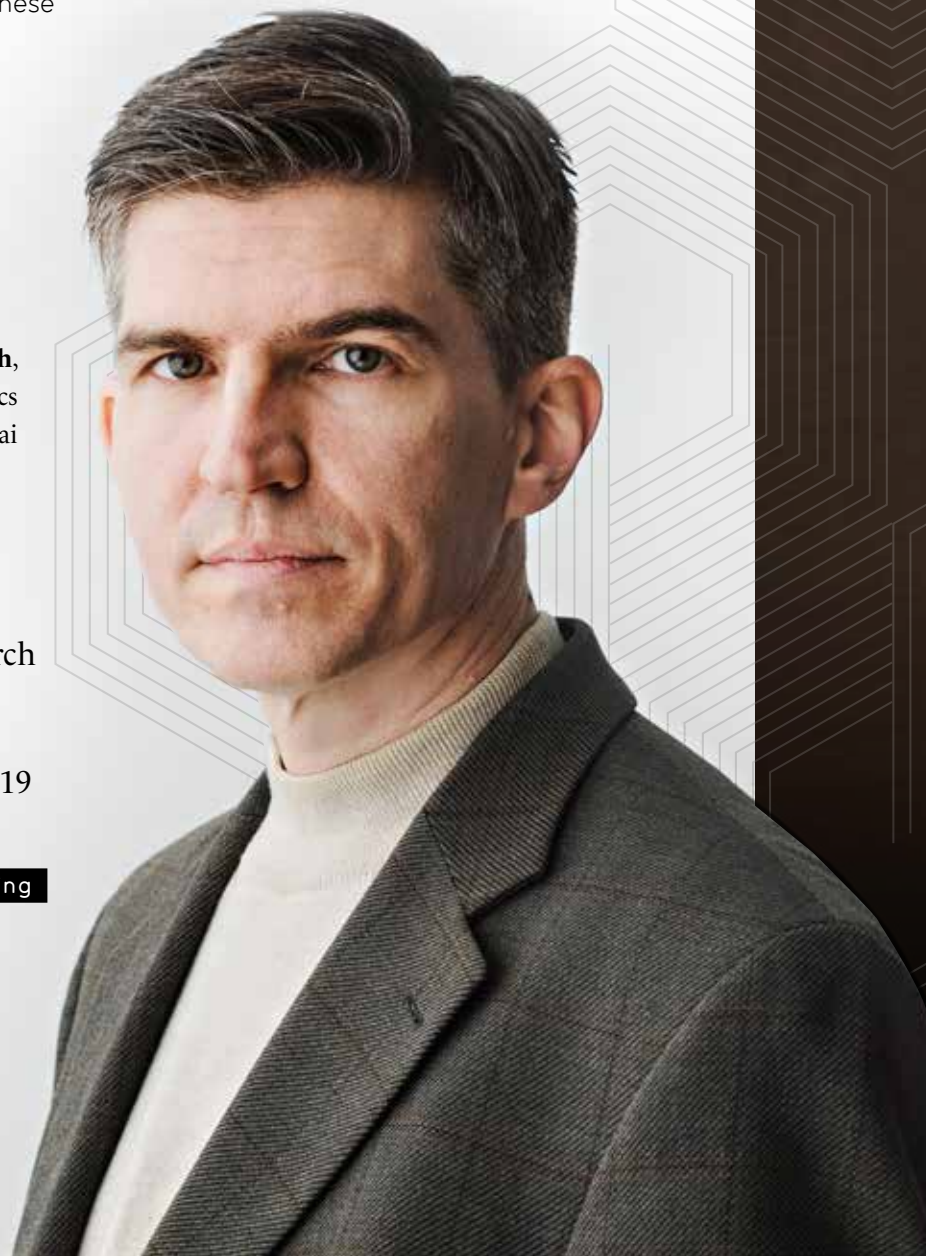
VACCINE TECHNOLOGY FOR FUTURE PANDEMICS

Nafiseh Nafissi
Alumnus (MSc '09, PhD '13)
Faculty of Science
School of Pharmacy

In the midst of a surge of COVID-19 cases in fall 2020, hopeful news emerged: Vaccine trials by several large drug makers showed promise.

But what about the next pandemic? That's what Nafiseh Nafissi (MSc '09, PhD '13), executive vice-president of research and development at Mediphage Bioceuticals and her colleagues are thinking about.

Find out more about how this Waterloo spinoff company is developing a new vaccine platform that could lead to a faster response when the next global health crisis hits.

uwaterloo.ca/news/mediphage

PLATFORM EXPANDS PHARMACY CARE

Rui Su
Alumnus (MSc '09, PhD '13)
Faculty of Science
Co-founder, MedMe Health

Rui Su (PharmD '18) and her co-founders Purya Sarmadi and Nicholas Hui have developed a product that is supporting pharmacists and earning funding across Canada and beyond.

Together, they founded MedMe Health, a digital patient care platform that helps pharmacists deliver their clinical services at scale.

Find out more about how MedMe is focused on the gaps in the pharmacist's clinical workflow and how they built solutions to streamline their delivery of clinical services.

uwaterloo.ca/news/medme

PANDEMIC HIGHLIGHTS IMPORTANCE OF SUPPORTS FOR PEOPLE WITH DEMENTIA

Laura Middleton became passionate about Alzheimer's research after a much-loved aunt was diagnosed with early-onset Alzheimer's at age 47.

"Her daughters were 12, 14 and 16, and she was my mom's best friend, so it had a huge impact on our family," says Middleton, a Kinesiology professor in the Faculty of Health. "I was interested initially in strategies to help reduce the risk of developing dementia. But gradually, I realized that if we had had better supports, if we could reduce stigma, if we could promote inclusion, her life after her diagnosis also could have been so much better."

Find out how a new healthy living program and a virtual reality exercise game will support people living with dementia at home and in long-term care.

uwaterloo.ca/news/DELIGHT

Laura Middleton
Professor, Faculty of Health
Brain and Body Lab

Our current and future generations deserve nothing less than global co-operation on sustainable technologies and policies.

SUSTAINABLE PLANET

70% of carbon emissions are created by cities.

WORLD ECONOMIC FORUM, 2021

6 OF THE WARMEST YEARS ON RECORD

have taken place since 2015.

- NASA, VITAL SIGNS OF THE PLANET

OUR OPTIONS FOR SAVING THE EARTH ARE BECOMING RISKIER

Massive engineering projects could reverse climate change and reduce poverty – but they are dangerous.

JUAN MORENO–CRUZ

Professor, Faculty of Environment
Canada Research Chair in Energy Transitions

With everything else going on, it's easy to forget the climate crisis. Juan Moreno-Cruz, a researcher in the Faculty of Environment and a Canada Research Chair in Energy Transitions, has a not-so-gentle reminder.

"Climate change is still out there and it's only getting stronger," he says, stressing that hopes for a co-ordinated effort in reducing emissions are vanishing. Riskier solutions to manage climate change should now be on the table.

"I actually hate when people say, 'climate solution,'" Moreno-Cruz says, who arrived at the University of Waterloo via his native Colombia. At each stop in his academic career, this engineer-turned-economist became obsessed with looking at a problem that will be with us, "essentially for the rest of time – there are no so-called solutions at the moment. At this point, we are not problem solvers, but problem managers."

What Moreno-Cruz wants us to get real about is the magnitude and urgency of the problem we face. With governments and industry moving too slowly, can big bold engineering ideas save us in the end?

CLIMATE ENGINEERING IS A HOT-BUTTON TOPIC

Climate engineering, better known as geoengineering, is a hot-button topic. Debate is swirling around massive projects such as sucking carbon dioxide out of the sky so the atmosphere will trap less heat, and even launching a mirror into space to reflect sunlight away from the planet so less heat is absorbed.

"I know, this sounds like science fiction, but many scientists around the world are doing research on these options," Moreno-Cruz says.

For Moreno-Cruz, Hail Mary engineering projects that place reflective particles in the sky give him pause. But his personal academic journey compelled him to examine the impact of climate change on vulnerable populations and this is a last stop.

CLIMATE CHANGE AFFECTS POORER COUNTRIES MORE THAN RICH COUNTRIES

As with most crises, the poorest people on the planet routinely suffer the most from the effects of climate change and, on occasion, even well-meaning climate-change solutions.

"As an engineering student in Colombia, I focused more on how to manage the pressing problems of a developing country. It was natural work, urgent work," Moreno-Cruz says. "But the more exposure I had to academics from North America and Europe I saw the kinds of longer-term problems they were working on, climate change especially. The question formed in my head was: 'How do we deal with a changing climate while also providing for the basic needs of poor populations?'"

A recent study in Nature Communications, co-authored by Moreno-Cruz and an international team of transdisciplinary researchers including Anthony Hardin and Katharine Ricke of University of California San Diego's School of Global Policy and Strategy, reflects the culmination of this big-horizon work.

By collaborating with researchers around the world in engineering, economics, development studies and more, he's discovered that at least one proposed geoengineering project – reflecting sunlight away from earth by releasing small reflective particles in the stratosphere – could help avoid the worst consequences of global warming and raise GDP in less affluent countries.

It's a seductive gambit. The ability to simultaneously fight climate change and poverty – perhaps our two most wicked problems.

"We find hotter countries respond more to small changes in temperature," Moreno-Cruz says. "Because poorer countries tend to be hotter, there is a disproportionate impact of climate on those countries. The reduction in temperature created by solar geoengineering would benefit poorer countries more than richer countries, reducing inequalities. The rich countries still benefit from solar geoengineering as well, so together, the world becomes richer."

GEOENGINEERING PROJECTS COULD THREATEN BIODIVERSITY

But there is still much uncertainty and some major risks to geoengineering approaches.

"I've talked with friends who are ecologists, including the Faculty of Environment's Jeremy Pittman, and I have realized the issues that come with the introduction of solar geoengineering could threaten biodiversity," Moreno-Cruz says. "Again it comes down to us accepting that this is not a solution, but a management strategy over a long timeline. Deploying radical technical projects and then not sustaining them could cause global temperatures to rebound much too fast. How will our ecosystem react?"

Moreno-Cruz stresses that he and his co-authors can't advocate whether solar geoengineering should be implemented by Canada or elsewhere. "I am a nerd. I focus on one aspect of these projects. Making them a reality and making them fair to people and the planet, can only happen if we think of climate change action as holistic," he says.

"We should not be distracted by shiny new technologies. We need to understand them, but we must work to reduce emissions of greenhouse gases and we need to bring people up from poverty. Let's make people better off. That's the best way to manage climate change."

Amelia Holcomb
Graduate student
Faculty of Mathematics

Amelia Holcomb was working at one of the biggest tech firms in the United States after graduating from Yale University when she started to grow restless: "I found myself asking why I was doing what I was doing. If I succeed ... how does that change the world?"

Holcomb realized she wanted to use her background in math and computer science to tackle climate change.

WORKING FOR A ZERO-CARBON FUTURE

Find out more about how Holcomb is researching how mobile phone sensors and drones can be used to measure forest carbon.

uwaterloo.ca/news/reforestation

AFTER THE FLOOD

When a flood hits a Canadian community and rising waters wash out roads, governments at all levels respond with heroic evacuations of vulnerable residents and emergency food and shelter.

But what are the hidden costs to communities when flood waters recede, and why are some devastated while others rebound?

"We know how much it costs to rebuild a washed-out road. What we don't consider is the cost of people getting knocked out of the workforce, suffering mental health problems as a result of the shock, and the ripple effect throughout the community," says Jason Thistlethwaite, a professor in the School of Environment, Enterprise and Development and an expert on flood risk.

Find out more about Canada's first comprehensive flood risk model that shows which communities are at greater risk of flood devastation over the long term.

uwaterloo.ca/news/flood

Jason Thistlethwaite
Professor, Faculty of Environment
Climate Risk Research Group

The thrilling discoveries of today will secure our prosperity, health and communities for generations to come.

TRANS FORMATIONAL DISCOVERIES

Waterloo is

CANADA'S #1 RESEARCH UNIVERSITY

in the comprehensive category.

RESEARCH INFOSOURCE, 2020

Waterloo has

$247.7M

in research funding from public and private sources.

CONSERVING ARCTIC CHAR WITH

WESTERN SCIENCE AND INDIGENOUS KNOWLEDGE

A PhD student partners with Indigenous elders and fishers to understand a changing fish population in Nunavut.

PhD student Spencer Weinstein is using research techniques from fundamental biology and ecology to determine if the Arctic char fish population near Kugluktuk, Nunavut is declining.

But Weinstein knows that to gain a holistic understanding of the changes that are occurring, she must also incorporate the knowledge and stories shared by the Indigenous people who live there.

"In addition to telling us that the fish are declining, the community is also saying that the fish look different. They are calling some of the fish that look different by different names," says Weinstein, a Waterloo Biology student who recently won a prestigious 2020 Vanier Scholarship. "We should be listening to the people who have lived in these communities and fished in these waters for generations."

SPENCER WEINSTEIN

Graduate student
Faculty of Science

"

WE SHOULD BE LISTENING TO THE PEOPLE WHO HAVE LIVED IN THESE COMMUNITIES AND FISHED IN THESE WATERS FOR GENERATIONS.

"

BRIDGING SCIENCE AND STORIES TO UNDERSTAND ARCTIC CHAR

Weinstein is working with the Kugluktuk Hunters and Trappers Organization to incorporate their knowledge into the research project so we can all better understand what is going on in the Coppermine River.

Weinstein wants to determine if the char are declining and whether another fish species might be moving in and competing with the char, and she is looking for indications of hybridization and genetic changes in the fish.

One would never guess Weinstein would end up working with an Indigenous community in the far north. Originally from New Jersey, Weinstein did her master's degree in Texas, studying rainbow trout.

But during her undergraduate studies, she participated in an experiential learning trip to a Cree community in Quebec. That sparked a deep respect for Indigenous communities, their knowledge and relationships with the land.

ANSWERING QUESTIONS THAT ARE IMPORTANT TO THE INDIGENOUS COMMUNITY

A key principle of the work done under the supervision of Heidi Swanson, a Waterloo professor in Biology and Research Chair in Fresh Water Ecology, is that it should focus on questions the community wants answered, Weinstein says. "We want to know from the get-go that what we're doing is important to them."

The partnership with the Kugluktuk Hunters and Trappers Organization is critical because the fish samples come from local fishers, rather than setting up nets and taking additional fish out of the river.

The partnership has been especially important during the COVID-19 pandemic. Typically, Weinstein would be in the community taking photographs of the fish and getting samples of the fins for genetic analysis. In 2020, because of the pandemic, she couldn't be there, but the community came through.

"We have incredible community partners who got things mobilized and were able to collect all of the samples for us. We're incredibly grateful for that. Hopefully, when travel is allowed again, I'll be able to go there again to interview elders and fishers for the traditional knowledge component."

IS CLIMATE CHANGE DRIVING CHANGES IN ARCTIC CHAR?

Part of Weinstein's work attempts to quantify the decline of the char and whether climate change is a driver. More than any other freshwater fish, char are adapted to cold water. It is possible, because of warmer waters, other species are moving in and competing for resources, making it harder for char to survive, she says.

The long-term effects of climate change on Arctic char populations are unknown. "But we need to do everything we can to maintain and restore habitats and populations," she says.

Arctic char is an important food source for the Indigenous population, both culturally and in practical terms. "Most food in the grocery store is imported and is cost-prohibitive for a lot of people. Many people depend on fishing and on other traditional foods."

Her research will inform a long-term management and habitat restoration plan to help the community maintain a sustainable fish supply. "The ultimate goal is conserving the fishery," Weinstein says.

Climate change is most visible in the North right now, Weinstein adds, but "eventually it is going to affect all of us." ▮

Niayesh Afshordi
Professor, Faculty of Science
Waterloo Centre for Astrophysics
Perimeter Institute for Theoretical Physics

ECHOES FROM BLACK HOLE COULD FORCE US TO RETHINK LAWS OF PHYSICS

Find out how gravitational echoes may confirm the late Stephen Hawking's quantum black hole hypothesis.

uwaterloo.ca/news/echoes

Eons ago, a cataclysmic crash between two neutron stars caused a convulsion that spread ripples of gravitational waves across the cosmos.

About 130 million years later, on Aug. 17, 2017, the Laser Interferometer Gravitational Wave Observatory (LIGO) detectors on Earth picked up the chirping of those gravitational waves.

It was a treasure trove of data that excited astrophysicists around the world, including Niayesh Afshordi, a professor in the Faculty of Science.

There is evidence the colliding neutron stars – which are incredibly dense stellar corpses that are only the size of a city but heavier than the sun – merged into a rapidly spinning small black hole. ▮

YOU+WATERLOO= IMPACT

The University of Waterloo is at the heart of a critical innovation community where talent, world-class research and entrepreneurial spirit come together to connect imagination, ideas and impact. We are proud to connect with industry, government and community organizations to create the next generation of talent for the global research community and the economy.

Get to know Canada's most experiential university
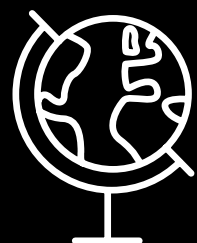
DRIVING ECONOMIC IMPACT

$295.5M
reported earnings by Waterloo co-op students in 2019/20

22,443 WORK TERMS
in 60+ countries with 7,182 active employers
2019/20

474 University of Waterloo entrepreneurs have raised

$12.9B
PITCHBOOK 2020

WATERLOO'S TOP COMPANIES
Capital raised in (millions USD)
PITCHBOOK 2020

Instacart *$2233.82*
Wish *$1800.33*
Databricks *$897.36*
Netskope *$744.3*
Kuaidi Dache *$700*

DEVELOPING TALENT FOR THE FUTURE

Degrees granted in 2020:
6,658 UNDERGRADUATE DEGREES
2,036 MASTER'S DEGREES
342 PhD DEGREES

#1 IN CANADA FOR

› Computer Science, Mathematics, Engineering
MACLEAN'S 2021, OVERALL

› Experiential learning
MACLEAN'S 2021, COMPREHENSIVE

94.8%
of employers describe their Waterloo co-op students as very good to outstanding
2019/20

TOP UNIVERSITY IN CANADA FOR
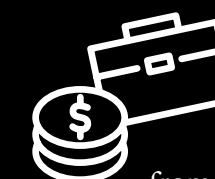
› Employer-student connections
› Graduate employment rate
QS GRADUATE EMPLOYABILITY RANKINGS 2020

RESEARCH FOR GLOBAL CHALLENGES

#1 RESEARCH UNIVERSITY
of the Year among Canadian comprehensive universities for 13 consecutive years
RESEARCH INFOSOURCE 2020

$247.7M
in research funding from public and private sources
2019/20

2019/20
26% research funding from corporate collaborations

$35.7M
direct industry funding

$28.6M
government matching funds

74 CANADA RESEARCH CHAIRS
5 KILLAM PRIZE WINNERS
1 NOBEL LAUREATE
2020/2021

YOU+WATERLOO

Our greatest impact happens together.