LIFE IN 2027

EXCELLENCE, INNOVATION, LEADERSHIP:
RESEARCH AT THE UNIVERSITY OF TORONTO

Ideas about tomorrow from our next generation.

GETTING TO 2027, U OF T'S BICENTENNIAL

LIFE IS CHANGING. OUR WINTERS ARE WARMER. POLAR BEARS ARE LOSING THEIR ICY HOMES. **OUR BOOKS ARE BECOMING ELECTRONIC.** STEM CELLS OFFER WONDROUS POSSIBILITIES FOR CURING DISEASE. PARENTS AND CHILDREN ARE FINDING THEIR LIVES MORE HECTIC THAN EVER BEFORE WHILE GRANDMA AND GRANDPA ARE LIVING TO 100 AS A MATTER OF COURSE. **BUT WHO'S GOING TO CARE FOR THEM WHEN THEY CAN'T TAKE CARE OF THEMSELVES?** THE CORPORATIONS THAT BUILT THE 20TH CENTURY ARE DECLARING BANKRUPTCY WHILE NEW ONES BURST ONTO THE SCENE. **THE MIDDLE CLASS IS DISAPPEARING.** MOST PEOPLE DON'T SMOKE, BUT MORE THAN EVER BEFORE ARE OBESE. **WE CAN REPLACE BAD HIPS AS EASILY AS WE USED TO TAKE OUT TONSILS.** NARCOTICS STILL ADDICT US. AT THE SAME TIME, WE HAVE DEVELOPED DRUGS THAT CAN KEEP A PERSON WITH HIV ALIVE AND RELATIVELY HEALTHY FOR YEARS. ***OCCUPY* HAS A DIFFERENT MEANING NOW. DEMOCRACY AND FREEDOM ARE BECOMING CHARACTERISTICS OF LIVES THAT WERE PREVIOUSLY SHACKLED BY DICTATORSHIP AND TYRANNY.** WE CAN'T SEEM TO GET PUBLIC TRANSIT RIGHT. BUT WE HAVE HYBRID CARS AND ARE MAKING ALTERNATIVE ENERGY A GOAL WE KNOW WE CAN REACH. **OLD GUARD ECONOMIES ARE FALTERING WHILE FORMER DEVELOPING NATIONS ARE TAKING HOLD OF THE GLOBAL ECONOMY. TO *GOOGLE* AND *TWEET* ARE PARTS OF THE NEW, UNIVERSAL LANGUAGE.** THE WORDS OF SHAKESPEARE STILL SET THE STANDARD IN ANY NUMBER OF WAYS. **WE ARE CLOSER TO FINDING LIFE ELSEWHERE IN THE UNIVERSE. BUT IF WE DO, HOW WILL THAT CHANGE US?**

AND ALL THAT ONLY BRINGS US UP TO NOW.

WHAT HAPPENS NEXT?

University of Toronto researchers cannot predict the future. Through the collective force of 5,000 of the world's brightest scholars, however, we are working on the knowledge it will take to deal with the future.

We asked 16 U of T professors in the early stages of their careers to talk about the future by way of their disciplines and the themes of our Strategic Research Plan, which you'll see indicated throughout these pages.

The University of Toronto Strategic Research Plan 2012-2017


EXPLORE


SUSTAIN


PROMOTE


ENGAGE


ADVANCE


ENABLE


BUILD

The researchers featured here discuss their research and its potential impact for the future. We chose 2027 to highlight how research today might impact tomorrow as the University enters its third century of operation.

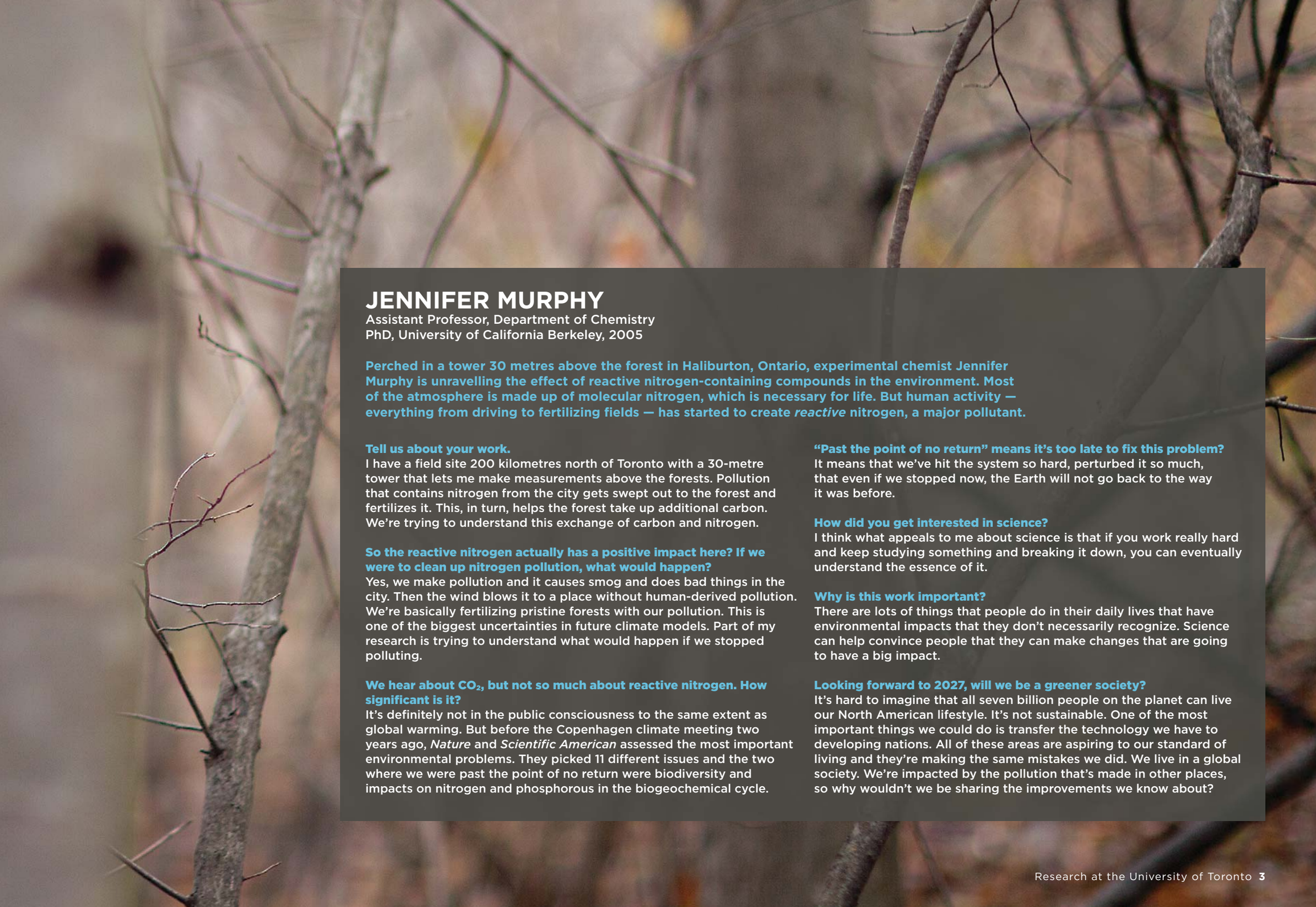
Since our founding in 1827, our mission hasn't changed – U of T prepares students for a complex world and creates an environment for our researchers to analyze and contribute to a better future and stronger citizens.

Today, U of T is ranked among the globe's top institutions of higher education. Please see "U of T Research By the Numbers" (in this package), which demonstrates our research and innovation impact.

In this spirit, I present you with *Life in 2027* and the thoughts of our remarkable next generation of scholars.

PROFESSOR R. PAUL YOUNG, PhD, FRSC
Vice President, Research

“SCIENCE CAN HELP CONVINCE PEOPLE THAT THEY CAN MAKE CHANGES THAT ARE GOING TO HAVE A BIG IMPACT.”



JENNIFER MURPHY

Assistant Professor, Department of Chemistry
PhD, University of California Berkeley, 2005

Perched in a tower 30 metres above the forest in Haliburton, Ontario, experimental chemist Jennifer Murphy is unravelling the effect of reactive nitrogen-containing compounds in the environment. Most of the atmosphere is made up of molecular nitrogen, which is necessary for life. But human activity — everything from driving to fertilizing fields — has started to create *reactive* nitrogen, a major pollutant.

Tell us about your work.
I have a field site 200 kilometres north of Toronto with a 30-metre tower that lets me make measurements above the forests. Pollution that contains nitrogen from the city gets swept out to the forest and fertilizes it. This, in turn, helps the forest take up additional carbon. We're trying to understand this exchange of carbon and nitrogen.

So the reactive nitrogen actually has a positive impact here? If we were to clean up nitrogen pollution, what would happen?
Yes, we make pollution and it causes smog and does bad things in the city. Then the wind blows it to a place without human-derived pollution. We're basically fertilizing pristine forests with our pollution. This is one of the biggest uncertainties in future climate models. Part of my research is trying to understand what would happen if we stopped polluting.

We hear about CO_2, but not so much about reactive nitrogen. How significant is it?
It's definitely not in the public consciousness to the same extent as global warming. But before the Copenhagen climate meeting two years ago, *Nature* and *Scientific American* assessed the most important environmental problems. They picked 11 different issues and the two where we were past the point of no return were biodiversity and impacts on nitrogen and phosphorous in the biogeochemical cycle.

"Past the point of no return" means it's too late to fix this problem?
It means that we've hit the system so hard, perturbed it so much, that even if we stopped now, the Earth will not go back to the way it was before.

How did you get interested in science?
I think what appeals to me about science is that if you work really hard and keep studying something and breaking it down, you can eventually understand the essence of it.

Why is this work important?
There are lots of things that people do in their daily lives that have environmental impacts that they don't necessarily recognize. Science can help convince people that they can make changes that are going to have a big impact.

Looking forward to 2027, will we be a greener society?
It's hard to imagine that all seven billion people on the planet can live our North American lifestyle. It's not sustainable. One of the most important things we could do is transfer the technology we have to developing nations. All of these areas are aspiring to our standard of living and they're making the same mistakes we did. We live in a global society. We're impacted by the pollution that's made in other places, so why wouldn't we be sharing the improvements we know about?

"WE MUST POOL OUR KNOWLEDGE OF ERGONOMICS, DESIGN AND PSYCHOLOGY TO BUILD BETTER INTERFACES."

DANIEL WIGDOR

Assistant Professor, Department of Computer Science and
Department of Mathematical and Computational Sciences, U of T Mississauga
PhD, University of Toronto, 2008

Daniel Wigdor is a computer scientist who's as comfortable quoting George Orwell as he is analyzing the latest iPhone release. He recently made the leap to university research from a career at Microsoft.

What's your interest in human-computer interaction?
Normally when you interact with a computer you're limited to pointing, clicking and dragging. Most interfaces are built around these basic actions because they are easy to do with a mouse. But technology has become ubiquitous and input is happening directly to screens, with pens, as well as with the mouse. By changing the fundamental way we give input we can empower users to feel both natural and more comfortable. The iPhone, while beautiful and fun to use, still utilizes a point and click interface with a finger. My research focuses on the creation of gesture languages and user interfaces that enable people to give input in a way that better suits the device and context of use. This was a large part of my role at Microsoft, where I was an architect working on technologies like Kinect and it's one of the areas I am excited to further develop at U of T.

Why is it so hard to think about interacting with a computer differently?
In *1984,* George Orwell talked about "newspeak." The idea was to purge dissent from the vocabulary and therefore from the mind. The tools people use to design systems are built on top of a mouse and keyboard. So everything comes out looking like a user interface for a mouse and keyboard. But people interact with technology differently now. We must pool our knowledge of ergonomics, design and psychology to build better interfaces. It takes years of working in a new design space to get away from a predominant way of thinking.

You referenced Orwell earlier. Are we any better for the onslaught of technology we're experiencing?
There are certainly good things that come from technology. It's a tool for democracy in the sense that these technologies can be used to spread information in ways that are less likely to be controlled.

As with any tool there is a serious risk of its use becoming a crutch that many users come to rely on, myself included. I don't even know my best friends' telephone numbers. When I have children I would prefer that they attend a school that doesn't use computers. Too often in schools where computers are part of the curriculum, the lesson becomes about the tool more than about the content.

What do you see for 2027?
I see a personal symphony of devices. The current model is to have a phone, a tablet and so on, but they all sync to a computer. This notion of the PC as the hub is going away.

Screens will be as cheap and plentiful as paper. Each of our devices and surfaces will be empowered to be a fully functional piece of that symphony, but specialized — applications will span multiple devices. You will use multiple pads and phones at the same time.

"YOU HAVE TO DO DISCOVERY SCIENCE BEFORE YOU DO CLINICALLY-ORIENTED RESEARCH."

ANNE-CLAUDE GINGRAS

Associate Professor, Department of Molecular Genetics
Principal Investigator, Samuel Lunenfeld Research Institute, Mount Sinai Hospital
PhD, McGill, 2001

Anne-Claude Gingras is a leader in the field of proteomics — the study of proteins. Her work straddles basic science — exploring the unknown properties of cells — and the more practical field of technology development. It's also caused her to stumble onto some surprising discoveries.

Why do we care about proteins?
Because they do everything in cells. Genetic information is encoded in the DNA but the machinery that reads this information and translates it into something usable is all protein-based. Most of the building blocks of humans — or any organism for that matter — are protein-based. Proteins tend not to work in isolation. They form complexes with other proteins so what we're doing is trying to understand the links between proteins.

Tell us about your research in particular.
First, we do technology development for proteomics, building tools and disseminating them to the research community with an open source licence. We also work on phosphatases, which are a particular category of proteins. To do this work we use the tools we're developing in the other half of the lab. So the biology fuels the technology development and vice-versa.

Is the idea just to understand how proteins work or are there applications?
Both. The molecules I care about are poorly understood. Before we can get into applications we need to understand how they work. But as we're doing these projects, we stumble onto things. There is a rare disease called Cerebral Cavernous Malformation. It causes disorganized blood capillaries in the brain, resulting in lesions. Depending on how bad your case is, it can be just one small lesion in a place that's not so important for your function, or it could be several or bigger lesions in areas that are required for function. Until now there has been no cure but surgery. We stumbled onto this looking at one of our phosphatases. We found it interacts with the protein involved in the disease. So now we're working with other researchers to try to tackle this disease.

That's the power of basic science.
Yes, you have to do the discovery science first before you can jump in to try to do clinically-oriented research. I never thought I would be doing vascular biology. I had never heard of Cerebral Cavernous Malformation before, but now I go to meetings organized by the families of people who have it.

How did you get interested in biology?
I was always interested in both humanities and science. I was accepted to law school, but the summer before I started, I thought, "This is not really what I want to do." So I went back and did my undergrad in biochemistry. Then I worked in a lab one summer and I thought, "Wow, this is fun!" I never left.

It's 2027, what do you see?
In terms of the biology, we're still picking the low hanging fruit — and there is a lot of low-hanging fruit! For the proteins we study, there are 150 of them in a human cell, but about only 20 of them have been studied in detail. So there's still a lot of basic science to do. Beyond that, the big challenge is how to deal with and visually represent the huge volume of data we are generating. We'll need to develop better ways of doing this.

PROMOTE:
Healthy People,
Healthy Communities,
Healthy World

DANIEL ROTH

Assistant Professor, Departments of Paediatrics and Nutritional Sciences, University of Toronto
Clinician-Scientist, The Hospital for Sick Children
PhD, Johns Hopkins University, 2011

When he was a medical student, Daniel Roth did an internship with a public health research team in Peru. It was an experience that opened his eyes to the challenges of people living in resource-limited regions of the world. Today he is focused on two fronts. As a clinician, he treats children at The Hospital for Sick Children. As a scientist, his work takes him to the other side of the globe where he conducts research on maternal-infant nutrition and infectious diseases in Pakistan and Bangladesh.

We seem to be paying more attention to child and maternal health in recent years. What's the scope of the challenge?
Worldwide, between seven and eight million children under the age of five die every year, mostly in low-income countries. Fortunately, that number has been decreasing annually. There have also been declines in the rates at which women die during or shortly after pregnancy. The United Nations Millennium Development Goals (MDGs), which are to be achieved by 2015, are widely used as indicators of progress in global public health promotion and poverty reduction.

Tell us about your work.
My primary field of interest is child nutrition. Globally, it has been estimated that about one-third of child deaths before age five are caused by nutritional deficiencies. My current work is looking at the role of vitamin D status in pregnancy. One of our key questions is whether infants born with larger vitamin D stores have better growth and stronger immune systems that enable them to more effectively fight infections.

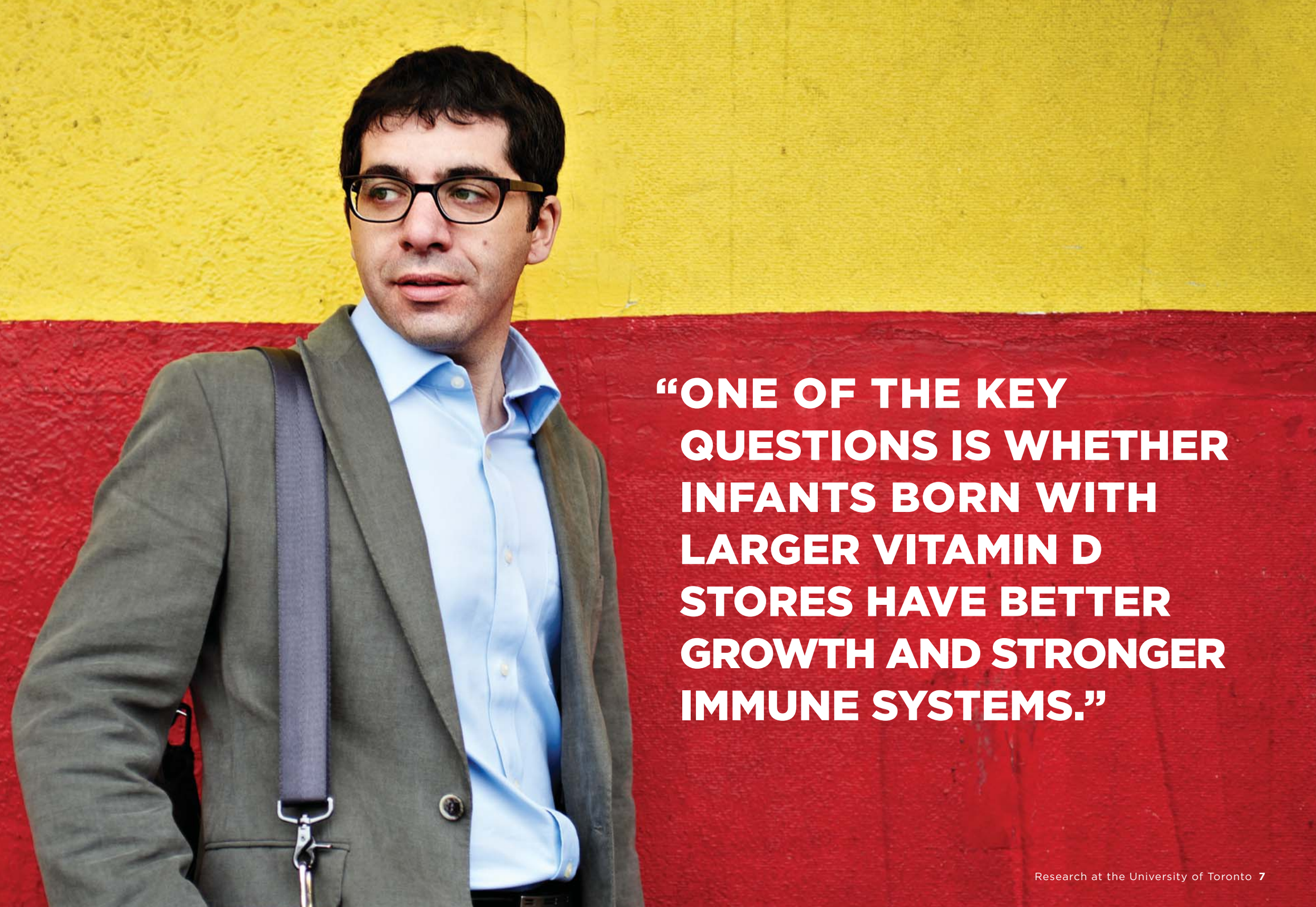
Are you seeing progress in the field of child and maternal health?
There has been important progress in both maternal and child health indicators. For example, in Bangladesh they've seen reductions in child mortality and they will probably achieve the child health MDG, which is a two-thirds reduction in the child mortality rate.

Biomedical innovation is only a part of the picture. Economic development — although a more nebulous goal — is ultimately more important. Countries have to be able to finance health. For example, they have to be able to purchase enough vaccines for their entire population, as well as maintain a health system that can distribute those vaccines.

We overestimate the role of our deliberate actions — say, building a hospital — and underestimate the role of less easily measured factors. We know, for example, there's an important association between literacy and child health — if you educate girls who become educated mothers, we are pretty sure they will have healthier babies. But that's not easy to measure or implement.

Looking to 2027, what will change?
One change that will happen within the next 15 years is in how we think about progress in global public health. There's going to be a formal rethinking of this as we approach 2015 because that's when the MDGs will mature. Some countries will have done better than others. But I have no doubt there will be an initiative to establish new targets and mechanisms to strengthen the ways in which progress is monitored.

In my own field, we are already seeing a greater emphasis on child neurodevelopment — moving beyond the idea that if children survive to the age of five, that's success. There will be more recognition of the fact that children need to continue to develop to become happy, healthy and productive members of their community.



“ONE OF THE KEY QUESTIONS IS WHETHER INFANTS BORN WITH LARGER VITAMIN D STORES HAVE BETTER GROWTH AND STRONGER IMMUNE SYSTEMS.”

"THE QUESTION IS CAN WE USE LIGHT FOR COMMUNICATIONS BETWEEN COMPUTERS, BETWEEN CHIPS AND ON A SINGLE CHIP?"

JOYCE POON

Assistant Professor, Edward S. Rogers Sr. Department of Electrical and Computer Engineering
PhD, California Institute of Technology, 2007

As a high school student, Joyce Poon was interested in medicine. A summer job in a physics lab introduced her to photonics — the study and use of light. Now she's thinking about how to use light to change computing as we know it.

Tell us about your research.
I work in photonics — the study of light. My group invents tiny photonic devices that you can't see with the naked eye. The devices we work on have features that are about 1/500 the width of a human hair.

The idea is that photonic, or optical, devices would eventually replace some traditional electronic components in things like computers, right? What's the difference between photonics and optics?
Electronics and photonics work together. Electronics work well for computing and processing data. Light is great for moving large volumes of data. Inside computers are components that need to talk to each other — this is currently done by transmitting electrical signals over metal wires. Wires connect the computing units within a data-centre, chips within a computing unit and different parts of a single chip. A major challenge, especially for very large data centres, is their power consumption. A lot of this power is being spent on communication, which now exceeds that spent by the electronics on computation.

My group is researching the photonic devices that can change some of the wire connections to optical connections, which can be much more energy efficient. We already use fibre optics to communicate over very long distances. The question is can we use light for communications between computers, between chips and on a single chip? The challenge in adapting photonics to computers is to make high-performance optical devices that are small, energy efficient and densely integrated with the electronics.

Can you give us a sense of the scope of the power consumption we're talking about?
Currently the global power consumption of data centres is about 220 billion kilowatt hours a year. In the U.S. alone, the cost of this energy is about $10 billion a year. And it's growing at an exponential rate. It's not sustainable.

How did you get interested in this work?
I was planning to do biomedical research but after my second year I had an offer from the physics department for a summer research position. My mom encouraged me to take it, saying, "You're going to do biomed for the rest of your life!" So I went to the physics department and worked on a laser. Then I took a wonderful course called "Physical Electronics," which introduced me to the field of electronic and optoelectronic devices. I thought it was the greatest thing ever — a discipline that sits between science and engineering that allows you to apply discoveries in physics to design and make useful devices that are foundational to all electronic and computer technologies.

What do you see for 2027?
By 2027, I think we will see optics and electronics working together in a densely integrated way in microchips, in data centres, as well as in personal computers and multimedia hubs in our homes. There are great advances happening in electronics and across the disciplines in electrical and computer engineering. Together, these developments will change how people live, work and interact.

"IT'S IMPORTANT TO ANSWER THE QUESTIONS, 'ARE WE ALONE?' AND 'WHERE DID WE COME FROM?'"

SABINE STANLEY

Associate Professor, Department of Physics
PhD, Harvard University, 2004

Growing up in northern Ontario, Sabine Stanley used to gaze at the stars. "I always thought it was comforting to know they were out there," she says. Today, an expert in the study of magnetic fields, she's sifting through the sky, looking for evidence of Earth-like planets.

Why study magnetic fields?
Our magnetic field shields us from the solar wind, which is made of high energy particles that come from the sun. If a rocky planet has a magnetic field there's a better chance that it's hospitable to life. Magnetic fields also tell us about our planet's history. As rocks on Earth's surface cool out of lava, they freeze in the magnetic field at the time that they formed.

How can you tell if a planet has a magnetic field?
Without being near the planet, it's difficult but not impossible. We actually knew about Jupiter's magnetic field in the 1950s — long before we sent probes there — because radio emissions get beamed to us. When a planet has a magnetic field the solar wind particles can cause electromagnetic radiation when they interact with this field. We can sometimes see that. Most of the ways we have of finding planets involve detecting the effect they have on their stars, whereas this would be a signal from the planet itself.

Why is this work important?
Imagine if we knew that there was life elsewhere. It would have a profound effect on our beliefs. I think it's important also to answer the questions, "Are we alone?" and "Where did we come from?"

Do you think there is life elsewhere?
If it formed here it likely formed elsewhere. We just have to figure out how to find it.

Looking ahead in our crystal ball — it's 2027 — what's happening?
We will have found many Earth-sized planets from a variety of detection methods. The Kepler mission recently detected the first Earth-sized planets, so by 2027 we'll have lots of them. Some might be in what's called the "habitable zone." We like to think that water is important for life, but you have to be a certain distance away from a sun so that the water is liquid. Right now we can't detect Earth-sized planets there, we can only detect them really close to the parent stars. By 2027 we'll have found other solar systems like ours. Maybe we'll have indications of intelligent life on those planets — that's the long shot.

How would we know if there was life on one of these planets?
Signs of life include oxygen and ozone in the atmosphere — and radio emissions. We've beamed radio emissions to space, so maybe we can detect these types of things from other planets. Then we'll be able to say there's a good chance that there's an intelligent society there.

Would we be able to communicate with them?
We'd send them a message but it would take a very long time for them to send a message back — tens to hundreds of years. So there are communications issues!

“CLIMATE CHANGE IS REAL. IN THE NEXT 15 YEARS, CLIMATE IMPACTS WILL INTENSIFY AND BECOME THE DOMINANT CHALLENGE OF OUR TIME.”

LINDSAY SCHOENBOHM

Assistant Professor, Department of Geology and
Department of Chemical and Physical Sciences, U of T Mississauga
PhD, Massachusetts Institute of Technology, 2004

Lindsay Schoenbohm found her passion for our planet when she was in Grade 8 at Roosevelt Junior High in Appleton, Wisconsin. "I took an earth science class with an extremely enthusiastic teacher, Connie Roop, who I'm still in touch with." Today, Schoenbohm is examining how Earth's geology is linked to climate at field sites in Argentina, China and Turkey.

Your research focus is tectonic geomorphology. What does that mean?
Tectonics refers to the plates that make up the surface of the Earth. As these plates move around, they are responsible for phenomena that are of interest to society, such as earthquakes, and the formation of mountains and mineral deposits. Geomorphology is the study of landforms at the surface of the Earth and the processes that shape them, such as rivers and glaciers. Ultimately, my focus is on understanding tectonics but using the geomorphology of the surface of the Earth as a tool to explore it.

Why is this work important?
I teach a big intro class and I love doing that because I have the potential to impact the way students think about the Earth. One of the special things about geology is that it deals with deep time — billions of years. Another challenging aspect of it is that you can't do experiments in the same way that you can with other sciences because of the spatial scale and this deep-time aspect. There's always something missing because the information has eroded. It's like detective work — you have to piece together these clues and use partial information to find the most probable story. Also, this work is not just about rocks. It's incredibly relevant to two of the major issues facing the world today — natural resources and climate change.

How do we get the planet to 2027 in a healthy way?
All the resources we have on the planet are under pressure right now. We have to be better at finding and extracting them and we have to do so more cleanly and safely. And we need to find energy alternatives. Earth science is at the heart of this. Climate change is real. In the next 15 years, climate impacts will intensify and become the dominant challenge of our time. Climate is also a political issue. Earth scientists will continue to improve the scientific findings, but we understand the situation well enough right now that society should be acting. But taking action is primarily in the hands of government and there has been a disconnect between science, politics and public perception. We all need to get connected.

What's next for you?
I have ongoing projects in China and Argentina, but I just started a new project in Turkey. There have been a couple earthquakes in eastern Turkey recently caused by movements on active faults. I'm working with a team on active faults just to the west of this region. This is part of a multidisciplinary project looking at how processes in the deep mantle relate to faults at the surface and to changes in topography. Climate is tied to this story as well. By studying the rock record of climate change we can understand how mountains have uplifted in the past and how our modern climate may evolve.

How do you learn innovation?

To manage the challenges that will always face global society, we will need generations of innovative minds in every discipline. In addition to its role as one of the world's leading research institutions, U of T is also renowned as a community where the innovators of tomorrow learn about the complexities of life on Earth — and how to apply their knowledge to the quest of creating a brighter future.

We are pleased to introduce you to 14 people currently learning to innovate at the University of Toronto.

TOMORROW'S

LESLEY DOOKIE
PhD student, Ontario Institute for Studies in Education of the University of Toronto

Working with:
Prof. Indigo Esmonde

Hometown:
Toronto, Ontario

MICHAEL GLUECK
Master's student, Department of Computer Science

Working with:
Prof. Daniel Wigdor

Hometown:
Toronto, Ontario

RINALDO CAVALCANTE
PhD student, Department of Civil Engineering

Working with:
Prof. Matthew Roorda

Hometown:
Fortaleza, Brazil

STEFAN FERRARO
PhD student, Department of Political Science

Working with:
Prof. Christopher Cochrane

Hometown:
Newmarket, Ontario

ASHLEY MARIKO AIMONE
PhD student, Dalla Lana School of Public Health

Working with:
Profs. Stanley Zlotkin and Donald Cole

Hometown:
Toronto, Ontario

MINA TADROUS
PhD student, Leslie Dan Faculty of Pharmacy

Working with:
Prof. Suzanne Cadarette

Hometown:
Toronto, Ontario

INNOVATORS

JULIE-ANNE GANDIER
PhD student, Department of Chemical Engineering and Applied Chemistry

Working with:
Prof. Emma Master

Hometown:
Ottawa, Ontario

ALEX MACKAY
Master's student, Department of Electrical and Computer Engineering

Working with:
Prof. Joyce Poon

Hometown:
Moose Jaw, Saskatchewan

RYAN VILIM
PhD student, Department of Physics

Working with:
Prof. Sabine Stanley

Hometown:
Thunder Bay, Ontario

BONNIE HAYDEN CHENG
PhD student, Rotman School of Management

Working with:
Prof. Julie McCarthy

Hometown:
Toronto, Ontario

JEAN-PHILIPPE LAMBERT
Postdoctoral fellow, Samuel Lunenfeld Research Institute, Mount Sinai Hospital

Working with:
Profs. Anne-Claude Gingras and Tony Pawson

Hometown:
Ottawa, Ontario

SAMAR ZARIFA
Master's student, John H. Daniels Faculty of Architecture, Landscape, and Design

Working with:
Prof. Aziza Chaouni

Hometown:
Abu Dhabi, United Arab Emirates

JEFF GEDDES
PhD student, Department of Chemistry

Working with:
Prof. Jennifer Murphy

Hometown:
Hamilton, Ontario

RENJIE ZHOU
PhD student, Departments of Geology and Chemical and Physical Sciences, U of T Mississauga

Working with:
Prof. Lindsay Schoenbohm

Hometown:
Nanyang, Henan Province, China

"TRANSPORTATION IS ABOUT HOW PEOPLE MAKE CHOICES."

MATTHEW ROORDA

Associate Professor, Department of Civil Engineering
PhD, University of Toronto, 2005

We all know the frustration of being stuck in traffic, or on an overcrowded bus. But most of us don't spend much time thinking about the *other* side of the transportation system — the part that moves goods. Matthew Roorda studies the hidden impacts of the freight transport system.

What's the focus of your research?
Our transportation system is shared between people and freight. I've been focusing on freight transportation. I'm looking at how businesses interact with one another, how they form supply chains, how they contract with one another for logistics services and eventually how that translates to trucks on the road. I'm trying to figure out the best infrastructure and transportation policies so goods can move efficiently. This means benefits for the economy but also for the sustainability of our transportation systems.

We also simulate traffic and truck flows on the roads, simulate emissions that are coming from those vehicles, how those emissions are dispersed through the air and how they affect the population. Then we can look at the impact of a government policy. For example, we have analyzed what the emissions effects would be if we were to substitute low emissions vehicles for medium-duty diesel trucks. When you replace some of the older high-emitting trucks with brand new hybrid electric engines, how much emission reduction do you get? And who benefits from that and where?

How did you get into this?
A lot of civil engineering is about hard physical infrastructure — beams bending, how much load can a building withstand and so on. But I like the human element, this idea that there's an interaction between humans and the infrastructure. That's what attracted me to transportation. It's very much about how people make choices.

Looking forward to our 2027 date, what has to happen to make our freight system more sustainable?
We need policies to encourage shorter-distance travel and we're going to have to look at more efficient means of getting goods from their points of origin to consumers. One of the solutions is e-commerce. It's better to have a truck making many deliveries on one tour than to have everybody in their private automobiles travelling longer distances to get that product.

How we organize our cities is also important. Because of population increases, there's a lot of pressure to build residences encroaching on industrial land and that tends to push industrial uses farther out. It's a conundrum: we want people to live in the city so they can make use of public transit, but then we have all of this freight that has to move much longer distances. We have to somehow come to grips with this competition for land.

When you're driving along Highway 401 are you just driving like a normal person or are you constantly counting trucks?
I do count trucks! But not personally — I have sensors installed on the side of the 401 that speak to trucks as they're passing by. I can't help but to check whether my sensors are still up there when I pass by.

"SHAKESPEARE REMAINS AN ENORMOUSLY INFLUENTIAL INTERNATIONAL CULTURAL FORCE."

HOLGER SYME

Associate Professor, Department of English and Department of English & Drama, U of T Mississauga
PhD, Harvard University, 2004

Holger Syme's expertise begins with William Shakespeare and extends to early modern theatre history, bibliography, literary theory and performance studies. He has recently published *Theatre and Testimony in Shakespeare's England* and is now embarking on a project that will examine how plays became books in the 1590s. "A printed play is a very different work of art from a performance. I want to know what made people think plays could be enjoyed as books and what this says about their culture — and about ours."

How did you become interested in this field?
I always knew I wanted to be an academic. I could never imagine not hanging out with books. There was a time in graduate school, though, when I wasn't sure if I might not prefer directing to writing about plays. So I worked in theatre and film for two years, but scholarship won out. I remain committed to the study of drama and especially of performance as a broader cultural phenomenon. UTM allows me to pursue my interests in a way that is unique in Canada. Our theatre and drama studies program combines conservatory training and serious academic inquiry into the history and theory of theatre. I couldn't imagine a better teaching situation.

Some people wonder about the relevance of the humanities and people like Shakespeare in today's global society. What's the point?
The humanities study human cultural activity and interactions. Knowing what we as a species have done or created over the centuries is inherently valuable. Civilization requires that kind of knowledge. We lose something that's essential to being human if we ignore that.

Shakespeare remains an enormously influential international cultural force. That in itself makes Shakespeare a subject worth studying, historically and critically.

But I don't think Shakespeare speaks great universal truths. In fact, he is very shifty, incredibly malleable. Take *Henry V.* Is it a pro-war play, about English unity in the face of overwhelming French forces, about manliness, endeavour and valour? Or an anti-war play about war crimes, political cynicism, and *realpolitik?* It works either way.

Shakespeare can be, and has been, co-opted for a huge variety of purposes. And that makes him unusual. Many authors famed in his time, such as Ben Jonson, are almost inaccessible now because they are so specific in their frame of reference. Jonson pins you down. Shakespeare is impossible to pin down. And that's why he could never become irrelevant.

How will the humanities fare in 2027?
If you do historical work, some things aren't going to change, because they can't. You will always look at documents and artifacts. It's the only way you can engage with the past — by encountering its texts and fragments. But what happens in that engagement is going to differ from generation to generation because ways of reading change historically. I can't predict the circumstances under which we'll be reading in 2027. But we'll still be reading in the humanities unless we stop being human. I hope there will be more ways of accessing information, making it understandable in new ways, opening it up to new interpretations. Mostly I hope things will be more democratic. The great challenge now is that many great electronic resources are incredibly expensive. I hope there will be more open access and that these conversations can become more inclusive.

EMMA MASTER

Assistant Professor, Department of Cell & Systems Biology and
Department of Chemical Engineering & Applied Chemistry
PhD, University of British Columbia, 2002

For most people, engineering brings to mind machines, chemicals and computers. But Emma Master is rethinking how we can harness the secret powers of plants — some of nature's most complex structures. The ultimate goal? Breaking our addiction to plastic.

Tell us about your work.
My group develops biological tools to produce new types of materials and chemicals from plants that could be used in place of petroleum-based products. What nature gives us in the form of plants is wonderful, but they're not always perfect for the applications we need. So we modify their chemistry using biocatalysts or enzymes, which are naturally-occurring substances that promote biochemical reactions. Reactions with enzymes can be done at lower temperatures and with less harsh reagents than many existing alternatives, so their application helps to ensure that both the end product, and the way it is produced, are sustainable.

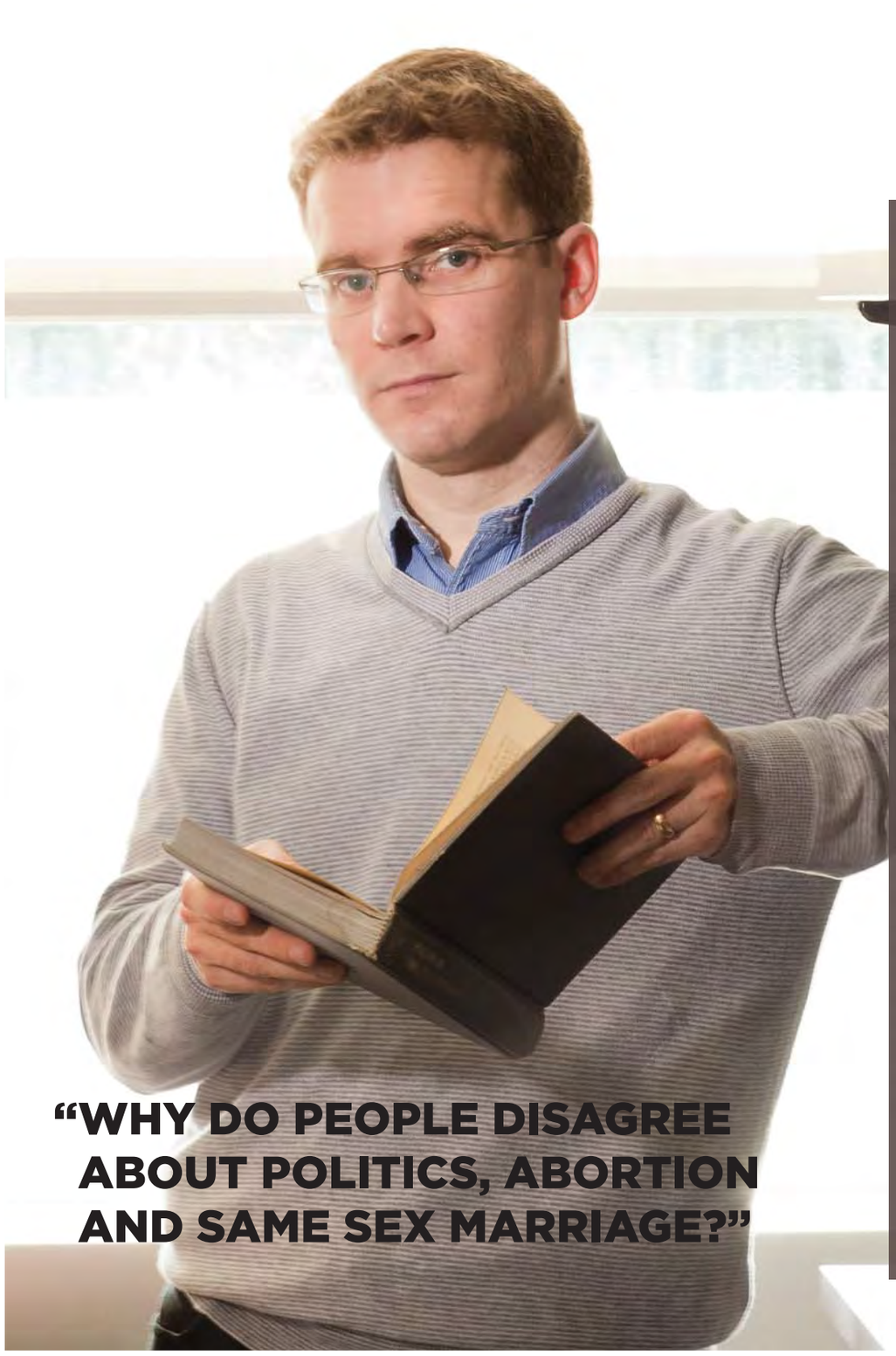
What kind of applications are you thinking about?
When considering the types of products that could be synthesized using the bioprocesses we are developing, I think single-use packaging materials are an important target. In most cases, the material used to package food becomes contaminated and so is difficult to recycle. While our current goal is substitution of plastics for something that is bio-based, in the future we want to improve upon the materials we currently use. For instance, one of the main reasons for food waste is food spoilage. We want to develop plant-based packaging materials that would reduce microbial decay of food and enhance preservation.

How did you get interested in this?
I had an instructor at a CEGEP in Montreal who introduced us to microbial genomes. I had understood microorganisms to be agents of disease, but hadn't realized that the vast majority are our friends and could be harnessed to substitute industrial chemical processes with more renewable bioprocesses.

It's 2027. Do you think that we will have made some progress in terms of replacing plastics?
Yes. We already see some of these biopolymers in our daily lives. Their sustainability is still questionable, though, because they tend to be based on food-related plants, displacing them from the food supply. We're trying to unlock the complexity of those plant components that aren't food-related. The question is — how do we effectively disassemble non-food related plant components and then reassemble them into something useful? Plants and other biological systems offer complexity, diversity and "programability" through genetic engineering. Some of the most ornate structures that we know are based on living systems. And we haven't really harnessed the complexity and malleability of them yet.

Transitioning from practices that harm the environment to more sound ones is going to be difficult.
My research is trying to enable this transition. We say "no more plastics," but what is the alternative? Our high standard of living currently relies on many plastic products, so we need to discover and develop alternatives. That's what many of us in this field of science and engineering are trying to do. And although the current aim of bioproduct development is often substitution of petroleum products, I believe that we can make something much better and much more interesting than replacements for existing plastic-based materials if we start to harness what we learn through genomics.

"WE SAY 'NO MORE PLASTICS,' BUT WHAT IS THE ALTERNATIVE?"



"WHY DO PEOPLE DISAGREE ABOUT POLITICS, ABORTION AND SAME SEX MARRIAGE?"

CHRISTOPHER COCHRANE

Assistant Professor, Department of Political Science and Department of Social Sciences, U of T Scarborough
PhD, University of Toronto, 2010

Left-wing, right-wing. Why do people divide themselves along political lines on major issues? This topic — which affects everyone's life — has fascinated Chris Cochrane since he was a Master's student. Today he is analyzing political disagreement using complex statistical analysis.

What is your research focus?
My main research interest is political disagreement — why people disagree about politics, abortion, same sex marriage, immigration and similar topics, the structure of political disagreement and how that ties into patterns of party policy, political competition and strategy. That's my big picture research agenda. At a more manageable level, I'm interested in left/right political disagreements and how they've changed over time.

How did you get interested in this field?
When I went to McGill, that was really the first time I realized the intensity of conflict around not only ideas but even cultural conflict. I can remember showing up to hear a speaker and there were police cars everywhere. The first thing that struck me was that intelligent, sophisticated people disagreed passionately about issues, even given the same evidence.

The left-right debate on many topics never seems to ease up. In fact, it seems more intense than ever.
These debates endure because people on opposing sides think about them from the standpoint of different sets of considerations. These are not debates about evidence, so to speak, even if they are sometimes pitched in these terms. An Occupy protestor is not going to abandon his tent if only he could see that free-market capitalism facilitates economic growth. An affluent conservative trader at the Chicago Mercantile Exchange is not going to join a revolution if only he could see that free-market capitalism leads to inequality.

People develop affective orientations toward different objects, groups and ideas. Topics that engage these orientations have the potential to generate emotional and enduring disagreements precisely because they are evaluated according to different criteria by those on opposing sides.

What does this hold for society over the next 15 years?
Social and political conditions are hard to predict in their own right and, importantly, these conditions do not determine what politicians must do, though they do limit what politicians can do if they want to succeed. In other words, they shape opportunities and incentives. In the Canadian context, a consequential political condition, certainly, is the rise of the NDP and its new dependence on support from Quebec. If the NDP continues to succeed, watch for a competitor to try to shift political discussion away from left-right issues that unite the NDP and toward Canada-Quebec issues that divide it. The NDP will try to do the opposite.

A consequential social condition in Canada is the changing pattern of immigration and a corresponding re-framing of the immigration discussions away from the traditional lines of multiculturalism and diversity and toward new considerations of reasonable accommodation and religion. Latent opinions about Canada-Quebec and religious accommodation are examples of opportunities that political leaders may, for a number of reasons, choose to pass over. There is an enduring repertoire of other issues, however, from which they can draw.

"UNLESS YOU HAVE SYMPTOMS REMINDING YOU TO TAKE THE MEDICATION, IT CAN BE HARD TO UNDERSTAND THE PAYOFF."

SUZANNE M. CADARETTE

Assistant Professor, Leslie Dan Faculty of Pharmacy
PhD, University of Toronto, 2006

Suzanne M. Cadarette became interested in osteoporosis when it struck her grandmother. "I was away at university and would return home to visit every four months," she remembers. "I literally witnessed the crippling consequences of untreated osteoporosis through my grandmother's experience."

Can you tell us about your research?
I'm interested in studying drug effects, and in particular, the methods we use to examine the safety and effectiveness of drugs. Think about how drugs get on the market — largely by randomized controlled trials of relatively small numbers of fairly healthy patients whose compliance is well controlled. And drugs are compared to placebos, meaning that they have to work compared to nothing. Once a drug is on the market, doctors have free range in terms of how they prescribe it. But the way drugs work in the real world is often different from what we see in trials. People don't always take drugs the way they are supposed to, or they may be taking them along with many other drugs, which can lead to unforeseen interactions.

I'm also interested in improving adherence to medication, particularly for asymptomatic conditions like osteoporosis. It can be hard to take a medication regularly when you don't have symptoms. With osteoporosis you don't necessarily have pain until you have a fracture. It's similar with high cholesterol and hypertension. Unless you have symptoms reminding you to take the medication, it can be hard to understand the payoff. This impacts behaviour. So once a new drug hits the market, not only are there potential safety issues and the need to consider the benefits of the new drug versus existing therapies, but patient behaviours may jeopardize benefits.

When you say, "pharmacy," we think of the drug store, but the field is changing, isn't it?
The scope of pharmacy practice is expanding from drug dispensing, to a more active role in disease management and helping patients understand how drugs work. Pharmacists are now trained to take a social behavioural approach with patients. With so many new drugs coming to market, doctors often don't have enough time to stay on top. More interprofessional teamwork will help improve healthcare and the health of Canadians.

What else do you do you see in the field for 2027?
First, we need better data so we can do a better job of studying the safety and effectiveness of drugs.

In terms of pharmacy practice, I see the use of technology skyrocketing. More patients will communicate with pharmacists and other healthcare professionals using interactive media. I also see a movement towards packaging information about drug safety and effectiveness in a way that resonates with the public. One of the challenges now is that the media tends to publicize potential rare adverse drug effects. But then patients stop taking their important preventive medications. It's hard to combat that. There's a huge potential to improve health literacy about the safety and effectiveness of prescription medications and we can work towards developing evidence-based resources that the public can trust.

"MORE PEOPLE UNDERSTANDING MORE MATH IS BETTER FOR DEMOCRACY."

INDIGO ESMONDE
Assistant Professor, Ontario Institute for Studies in Education of the University of Toronto
PhD, University of California, Berkeley, 2006

Indigo Esmonde is combining a background in math and a commitment to social justice to imagine a different world.

Tell us about your research.
I work with teachers who want to bring social justice issues into the math classroom. Thinking deeply about issues of equity is more often done in social studies classrooms, but if math is not a part of it then we're missing something. One of the biggest reasons to learn math is to make the world a better place.

I also work outside of schools. I've done studies of math learning in various contexts. Right now I'm doing a study of the Stop The Cuts movement in Toronto. I want to help people leverage mathematics to understand what governments, politicians and corporations are trying to do.

How did you get into this idea of leveraging math as a tool for a broader purpose?
I majored in math in undergrad — it was fun and interesting — and went on to do a Master's. I was involved in a lot of community organizing, in activism around globalization and gender issues. I was doing math all day and then going to these demonstrations. I ended up going to Berkeley to do a Master's and PhD in Education to bring together these two parts of my experience. Math itself is less and less important to me, except that it is such a powerful tool and is used by people in power. And I think what mathematicians know, and what people who haven't studied math don't know, is that mathematical models are political. Before you even get to doing the math you make a set of assumptions about the world that you then turn into equations and graphs. We need to know what those assumptions are.

Why is math scary for so many people?
Some things are hard to learn. Because math is hard, this idea of it only belonging to a certain group of people gets perpetuated. Identity is a big part of the frameworks that I use for thinking about learning. If math is seen as something that only geniuses do, that has an impact.

Why is the research you're doing important?
Mathematics is a huge gatekeeper. If you don't do well in math, chances are you're not going to do well in some other subjects. But beyond that, more people understanding more math is better for democracy. Barring people from mathematical knowledge is a civil rights issue. Bob Moses, who was an American civil rights worker in the 1960s, has spent the last 30 years teaching kids algebra. It used to be they wouldn't let you register to vote if you weren't literate. Now lots of doors are closed to you, including participation in a democratic discussion, if you don't know the mathematics that's being used to make decisions.

What do you see for life in 2027?
I would love to think that mathematics will get taken up in community organizing as one tool among many to build a better and more just society.

JULIE McCARTHY

Associate Professor, Department of Management, U of T Scarborough and Rotman School of Management
PhD, University of Western Ontario, 2003

Married with two young children, Julie McCarthy is faced with the challenge of managing work-life balance as much as anyone. The difference is that she lives it — *and* studies it.

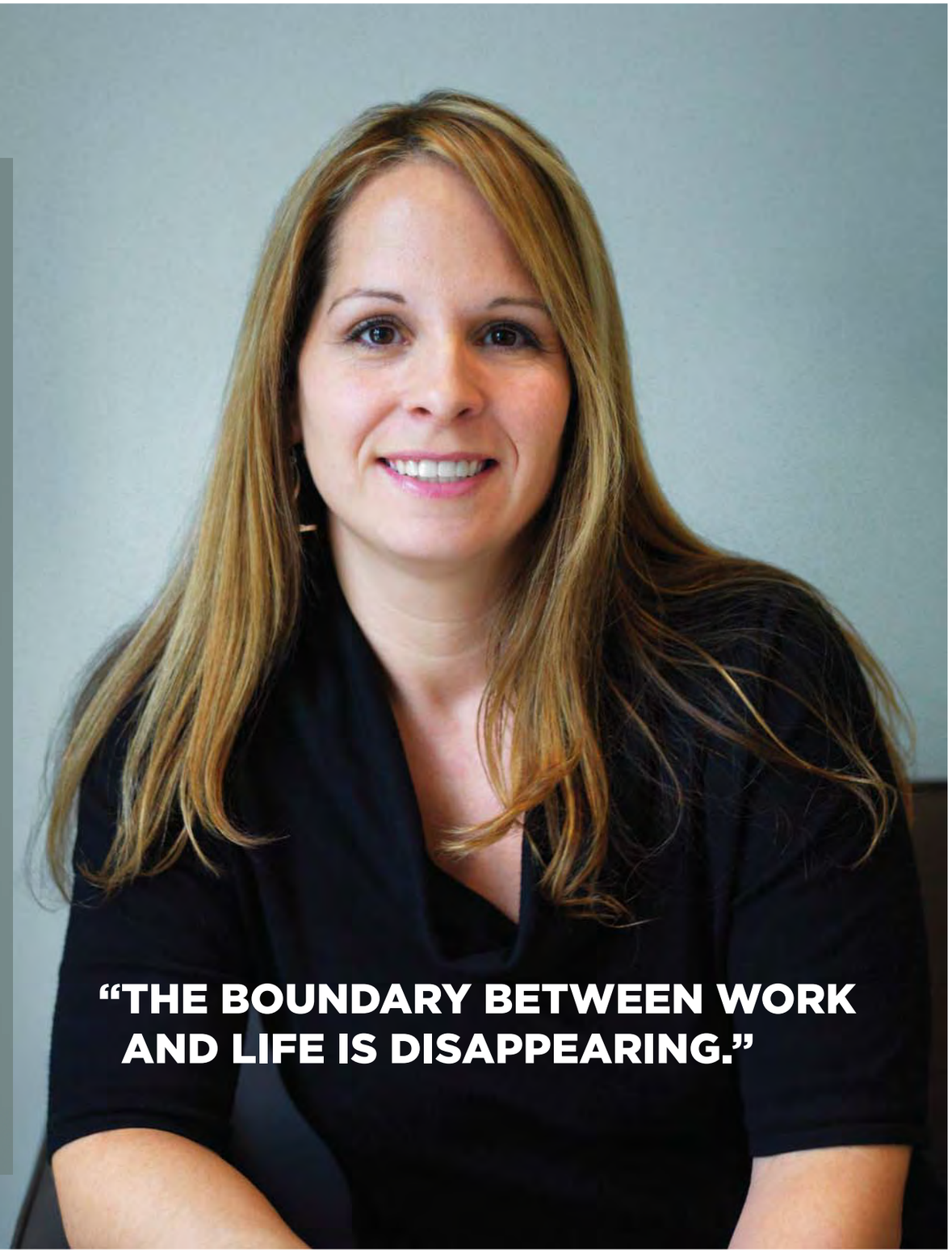
What's the focus of your work?
I examine organizational issues from the perspective of the employee. My ultimate goal is to identify the tools that people can use to achieve balance in their lives. I extend past research, which has focused on organizational policies and procedures such as flex time, by helping to empower employees to achieve balance. I've started to do this by focusing on coping behaviours and other strategies that can help employees recover from the stress of work and family life. Along this line, I plan to develop specific recommendations for workers around managing boundaries and helping people self-regulate their work and family time.

Why is work-life balance so tough?
The boundary between work and life is disappearing and as a result our jobs are highly integrated with our family life. It's something society is struggling with more and more. Part of the problem is that many people lack the resources to effectively divide their time and manage their priorities. So, people find themselves on a chaotic treadmill. A critical question is, "What's going to work best for my family and me?" We may need to ask if it is necessary to shut off our smart phones when we get home until the kids are in bed. These important questions have no firm answers because this new culture has happened so quickly that the research hasn't caught up to it yet. My goal is to pinpoint how people can most effectively achieve work-family balance.

Looking forward to 2027, are we going to solve the work-life balance problem?
We've reached a climax with the problem of blurring boundaries. Our fast-paced and high pressure economy, increased levels of anxiety and stress and competition for jobs are just some of the factors. We can't possibly ignore the problem. It's too critical. Again, I want to emphasize this point — critical not just from an economic perspective, or from the company's point of view — but critical for our children, families, communities and the health of our society. I'm optimistic that we will be able to identify a number of strategies for people to successfully achieve balance.

What's next for your research?
I have plans to expand the work-life balance literature to look at the implications of imbalance and conflict on children, partners and even on parents. This hasn't really been examined yet. What are the implications for my children if I have conflict across my various roles? What strategies will help buffer my children from any negative effects of work-life conflict?

I also want to study the impact of technology use on work-family balance. It's unrealistic to tell everybody to throw their smart phones in the garbage. But I do believe that if we look outside the box, we will find some innovative and clever ways to encourage people to achieve balance.



"THE BOUNDARY BETWEEN WORK AND LIFE IS DISAPPEARING."

IMOGEN DICKIE

Associate Professor, Department of Philosophy
D. Phil, Oxford University, 2003

In her first two years at the University of Canterbury in New Zealand, Imogen Dickie majored in math and physics. Then philosophy captured her imagination. "I got drawn in by questions like, 'What is a law of nature?' and 'What is a genuine explanation?'" Today, Dickie is one of Canada's leading young philosophers.

What does it take to be a good philosopher?
It's really a combination of precision and creativity — being able to think creatively while holding yourself to standards of precise expression and rigorous argumentation and being able to bring these standards to your assessment of other people's work without losing sight of how it is creative. And if you can get undergraduates to develop even a little of this kind of conceptual skill, it's a great thing for them.

What is your research focus?
My research is in the philosophy of language and mind. If you look at my dog sitting on the couch there, you have a visual experience and there's a causal story that psychologists can tell you about how the experience is produced. But then there's an additional question: How is your perceptual experience putting you in a position to think about the thing you are perceiving? The answer has to explain how your perceptual relation to a thing in the world justifies your beliefs. And it has to explain why the truth or falsity of your beliefs depends on what this particular thing is like. Then there are further, related, questions about how language enables us to communicate our thoughts to one another. I'm writing a book on these questions right now.

How is philosophy important to our future?
I think the study of philosophy is one way that we can keep the traditional intellectual virtues alive. One of the great things about education in Canada is that the professional degrees are graduate degrees, so everyone who goes to university starts out with a general undergraduate education. You might think, "Why bother getting a general undergraduate education when if there's something factual you need to know you can just Google it?" Subjects like philosophy teach people how to be reflective, conceptually creative and critical.

To get to 2027, is there something we need to do more or less of?
One thing we need to do is think more about what's important to us and how we should act to secure and safeguard the things we really value. An example is the fate of future generations. Of course we care about what people's lives are going to be like in the future. Yet we continue to behave as if it doesn't matter. Our post-industrial history has involved repeated instances of coming up with solutions to problems that have enabled us to go on using up the planet comparatively thoughtlessly. But it looks like that approach is really not working anymore. We can't rely on the people who come after us to develop solutions to problems that we make or contribute to. We need to be reflective and critical — cut off problems rather than just keep contributing to them. That's one of the glories of a general undergraduate education — it creates a generally reflective population.

"OF COURSE WE CARE ABOUT WHAT PEOPLE'S LIVES ARE GOING TO BE LIKE IN THE FUTURE. YET WE CONTINUE TO BEHAVE AS IF IT DOESN'T MATTER."

AZIZA CHAOUNI

Assistant Professor, John H. Daniels Faculty of Architecture, Landscape, and Design
M.Arch, Harvard, 2005

Grassless golf courses in the desert. Hotels that can be built on shifting sand dunes. These are a few of the innovations Aziza Chaouni has developed as she contemplates a future in which our supplies of oil — and water — are dwindling.

How did you get into architecture?
I grew up in Fez, Morocco, which contains one of the oldest medieval cities in North Africa, called the medina. It scared my brother and sister because it was not on a grid and you could get lost easily, but for me the labyrinthine aspect of the medina was very enticing: it encouraged discovery. As a child, I owned cats, dogs, birds, rabbits, hamsters, turtles and even a rooster. I wanted to either be a vet or an architect. My aunt was an architect and I looked up to her. She was always looking at things with a critical eye.

A lot of your work is about sustainability, isn't it?
Yes. It is clear we are going to run out of oil. Some countries will run out of water soon. We have no choice but to completely rethink how we conceive of our built environment and how we live.

Tell us about your work.
After graduate school I backpacked the Sahara for six months looking at how buildings adapt to extreme conditions. I realized that architects can learn valuable lessons from these buildings that have no choice but to be off the grid. From a Western perspective, the developing world is rarely seen as a source of innovation. I believe that studying the developing world allows us to look at our cities differently. And developing cities are changing so fast — they require models specific to their contexts rather than carbon copies of Western cities.

My trip changed the way I perceive architecture and its relationship to sustainability. I initiated documentation of emerging typologies of architecture in deserts, trying to comprehend how they deal with energy and water. That led me to research I've been undertaking for the past three years with my colleague Liat Margolis, on innovative water technologies in arid climates. Useful technologies exist in other disciplines — agriculture, for example — but they're not brought into building systems. The goal of our team is to test how certain innovations — like a fog collecting system, or grey water recycling — can be integrated into building and landscape design.

Why is this work important?
According to the U.S. Energy Information Administration, buildings are responsible for 77 per cent of electricity consumption, and 47 per cent of CO_2 emissions. We talk about cars and factories, but everyone forgets about buildings.

Do you see any progress by 2027?
I'm an optimist — I don't like scenarios of doom. Our blessing is the fact that we're going to run out of oil so we'll need to find alternative solutions.

Running out of oil is a blessing?
It's an opportunity to transform the way we live. We will have to compromise, but what we don't realize now is that those changes might lead to a lifestyle that's actually better for our health and for our environment.

"WE HAVE NO CHOICE BUT TO COMPLETELY RETHINK HOW WE CONCEIVE OF OUR BUILT ENVIRONMENT AND HOW WE LIVE."

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THE QUESTION IS CAN WE USE LIGHT FOR COMMUNICATIONS BETWEEN COMPUTERS, BETWEEN CHIPS AND ON A SINGLE CHIP?

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