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REACH

2025

BEYOND

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REACH 2025
BEYOND

IN THIS ISSUE:

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- CPRS Toronto ACE Award, Best Publication category (2024, 2025)
- IABC Award of Merit (2024)

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CIFAR

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ABOUT CIFAR

The Canadian Institute for Advanced Research (CIFAR) is a globally influential research organization proudly based in Canada. We mobilize the world's most brilliant people across disciplines and at all career stages to advance transformative knowledge and solve humanity's biggest problems, together.

Dear CIFAR community,

I'm thrilled to share with you the 2025 issue of REACH. This year's theme, *Beyond*, perfectly reflects our unique model and mission – research that explores bold ideas, new frontiers and connections to create a better future.

In this issue, we go beyond disciplines, exploring unexpected collaborations, such as research being done at the intersection of the human microbiome and architecture to redesign buildings for better human health. We're also fostering interdisciplinary teams of scholars and public- and private-sector partners who are working together to develop responsible AI solutions for health care.

You'll discover the many ways CIFAR researchers are going beyond boundaries: whether it's finding innovative energy solutions, or uncovering the deep-rooted causes of hate, or investigating the intersections of art, ecology and geopolitics through food.

We'll take you beyond borders to Switzerland for our Forum on Radical Interdisciplinarity. And beyond the present, with support from partners like the Ralph M. Barford Foundation helping us anticipate future challenges. Finally, we'll look beyond the current generation of research talent, highlighting early-career researchers and their bold ideas – such as developing low-cost, hand-held quantum sensors to detect clean drinking water.

These stories highlight the remarkable breadth and brilliance of our global research community. At CIFAR, we take pride in our long-standing commitment to identifying and supporting unexplored areas of research – challenging skepticism and pushing boundaries. It's a testament to our belief in high-risk, high-reward scientific exploration that the work of longtime members Geoffrey Hinton and Paul Hoffman is now celebrated with the Nobel Prize in Physics and the Kyoto Prize, respectively. I'm pleased to share stories of their academic journeys in this issue that showcase how CIFAR has supported their bold thinking.

Of course, the important work featured and the continued work across our 15 research programs and the Pan-Canadian AI Strategy would not be possible without our donors, government and research partners, whose support and generosity enable CIFAR to drive meaningful impact and address critical challenges on the horizon.

I hope you enjoy this issue of REACH. Your continued contributions to CIFAR make it possible to advance transformative research that goes "beyond."

STEPHEN J. TOOPE
OC, LLD, FRSC
President & CEO, CIFAR

BEYOND BOUNDARIES

A year of breakthroughs in science and innovation

BY ABEER KHAN
ILLUSTRATIONS BY MAYA NGUYEN

From unveiling a groundbreaking method to predict dementia to potentially revolutionizing electronics, CIFAR researchers have pushed the boundaries of innovation this year. Here are some of their most exciting discoveries:

Fungal Kingdom: Threats & Opportunities

White-nose syndrome has devastated several North American bat species over the past 18 years. The syndrome is caused by an invasive fungus called Pseudogymnoscus destructans, which infiltrates the skin of hibernating bats and causes them to become more active than usual. This increased activity burns up the fat they need to survive winter and ultimately leads to starvation and death. How the fungus initiates its infection has largely remained a mystery until now. Fungal Kingdom: Threats & Opportunities Fellow Bruce Klein and Marcos Isidoro-Ayza, a PhD candidate at Klein's lab, have been able to study how the fungus gains entry and covertly hijacks cells' keratinocytes at the surface of bats' skin. This discovery offers new hope to better understand white-nose syndrome and save North American bats, who are facing an existential crisis.

Gravity & the Extreme Universe

The CHORD (Canadian Hydrogen Observatory and Radio-transient Detector) radio telescope, which is currently under construction, installed its first dish in January 2025. The project, which involves Gravity & the Extreme Universe Program Director Victoria M. Kaspi and Fellows Matt Dobbs, Ue-Li Pen, Ingrid Stairs and Kendrick Smith, will help address some of the most fundamental questions in science, such as the evolution of the universe, its composition, the origins of Fast Radio Bursts and the validity of Einstein's General Relativity on the largest scales. CHORD builds on the success of Canadian radio telescope CHIME (Canadian Hydrogen Intensity Mapping Experiment) and will be the world's most advanced fast radio transient detector, providing maps of large-scale structure and galactic emissions with unprecedented precision.

Humanity's Urban Future

For centuries, the media has advertised the future, from architectural plans to glossy magazine depictions of modernity. But how do these images emerge, and what role does the past play in shaping them? At the "Imag(in)ing Urban Futures" workshop in Mexico City, members of the Humanity's Urban Future program examined how diverse media – films, television, newspapers and AI – shape our urban imagination. This workshop inspired a forthcoming paper on this topic by Co-Director Simon Goldhill and Fellows Julie-Anne Boudreau and Roger Keil that aims to stimulate research and conversations about the urban future, driving engagement to better transform it.

Quantum Materials

Led by Pablo Jarillo-Herrero, a Quantum Materials Fellow, MIT physicists have created a transistor using a ferroelectric material that could revolutionize electronics. Ferroelectric material is a special crystal that can spontaneously generate positive and negative charges within itself and these charges can be flipped by applying an electric field. The material used in this advance, which the team discovered in 2021, is ultrathin and separates positive and negative charges into different layers. The transistor is remarkably durable and can survive 100 billion switches, making it the most resilient device ever. The ultrathin transistor could open the floodgate to deliver high-speed, energy-efficient electronic devices and denser computer memory storage.

Brain, Mind & Consciousness

As part of an international research team, Adeel Razi, a 2021-2023 CIFAR Azrieli Global Scholar in the Brain, Mind & Consciousness program, has discovered a new method for predicting dementia with over 80 per cent accuracy and up to nine years before diagnosis. The newly developed test analyzes functional MRI (fMRI) scans to detect changes in the brain's "default mode network" (DMN). The DMN connects brain regions to perform cognitive functions, and is the first neural network that Alzheimer's disease affects.

Child & Brain Development

Child & Brain Development Fellow Paul Frankland and a team of researchers at The Hospital for Sick Children (SickKids) in Toronto have found that stress significantly impacts how the brain encodes and retrieves negative memories. To test whether stress impacts memory specificity, the researchers trained mice to associate one sound with stress and another sound with no stress. The results found that acute stress prevented mice from forming specific memories, instead leading to more generalized memories encoded by more neurons. These findings can be applied to applications to treat post-traumatic stress disorder and generalized anxiety disorder.

CIFAR MacMillan Multiscale Human

Several researchers in the CIFAR MacMillan Multiscale Human program, including program Co-Director Sarah Teichmann and members Muzlifah Haniffa, Aviv Regev and others, published a new update on the Human Cell Atlas Consortium in *Nature*. The new findings include mapping all the gut's cells, producing a blueprint of human skeletons in utero, mapping the molecular architecture of the placenta, and more. Since its inception in 2016, the Consortium has aimed to create a complete biological map of human cells to better understand how the body works – in both health and disease.

A NEW ERA OF BUILDING DESIGN

BY MARK WITTEN
ILLUSTRATIONS BY ALEX ANTONESCU

How an unlikely collaboration between microbiome scientists and architects is reshaping building design for human health.

Humans spend an average of 90 per cent of their lives indoors, according to The National Human Activity Pattern Survey (NHAPS). That means built environments can greatly influence and shape our microbiome – the microbes that live on and within humans – for better or for worse.

Recognizing this profound impact, researchers are working at the intersection of human health and architecture to explore ways to design healthier spaces. This includes CIFAR researcher Thomas Bosch, a Fellow in the Humans & the Microbiome program.

For Bosch, the wake-up call for a paradigm shift in his work happened when he first met Columbia University architects Mark Wigley and Beatriz Colomina while on a research sabbatical in Berlin in 2019.

"We spent nearly a year together talking about how modern buildings and urban environments have contributed to a profound reduction in the microbial diversity essential for human health that began in about 1950 and has progressively worsened," says Bosch, a Professor at Kiel University and Director of the interdisciplinary research centre, Kiel Life Science, in Germany.

"I got very interested in how architects and designers think about the loss of diversity in microbiomes and human disease, and their ideas about different ways in which architecture could contribute to the restoration or preservation of microbial diversity."

As Wigley explains, the architecture of the 20th century – which is largely the architecture we still live in – is profoundly antibiotic in its approach. These sterile environments have contributed to negative health outcomes and the current health crisis in chronic diseases.

"The relationship between buildings and human biology is very intimate. As architects, we think of buildings as the way humans share microbes," explains Wigley, Professor of Architecture and Dean Emeritus of the Graduate School of Architecture, Planning and Preservation at Columbia University in New York.

Those seminal conversations in Berlin about the relationships between modern buildings and the human microbiome sparked a multidisciplinary project, supported by CIFAR's Catalyst Fund. It led to a perspective paper in the scientific journal *Proceedings of the National Academy of Sciences* (PNAS) in April 2024.

This influential, collaborative paper proposes a new dimension of microbiome research and a radical shift in urban and building design that calls for a microbiome-friendly architecture, which seeks to improve human health by exposing – rather than shielding people – from contact with their microbial environment. It includes contributions from over 20 international researchers in CIFAR's Humans & the Microbiome program and leading architectural researchers Wigley, Colomina and Forrest Meggers.

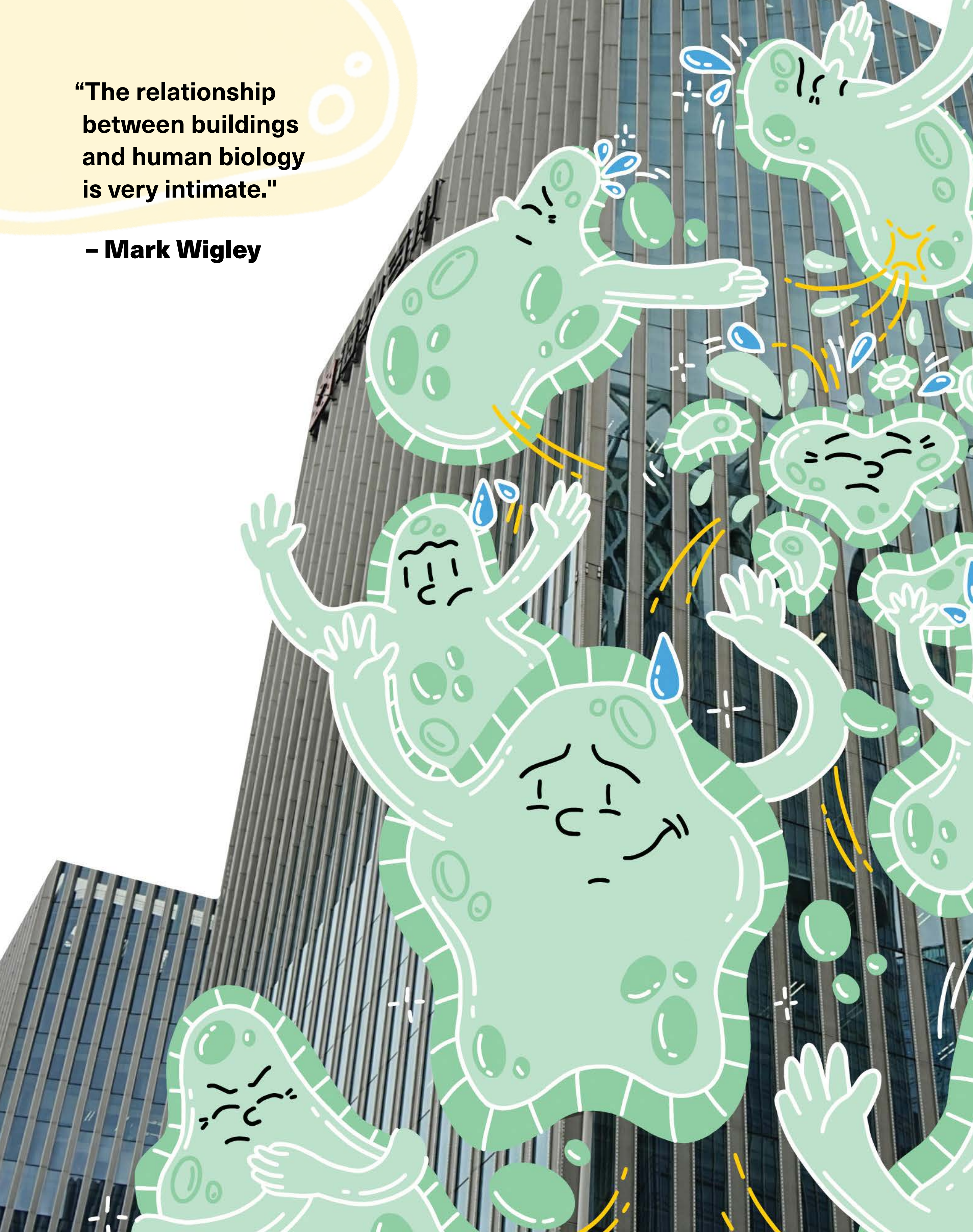
The paper argues that the depleted microbiome in buildings is a crucial environmental factor, which has accelerated the incidence of chronic diseases such as diabetes, asthma, heart disease, chronic bowel inflammation, multiple sclerosis, esophageal reflux, neurodermatitis, neurodegenerative diseases, food allergies and the rise of multiple cancers at younger ages.

"Humans are meta-organisms who have evolved with microbes as a functional unit over millions of years, and we know how important they are for human health," says Bosch. "Our health and fitness as humans depend on being together with a rich, diverse group of beneficial microbes that colonize our tissues, our gut, our skin and oral cavity. When we remove or eliminate these microbes and make it hard for them to survive in hostile, anti-microbial built environments, humans get sick."

"We need more permeability in architecture, which would allow for a greater exchange of beneficial microbes in buildings to support and maintain human health and fitness rather than enabling only harmful ones to survive and flourish."

– Thomas Bosch

> **"The relationship between buildings and human biology is very intimate."**
>
> **– Mark Wigley**



Bosch and his colleagues see the contemporary built environment as a little-studied and underrecognized culprit, which increases our susceptibility to multiple illnesses by disrupting the normal, healthy evolutionary relationship between the body and bacteria.

"People in cities live and work mostly in enclosed indoor environments, which are very dry, with no outdoor ventilation, and intended to keep microbes out with materials such as anti-microbial treated ceilings and paints," explains Bosch.

"But in our new thinking about the meta-organism, this ultra-hygienic architectural approach prevents human access to beneficial microbes and even worse, it accumulates, enriches and selects for microbes that we don't want in these buildings. These are the real bad guys, multi-resistant bacteria," he warns. "We need more permeability in architecture, which would allow for a greater exchange of beneficial microbes in buildings to support and maintain human health and fitness rather than enabling only harmful ones to survive and flourish."

Future architecture should be designed for better health and constructed in such a way that a complex and diverse microbiome can survive and thrive, say the researchers.

"The manifesto we wrote together with the human microbiome scientists in the *PNAS* paper argues that we need to change the prevailing modern architectural strategy, which separates humans from the soil, plants and most other species," explains Wigley.

Wigley suggests that a new era of building design should involve curating a more diverse array of microbes in the built environment, allowing for buildings to be open to the outside world and reconnect with plants, soil and other species. A useful model may be the human immune system, which doesn't simply exclude enemy pathogens from the body, but incorporates specific mixtures of microbes to maintain a safe, healthy balance.

Bosch sees promising signs that certain cities are moving towards a probiotic architecture – a rewilding of building interiors and cityscapes. "Singapore, for example, which is nothing but an urban environment, is a green city. The design of this modern city goes in the direction of adding nature back, a rewilding where you have these green buildings with plants on roofs and plants everywhere, and open soil where kids can play," he says, noting that cities in northern Europe, such as Oslo, are also getting rewilded. "When you go around Oslo, you find many areas with all kinds of wild plants and flowers, rather than sealed surfaces, like concrete."

"When we remove or eliminate these microbes and make it hard for them to survive in hostile, anti-microbial built environments, humans get sick."

– Thomas Bosch


Interdit d'entrer
KEEP OUT

Since the *PNAS* article was published, Bosch and his collaborators have been invited to disseminate their ideas more broadly in publications such as *The Microbiologist, and Cradle*, a German architectural magazine. Wigley and Colomina also organized an architectural exhibition, called *We the Bacteria: Towards Biotic Architecture*, which opened in Milan in May 2025.

With the collaborations of more than 20 CIFAR researchers in the *PNAS* paper, this project has also helped to advance the work of the Humans & the Microbiome program. Building on its original focus on the microbiome and the environment, these developments have spurred a broader movement within the program to understand the potential impact of the built microbiome on shaping the future of human health.

> **"I'm hopeful that the future generation of architects will think differently about how important these beneficial microbes are to human health."**
>
> **– Thomas Bosch**

"Thomas is amazing at connecting people together, as he did by introducing us to his microbiome research colleagues at CIFAR," says Wigley. "It was wonderful how this group who were from quite distinct subfields, often unrelated, could write a paper together which integrated so many different perspectives."

Melissa Melby, a Fellow in the Humans & the Microbiome program and among the authors of the paper, brought her distinct perspective as a biological and medical anthropologist who has conducted more than 20 years of research in Japan.

"I'm particularly interested in Japanese architecture and how it integrates nature in a way that likely fosters more microbial exchange," says Melby, a Professor in the Department of Anthropology at the University of Delaware. "This integrative interdisciplinary project allowed a lot of us as microbiome researchers to step back and ask questions that scientists had not really been considering before and envision new paths forward for how we can design and create healthier buildings and urban environments where people spend most of their time."

As a result of this rich, interdisciplinary collaboration, the built-environment microbiome has been newly identified as an environmental factor with a huge impact and bearing on human health.

"A very modern class of architects and designers are now being trained to make urban planning and new building designs more in harmony with our thinking about making indoor environments more accessible and permeable to the outside with open windows and permeable building materials," says Bosch. "I'm hopeful that the future generation of architects will think differently about how important these beneficial microbes are to human health." •

THE CYCLE OF HATE

WHY DO PEOPLE HATE?

CIFAR RESEARCHERS EXPLAIN THE VARIOUS WAYS INTERGROUP ANIMOSITY AND MISTREATMENT DEVELOP AND BUILD

BY ABEER KHAN
ILLUSTRATIONS BY SÉBASTIEN THIBAULT

Gathered around a dinner table after a Boundaries, Membership & Belonging program meeting in October 2023, researchers Victoria Esses, Hazel Markus and Stephen Reicher were reflecting on the state of the world today.

"We were lamenting how much conflict and hate there is – not just war and violence, but everyday acts of discrimination and policies that are hurting people, and we thought about what we could do to combat that," says Esses, a Fellow in the program.

Around the world, hate – acts of hostility, prejudice or discrimination towards individuals or groups – has been steadily on the rise. In May 2020, the United Nations raised the alarm about a "tsunami of hate and xenophobia, scapegoating and scaremongering around the world" during the COVID-19 pandemic. In Canada, the number of police-reported hate crimes rose by 72 per cent from 2019 to 2021.

As our world becomes increasingly polarized, Esses, Markus and Reicher knew there was a vast amount of literature on hate and why it occurs. However, it has been historically challenging to bring these ideas together in an accessible format for broader audiences. To bridge this gap and explain how intergroup animosity and mistreatment develop and build, they created The Cycle of Hate project.

WHAT IS THE CYCLE?

The researchers collaborated to identify 10 key factors and position them across a continuum, provoking hate and leading to its justification. The 10 factors are organized into four "hate provoker" components – history, current context, call to arms and the justification of mistreatment – and individuals and groups can enter the Cycle at any stage.

The first component uses history to justify mistreatment. This can be group history – stories we tell ourselves about our ethnic or national group – or individual stories that come from personal or family experiences, explains CIFAR Fellow Allison Harell.

That history can influence identity and behavioural norms and lead to interpretations of the current context that emphasize competition between groups. When a group is seen as threatening your situation, coupled with a lack of control and chaos in society, this makes the "other" group particularly likely to be a target of hate.

When history and current context create these discourses, it's easier for there to be a call to arms to hate "others" by figures in leadership and in the ways the media portrays "other" groups.

Within these conditions, moralization occurs, where harming others is seen as the right thing to do. This leads to the dehumanization of the "other" group so that they don't need or deserve to be treated as human. In this way, mistreatment is justified.

"There's this dehumanization process that happens when we start thinking of the other group as threatening. This leads to the justification of hate," says Harell, a Professor of Political Science at Université du Québec à Montréal. She joined the project alongside fellow Boundaries, Membership & Belonging members Prerna Singh and Vijayendra Rao after learning more about it at a CIFAR program meeting.

The group emphasizes that these hate factors belong in a cycle because they don't happen in isolation.

"Once you're in it, it's really hard to get out, and it becomes mutually reinforcing," says Singh.

The project goes on to explain how the factors that lead to intergroup hate can feed each other and promote escalation. "Once initiated, the cycle requires some mindful strategies to intervene," explains Esses, the Director of Western University's Network for Economic and Social Trends and a Professor of Psychology.

Reicher, a Boundaries, Membership & Belonging Fellow, says the group felt it needed to develop an understanding of hate that didn't just recognize it as a hot emotion. "It is about people harming others, often regretfully and without malice, and even thinking that they are doing good," he says.

As a consequence, getting people to recognize what is hateful and when they're acting hatefully cannot be presupposed – it's a major aspect of combatting hate, he explains.

MEET THE RESEARCHERS

VICTORIA ESSES

ALLISON HARELL

HAZEL MARKUS

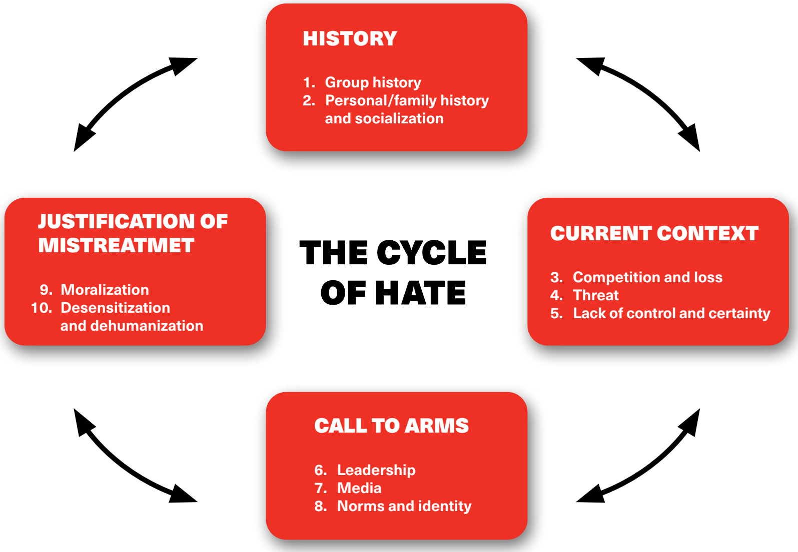
PRERNA SINGH

VIJAYENDRA RAO

STEPHEN REICHER

“Hate is not inevitable. It's something that humans make in their society and politics, so humans can unmake it."

"It's mobilized and therefore, we need to think about how we can organize counter-mobilizations,” says Reicher, a professor of psychology at the University of St. Andrews.



HOW CAN THE CYCLE OF HATE MAKE A DIFFERENCE?

The group’s goal for the project is twofold. They're striving to show how everyday people's thinking can often contribute to this Cycle of Hate, even if it doesn’t lead to violence but instead to everyday acts of mistreatment. They’re also looking at interventions – namely, raising public awareness and alert recognition – so that when individuals fall into this cycle or when hatemongers are trying to draw them into it and justify mistreatment, they can recognize it and break free from the cycle.

“The first step is an acknowledgment that this might be happening either to you or to a loved one,” says Singh, the Mahatma Gandhi Associate Professor of Political Science and International Studies at Brown University.

The team also hopes that their analysis can allow individuals, organizations, associations, institutions, states and communities to reflect on how they might be implicated in the process of hate.

“We want to make the knowledge have an impact. We want it to have practical use,” says Hazel Markus, an Advisor in the program. Markus, the Davis-Brack Professor in the Behavioral Sciences at Stanford University, says the group has discussed packaging the Cycle of Hate into a tangible resource like an infographic or graphic novel so that policymakers, social workers, educators and even kids can reference it. They're thinking of various storytelling opportunities to catch people’s attention and resonate with them.

"Hate is one of the biggest challenges we face as human beings."
– Vijayendra Rao

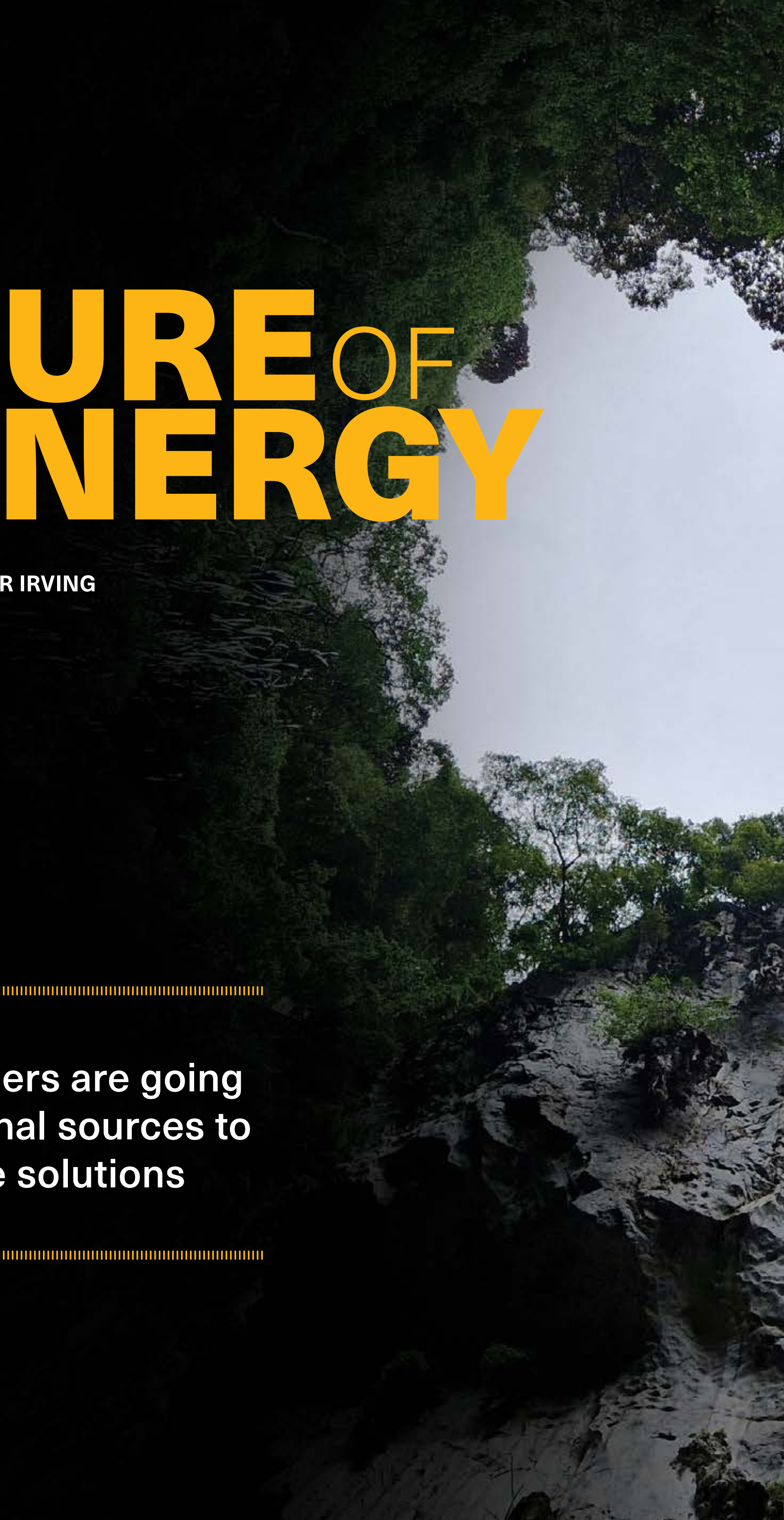
The team has plans to present their work on the Cycle at the World Bank in the spring, focusing on its relevance to international development. They’re also planning to focus on the solutions to intergroup animosity and mistreatment and investigate how to intervene in each of the Cycle's four components.

Together, Esses, Harell, Markus, Rao, Reicher and Singh all share a similar sentiment: addressing and combatting hate is essential to humanity's future well-being.

“Hate is one of the biggest challenges we face as human beings,” says Vijayendra Rao, Chair of the Boundaries, Membership & Belonging Advisory Committee and lead economist in the Development Research Group at the World Bank.

Moving beyond hate will allow humans to work together to address challenges facing everyone as a global community.

“Climate change, pandemics, destruction of species – these are big challenges for humanity and no small group of people can overcome them themselves,” Esses says. “What hope is there for us to work together if we can't get along?” •



THE FUTURE OF ENERGY

BY TYLER IRVING

CIFAR researchers are going beyond traditional sources to find sustainable solutions

The world needs energy. It powers everything we do, from transportation to manufacturing to simply heating and lighting our homes. As the global population grows and living standards continue to increase, demand for energy is expected to rise for the foreseeable future.

At the same time, many of our current sources of energy have big drawbacks. They pollute our air and water and produce the carbon dioxide that is driving climate change. Meeting both our needs and our emissions targets will require a major shift in how energy is produced, stored and used.

Through programs such as Earth 4D: Subsurface Science & Exploration and Accelerated Decarbonization, CIFAR researchers are going beyond existing paradigms – both to find new, more sustainable sources of energy, and to make better use of the ones we already have.

Hunting for hydrogen

Whether it's burned directly for heat or fed into a fuel cell to generate electricity on demand, hydrogen produces zero carbon emissions, making it very attractive as an alternative energy source.

Unfortunately, today, hydrogen is most commonly produced as a byproduct of the fossil fuel industry, with natural deposits of pure hydrogen thought to be rare. But that may be changing.

"We've known for a long time that in the deep ocean, water can seep down into cracks in volcanically active areas, where it reacts with rocks to produce hydrogen," says Barbara Sherwood Lollar, a Professor in the Department of Earth Sciences at the University of Toronto and Co-Director of the Earth 4D program.

"It emerges at hydrothermal vents, also known as 'black smokers,' and there are whole ecosystems that survive on the hydrogen produced there.

"But this same phenomenon happens with continental rocks as well. The rocks are cooler, so the rate [of hydrogen production] is different, but the reactions are the same."

"Systems that are open and close to the surface can get lots of groundwater flushing them out, and they also get seeded with microbes that consume the hydrogen."

– Barbara Sherwood Lollar

University of Toronto students in Barbara Sherwood Lollar's lab sampling for groundwaters, dissolved gases and microbiology, kilometres below the surface of the Earth.

Photos courtesy of Stable Isotope Lab University of Toronto.

In 2014, Sherwood Lollar and her colleagues published a paper in *Nature* in which they estimated that globally, continental rocks, the types of rocks that make up the landmasses on Earth, produce about as much hydrogen as the ocean floor systems do. The question now is whether – and where – it may accumulate in the continental subsurface.

"Systems that are open and close to the surface can get lots of groundwater flushing them out, and they also get seeded with microbes that consume the hydrogen," says Sherwood Lollar.

"If they are too deep, or hydrogeologically tight, then the water can't get there in the first place. The sweet spot is somewhere in between, ideally with a cap rock to hold the hydrogen in."

The discovery of large deposits of natural hydrogen could be transformative for our energy systems. In the short term, it could displace the use of hydrogen derived from fossil fuels, which is used in industries such as chemical production and oil refining. It could also be mixed with natural gas to lower its carbon footprint.

Sherwood Lollar is currently working with the Geological Survey of Canada to raise awareness of natural hydrogen and its many possibilities. If proven viable, natural hydrogen could become a game-changing clean energy source. For Canada, it's an opportunity to build momentum for its Hydrogen Strategy and lead as a global supplier and producer of low-carbon hydrogen. She's also collaborating with the Royal Society of London to chair an expert report on the topic of global potential for natural hydrogen resources, to be released in the spring of 2025.

But for Earth 4D researchers, hydrogen is just the beginning. They're also looking at new ways of locating critical elements, such as lithium for batteries, as well as helium, which has a range of industrial and medical uses.

Barbara Sherwood Lollar, Professor in the Department of Earth Sciences at the University of Toronto and Co-Director of the Earth 4D program

"Our carbon mineralization technology effectively extracts critical metals while converting the rest of the ore into solid carbonates by fixing captured CO_2."

– Ah-Hyung "Alissa" Park

Capturing carbon

While potential new sources of energy are exciting, there is also plenty of room to improve the existing ones.

For example, we know that burning fossil fuels emits carbon dioxide, which drives climate change. But what if we could increase the amount of energy we gain for every tonne of carbon emitted, or even prevent those emissions altogether?

Those strategies, collectively known as carbon capture, utilization and storage (CCUS) are among the key goals of CIFAR's Accelerated Decarbonization program.

"We know how to capture CO_2 from point sources quite well," says Ah-Hyung "Alissa" Park, the Ronald and Valerie Sugar Dean of the UCLA Samueli School of Engineering and a Fellow of the Accelerated Decarbonization program.

"The challenge is that right now, CCUS technologies are still costly, policies mandating them do not exist, and the market for captured carbon is at the beginning stage of creation."

One possible use of captured carbon is to simply inject it underground, a process that has been employed for decades to squeeze oil out of wells.

But thanks to the latest research, new possibilities are emerging, such as using renewable energy to convert captured CO_2 into carbon monoxide, methane, ethanol and other carbon-based chemicals, materials and fuels.

For their part, Park and her team are pursuing a promising synergy between carbon capture and the extraction of elements such as lithium, cobalt and so-called 'rare earth' elements – all of which are critical in clean energy technologies.

"Our carbon mineralization technology effectively extracts critical metals while converting the rest of the ore into solid carbonates by fixing captured CO_2," says Park.

"These solid carbonates can be used as sustainable construction materials, paper and plastic fillers, and more."

While governments around the world have attempted to increase the monetary cost of emitting carbon into the atmosphere via taxes or cap-and-trade systems, today it remains the cheapest and easiest option. Significant improvements in CCUS technologies could reverse that dynamic, turning carbon from a waste product into a valuable resource – one that powers a circular carbon economy.

If successful, these advances could transform entire industries, making clean technologies more affordable and accelerating the transition to a global net-zero – and researchers in the Accelerated Decarbonization program, like Park, are working to make that future a reality. •

Alissa Park's research group in the lab at Columbia University, where she taught until August 2023. Photo courtesy of Alissa Park.

Ah-Hyung "Alissa" Park, the Ronald and Valerie Sugar Dean of the UCLA Samueli School of Engineering and a Fellow of the Accelerated Decarbonization program

NOVEL NETWORKS

BY KRISTA DAVIDSON

Experts from across sectors are joining forces to find responsible AI solutions in health care. Their work could better predict and prevent deadly diseases such as diabetes and heart disease.

"A lot of ink has been spilled on the idea of responsible AI. It's easy to think of AI as an artifact, but there's more to the way we think about deploying and governing these technologies – and that responsibility can and should be embedded throughout the entire process."

James Shaw

Assistant Professor at the University of Toronto,
Canada Research Chair in Responsible Health Innovation

"We know it can be done. We have the technology, but we don't know how to adapt it into a highly regulated, complex health care system."

Laura Rosella

Professor at the Dalla Lana School of Public Health at the University of Toronto, Canada Research Chair in Population Health Analytics

Imagine a future where technology helps doctors assess the likelihood of a specific population developing type 2 diabetes, or more quickly identify signs of heart disease in medical images. Advances in artificial intelligence (AI) are steadily enhancing how we approach longstanding challenges in health care, offering new tools to support earlier detection and more personalized care.

Although AI has opened a world of possibilities within health care, much work remains to overcome existing barriers to deployment. CIFAR's Solution Networks were developed to untangle AI's emerging impacts on society and implement responsible solutions.

Currently, two CIFAR Solution Networks are breaking down barriers and bringing together distinct networks of interdisciplinary experts, researchers and people from the public and private sectors to find answers.

Predicting and preventing type 2 diabetes

According to the National Institutes of Health, type 2 diabetes is one of the fastest-rising chronic health conditions in the world. It's also seriously expensive – with a projected economic burden of more than $2 trillion (USD) by 2030.

In Canada, the statistics show a worrying upward trend in the rise of diabetes with about $50 million per day spent on health care in Canada to treat diabetes and manage related complications.

These statistics are disheartening, considering type 2 diabetes is preventable, but progress is stalled by a slew of intersecting factors: socioeconomic disparities, poor access to health care, high medication costs and lack of access to healthy and affordable food.

CIFAR's AI for Diabetes Prediction & Prevention Solution Network is working with partners in Peel Region in Ontario – one of the largest and most diverse municipalities in Canada with a high prevalence of diabetes – to overcome these barriers.

The team is co-designing a socially responsible deployment of a set of already-validated machine learning-based algorithms that can predict, and thereby prevent type 2 diabetes at the population health level. They hope this work will help promote the integration of prevention and management programs to the segments of the population most at risk.

"We know it can be done. We have the technology, but we don't know how to adapt it into a highly regulated, complex health care system," says Laura Rosella, a Professor at the Dalla Lana School of Public Health at the University of Toronto and a Canada Research Chair in Population Health Analytics. Rosella co-leads the Solution Network, which consists of six interdisciplinary researchers in areas such as bioethics, computer science, epidemiology and community health.

The team is working directly with providers, public health officials, and other decision-makers to help shape the technology's design. It will combine scientific knowledge of the disease with an AI platform to integrate it at the population level. The team hopes to see their tool implemented by fall 2026.

"The tool bridges the gap for good governance, decision making and a clear systematic process for engaging the right people at the right time when deploying technologies," explains James Shaw, an Assistant Professor at the University of Toronto and a Canada Research Chair in Responsible Health Innovation.

Given the complexity of the health care system, this needs to be approached carefully.

"A lot of ink has been spilled on the idea of responsible AI," says Shaw. "It's easy to think of AI as an artifact, but there's more to the way we think about deploying and governing these technologies – and that responsibility can and should be embedded throughout the entire process."

Transforming the future of medical imaging with AI

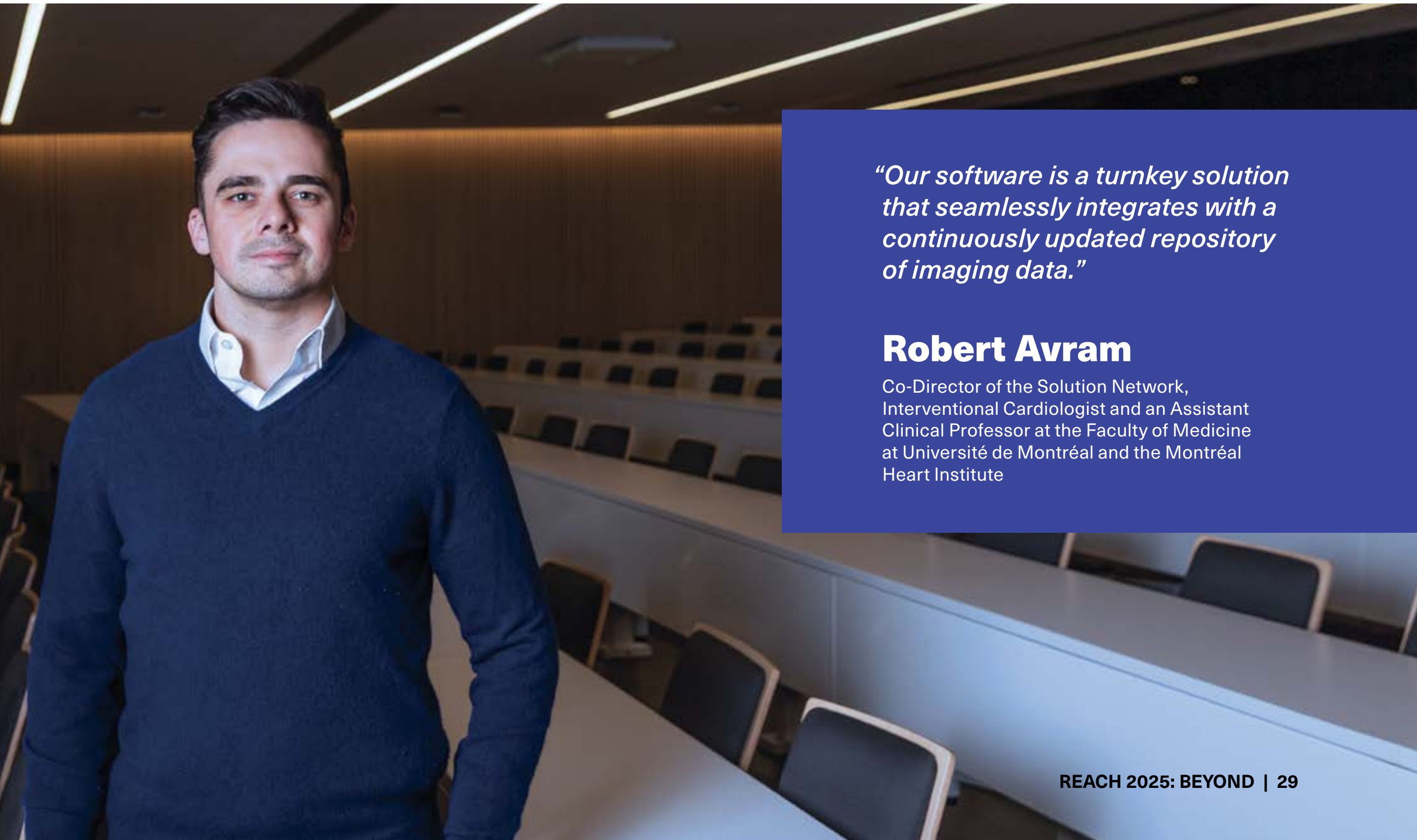
AI has already transformed medical imaging technology – such as X-rays, MRIs and CT scans – making it easier than ever to detect, prevent and treat the onset of diseases. Yet, in Canada, current restrictions limit the deployment of AI tools at early testing stages – whether for commercial or research models – due to regulatory constraints, confidentiality and safety concerns.

A team of multidisciplinary researchers has come together to form a Solution Network on Integrated AI for Health Imaging. Their new tool, known as the Pictures Archiving Communication System (PACS) - AI, could revolutionize the use of AI for medical imaging.

PACS systems are widely used in hospitals across North America and Europe to store medical images. However, integrating AI models into PACS has proven difficult. PACS-AI addresses this by providing a secure interface for AI models to interact with PACS in real time, enabling testing validation and regulatory approval processes. This accelerates physician access to AI tools, enhances patient care and facilitates impact evaluation, ultimately enhancing diagnostic accuracy and improving clinical workflows.

"Our software is a turnkey solution that seamlessly integrates with a continuously updated repository of imaging data," explains Robert Avram, Co-Director of the Solution Network. Avram is an interventional cardiologist and an Assistant Clinical Professor at the Faculty of Medicine at Université de Montréal and the Montréal Heart Institute.

"It supports a broad range of modalities – from complex 3D scans and MRIs to standard 2D images like chest X-rays – and facilitates the rapid deployment of advanced computer vision models for enhanced diagnostic support."



"Our software is a turnkey solution that seamlessly integrates with a continuously updated repository of imaging data."

Robert Avram

Co-Director of the Solution Network, Interventional Cardiologist and an Assistant Clinical Professor at the Faculty of Medicine at Université de Montréal and the Montréal Heart Institute

"With PACS-AI, clinicians will be able to process many modalities and standardize algorithms."

Samuel Kadoury

Computer Software Engineer and a Full Professor at Polytechnique Montréal, Researcher at the Centre Hospitalier Université Montréal (CHUM) Research Centre

The novel tool has already supported groundbreaking research and garnered positive attention from the medical community, including a publication in the *New England Journal of Medicine: Artificial Intelligence*. In a study involving over 200 patients in Montréal, San Francisco, and Ottawa, CathEF – an AI algorithm for detecting systolic heart failure in heart attack patients – was successfully integrated into PACS-AI. It proved both fast and accurate, delivering predictions in under five seconds and reliably identifying underlying heart damage.

"With PACS-AI, clinicians will be able to process many modalities and standardize algorithms," adds Samuel Kadoury, a computer software engineer and a Full Professor at Polytechnique Montréal and researcher at the Centre Hospitalier Université Montréal (CHUM) research centre. "This means that the same prediction AI algorithms can be used irrespective of where images are acquired, or whether it is used for research or in clinical trials."

The team, which includes experts in cardiology, computer science, health analytics, information technology law, medical imaging and machine learning, is working on both an open- and closed-source platform of PACS-AI. Their interdisciplinary expertise will help translate AI tools into health care and provide other researchers and clinicians with responsible AI mechanisms – for example, a set of fairness metrics that can help physicians assess the data used to train the models – which will help physicians and researchers advance future research.

"Many platforms in existence are closed source and are challenging to modify. We want to support both the research and clinical community. Our aim is to have cutting-edge models that are not yet regulated to be used for experimentation, but we also want to be able to support regulated algorithms that have Health Canada or FDA approval for clinical care," says Avram.

The goal is to enable physicians with different expertise and specialties, such as radiology and regional oncology, to integrate AI tools into their clinical workflows while also increasing accessibility to advanced medical testing and health care.

At the time of publication, PACS-AI has already been integrated as a research tool at the Montreal Heart Institute, CHUM and the Ottawa Heart Institute, with more to come.

Elissa Strome, Executive Director for the Pan-Canadian AI Strategy at CIFAR, says: "As AI continues to be integrated into our health care systems, the challenge will be to ensure that progress aligns with the values of responsible and ethical innovation. By creating space for collaboration across disciplines and sectors, and including users and patients in the design process, these Networks are shaping a future where leveraging data, AI and real-world expertise, means better care for patients."

CIFAR's Solution Networks are setting the stage for a vibrant, equitable and healthy future. •

AI-POWERED ROBOTS

These socially assistive robots could revolutionize elder care

BY ABEER KHAN

Beyond the Solution Networks, CIFAR's researchers are harnessing AI to address other critical issues in health care – including how to support Canada's rapidly aging population.

In Canada, older adults make up the fastest-growing demographic. According to Statistics Canada, seniors living to age 85 and beyond may face a number of limitations and health challenges, which will put increasing pressure on all levels of government to ensure adequate support.

Goldie Nejat a Fellow in CIFAR's Innovation, Equity & the Future of Prosperity program, aims to ease this pressure with socially assistive robots. These AI-powered robots are designed to provide cognitive and social interventions in long-term care homes, helping older adults with daily living activities and leading group recreational activities, from prepping meals to playing memory games to even scoring bingo cards.

"As we age, there is more chance of physical and cognitive impairment. Robots can revolutionize care and meet the growing demand and urgent need for caring for our aging population," says Nejat, a Professor at the Faculty of Applied Science & Engineering at the University of Toronto.

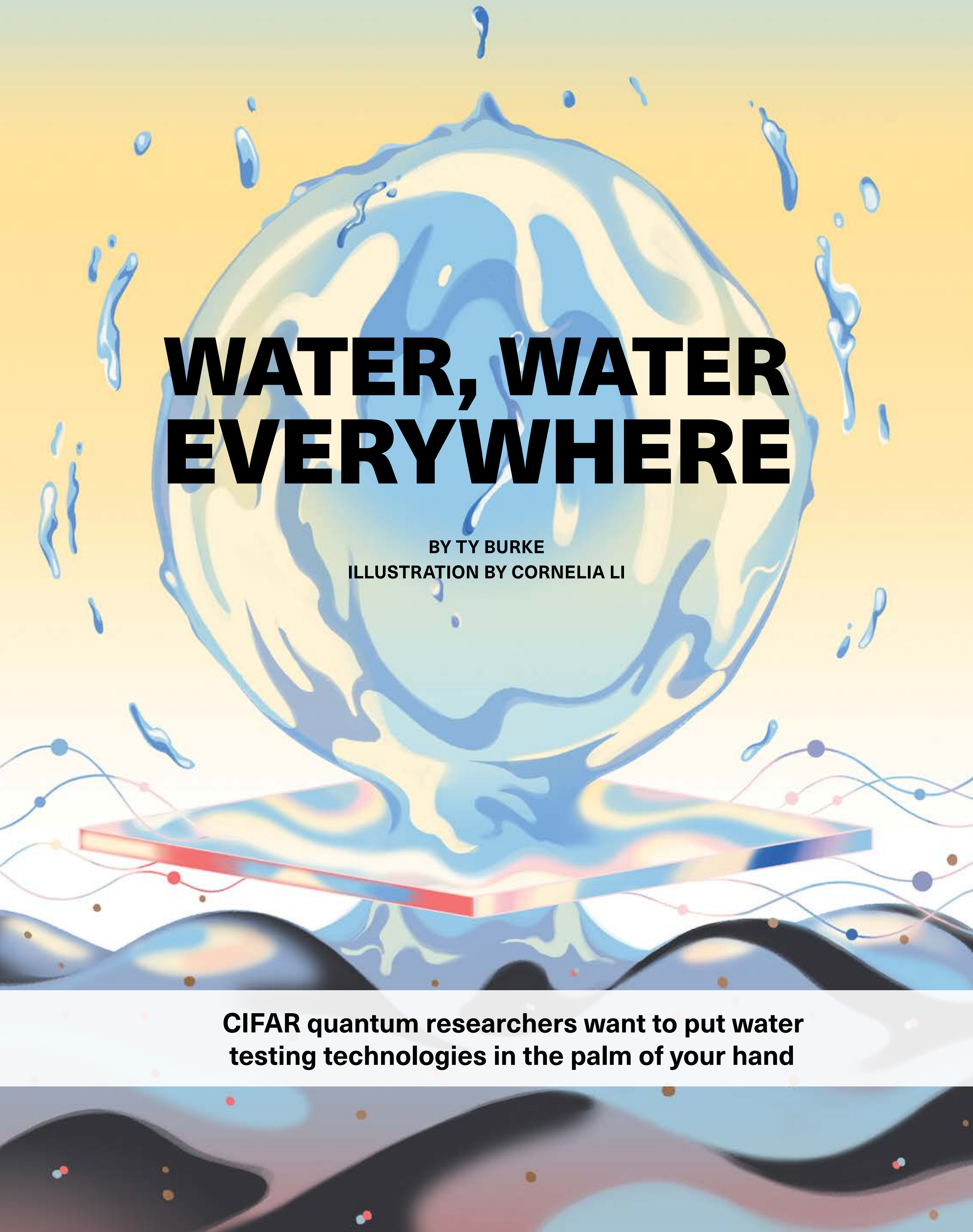
Her team focuses on developing intelligent socially assistive robots to help support individuals, improve their quality of life and well-being, and help promote independent living and aging-in-place. The robots can meet the care needs and wants of users, whether it's older adults or caregivers.

"It is imperative to support caregivers as well due to the emotional, physical and psychological burden they experience," Nejat explains.

In addition to elder-care applications, Nejat's research focuses on developing intelligent mechanical, electrical and computational systems with applications in emergency response, search and rescue, retail, security and surveillance and manufacturing. Her work exemplifies how AI is accelerating gains in vastly diverse fields.

WATER, WATER EVERYWHERE

BY TY BURKE
ILLUSTRATION BY CORNELIA LI



CIFAR quantum researchers want to put water testing technologies in the palm of your hand

Clean drinking water is a basic necessity. Yet, according to the World Bank, nearly 2 billion people around the world don't have access to reliably clean drinking water. Each year, 3.5 million people die from water-borne diseases like dysentery and cholera. Contaminants like plastics, arsenic and hazardous chemicals can contribute to long-term health problems like cancer.

Researchers in CIFAR's Quantum Information Science program want to change this. They're developing hand-held quantum sensors to identify contaminants in water to help people identify risks before it's too late.

Ashok Ajoy, an Assistant Professor of Chemistry at the University of California Berkeley

"Ideally, you want a technology that is non-invasive, inexpensive and portable," says Ashok Ajoy, an Assistant Professor of Chemistry at the University of California Berkeley, and a CIFAR Azrieli Global Scholar. "That way, the technology can be deployed at scale."

Ajoy is collaborating with Christine Muschik of the University of Waterloo's Institute for Quantum Computing to develop a nuclear magnetic resonance spectroscopy device. It's capable of identifying trace amounts of contaminants by measuring their effect on the spin of electrons. In this device, infinitesimally small droplets of water are embedded in a drop of oil and circulated through a tiny channel at high speed. The liquid flows past a sensor made of nanoparticles of diamond.

And their magic is in their defects, called nitrogen vacancy centres. These centres fluoresce – or light up – when exposed to magnetism.

"These defects are what make a diamond pink," says Ajoy. "And if you shine green light on them, they fluoresce red. This fluorescence is property of the spin of the electron in the defect centre. The amount of fluorescence is a function of the electron's spin, and can be measured with very high precision."

This paves the way to identifying specific contaminants like plastics or agricultural chemicals based on their unique magnetic signature. And Ajoy and Muschik's device is highly sensitive – able to detect levels of magnetism just one-millionth the strength of Earth's magnetic field.

The device that Ajoy and Muschik are developing promises precision and portability, and would be a dramatic improvement on the technologies currently used to identify contaminants. One such machine is the mass spectrometer, a kind of atomic scale that has been around for decades.

Mass spectrometry can detect vanishingly small quantities of a material by measuring atomic weights. But these devices can be as large as a room and cost millions of dollars. There is no way to take one to a rural village well, or a disaster zone where the water supply has been compromised.

"In principle, the device could be made very small, and the costs are low too," says Ajoy. "People often think it is expensive because it uses diamonds, but the diamonds we use are very cheap. In one recent experiment, the diamonds in the device cost less than the oil we used. And the laser could be a low-cost diode. There is nothing fancy in this device, and the entire thing could be made at a relatively low cost."

Like many other quantum sensing technologies, nuclear magnetic resonance technology is more evolutionary than revolutionary. Quantum sensors can be more sensitive, cheaper or portable, unlocking new applications and putting the technology in the hands of people who don't currently have access to them.

Ajoy credits the flexibility of CIFAR funding with advancing this research. It allowed him to attend molecular sensing conferences that deepened his understanding of droplet technology. And CIFAR's twice-annual Quantum Information Science program meetings connected Ajoy with leading researchers like Muschik, who brought a theoretical lens to the work. •

GEOFFREY HINTON

The long game of AI, and a Nobel Prize to show for it

BY LIZ DO

When Geoffrey Hinton first joined CIFAR in 1987, artificial neural networks – computer systems modeled on the human brain and nervous system – were met with doubt that they would ever work. But Hinton saw a different future.

"My main message is, if you want to do important basic research, you should look for something where you think people are doing it wrong." He says. "You shouldn't give up on your belief until you understand why you are wrong."

CIFAR saw a different future as well. With the longstanding belief that advancing fundamental research is key to transformative impact, CIFAR predicted the potential AI could have on our world. The organization was an early supporter of Hinton's research and vision.

"I came to Canada in 1987 partly because CIFAR offered me a fellowship," he says, adding that it enabled him to pursue his important work alongside his teaching at the University of Toronto.

In 1983, CIFAR launched the program AI, Robotics & Society. Later, in 2004, it launched Learning in Machines & Brains, of which Hinton would become a longtime member alongside fellow AI pioneers Yoshua Bengio and Yann LeCun. In 2018, the three of them were awarded the A.M. Turing Award – considered "the Nobel Prize in computing."

Over the last 20-plus years, the Learning in Machine & Brains program has helped maintain Canada's leadership in AI, thanks to the leading-edge work of its members and the connective tissue CIFAR provided – and continues to provide – to spark ideas.

Of course, today, neural networks have revolutionized the world, propelling advancements in health care, transportation and communication, to name just a few – their rise is a testament to playing the long game, and the power of fundamental research.

"Fundamental basic research often doesn't have an effect for many, many years," says Hinton. "Politicians are interested in something they can claim credit for, it's difficult for them to claim credit for the outcomes [if research advancements take many years]. But that's why we need to keep encouraging them to fund it."

For Hinton, his work took decades to overcome skepticism before becoming revolutionary. He was awarded the Nobel Prize in Physics in 2024 alongside physicist John J. Hopfield, a recognition he describes as "quite satisfying."

"It basically means all those years ago, when we were working on neural nets, and everybody was saying, this is not the right approach, we were right." •

PAUL HOFFMAN

A visionary who unraveled Earth's icy mysteries

BY LIZ DO

When Paul Hoffman joined CIFAR's Earth System Evolution program in 1995, he was widely recognized for demonstrating that plate tectonics have operated on Earth for billions of years. CIFAR's support, however, allowed Hoffman to explore new, ambitious ideas beyond conventional thinking.

His curiosity led him to contribute to the Snowball Earth hypothesis, which proposes that the expansion of polar sea ice eventually reached a critical threshold, plunging the entire ocean into a global deep freeze that lasted millions of years. Over time, the gradual accumulation of volcanic greenhouse gases triggered a rapid and dramatic warming, leading to a period of intense heat until the excess gases were eventually drawn down. These extreme climate swings would have had profound effects on the evolution of microbial life, which was already well established by the time the Snowball Earth events are thought to have occurred.

Hoffman's bold hypothesis was initially controversial, sparking extensive investigation and debate within the scientific community, and even within the Earth System Evolution program.

However, "CIFAR was very encouraging," he says. "Why did I do the heavy slogging against a lot of opposition initially? Because I was reaffirmed every year when I met with CIFAR [researchers], and they, of course, accelerated my progress because I had world-leading experts I could meet and talk with."

The Snowball Earth hypothesis is now a cornerstone of modern Earth system science research. This groundbreaking work led him to receive the prestigious Kyoto Prize in Basic Sciences in 2024, making him the first geologist to receive this distinction. "The most thrilling thing was having geology recognized as a basic science," he says.

Hoffman's contributions have not only deepened the world's understanding of Earth's icy past, but his work inspires ongoing research into climate change and evolutionary biology. Today, research into earth sciences also remains ongoing at CIFAR through the Earth 4D: Subsurface Science & Exploration program.

Reflecting on his academic career, Hoffman emphasizes that CIFAR's support for fundamental research and its interdisciplinary environment was essential in enabling his visionary work from the very beginning.

"Working with such a diverse group as we had in CIFAR and meeting on an annual basis to discuss our ongoing research was extremely valuable," he says. "I could never have had the success I had with Snowball Earth without CIFAR." •

CIFAR FORUM ON RADICAL INTERDISCIPLINARITY IN PHOTOS

BY LIZ DO AND ABEER KHAN
PHOTOGRAPHY BY MARC BADER

In March 2025, Canadian and Swiss researchers from across disciplines convened in Geneva for the CIFAR Forum on Radical Interdisciplinarity. Held in partnership with the Swiss National Science Foundation (SNSF), the forum engaged exceptional junior faculty and postdoctoral scholars to identify frontier topics in interdisciplinary research and inspired collaborative opportunities for early-career researchers to take risks across disciplines.

This year's theme, *Boundless*, encouraged participants to think beyond disciplines, borders and species – from the smallest cells in living systems to exploring life outside our planet.

Here's a glimpse into the energy, curiosity and collaboration that defined our first-ever forum on Radical Interdisciplinarity.

1 Participants like Rita Orji, Professor of Computer Science, Dalhousie University, explored Geneva and collaborated outside a formal setting at the Musée d'Histoire des Sciences, located in the Parc de la Perle du Lac. The museum houses antique scientific instruments and its galleries showcase scientific breakthroughs and revolutions in scientific knowledge and ideas.

2 CIFAR President & CEO Stephen Toope (right) led a panel on breaking boundaries in research. The panel featured (from left): Torsten Schwede, President of the SNSF Research Council, Pippa Wells, Deputy Director for Research & Computing, CERN and Frédérique Guérin, Deputy Director for Strategic Programmes, Geneva Science-Policy Interface.

3 Among the presenters at the three-day meeting was Syed Ishtiaque Ahmed, an Associate Professor of Computer Science at the University of Toronto. Participants gave one-minute introductions to their research, explaining how it connects to the themes of boundlessness and interdisciplinarity.

4 Forum participants pose for a group photo. The meeting encouraged early-career researchers to take bold risks, push boundaries and collaborate across disciplines. "CIFAR provided a uniquely collaborative environment where scientists from diverse fields could convene and share insights. In an era of growing specialization, such opportunities for genuine cross-disciplinary exchange have become increasingly rare," said Adrian-Stefan Andrei, group leader and SNSF Ambizione Fellow at the University of Zurich.

5 Sian Kou-Giesbrecht, an Assistant Professor in the Department of Earth & Environmental Sciences at Dalhousie University, was among the attendees who joined dynamic roundtable discussions. Pressing topics included AI, power and knowledge, science and culture, and integrating ethics with genomics and environmental science. Each session began with brief presentations to ignite bold, interdisciplinary dialogue.

6 Ianina Altshuler, Assistant Professor, École Polytechnique Fédérale de Lausanne (left) and Peter Higgins, Kavli-Laukien Postdoctoral Fellow, Harvard University (right) take advantage of a coffee break to learn from their peers across disciplines and borders.

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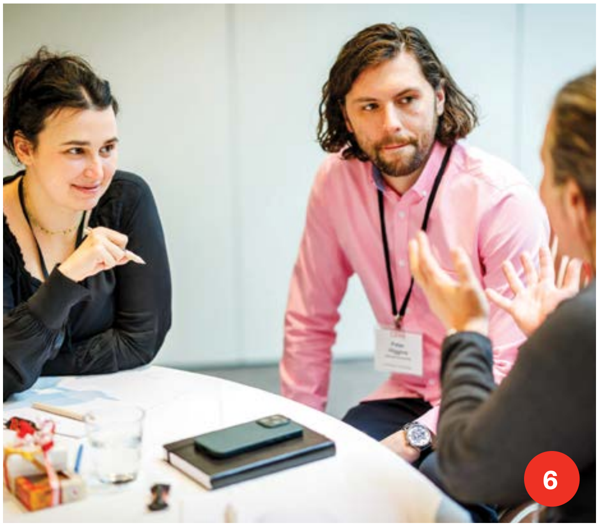
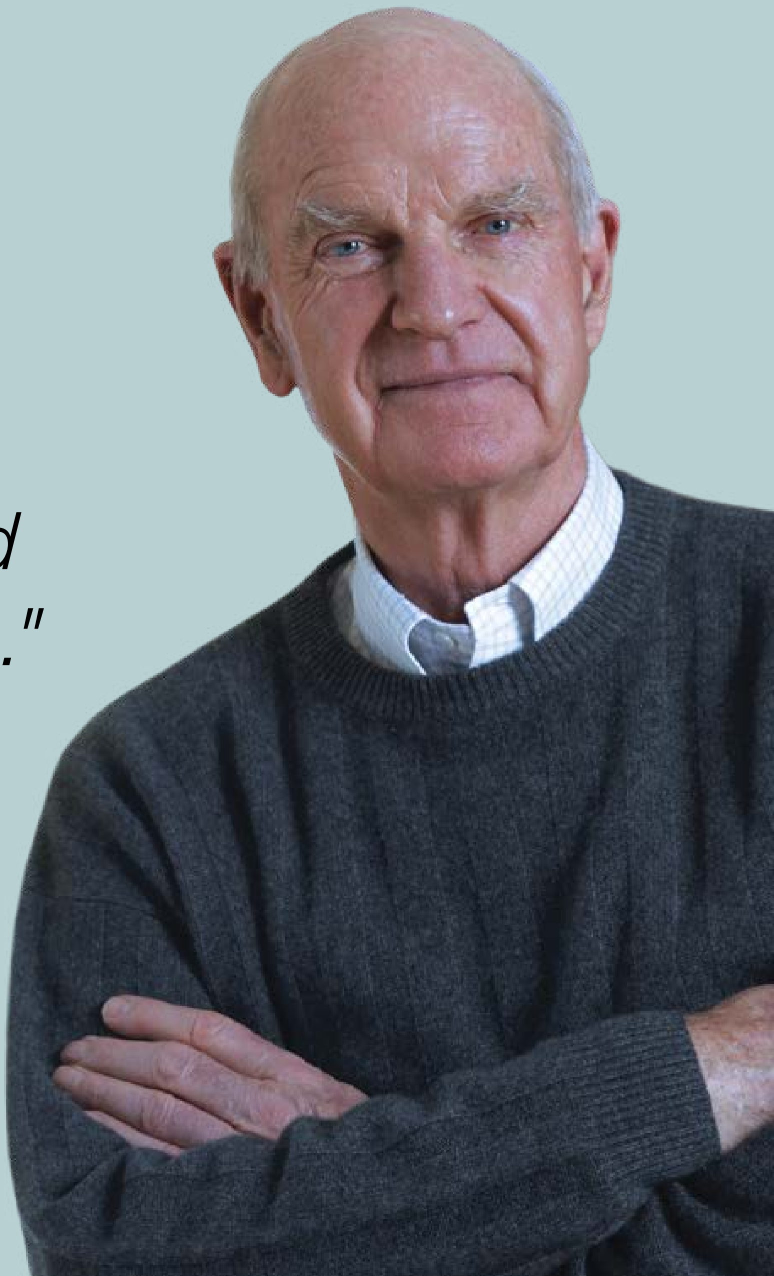


6

RALPH M. BARFORD

A life of people and possibilities

BY JP UDO



"He was always pursuing new frontiers, excited about the future."

– Beth Malcolm

The Ralph M. Barford Foundation's recent gift established the CIFAR Ralph M. Barford Discovery Initiative, enhancing foresight and horizon scanning to anticipate challenges and opportunities in the decades ahead.

Ralph M. Barford's life was marked by a relentless pursuit of discovery – a thread woven through his roles as a business visionary, devoted family man, intrepid explorer and early supporter of CIFAR.

Honouring this legacy, the directors of the Foundation have dedicated a significant gift to establish the CIFAR Ralph M. Barford Discovery Initiative. This initiative enhances CIFAR's capacity for foresight and horizon scanning, enabling a proactive approach to identifying emerging challenges and opportunities 20-30 years into the future.

Raised in Toronto, Ralph's fascination with new frontiers began early, nurturing a curiosity about people and the future that shaped his extraordinary journey.

After completing his education at Harvard Business School under the mentorship of pioneering venture capitalist Georges F. Doriot, Ralph embraced the thrill of entrepreneurship. "He was always pursuing new frontiers, excited about the future," remarks his daughter, Beth Malcolm. "He was a very practical businessman who always tried to manage risk, but he remained a huge optimist with faith in people." Ralph's optimism and belief in people's potential extended naturally into his role as a father, where he instilled the same enthusiasm for exploration in his six children.

His love for discovery was most vividly expressed through Ralph's extensive travels, ultimately visiting nearly every country on Earth. These journeys were transformative, introducing him to diverse people, places and ideas, each encounter broadening his perspective. Beth clearly remembers his joy and gratitude while recounting these experiences, noting, "You could see his amazement at the good fortune of having met these people and being able to share their stories with us."

Friend and colleague Tony Arrell, a successful business leader and committed philanthropist, reflected, "Ralph had this incredible capacity to see opportunity where others saw uncertainty. He saw a world full of possibilities, and it seems to me that his support of CIFAR was an extension of his optimism."

Bruce Mitchell, a distinguished business executive and CIFAR Emeritus Board Member, added, "It was in Ralph's very nature to recognize the immense potential in Fraser Mustard's vision for CIFAR – a groundbreaking idea. An astute investor, entrepreneur and bold leader, Ralph would have quickly calculated that the possibilities far exceeded any risks."

Ralph deeply valued surrounding himself with intelligent people who brought diverse expertise and perspectives. To this end, the Barford Foundation's recent gift to CIFAR embodies his commitment to intellectual discovery and the belief that meaningful progress arises from thoughtful collaboration among bright, curious minds.

This generous gift advances one of CIFAR's key strategic goals: anticipating future challenges and opportunities. By exploring issues likely to shape the world in 10, 20 or more years, the CIFAR Ralph M. Barford Discovery Initiative will help the organization to identify emerging threats and opportunities that will impact global health and prosperity.

Beth beautifully encapsulates her father's legacy, emphasizing the personal and communal aspects of discovery. Reflecting on the significance of the foundation's gift to CIFAR, she notes warmly, "This donation is going to be an adventure. I think the Board just knew it would appeal to him – it's a great way to honour his memory." •

Donors are essential to helping us answer some of most important questions facing science and humanity. Join our global donor community: **cifar.ca/donatenow**

BEYOND THE DINNER PLATE

Future Flourishing researchers use food as a tool to address global extractivism and inequality

BY LIZ DO

For more than a decade, researchers Daniel Fernández Pascual and Alon Schwabe, Fellows in the Future Flourishing program, have collaborated on their project, *Cooking Sections*. Their work investigates the systems that shape the world through food, tracing the spatial, ecological and political legacies of extractivism – the large-scale extraction of raw and natural resources for export.

Cooking Sections has taken them to northern Istanbul to explore fragile wetland ecologies through the lives of semi-wild water buffalo and to Kivalian, an Iñupiaq village in Arctic Alaska to document local voices in their fight for relocation and climate justice.

Since 2016, they have been working in the islands of Skye and Raasay, Scotland. There, seashells discarded from restaurants are given new life as a new building material and art installation. *Bivalve Murals* offers an artistic and ecological process to address the environmental harm caused by salmon farming.

"Decades of intensive salmon farming has led to pollution and dead zones that are destroying the marine environment – not only in Scotland – but in many other places in the world, including Canada," said Fernández Pascual, a Principal Investigator at CLIMAVORE x Jameel at the Royal College of Art (RCA) in the United Kingdom.

As an alternative to salmon, bivalves – aquatic mollusks such as clams, mussels and oysters – offer a low-impact approach to aquaculture. Unlike salmon, they don't require antibiotics or synthetic inputs and even actively filter and clean the water around them.

"We've been calling for divestment from salmon farming and investment into other forms of aquaculture that are more regenerative and to work together with residents to think of cultural tradition transitions to do that," explains Schwabe, who is also a Principal Investigator at CLIMAVORE x Jameel at the RCA.

Fernández Pascual and Schwabe worked with restaurants to remove salmon from the menu, and with local schools to develop apprenticeship programs to train the next generation of cooks to incorporate bivalves.

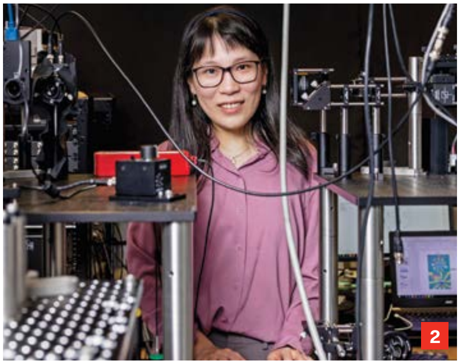
To mitigate food waste, they're using the bivalve shells collected and discarded from local restaurants to create a terrazzo-like material that offers a sustainable alternative to cement. They've used the compacted material to create artistic murals, created in two parts, "twins," as they call them. One is installed in a local community space; its counterpart will enter a museum collection at the MSU Broad Museum and the University of Edinburgh. Sales of these works will help fund a local production facility for the material.

Beyond material innovation, the project represents a long-term model for ecological and cultural repair.

"For us, success means figuring out how to extend these processes – not just for three years, but for 100 years," said Fernández Pascual. "What would it mean if there is this localized action and research, brought together in one place, for a very long period of time?"

This is your impact!

Because of you, these world-renowned researchers and next generation leaders are inspired to challenge traditional scientific boundaries. CIFAR donor support fuels their curiosity, turning ideas into knowledge and lasting impact.



1. New conversations start at CIFAR's Women in Research Leadership Development Symposium in Kigali, Rwanda.

2. CIFAR Azrieli Global Scholar Qiong Ma in her optics lab.

3. Rich Sutton, Canada CIFAR AI Chair, was awarded the prestigious Turing Award in 2025 for his groundbreaking advances in computer science.

4. At United Nations University in Tokyo, Japan, CIFAR Azrieli Global Scholar Benjamin Rosman joins Rector Prof. Tshilidzi Marwala.

5. CIFAR Fellows Yoshua Bengio and Yann LeCun, previous Turing Award winners, discuss CIFAR's connection to their work.

6. Our Neuroscience of Consciousness Winter School participants.

7. 2024 Deep Learning + Reinforcement Learning Summer School.

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