President's Update 2022

GLOBAL IMPACT

UNIVERSITY OF WATERLOO

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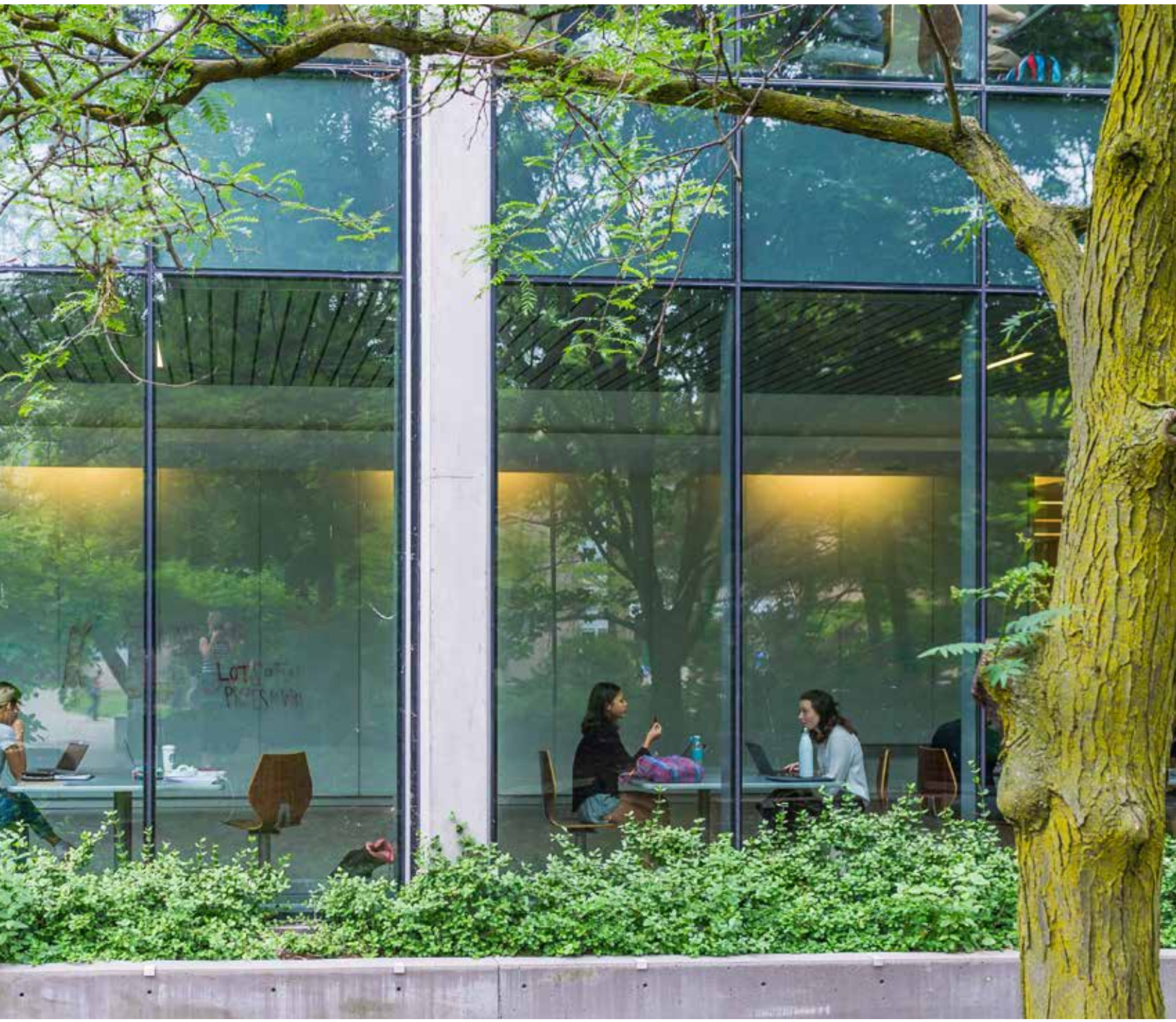


Addressing global challenges through

EDUCATION, RESEARCH AND INNOVATION

I am delighted to introduce my first edition of the annual Global Impact Report. It has been inspiring to learn about the history of the University and its unconventional founding. Our institution was founded by local community leaders to meet the many challenges of the day and to propel the region, and our nation, forward.

Being unconventional has fostered a spirit of curiosity and taking risks – to not only generate new ideas through research excellence but convert those ideas to create something that has a positive impact on the world.

Waterloo's unique approach to addressing the world's greatest challenges is built on boundary-pushing research, experiential education and entrepreneurship. And we bring these strengths to bear on addressing the human dimensions of global challenges, understanding and enhancing human experiences and examining ways to translate knowledge for governance and policy.

"The seismic shifts happening today are an opportunity for us to build on our tradition of innovation and discovery, and design human-centered solutions for a better future."

VIVEK GOEL
President and Vice-Chancellor

Throughout the report, you will encounter examples of Waterloo researchers, alumni and students who are making a tangible global impact today, while addressing and shaping the changing realities of our future.

Our world faces many challenges, such as rising geopolitical tensions, the decline of multilateralism, and the rise of populism and nationalism. We are more connected than ever with digital technologies – yet we are also more divided than ever as these tools drive misinformation and disinformation. The COVID-19 pandemic has demonstrated how fragile our global society has become, with a new virus able to have devastating impact in a short period of time. Yet the existential crisis that we face, the climate emergency, promises to have even more dire consequences for humans and our planet.

The pandemic response has also highlighted Waterloo's resilience, innovative thinking and leadership. Through education and research, we can help solve some of these big global challenges today and in the future in unconventional ways.

The seismic shifts happening today are an opportunity for us to build on this tradition of innovation and discovery, and design human-centered solutions for a better future. Waterloo was built for change, and we know how to prepare the next generation to lead in the face of social and economic transformations.

Our rich history of bold innovation is making a global impact today, and inspiring our future, as we navigate this period and reimagine a better world.

CONNECTING WITH IMPACT

The University of Waterloo is leading innovation that drives global prosperity. We're home to the world's largest co-op education network, game-changing research and technology, and an unmatched entrepreneurial culture. Together, these create solutions that tackle today's challenges and transform our future.

42K	4K	4	6	30	12
STUDENTS	FACULTY SUPPORT STAFF	CAMPUSES	FACULTIES	RESEARCH CENTRES	FACULTY-BASED SCHOOLS

TALENT

Developing talent for a complex future by...

Velocity – Canada's most productive incubator – creates economic and social impact by helping founders grow startups into companies that scale.

INTEGRATING WORK WITH LEARNING

19K+ students
employed in co-op work terms (2020/21)

No. 1 in Canada
for employer-student connections
(QS Graduate Employability Rankings 2020)

Home of the Work-Learn Institute – the only institute of its kind researching the development of talent through quality work-integrated learning programs

INVESTING IN LIFELONG LEARNING

WatSPEED – professional education to enable leaders to thrive in our ever-changing world

PROPELLING INNOVATORS

$3.6 billion
in funding raised by Velocity companies and generating 5K+ jobs (2022)

Building the **Innovation Arena** to strengthen Canada's health tech ecosystem

Over 45 support and for-credit programs for entrepreneurs

COMMUNITY

Strengthening sustainable and diverse communities by...

GROWING OUR GLOBAL NETWORK

4.5K INTERNATIONAL STUDENT EXPERIENCES

230K ALUMNI

154 COUNTRIES

Number of University of Waterloo alumni per country *excluding the United States and Canada

LEADING A CALL-TO-ACTION ON CLIMATE

Founding institution for **Sustainable Development Solutions Network Canada** to advance the UN's Sustainable Development Goals

Home to **Canada's largest Faculty of Environment**

OVERCOMING THE STATUS QUO

President's **Anti-Racism Taskforce** established in 2020

Indigenous and Black faculty cluster hiring initiative (2021)

New **Black Studies** programs (Fall 2022)

Home to the Glow Centre – Canada's oldest continuously running LGBTQ2+ student organization

Indigenous entrepreneurship program established in 2021

Jacob Crane is the p
new entrepreneurshi
Indigenous students

INVESTING IN STUDENT LIFE AND WELL-BEING

Expansion of the **Student Life Centre and Physical Activities Complex** (2021)

Opening of the **Feridun Hamdullahpur Field House** (2019)

Implemented all 36 recommendations from the **President's Advisory Committee on Student Mental Health** report (2021)

The Feridun Hamdullahpur Field House opened in 2019 and adds 65,000 square feet of new recreational space.

rogram manager for the
p training program for
launched in 2021.

RESEARCH

Advancing research for global impact by...

WATonoBus is a self-driving shuttle bus developed by a team of Waterloo researchers – it's the first of its kind at a Canadian University.

REWARDING RESEARCH INNOVATIONS

Creator-owned intellectual property rights policy

Over 100 funded research chairs

ATTRACTING THE BEST AND BRIGHTEST

74 CANADA RESEARCH CHAIRS

1 **NOBEL LAUREATE**

5 KILLIAM AWARD WINNERS

COLLABORATING WITH INDUSTRY AND GOVERNMENT

30% of Waterloo's research funding is from industry collaborations

$245 MILLION in research funding from public and private partners (2020/21)

ENHANCING INTERNATIONAL PARTNERSHIPS

300+ university partnerships across **50 countries and regions**

Centre for Eye and Vision Research – the world's first international research hub for vision science

DONNA STRICKLAND

Nobel Laureate in Physics 2018
Professor, Faculty of Science

Donna Strickland is a professor in the Department of Physics and Astronomy and is one of the recipients of the Nobel Prize in Physics 2018 for developing chirped pulse amplification.

GLOBAL IMPACT THEMES

Human-technology interaction

Examining the power of technology and its influence on our daily lives.

Next-generation computing

Finding new ways to harness computing technologies to improve the world.

Social and economic prosperity

Continually striving for fairness and harmony, so everyone can flourish.

Sustainable futures

Combining knowledge to create a prosperous future for humanity and our planet.

Advancing health innovation

Crossing disciplines for health solutions that enrich lives and advance life-saving care.

Transformational discoveries

Making breakthrough discoveries through research that will power unknown futures.

Our interactions with technology are increasing at a dramatic rate, from artificial intelligence that is used daily by billions of people to robotics that augment human capabilities.

As technology becomes more integrated into every aspect of our lives, it has brought positive innovations, such as extended access to medical care, but it has also created fears and new threats. Technological advancements are influencing our understanding of what it means to be human.

HUMAN–TECHNOLOGY INTERACTION

ARTIFICIAL INTELLIGENCE

with human understanding

To deliver on promised benefits, AI must be built to co-operate

Whether it's a digital assistant, like Siri, predictive text, social media or a vehicle with autonomous functions, many of us use or rely on some form of Artificial Intelligence (AI) daily.

Within the next few years, AI systems will become even more complex. Kate Larson, a professor in the David R. Cheriton School of Computer Science, and her colleagues have argued that if AI does not engage well with humans, it could fail to deliver benefits. "There are ongoing issues of ethics, regulation and privacy," she says. "If we don't design AI systems people can trust, there will be a backlash."

Larson conducts research on Multiagent Systems – AI systems that interact with one another – and recently collaborated on a research paper discussing the need for co-operative AI.

Co-operative AI refers to the ability of AI agents to work alongside or with other AI agents or people. It can also refer to AI that is used to better support teamwork and collaboration.

A NEED FOR AI WITH SOCIAL UNDERSTANDING

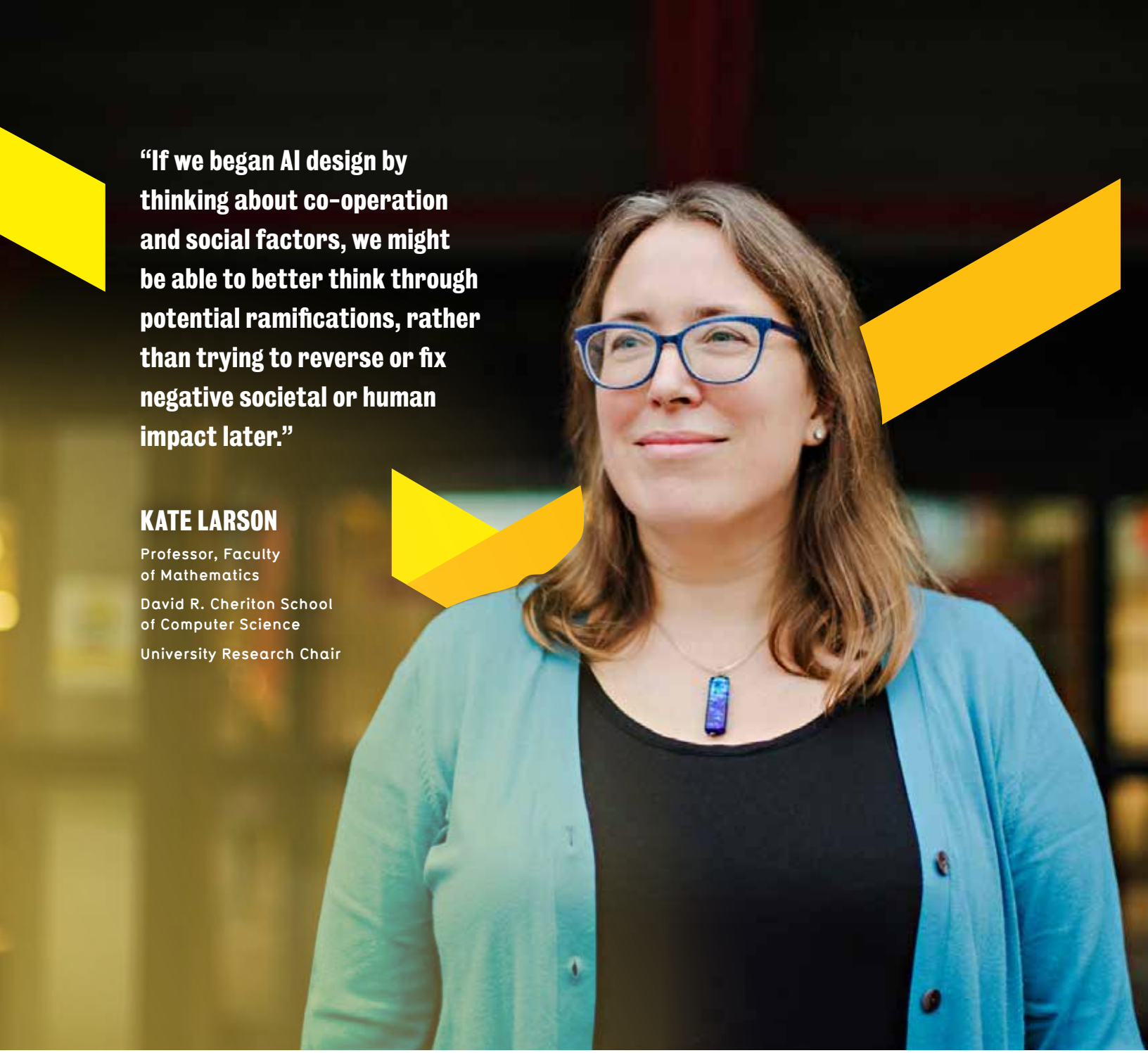
Although it is used by billions of people daily, AI has limited understanding when it comes to interactions with humans and other agents. Early multi-agent research focused on AI that learns to beat an opponent, for example in two-player zero-sum games such as chess or Go. "This is a start, but it is not how the world works," Larson says. "We need to look at how to change the questions and approaches we are taking when designing AI, so that we have a stronger focus on co-operative intelligence."

Already, there is a need for AI that has social understanding and can interact with others. Autonomous vehicles, for example, are not driving in isolation. They're driving alongside pedestrians, cyclists and other vehicles and have human operators.

"We're seeing some unintended consequences of AI that doesn't have social understanding," Larson says, referencing social media algorithms that have contributed to the spread of misinformation. "Algorithms like these are meant to improve user engagement, but this may not be the metric we want to focus on. If we began AI design by thinking about cooperation and social factors, we might be able to better think through potential ramifications, rather than trying to reverse or fix negative societal or human impact later."

AI RESEARCH AT WATERLOO

Larson, who is a University Research Chair and was also appointed a Pasupalak AI Fellow, has always been interested in group dynamics and organizing groups of people to complete projects or take meaningful action. She supervises students who are interested in building and researching teams of AI agents and studying how they can learn to co-operate within their team, as well as students who look at using ideas from machine learning to uncover better ways of voting.



"If we began AI design by thinking about co-operation and social factors, we might be able to better think through potential ramifications, rather than trying to reverse or fix negative societal or human impact later."

KATE LARSON

Professor, Faculty of Mathematics

David R. Cheriton School of Computer Science

University Research Chair

Waterloo has a multitude of AI researchers, groups and initiatives, including the Waterloo Artificial Intelligence Institute and the Artificial Intelligence Group. Larson is a member of both groups, and believes there are many opportunities on campus for further exploration of co-operative AI and interdisciplinary collaboration on the topic.

THE FUTURE OF CO-OPERATIVE AI

"There has been a paradigm shift in AI in the last decade," Larson says. "AI has moved from research and labs and has become integrated into many facets of our society."

Larson believes that to successfully build and design AI models that have social understanding and can truly benefit humanity, an interdisciplinary approach is needed. "We'll need to work closely with those in other fields, such as psychology, philosophy, law and policy, history and sociology. It's essential to work alongside researchers that study and understand co-operation."

Neurotech for intuitive

HUMAN–MACHINE INTERACTIONS

and faster gaming

Waterloo's Engineering Bionics Lab is a hub of innovation for interfaces and technologies that augment human capabilities

Ning Jiang has an early memory of visiting the hospital where his parents worked in China and seeing someone walking with the aid of a prosthetic. This experience, and others he had as the son of two physicians, led Jiang to begin thinking how technology could be used for good. A professor in the Department of Systems Design Engineering, Jiang is fascinated with devices and technology that can enhance human health and the way people experience the world around them.

Jiang is also the founder and director of the Waterloo Engineering Bionics Lab, where new interfaces and technologies that augment human capabilities are designed and tested. "My goal is to develop technologies that are easier to use and more accessible, technologies that will allow people to better interact with the external world, especially when there is a medical need but also for productivity and entertainment purposes."

ADVANCING TECHNOLOGY AT THE BIONICS LAB

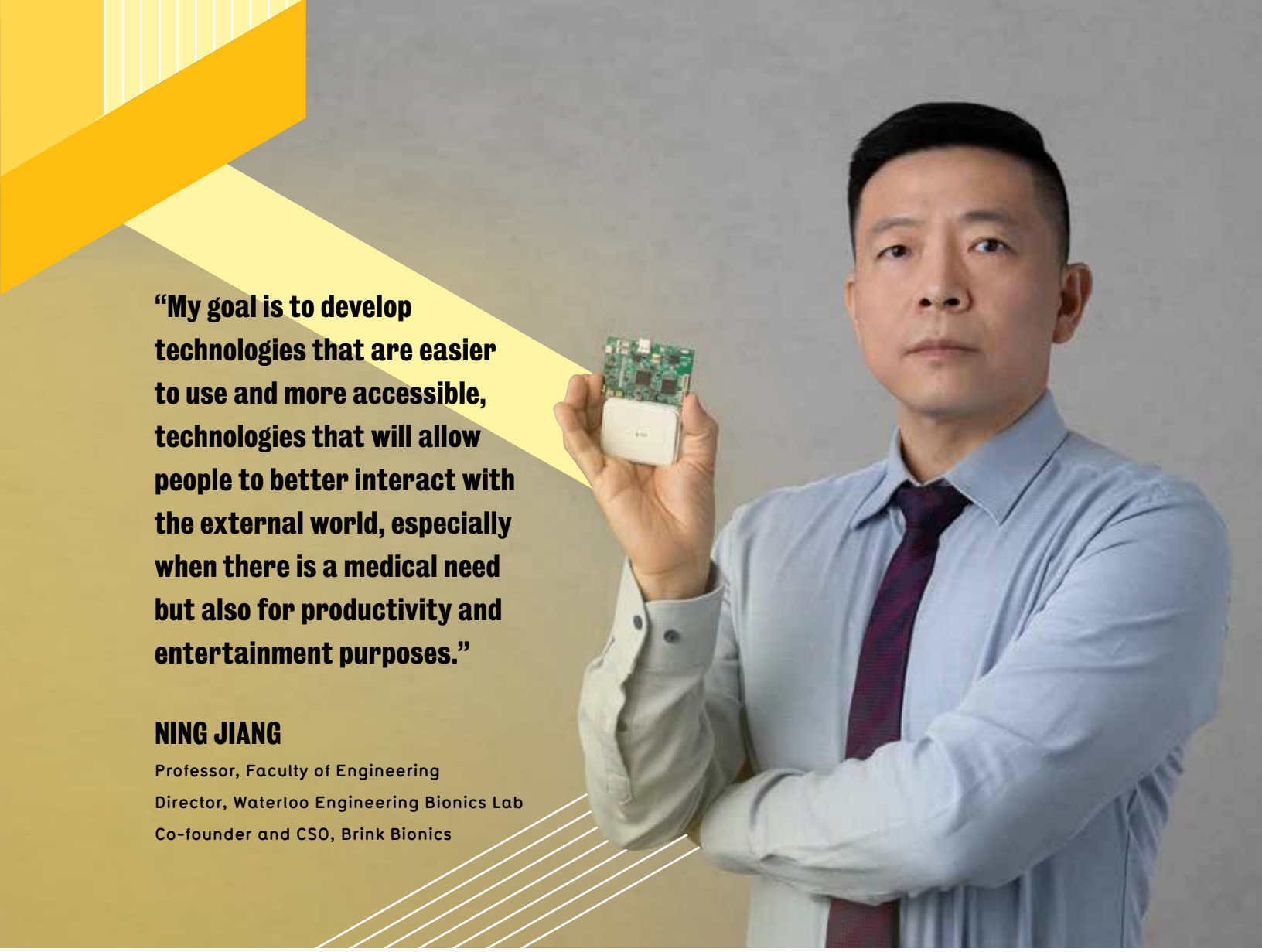
Operating since 2015, research at the Waterloo Engineering Bionics Lab has focused mainly on building assistive and rehabilitation devices for persons with disabilities, such as upper-limb prosthetics or brain-controlled devices that aid stroke victims' recovery. Research is also being done in other areas, such as health monitoring.

The bionics lab researches non-invasive neuro-signals that can enhance the performance of human-machine interactions. During these interactions, a brain-computer interface (BCI) extracts signals from the brain and immediately communicates to the technology so that it behaves exactly as the user intended, for example, in patients with amputations.

Using EMG signals from contracting muscles, the technology decodes the patient's intention, such as moving a finger, and transmits the results to the prosthetic hand, which then moves exactly as the patient intended. The advantage of using these types of signals is that the technology can easily interpret human intentions.

AN ENTREPRENEURIAL ENDEAVOUR

The development of this neurotechnology led to the founding of the first company out of the Engineering Bionics Lab in 2018. Brink Bionics was founded by Jiang, along with co-researchers Jiayuan He and Erik Lloyd (MASc '19). It began as a bionic arm company, winning the Velocity Fund Pitch Competition, and has leveraged entrepreneurial support offered by the Velocity incubator. The company has since pivoted to use neurotechnology for gaming, filling a gap in the market left by conventional gaming controllers.



"My goal is to develop technologies that are easier to use and more accessible, technologies that will allow people to better interact with the external world, especially when there is a medical need but also for productivity and entertainment purposes."

NING JIANG

Professor, Faculty of Engineering

Director, Waterloo Engineering Bionics Lab

Co-founder and CSO, Brink Bionics

"During my time in the Engineering Bionics Lab, I was encouraged to pursue neurotechnology research that had the potential to impact lives beyond the conventional goals of scientific publications," says Lloyd, CEO of Brink Bionics.

"Because of this entrepreneurial attitude, as well as the engineering resources and support made available by the University of Waterloo, we founded Brink Bionics. To date, we have raised close to $500,000 in funding from pitch competitions and venture capital, and launched our first neurotechnology product."

The company is now in another venture capital fundraising round to build out the next version of their gaming gear for neuro-enhancement.

THE FUTURE OF BIONICS

Jiang says filling medical and health-care needs is still the main direction for the Waterloo Engineering Bionics Lab.

He believes we will see a shift in the next few years in which bionics becomes a regular part of our lives and people increasingly incorporate biotechnologies into their bodies to enhance capabilities.

"Right now, things like electronic implants are more in the fringe or subculture of society," he says. "But humans will be integrating more technology and bio-machinery to enhance their functions in the near future. There is a lot of research happening in these areas and advances are being made at a fast pace."

STUDENT SPOTLIGHT

THE FUTURE OF SPECIALIST CARE IN AFRICA

MedAtlas is creating a digital solution to make fertility care in Africa more accessible

Africa is the fastest-growing digital adopter in the world, and Margaret Mutumba sees huge potential for a digital solution to address inequitable access to care.

Mutumba was born and raised in Uganda, and after completing her master's degree in England, she returned home to work in health care. She has overseen fertility clinics across Africa and witnessed firsthand the barriers patients face in accessing specialist care. She founded MedAtlas, an affordable telemedicine platform that digitally connects patients to a specialist.

"I never saw myself as an entrepreneur. Coming from a public health background, I have always been used to working in established traditional systems," says Mutumba, a PhD candidate in Public Health and Health Systems. "It wasn't until I attended a Concept pitch competition that I thought, 'I could do this.'"

MARGARET MUTUMBA

PhD candidate, Faculty of Health

Founder, MedAtlas

Concept

Read how MedAtlas is creating the future of specialist care in Africa.

uwaterloo.ca/news/medatlas

In a future where devices, data and technologies bring both promise and risk, innovators are customizing solutions to improve our lives.

Whether it's solving the problem of how to protect sensitive information, creating an algorithm for better efficiency in a hospital or discovering innovative uses for quantum computing, researchers are leveraging promising new computing technologies for real-world applications.

NEXT-GENERATION COMPUTING

The next big

COMPUTING EVOLUTION

Researcher Christine Muschik thinks outside the box with quantum computing innovations

Computing evolutions of the past few decades have already taken us from floppy discs to an era of almost instantaneous communication in an internet-connected world.

But quantum computers promise "an even bigger transformation," says Christine Muschik, a Physics and Astronomy professor and member of Waterloo's Institute for Quantum Computing.

"You could simulate, for instance, new materials," Muschik says. "You could develop better fertilizers. You could come up with new ways to remove carbon dioxide from the atmosphere. You could design new drugs." These are examples of what she calls "interesting problems" that quantum computers could be used for.

THE QUANTUM SUPERPOWER FOUND IN NATURE

Present-day supercomputers have their limits. They process information in the form of zeros or ones, one line at a time. This means that no matter how big or how powerful they are, some simulations are so complex they can't be done with classical computers.

But nature has an amazing computing superpower. It is called superposition, whereby information can be grasped in more than one state at the same time. "The classical computer runs out of steam and out of memory in keeping track of all the combinations, but nature does it effortlessly," Muschik says.

Being able to build computers to harness this quantum superpower is a long-standing dream of physicists. That's what Muschik is working on. She wants quantum computers that can solve interesting problems, such as simulating quantum interactions, biochemical interactions, processes inside a neutron star or the early moments of the universe.

NEW METHODS OF SCIENTIFIC COMPUTING

In regular computers, there is a lot of error correction going on, as the bits of ones and zeros are being processed using the gates on a computer chip. But in a quantum computer, the many mistakes get through, quickly overwhelming the ability to correct the errors.

To solve this problem, Muschik is thinking outside the box and reimagining what computing itself could look like. "We are coming up with new methods for scientific computing," she says.

Muschik is internationally recognized for her creative research. She was selected as a 2019 Alfred P. Sloan Research Fellow in Physics, an award for

early-career scientists of outstanding promise. She is still one of few women in the field, although she says women are getting much more support now.

CONTINUING QUANTUM COMPUTING RESEARCH

Muschik's group most recently performed the first-ever simulation of baryons – the particles that make up the matter that surrounds us – on a quantum computer.

To achieve this, the group used hybrid computing whereby a classical and a quantum computer are tied together in a kind of feedback loop. The classical computer is tasked with parts of a problem that it can do easily, and then the quantum computer can take over the parts that are too complicated.

Muschik's group has also been working on a completely new method to get around error-prone quantum gates in hybrid computing. When particles are entangled, the state (such as the spin value) of one particle in the pair can change instantly when a measurement is made on the other particle. Muschik's group has shown that it is possible to do a series of measurements and calculations, without the need for quantum gates.

"The algorithms to do this look really strange because it's a completely different computing concept, but we have shown that it works," Muschik says. Next, she hopes to team up with an experimental group to further develop this new measurement approach.

"What is very interesting about this field is that there is so much unexplored territory. There is a lot of room for true innovation and space for new ideas."

"What is very interesting about this field is that there is so much unexplored territory. There is a lot of room for true innovation and space for new ideas."

CHRISTINE MUSCHIK
Professor, Faculty of Science
Institute of Quantum Computing
Perimeter Institute

Privacy and cybersecurity can foster

21ST CENTURY DEMOCRACY

Canada Research Chair Ian Goldberg sees privacy as a precondition for freedom, dignity and autonomy

For cybersecurity researcher Ian Goldberg, privacy is an expansive concept, one that is intertwined with the possibilities for individual flourishing and the practice of democracy in a digital age.

Goldberg is the Canada Research Chair in Privacy Enhancing Technologies and a professor in the David R. Cheriton School of Computer Science. His research and innovation in cybersecurity and privacy have made him a giant in the field.

"Privacy is a much broader concept than just keeping information secret," he says. "Privacy is about freedom, dignity and autonomy, some of the core ideals of democratic societies."

CYBERSECURITY IS ABOUT MORE THAN PROTECTING PERSONAL INFORMATION

As Goldberg points out, cybersecurity has evolved in such a way that protecting specific information such as credit cards or personal data is not necessarily the biggest concern.

"We're actually quite good at protecting the content of the information that is transferred across the internet," he says. "What we are less good at is protecting the metadata, which is the information about who is communicating, how long they communicate or who they communicate with.

"And it turns out you can learn a lot about individuals or companies or even government organizations just by knowing who is communicating with who."

Examples of this kind of metadata include location data that a smartphone may record, or a list of the websites or social accounts a user may visit or follow. Companies collect and analyze such metadata and may then use it to direct users to specific kinds of content or products.

AN ISSUE OF DEMOCRACY WHEN ALGORITHMS CREATE ECHO CHAMBERS

This amounts to a form of "social sorting" and puts limits on the possibilities for an individual because users are purposefully directed to specific content rather than having an authentic choice.

"People need to be able to make decisions and discover themselves, especially youth," Goldberg says. "Think about those from equity-deserving groups, such as LGBTQ+ youth. They need to be able to discover both themselves and their communities without having all their actions observed and monitored, especially if they live in a place where being queer is illegal, for example.

"Going a step beyond that, privacy is important as a society because we need people to be able to

"Privacy is a much broader concept than just keeping information secret. Privacy is about freedom, dignity and autonomy, some of the core ideals of democratic societies."

IAN GOLDBERG (BMath '95)

Professor, Faculty of Mathematics

David R. Cheriton School of Computer Science

Cybersecurity and Privacy Institute

Canada Research Chair in Privacy Enhancing Technologies

step out of bounds," he adds. "The set of laws and social norms we have today are not the best set. It would be hubris to think they are. We need it to be the case that people can violate social norms in order that those social norms can change."

Goldberg believes digital spaces must be free and allow people to discover, collaborate and build productive relationships for 21st century democracy to thrive. Privacy is the means to make those digital spaces free.

PRIVACY AND CYBERSECURITY AT WATERLOO

Goldberg's work in cybersecurity and privacy is supported by several initiatives at the University of Waterloo, which he sees as a hub for innovations in privacy. He is a member of the Cryptography, Security and Privacy group and the Cybersecurity and Privacy Institute (CPI). Recently, he has been working on a new interdisciplinary research and teaching program through CPI.

"CPI has brought together interdisciplinary researchers from all across campus," Goldberg says. "This kind of infrastructure creates a nexus for different kinds of privacy-related work. Waterloo has a tradition of research on the technical side in cryptography, security and privacy that brought together math and computer science and engineering. Now in CPI we bring together researchers in social sciences and humanities as well. It's an exciting development and already bringing new insights."

STUDENT SPOTLIGHT

OPTIMIZING OPERATING ROOM EFFICIENCY

Using machine learning to address the backlog of surgeries caused by COVID-19

For Natasha Rozario, going to the University of Waterloo wasn't just an opportunity to study and complete a degree. It was a chance to do research with a social purpose and to help create a better world.

As an undergraduate Computer Science student, Rozario felt called to help address the backlog of surgeries that had piled up because of the COVID-19 pandemic, when so many elective operations were cancelled due to pressure on the health-care system. In 2020, she created an innovative program based on a machine learning algorithm to optimize operating room efficiency and get more people access to life-changing or life-saving surgeries.

"There are a lot of applications for this kind of research," Rozario says. "Especially in a hospital where everything is based on information systems, there's a lot of room for optimization."

NATASHA ROZARIO

Student, Faculty of Mathematics

David R. Cheriton School of Computer Science

Read how Rozario uses machine learning to solve a real-world challenge.

uwaterloo.ca/news/operating-room

Knowledge, advanced technologies and societal disruptions are rapidly changing how we interact with one another.

Diversity in academic, workplace and entrepreneurial spaces takes intentionality, but it allows creativity and innovation to flourish. The result is inclusive companies and fields of study that have the power to shape and grow local and global economies for social impact.

SOCIAL AND ECONOMIC PROSPERITY

A BETTER FUNDING MODEL *for startups*

Clearco challenges the status quo with unbiased investment opportunities for entrepreneurs

From about the age of 10, Andrew D'Souza (BASc '08) began to think of inventive ways to earn money. An early entrepreneur whose family immigrated to Canada from India, D'Souza started providing his neighbours with services, such as newspaper delivery, lawn mowing and dog walking. Today, D'Souza is the co-founder and CEO of Clearco, a Toronto-based fintech company that has invested $2.2 billion into 5.5 thousand ecommerce companies.

A big draw for D'Souza to the University of Waterloo was the co-op program because it allowed him to try different work placements alongside his classroom learning in the Systems Design Engineering program. Through his placements, D'Souza was able to narrow in on his career interests and decided entrepreneurship might be a good fit. He was drawn to the tech-startup sphere and accepted an invitation from Chamath Palihapitiya (BASc '99), an early senior executive at Facebook and the founder of Social Capital, to work at a startup in Silicon Valley after graduation.

Although D'Souza later became the COO of education startup TopHat and the president of Nymi, a wearable platform focused on identity and security, it was his time in Silicon Valley that led to the idea behind Clearco.

D'Souza noticed that entrepreneurs in Silicon Valley were advantaged, not because of superior ideas but because of their location, education and access to investors. He believed there should be a better, more accessible way for startups to get funding. Seeking to level the playing field for entrepreneurs, Clearco pioneered a funding model that removes biases by using data science. Co-founded in 2015 with Michelle Romanow, a Canadian tech entrepreneur known for her season on the cast of CBC's *Dragon's Den*, Clearco's mission is to open up opportunities for entrepreneurs who operate online, no matter their journey, location or business solution.

Traditional venture capital funding relies on pitches and networking and retains equity, but Clearco uses AI technology to collect data to evaluate a company's eligibility for investment and does not take ownership or control. Instead, the investment is paid back through a small percentage of the company's revenue along with a minimum six per cent return. Clearco's algorithm takes fewer than 20 minutes to determine whether an investment can be made and how much.

Bias in traditional funding models is common, with statistics showing female entrepreneurs draw a very small percentage of venture capital dollars annually.

Clearco, however, funds eight times more women, and 30 per cent of its entrepreneurs are People of Colour. They also focus on being accessible to entrepreneurs who may be far from networking opportunities offered in major cities.

"If you only fund entrepreneurs that look a certain way and only invest in certain types of companies, the result is homogeneous companies that benefit a singular group," D'Souza says. "But if you enable diversity of founders, companies and ideas, the world will look much better. Whether it's improvements to health care or sustainability solutions, every entrepreneur has their own vision, but they need support and resources to get off the ground."

Last year, Clearco reached unicorn status, a designation for tech startups that achieve valuations of $1 billion U.S. The company began by providing accessible funding for startups, but plans to continue expanding what it offers online entrepreneurs, positioning itself as a partner and providing founders with everything they need to succeed.

Challenging the rise of hate and

MISINFORMATION

Philosopher Jennifer Saul is pushing the bounds of a classical discipline to counter racism, misogyny and the spread of misinformation

In recent years, analytic philosopher Jennifer Saul has noticed two disturbing trends coinciding: the spread of hate and the rise of conspiracy theories in political discourse.

As Waterloo Chair in Social and Political Philosophy of Language, Saul's research brings together the tools of philosophy, psychology and linguistics to examine this increase in racism, sexism and misinformation.

"Philosophy is traditionally about uncovering timeless truths, but you can't write about what it means to have a just society without addressing the real problems that keep us from achieving justice," Saul says.

Saul's research impact covers a broad scope, focusing on the United Kingdom, U.S. and Canada. She's a consulting expert in identifying and addressing misleading statistics and a tireless advocate for increasing diversity in philosophy. Her collaborations both inside and outside academia, including a recent panel with the UN on the misuse of statistics, have earned her a place among Academic Influence's 10 most influential living philosophers of the past 10 years.

SHIFTING PERCEPTIONS OF WHAT IS ACCEPTABLE

Although it might be easy to recognize a racial slur or fact check a statistic, some linguistic devices are far more subtle – and no less damaging – in shaping how people think, Saul says.

"The problem isn't just people using slurs that are obvious and easy to spot. You need to look at things in a much more sophisticated way and be aware of these other connotations," Saul says. "Sometimes it's intentional. Sometimes it isn't. It's profoundly tricky because these devices are selected precisely because they're ambiguous and can transmit different messages to different groups."

Another deceptive tactic involves carefully positioning controversial comments or conspiracy theories to make people more comfortable. Prefacing inflammatory or misleading content with "Lots of people are saying," "I'm just asking questions" or "I just think we should think about this" avoids a direct claim and makes it seem more acceptable to entertain what people might have dismissed otherwise.

"We have a stereotype of what conspiracy theorists are like, but when it seems like a reasonable person is 'just asking questions,' then people may feel more comfortable reading some conspiratorial claim and passing it on to their friends," Saul says.

The stakes are even higher with world leaders. Saul's work considers hate speech advanced during the Trump presidency. Sometimes racism makes its way into public policy, such as banning travellers from certain countries entering the U.S. under the guise of "just until we understand what's happening."

"Philosophy is traditionally about uncovering timeless truths, but you can't write about what it means to have a just society without addressing the real problems that keep us from achieving justice."

JENNIFER SAUL
Professor, Faculty of Arts
Waterloo Chair in Social and Political Philosophy of Language

Saul refers to these little additions devised to mask extremism as "fig leaves," causing people who might otherwise have hesitated to go along with what's being said.

"Just because somebody added a comment designed to soften their statement doesn't mean it's okay," Saul says. "There's potential to shift what we see as acceptable versus unacceptable, and I think this does a huge amount of damage."

WHY AUTOMATION WON'T SOLVE THE PROBLEM

Social media companies, the media and many industries are looking to stamp out harmful language, but Saul warns there are no shortcuts. Simply blocking certain terms or creating blanket policies can miss the nuances of language, and risks preventing much-needed discussion about social justice. Critical thinking will be increasingly important for individuals and organizations alike.

"This stuff can't be automated. There's no easy rule to formulate. It really needs to be thought through by humans," Saul says. "You need to engage with the complexity and look at things in a much more sophisticated and careful way. Whether the harm is intentional or not, the effects might be the same but the way you want to respond to the person doing it is going to be different."

STUDENT SPOTLIGHT

USING DATA TO ADVANCE DIVERSITY, EQUITY AND INCLUSION

Lunaria helps organizations create workplaces where people of all identities can flourish

Cassie Myers was an undergraduate Arts student when a professor took her class to visit a startup incubator on campus. That visit was the beginning of a mindset change for Myers. "I knew I had a lot of issues that I cared about, but before then I had never considered entrepreneurship as a viable future for myself," she says.

Today, Myers is the founder and CEO of Lunaria, a diversity, equity and inclusion (DEI) company with four employees and office space in the Grebel Peace Incubator at the University of Waterloo – the very place she was first exposed to entrepreneurship.

"Our whole premise is that by measuring your DEI work, you maintain accountability. With data we can clearly see how things are improving or not," Myers says. "Data really helps break down some of the barriers to growing inclusion and equity, because the numbers are difficult to discredit."

CASSIE MYERS (BA '18)

Alumnus, Faculty of Arts

Founder and CEO, Lunaria

Grebel Peace Incubator at
Conrad Grebel University College

Read how Lunaria is helping businesses change workplaces to be more diverse, equitable and inclusive.

uwaterloo.ca/news/lunaria

The sustainability of our quality of life is intricately connected to our social, economic and environmental well-being.

The global climate emergency is the greatest threat to our collective future. We must lead the social, economic and geopolitical changes required to ensure a prosperous future for humanity and our planet.

SUSTAINABLE FUTURES

Flying the

ENVIRONMENTALLY FRIENDLY SKIES

Researcher Suzanne Kearns pioneers the Waterloo Institute for Sustainable Aeronautics

"I have a new dream, and that's to support aviation's movement towards sustainability."

SUZANNE KEARNS

Professor, Faculty of Environment

Director, Waterloo Institute for Sustainable Aeronautics

For as long as she can remember, University of Waterloo Aviation professor Suzanne Kearns dreamed of flying, and at age 15 she began training for a career as a pilot. On her 16th birthday – the first day she could legally drive a car – she flew solo for the first time.

Back then Kearns could never have imagined doubting her dream job. But as she, and the world, woke up to the fact that air transport is a key contributor to climate change, an unsettling truth began to sink in.

"Given that relatively few people on Earth have the opportunity to fly, aviation's outsized impact on the planet is unacceptable," she says. "But like my teenage self, I like a good challenge. So, I have a new dream, and that's to support aviation's movement towards sustainability."

In fall 2021 that new dream came one step closer to reality with the launch of the Waterloo Institute for Sustainable Aeronautics (WISA), making Waterloo, and Canada, a pioneer in reforming an industry that accounts for more than two per cent of global carbon emissions.

SOCIAL, ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY

Kearns, who first began exploring how sustainability related to aviation when she created an aviation sustainability course in Waterloo's Faculty of Environment, believes sustainability goes beyond environmental considerations to include social and economic factors.

"I remember what it feels like to be the only woman in the classroom, and to feel like your dream profession doesn't have a place for you," she says. "Supporting equity, diversity and a sense of belonging in the industry is a critical sustainability consideration, which supports the viability of the future workforce."

Bringing together close to 50 researchers from all six University faculties, interdisciplinary collaboration is foundational to WISA. WISA-affiliated researchers include social scientists and psychologists working in tandem with engineers, technologists and environmentalists.

The advisory committee includes Chris Hadfield, the first Canadian commander of the International Space Station, and industry experts including Wendy Bailey, chief of environmental protection and standards civil aviation at Transport Canada and Thomas Lagaillarde, head of product portfolio and programmes and managing director Canada for NAVBLUE, an Airbus company.

Waterloo's Faculty of Environment, where WISA is housed, is Canada's largest faculty devoted exclusively to sustainability. Its experts work at the intersection of nature, human behaviour and technology.

"I understand people feeling guilty about flying because of the climate impact," Kearns says. "But the truth is, often there just isn't a substitute to flying. Our delicate COVID-19 vaccines arrived by plane, as do trillions of dollars of goods. And in our now globalized world, air travel is the only feasible way to connect with our loved ones living overseas.

"Environmental sustainability is where WISA's transdisciplinary DNA really shines," Kearns adds. "We have applied mathematicians using algorithms to improve logistics, engineers improving aerodynamics, chemists inventing renewable fuels and environmentalists exploring electric planes. All of this adds up to lower carbon emissions, which is a central goal of ours."

PERFECT TIMING

The broad-based team will foster research, cross-sector partnerships and experiential learning to create a viable future for vital air transport.

"As we emerge from closed borders and lockdowns, aviation will play a critical role in reigniting the global economy by transporting goods, humanitarian aid, and connecting us in person once again," Kearns says. WISA is uniquely positioned to address these global challenges by leveraging technology, research and talent to drive environmental, economic and social prosperity.

VALUING WATER

for our shared sustainable future

Canada Research Chair Kelsey Leonard puts Indigenous knowledge at the forefront of environmental justice

Today the planet is straining under the weight of human development and governments and institutions are searching for innovative answers to protect our future. Thanks to the efforts of researchers such as Kelsey Leonard, who joined Waterloo's Faculty of Environment in 2020, we're exploring and valuing essential environmental knowledge long ignored by non-Indigenous decision-makers.

Indigenous Peoples have vast knowledge systems and scientific traditions that can work alongside western scientific methods. With global warming now raising sea levels, Leonard's position as Canada Research Chair in Indigenous Waters, Climate and Sustainability will help her explore ways to facilitate Indigenous knowledge to restore our threatened oceans, lakes and rivers while assuring Indigenous sovereignty.

"A big part of who I am as a scholar and a scientist is very much informed by the identity of being a water person and a person from the shore," says Leonard, a citizen of Shinnecock Indian Nation, which is on what's known as Long Island, New York.

The territory of the Shinnecock Nation sits on a peninsula jutting out into Shinnecock Bay and shares a barrier island protecting it from the Atlantic Ocean. The people of the Shinnecock Nation are skilled fishers and were traditionally whalers.

CO-MOBILIZATION OF INDIGENOUS AND WESTERN SCIENCE

Leonard earned her law degree in 2015, wanting to address many of the structural injustices embedded within the law.

"My research centres around Indigenous water justice, including identifying pathways for Indigenous conservation practices to inform international water policy," says Leonard, who recently contributed her expertise to the development of the U.S. Fifth National Climate Assessment (NCA5). Her TED Talk, *Why lakes and rivers should have the same rights as humans*, has been viewed by more than 3 million people.

Leonard represents the Shinnecock Indian Nation as a steering committee member of the Mid-Atlantic Committee of the Ocean, charged with the protection and restoration of America's ocean and coasts. Her scientific and policy background led to her expert testimony on ocean-based climate solutions before the U.S. Congress.

"Indigenous Peoples are on the front lines of many of the world's water security crises. The water challenges and innovations present in our communities can offer best practices for adaptation and resiliency for other communities or societies facing similar water injustices," she says.

Indigenous Peoples have been excluded from international water management because of an intellectual inherited legacy of colonialism that fails to acknowledge Indigenous experience and expertise.

It's something Leonard explores in her most recent report, *Turtle Island (North America) Indigenous Higher Education Institutions and Environmental Sustainability Education*. In it she applies a critical lens to the environmental and sustainability programs of the 38 tribal colleges and universities

"Indigenous Peoples are on the front lines of many of the world's water security crises. The water challenges and innovations present in our communities can offer best practices for adaptation and resiliency for other communities or societies facing similar water injustices."

KELSEY LEONARD

Professor, Faculty of Environment

Canada Research Chair in Indigenous Waters, Climate and Sustainability

Water Institute

in the United States and 26 Indigenous post-secondary institutions in Canada.

"Knowledge translation for co-mobilization of Indigenous and western science to address climate change is one of the greatest obstacles facing contemporary transboundary water governance," she says.

USING INDIGENOUS KNOWLEDGE FOR GLOBAL WATER CHALLENGES

"In the context of my transboundary research in the region, Indigenous environmental leaders from the Great Lakes often shared with me the belief that every living entity on the planet has a purpose, and as a human being our goal is to understand these relationships, roles and responsibilities to that other entity."

Although her work has brought her from New York to the Grand River valley (or Kenhionhata:tie, as it's known by the Mohawk), Leonard's focus on water justice remains local as well as global, and her advocacy unwavering.

"Indigenous science is built from vast knowledge systems that have thrived for millennia in stewardship of Turtle Island and should be the foundation of our shared sustainable future," she says.

STUDENT SPOTLIGHT

BUILDING A SMART CLOUD-BASED BATTERY MANAGEMENT SYSTEM

Advancements in lithium-ion batteries will pave the way to a more energy-efficient society

"I've always called this era the renaissance of energy innovation," says Manh-Kien Tran, a Chemical Engineering PhD student and a Vanier scholar. His research centers on an innovative field: cloud-based battery management, with a focus on lithium-ion batteries.

Lithium-ion batteries are extremely prevalent, found in everything from household electronics to electric cars. Still, Tran understands why people might not have battery evolution on their radar. Batteries are not a new solution, and yet they give Tran and his fellow researchers hope for a future that is more energy efficient. Advancements in energy storage systems and cloud technology could allow us to store seemingly endless amounts of data for optimal battery management.

"They're going to be more common and more usable." And as a result, "we're going to have cleaner, cheaper energy."

MANH-KIEN TRAN (BASc '18, MASc '20)

PhD student, Faculty of Engineering

Vanier Canada Graduate Scholarship recipient

Read how advancements in lithium-ion batteries will pave the way to a more energy-efficient society.

uwaterloo.ca/news/battery-research

ADVANCING HEALTH INNOVATION

Gaps in patient experience and urgent care are being filled by unexpected innovators from a variety of fields and disciplines.

Medical advancements are influenced by entrepreneurs, scientists, engineers and mathematicians who are innovating traditional approaches to care. Breakthroughs in technology and research are shaping efficiency, access and early diagnosis for life-saving care.

Pharmacies lead the way with digital technologies to

IMPROVE PATIENT CARE

With lessons learned from the pandemic, Kelly Grindrod's research continues to position pharmacies as key players in public health care

During the global COVID-19 pandemic, digital technology tools helped pharmacies expand their role on the front lines of patient care.

Online vaccination bookings, pharmacy websites that answered frequently asked questions and digital tools that managed the supplies of vaccines and other medications became essential.

"The pandemic showed us that pharmacists have a much bigger role in health care than the public had realized," says Kelly Grindrod, a professor at Waterloo's School of Pharmacy. "When a lot of family doctors had to shut down their practices or medical staff were busy in the hospitals, the pharmacists were there."

DIGITAL TECH TO STREAMLINE VACCINE CLINICS

Grindrod's research focuses on user-testing of digital technology in health care. She and her students work in close collaboration with other departments, such as Waterloo's Faculty of Engineering, to do user testing of new technologies.

One example was a vaccine tracking app built by Ryan Tennant, a PhD student supervised by Professor Catherine Burns of the Systems Design Engineering program at Waterloo. The app helped manage the complicated supply and demand of vaccines. Vaccine clinics and pharmacies were trying to minimize the unused doses at the end of the day to ensure precious vaccines were not wasted. The app was designed to help them do exactly that.

Grindrod's team helped test the app at two vaccine clinics. "That was an example of an invisible solution that the public would never know about, but it was important in a situation where we had vaccines that were like 'liquid gold.' It helped minimize waste and that was wonderful," she says.

GOING BEYOND THE CLINIC WITH ONLINE EDUCATION PLATFORMS

Grindrod's team is also involved in creating vaccine education tools for health-care stakeholders, which could be used to reach global audiences to combat vaccine misinformation.

"You can't just put information out there," Grindrod explains. "You need to test it with people that you want to deliver it to, and that's where our expertise comes in."

Prior to the pandemic, Grindrod developed the Pharmacy 5in5 online continuing education program for pharmacists, first testing it with her students and then with alumni and practicing pharmacists. That project originated at the University of Waterloo School of Pharmacy and is now being used nationally to help support busy pharmacists in their ongoing learning.

Grindrod was also the pharmacy lead on the Waterloo Region Vaccine Task Force, helping engage pharmacists and interns in vaccination clinics. As the pandemic wanes, she hopes the pharmacies can become key to helping people catch up on the other vaccinations that have been missed over the last couple years.

"We are entering a new phase, when what we have been building and learning during the pandemic will have to be applied to other areas where we have fallen behind. We have enormous work to do to catch up in critical areas such as disease prevention and screening or chronic disease management," Grindrod says.

THE FUTURE OF DIGITAL TECH IN PHARMACIES

The technology being used in health care today can involve everything from social media to mobile apps and connected networks, as well as technologies such as barcoding and scanning health-care cards right into a computer system.

"What I would have thought digital technology meant five years ago, now means so many more things. It's all about information," Grindrod says. "But with all different technologies and online platforms, the user testing is important to ensure that these tools work as intended. We want to build great systems that are a lot better."

Grindrod says the lessons learned during the pandemic can be a springboard to improve health care by making pharmacists across Canada and globally an extension of public health in communities.

"We are entering a new phase, when what we have been building and learning during the pandemic will have to be applied to other areas where we have fallen behind. We have enormous work to do to catch up in critical areas such as disease prevention and screening or chronic disease management."

KELLY GRINDROD
Professor, Faculty of Science
School of Pharmacy

Waterloo startup testing nanotechnology to reach

BETTER POSTOPERATIVE PATIENT OUTCOMES

Smart monitoring system is designed to help caregivers identify leaks, bleeds or potential infections early

As a child, Youssef Helwa was mesmerized by his mother's stories about the patients she cared for as a surgeon. Those conversations became the inspiration behind his company, NERv Technology Inc., a smart monitoring system that alerts health-care providers to complications following abdominal surgery.

About 33.5 per cent of abdominal surgeries may have post-operative complications that are typically clinically silent with no symptoms, but may become life threatening.

"The best way to comprehend the problem is to think about the operative care journey for patients," Helwa says. "Patients come out of surgery, and unfortunately, a subset of these patients end up developing some sort of complication. They start becoming sick with symptoms, and the doctors have to start playing the game of investigating why these patients are feeling sick."

NERv's smart monitoring system removes some of that guesswork by helping caregivers identify leaks, bleeds or potential infections. Detecting these silent issues allows the health-care provider to intervene before the complication becomes critical.

BRIDGING ENGINEERING AND MEDICINE

Helwa's path to creating NERv started at age 15. He was living in Saudi Arabia when he learned about the Nanotechnology Engineering program at the University of Waterloo. The following year, he began his studies and soon discovered the potential impact engineering could have on medical care. "I started to wonder if I could bridge engineering with current problems in medicine to come up with a way to have better results for how patients recover."

Helwa befriended Amr Abdelgawad and the two began to build a vision of how they would disrupt the field of medicine.

"Both of us come from families who are in medicine. Together we aligned our vision and our objectives to make something happen. We worked on our ideas throughout our undergrad program, and then during my master's, I had a supportive supervisor who empowered us to continue to work on the company. That gave us access to state-of-the-art research facilities and great minds who helped us tackle one challenge after another."

THE GROWTH OF A BIOMEDICAL ECOSYSTEM AT WATERLOO

When Helwa and Abdelgawad started to work on NERv, the ecosystem for medical devices was still new in the region.

"When we got started, there was a lot of knowledge and a lot of past experiences from software and hardware companies, but there weren't many medical

device companies. The ecosystem advanced dramatically over the last five to seven years. The number of medical companies increased exponentially. Waterloo has been behind that change with the University's biomedical engineering program and places like Velocity and Medical Innovation Xchange helping health-care startups."

He credits Waterloo with preparing him to embark on the life of an entrepreneur. "My time [at Waterloo] was a valuable transformational experience for me. It's not like I come from a family of entrepreneurs. Waterloo provided that strong entrepreneurial mindset and mentality."

Waterloo health innovation got a boost in 2021 thanks to a $10-million investment from FedDev Ontario. The investment supports a partnership between Velocity, Western University, the City of Kitchener and Medical Innovation Xchange to build a Southwestern Ontario Health Innovation network and nurture innovators and entrepreneurs as they scale.

CLINICAL TRIALS AND BEYOND

NERv is conducting clinical studies across North America and has recently raised more than $3 million in funding.

"Very recently, we reached the point where our devices are functioning every minute of every day on patients somewhere in the world. The feedback has been incredible. We went into the clinical studies with certain expectations, and so far, it's been a blessing where we are surpassing every one of our expectations."

"My time [at Waterloo] was a valuable transformational experience for me. It's not like I come from a family of entrepreneurs. Waterloo provided that strong entrepreneurial mindset and mentality."

YOUSSEF HELWA (MASc '17)

Alumnus, Faculty of Engineering

Co-founder and CEO, NERv Technology Inc.

Velocity Alumni

STUDENT SPOTLIGHT

STUDENTS IN THE WORKPLACE INNOVATION PROGRAM HELP ORGANIZATIONS FIND SOLUTIONS TO REAL-WORLD PROBLEMS

Every year, KidsAbility supports more than 11,000 children and youth with disabilities in Southwestern Ontario. Kids receive therapy services through programs designed to support communication, social and physical goals, but face significant challenges when they age out of these services at 21 years old. This challenge of transition was a perfect fit for the Workplace Innovation program at GreenHouse – the Social Impact Incubator located in St. Paul's University College at the University of Waterloo.

"This particular program is an amazing opportunity that allows you to solve real problems from different organizations and create an impact in your community," says Charlotte Ogalesco, a former Workplace Innovation program student. Her team's solution is an online resource hub called Transition Space. While organizations such as KidsAbility gain valuable support through the program, student team members also benefit from working on a challenging and meaningful project.

CHARLOTTE OGALESCO (BSc '21)

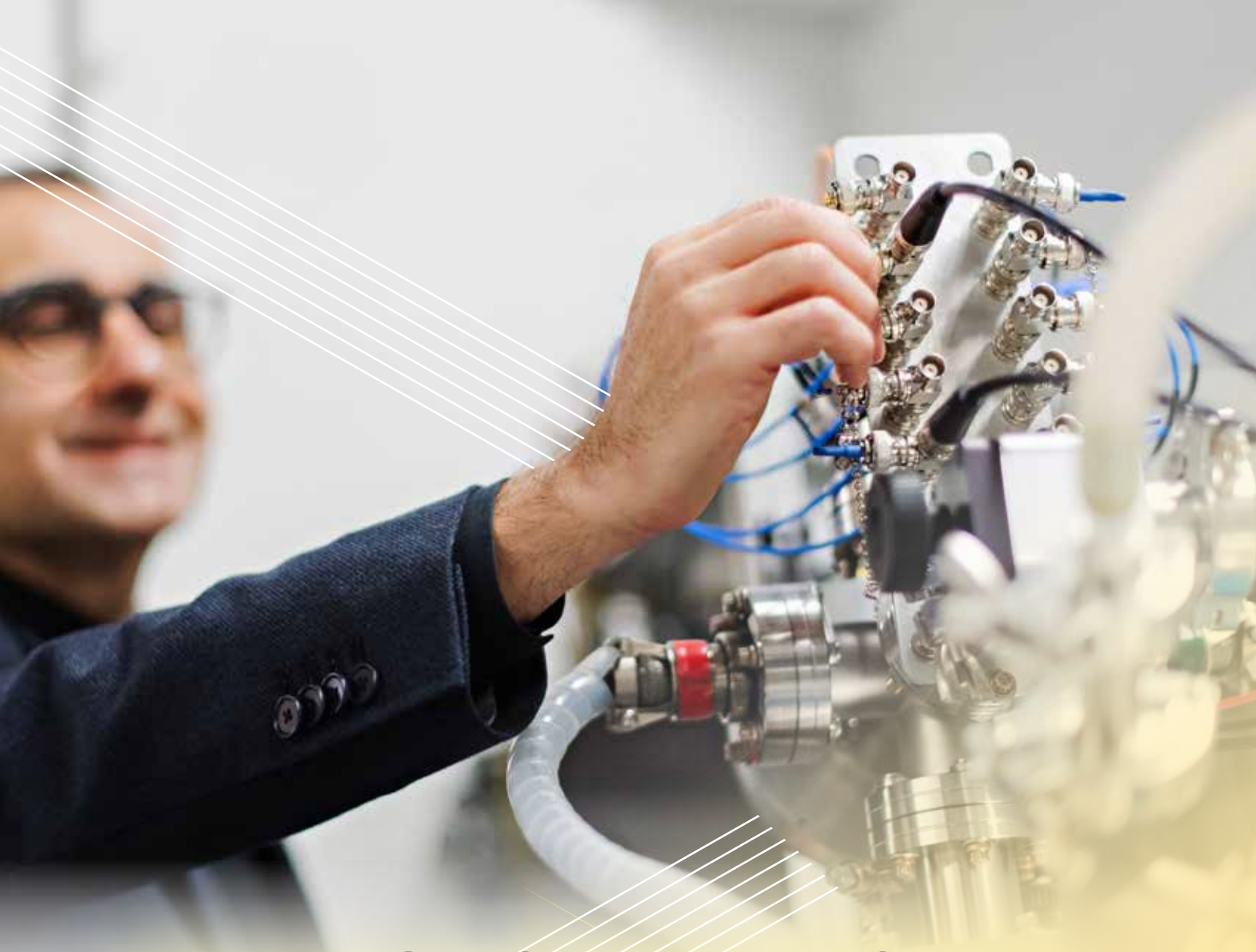
Alumnus, Faculty of Health

Co-founder, Transition Space

Greenhouse at St. Paul's University College

Read how Transition Space is helping KidsAbility clients transition into adulthood.

uwaterloo.ca/news/workplace-innovation



TRANSFORMATIONAL DISCOVERIES

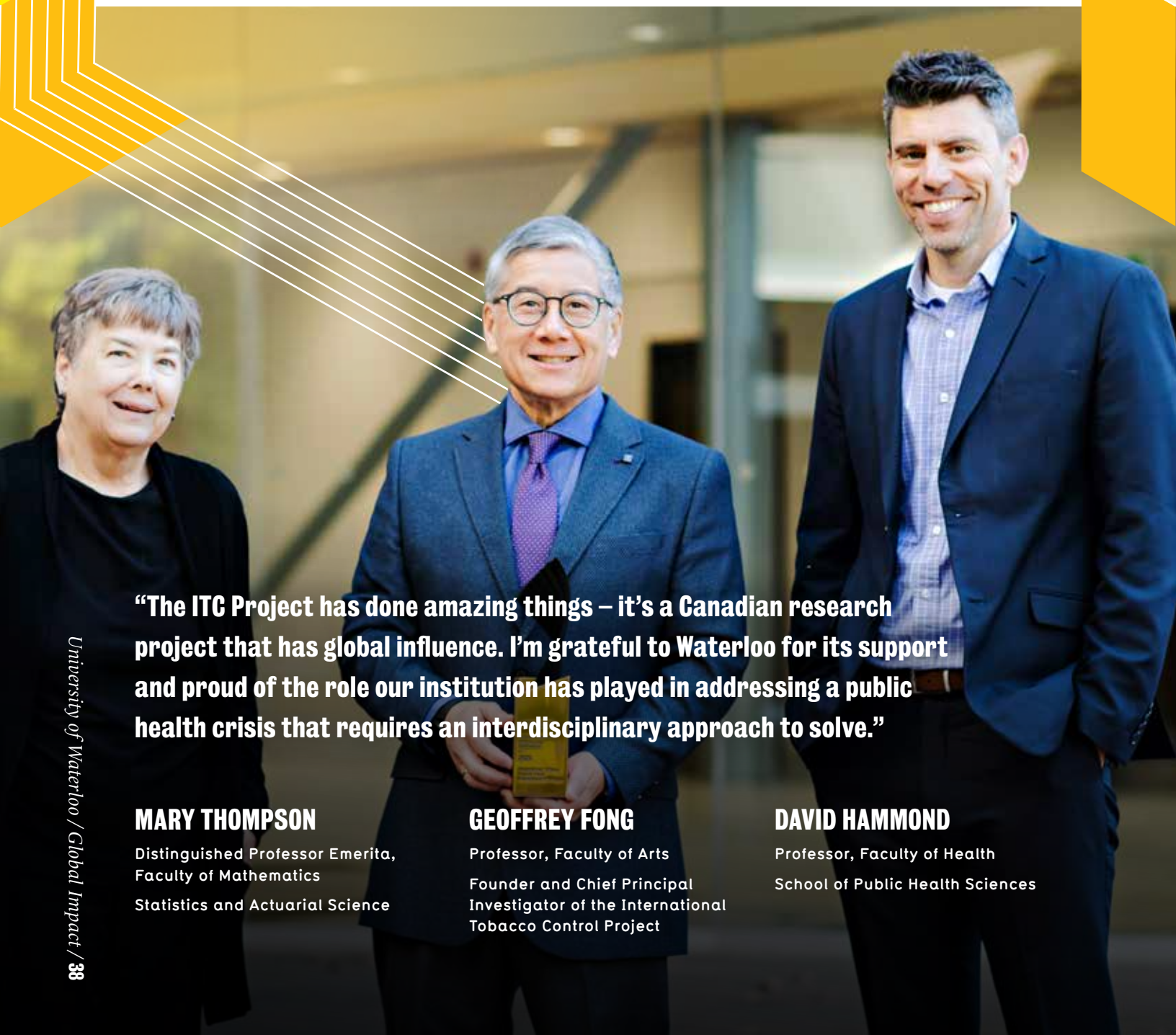
Transformation and meaningful change are borne of curiosity.

The next big breakthrough will be built on the shoulders of the science and research that came before it – discoveries that are a result of perseverance and an open mind. From questions about how to view the human body on a nanoscale to those about standing up to powerful industries, seeking answers is the first step to changing the world.

How science improved the health of

MILLIONS WORLDWIDE

Meet the interdisciplinary team fighting the number one preventable cause of death in the world



"The ITC Project has done amazing things – it's a Canadian research project that has global influence. I'm grateful to Waterloo for its support and proud of the role our institution has played in addressing a public health crisis that requires an interdisciplinary approach to solve."

MARY THOMPSON
Distinguished Professor Emerita, Faculty of Mathematics
Statistics and Actuarial Science

GEOFFREY FONG
Professor, Faculty of Arts
Founder and Chief Principal Investigator of the International Tobacco Control Project

DAVID HAMMOND
Professor, Faculty of Health
School of Public Health Sciences

The World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) was created almost 20 years ago to turn the tide against the number one preventable cause of death in the world: smoking.

When the first WHO treaty was being negotiated, Psychology professor Geoffrey Fong realized a research program would be needed to evaluate the impact of tobacco control policies that would be implemented globally because of the FCTC.

ASSEMBLING AN INTERDISCIPLINARY TEAM

In 2002, three years before the FCTC came into force, Fong gathered an interdisciplinary team of experts from Waterloo and around the world, creating the International Tobacco Control (ITC) Project.

With Mary Thompson from Statistics and Actuarial Science in the Faculty of Math, and David Hammond, then a doctoral student and now a professor in the School of Public Health Sciences, the ITC team began its global research to evaluate FCTC policies.

The ITC Project began in four countries (Canada, U.S., U.K. and Australia), but now includes 31 countries, with a team of more than 150 researchers. It is the world's largest tobacco research program. ITC researchers have conducted over 180 surveys, involving more than 300,000 people and built a global data set of 150 million data points.

SCIENCE IS THE ANTIDOTE

ITC research has shown that FCTC policies such as higher taxation, comprehensive smoke-free laws, large graphic warnings and marketing bans are effective and save lives. The findings have been used in many countries, as well as by international organizations such as WHO, to strengthen and accelerate FCTC policies.

Hammond and Fong have been expert witnesses in many trials and government inquiries, called to present ITC evidence to counteract false or misleading tobacco industry claims.

"Good, timely and well-communicated science is the antidote to industry misinformation," Hammond says. "People said it could never happen – that we'd never put graphic warnings on cigarette packs or get rid of branding through plain packaging. But the power of evidence plus perseverance has made one of the most powerful industries bend to public health measures. That's very rewarding," Hammond explains.

A DISTINGUISHED AWARD

ITC research has led Canada and other countries to strengthen their tobacco control efforts, improving the health of millions. In 2021, the ITC Project received a prestigious Governor General's Innovation Award, which celebrates innovations that have a positive impact on quality of life in Canada.

Thompson, co-founder of Waterloo's Survey Research Centre, remembers when Fong approached her to help create the ITC Project. After 20 years, hundreds of studies, millions of dollars in research grants and a long list of awards, Thompson reflects with gratitude on how much they've accomplished:

"The ITC Project has done amazing things – it's a Canadian research project that has global influence," she says. "I'm grateful to Waterloo for its support and proud of the role our institution has played in addressing a public health crisis that requires an interdisciplinary approach to solve."

Because of his relentless work, Geoffrey Fong was recently appointed as an officer of the Order of Canada. Officers of the Order of Canada are recognized for an outstanding level of talent and service to Canadians or humanity at large.

LOOKING TO THE FUTURE

Until recently, cigarettes were the dominant nicotine product, but in the past decade e-cigarettes have risen in popularity. There is debate among researchers, advocates and governments about the potential for e-cigarettes to help smokers quit, which may be counteracted by their negative potential for addicting young people.

"We are conducting multi-country studies of e-cigarettes and other new nicotine products," Fong says. "We are measuring the effects of these products, and policies on them, on both youth and adults. The objective is to inform and support evidence-based policies on these new products in Canada and globally. In this sense, we are continuing down the path we began 20 years ago."

NEW QUANTUM IMAGING *could lead to a better understanding of diseases*

Researchers at Waterloo are developing a technique to take MRI capabilities down to the atomic scale

Magnetic Resonance Imaging (MRI) technology has changed the way we can look at muscles, ligaments and organs. New developments promise to take MRI technology down to the molecular level to help us better identify diseases that ravage the human body.

Raffi Budakian, who is the lead investigator of the Nanoscale Magnetic Resonance Imaging lab, a member of the Institute for Quantum Computing (IQC) and a professor in the Department of Physics and Astronomy at Waterloo, is developing a technique to take MRI capabilities down to the atomic scale.

SCALING DOWN MRI CAPABILITIES

MRI works on the millimetre scale. Budakian's lab uses the angstrom scale, a metric unit of length that is 10 million times smaller than a millimetre, as a measurement for exploring molecular imaging. The very precise angstrom scale requires extreme sensitivity in order to measure at the molecular level instead of the physical.

Using quantum sensors, Budakian's team has designed a new way to generate magnetic fields on nanometre light scales for imaging and controlling nuclear spins. Because spins are also quantum mechanical, they are harnessed for detection purposes using very intense magnetic fields on very short length scales of the order of 100 nanometres – which makes the MRI using the millimetre scale seem huge in comparison.

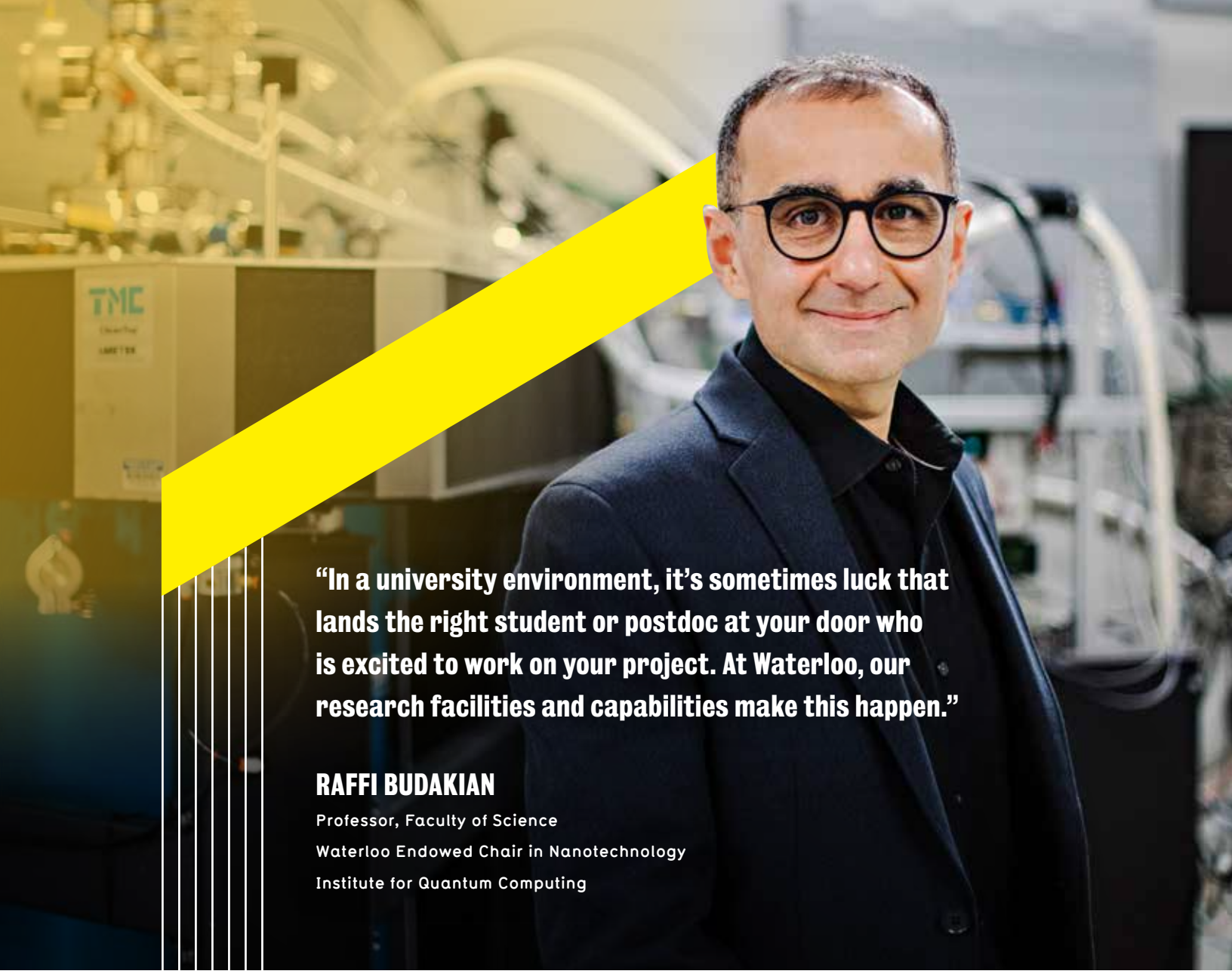
Budakian is excited about this new imaging technique, which his team calls nuclear magnetic resonance diffraction (NMRD) because diffraction is a very powerful tool for analyzing materials that have a crystalline structure, such as proteins.

"At a high level this work could be used to develop quantum technologies to study protein structure and dynamics," he says. "Understanding the structure of proteins is vital to drug development."

APPLICATIONS FOR VIEWING THE STRUCTURE OF PROTEINS

These materials include biologically relevant samples of virus particles and proteins that cause diseases, such as Parkinson's and Alzheimer's. Gaining a clear image of what these materials look like could have an immense impact on medicine, from better treatment to a deeper understanding of complex biomolecules.

Now that Budakian's team has found a way to do diffraction with NMR, with precise measurements that are accurate to a fraction of an angstrom, they are ready to put their machine and technique through extensive testing.



"In a university environment, it's sometimes luck that lands the right student or postdoc at your door who is excited to work on your project. At Waterloo, our research facilities and capabilities make this happen."

RAFFI BUDAKIAN
Professor, Faculty of Science
Waterloo Endowed Chair in Nanotechnology
Institute for Quantum Computing

"Our immediate goal is to do 3D crystal structure determination using NMRD, which is what we need for imaging protein structures," Budakian says. "My hope is that this will excite others to look at this technique and then develop it further."

INTERDISCIPLINARY RESEARCH AT ITS BEST

Teamwork and interdisciplinary research are paramount to moving ideas and theories into real world applications, Budakian notes. He looks at his team as a perfect of example of how ideas can become innovations. He works with a community of people at IQC with varied backgrounds in science, mathematics and engineering: theorists who ask questions, experimentalists who can realize the theory into practice, and fabricators who spend their time thinking about how to make these devices work better and better. In the lab, all the components come together to create satisfying results.

"In a university environment, it's sometimes luck that lands the right student or postdoc at your door who is excited to work on your project," he says. "At Waterloo, our research facilities and capabilities make this happen."

With financial support from Transformative Quantum Technologies at Waterloo, Budakian's miniscule imaging technique is poised to lead to big impacts on the future of human health and well-being.

STUDENT SPOTLIGHT

TAKING A STEP TOWARD SELF-WALKING ROBOTIC EXOSKELETONS

BROKOSLAW LASCHOWSKI (MASc ’16, PhD ’21)

Alumnus, Faculty of Engineering

Waterloo Artificial Intelligence Institute

Read how ExoNet is developing robotic exoskeleton legs capable of autonomous control and decision making.

uwaterloo.ca/news/exonet

Trailblazing research is transforming the field of rehabilitation medicine by developing robotic exoskeleton legs capable of autonomous control and decision making

Brokoslaw Laschowski is using his interdisciplinary education – spanning four academic degrees – as a toolkit to integrate robotics technology with rehabilitation medicine. His groundbreaking research has led to the creation of ExoNet, a wearable system that combines computer vision and deep learning artificial intelligence for autonomous exoskeleton control.

Until now, wearable robots operated by motors had to be manually controlled by a person using a smartphone application or joystick to select the desired locomotor activity. ExoNet allows the robot to think and control itself without human intervention.

“The success of this research project suggests that we’ve identified something really meaningful. We were one of the first groups to pursue this research area back in 2018,” says Laschowski, who was supervised by Dr. John McPhee. “Now our open-source image database is helping create a global impact on the international research community. Researchers across the world are developing new control algorithms for these wearable assistive technologies, for which our system can help advance.”

MORE THAN A SPACE

It's the future of health and innovation

The Innovation Arena, located in downtown Kitchener's Innovation District, will help accelerate our impact on innovation in Canada. With Velocity – our country's most productive incubator – at its core, the Innovation Arena will streamline commercialization pathways for businesses, fast-track delivery of new technologies and drive Canada's next wave of economic growth.

PRELIMINARY ARCHITECTURAL CONCEPTS

Extending our reach through strategic partnerships

A recent partnership between the University of Waterloo, Western University and the Medical Innovation Xchange (MIX) will connect emerging healthtech companies with a host of wrap-around supports from start to scale. With access to specialized labs and research partners, as well as proximity to primary health providers and research hospitals, innovators and entrepreneurs will together strengthen the health and technology sectors in Canada.

COMING IN 2023

Learn more at:

uwaterloo.ca/innovation-arena

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