ROUNDTABLE DISCUSSION ON

SUSTAINING THE FUTURE OF OUR PLANET AND OURSELVES

THE 2019 WHELEN LECTURE
UNIVERSITY OF SASKATCHEWAN, SASKATOON
MARCH 26, 2019

UNIVERSITY OF SASKATCHEWAN

The Whelen Lecture and CSIP Women in Science Speakers Series

The *Whelen Lecture* is made possible by an endowment left by distinguished chemist Dr. Myron Whelen, who earned his PhD at the University of Saskatchewan. This generous bequest has supported an annual series of lectures by internationally renowned speakers who come to campus, give a public lecture and engage with faculty and students. The inaugural lecture was held in 1987.

After a gap of a few years, the University invited Dr. Roberta Bondar, Canada's first female astronaut and the world's first neurologist in space, to deliver the *2019 Whelen Lecture*, in conjunction with the Johnson Shoyama Graduate School's (JSGS) Centre for the Study of Science and Innovation Policy *Women in Science Speakers Series*. Dr. Bondar delivered her lecture in the evening of March 26, 2019, before an audience of more than 500 in Saskatoon and at a satellite site at the JSGS University of Regina campus.

UNIVERSITY OF SASKATCHEWAN

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Centre for the Study of Science and Innovation Policy
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The 2019 Whelen and Women in Science Roundtable Discussion

Earlier in the day, Dr. Bondar was our guest at a roundtable research discussion on the topic of scientific exploration across disciplinary boundaries and beyond the academy, with linkages to Dr. Bondar's presentation theme of 'Sustaining the future of our planet and ourselves." The roundtable took place at Convocation Hall at the University of Saskatchewan and included an audience of more than 45 faculty and students from a wide range of disciplines, each with an interest in sustainability.

The session was set up as a roundtable with a moderator, **Dr. Irena Creed** (PhD), Executive Director of the School of Environment and Sustainability, 12 invited speakers from across the 13 colleges and schools, and Dr. Bondar, as discussant.

Each of the 12 panelists (presented in order of speaking) were invited to present their perspectives on the topic through 3-minute statements.

Dr. Markus Hecker (PhD), professor and Canada Research Chair at the School of the Environment and Sustainability and with the Toxicology Research Centre, works on predictive aquatic ecotoxicology.

Dr. Chithra Karunakaran (PhD), Manager of the Canadian Light Source, investigates the use of different synchrotron-based microscopy techniques to improve the sustainability of food systems.

Dr. Suzanne Kresta (PhD), professor and dean of the College of Engineering, researches turbulent mixing, multiphase flow and process kinetics.

Jason MacLean (LLB), assistant professor and environmental lawyer in the College of Law, studies climate change policy and sustainability pathways for the planet.

Dr. Regan Mandryk (PhD), professor of computer science in the College of Arts and Science, is developing computer games to improve mental health.

Dr. Ivar Mendez (PhD, MD), professor and Provincial Head of Surgery, is a prominent neurosurgeon at the College of Medicine.

Dr. Vikram Misra (PhD), professor and microbiologist at Western College of Veterinary Medicine, has been a leader in the university One Health Initiative that focuses on the human-natureenvironment interface that is an integral part of planetary health.

Dr. Peter Phillips (PhD), distinguished professor and scholar of science, technology and innovation in the Centre for the Study for Science and Innovation Policy at the Johnson Shoyama Graduate School of Public Policy.

Martin Phillipson (LLM), professor and dean of the College of Law, and a national leader in Indigenous Legal Education.

Dr. Cherie Westbrook (PhD), professor and a wetland scientist in the College of Arts & Science, studies impacts of beaver on Canada's landscape.

Proceedings

Dr. Irena Creed: It is significant that Dr. Bondar will be speaking tonight on 'Sustaining the future of our planet and ourselves.' Planetary boundaries is a concept that was introduced early in this millennia, by academicians together with governments and industries, who wanted to define a "safe operating space for humanity" as a precondition for sustainability of the planet (Rockstrom et al. 2009a, b). According to this concept, transgressing one or more planetary boundaries may trigger abrupt environmental changes within continental to planetary scales, which may lead to catastrophic events. Today, two boundaries (biodiversity and biogeochemical flows) have already been crossed and others—including climate change—are in imminent danger of being crossed.

Within the modern university system, individual disciplines have been key in developing and motivating exploration over the past millennium. However, the 21st century has presented challenges that require us to transcend these disciplines.

We are increasingly confronted with an increase in what planners Horst W.J. Rittel and Melvin M. Webber (1973) called "wicked problems"—problems that cannot be solved but only managed. The increase in wicked problems reflects the fact that the planet is becoming increasingly unstable and unpredictable in the Anthropocene—the geological period during which human activity has been the dominant influence on the planet.

The global community has responded with the United Nations Sustainable Development Goals. These 17 goals are a universal call to action to protect the planet and ensure that all people enjoy peace and prosperity. But these goals are only moral imperatives.

We need to come together to translate these moral imperatives into transformative actions. We need to think differently, moving beyond individual disciplines to look at the intersectionality of all disciplines. And we need to train differently—generating graduates who will be able to solve wicked problems.

This roundtable has been convened to explore how we can work more holistically and effectively across the academy and beyond to ensure the future sustainability of our planet, how we can avoid further exceedance of planetary boundaries and return to a safe operating space for humanity, and how we can ensure the human health, well-being, and equity for every citizen of this planet.

We explore these questions through five themes.


THE
TIME

Theme 1: Canada needs a policy landscape that will ensure the future sustainability of the Planet

Dr. Creed: Jason, many of the claims and disputes about how we use our environment end up being adjudicated in the legal system. How has this venue accommodated the different world views, knowledge claims and interests of the disparate groups that contest this issue in the courts?

Jason McLean, College of Law: This question is at once timely and telling. An increasing number of disparate groups—from civil society organizations to Indigenous communities, from victims in the Global South to various sub-national governments in the Global North—are turning to the courts of western legal systems in search for an alternative to nation-states' endemic inaction on climate change. The question is symptomatic of the larger policy pathology of our time: the pressing need and persistent failure to act urgently and ambitiously on climate change.

Is climate litigation a viable alternative to our stagnant public policymaking process? It is easy to see why so many hope it might be. Courts are—ideally—independent of commercial and political interests and influence. Courts trade in ostensibly objective facts and evidence. Courts test competing truth claims through a robust adversarial process.

This much is true, as far as it goes. But it does not go far enough. We are in the midst of an ongoing and steadily worsening planetary health crisis. The UN Intergovernmental Panel on Climate Change's 2018 special report on the environmental implications of global warming to 1.5 ºC above the pre-industrial norm exhorts the global community to rapidly undertake unprecedented systemic changes to the way governments, industries, and societies produce and consume energy, use land, and develop critical infrastructure. This existential task will require, above all, coordination and integration of science and public policy across multiple levels of governance, diverse cultures and worldviews, and increasing socioeconomic inequality.

Courts of law are simply not equipped to address this challenge. Courts work slowly. They proceed carefully and cautiously, case by case. They eschew questions of public policy and politics; when they do consider such questions—such as the constitutionality of Canada's proposed national price on carbon emissions—they view such questions through the narrow lens of extant legal precedent. Because they are by design conservative institutions, courts look backwards before glimpsing at what the future might hold or what the future should hold. The evidence they consider must be established, certain, and beyond even a hint of uncertainty. New advances are viewed with skepticism, while so-called

"alternative" worldviews—particularly Indigenous knowledge claims—are hardly considered at all, much less integrated into existing law.

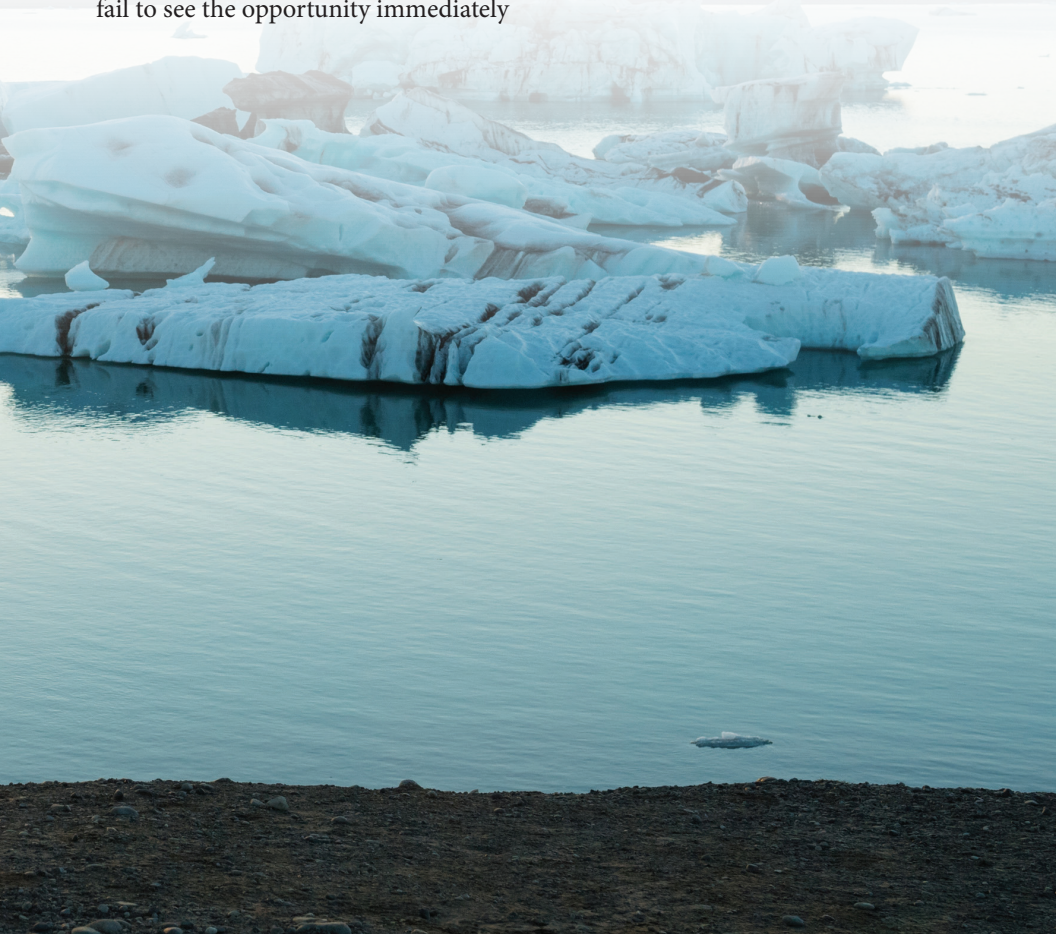
Indeed, the courts' core institutional competency—i.e. the testing of competing claims through an adversarial process in common law jurisdictions, and through a judge-led inquisitorial process in civil law jurisdictions—is simultaneously their most limiting feature when it comes to addressing climate change and sustainability.

Whereas courts are designed to resolve narrowly framed disputes, climate policymaking demands the formation of cooperative and collaborative coalitions across diverse and often competing constituencies. Climate policy scholars and advocates alike must learn to think outside the courtroom box.

Of course, the impulse to frame climate policy issues in narrowly circumscribed silos is not unique to law; it is direct outgrowth of the hyper-bureaucratization of

governmental decision-making and the hyper-disciplinary specialization of university teaching and research. Undisciplinary roundtables such as this one are very much the exception, not the norm. As scholars of climate change and planetary health seeking to inform the policy landscape required to ensure the future sustainability of the planet, we must immediately reverse this relationship of the norm and the exception in our thinking and organization.

This is no mean task. Reinventing climate change teaching and research in order to reinvent climate policymaking is a tall order. At the same time, to call for reinvention is to fail to see the opportunity immediately before us. I recently participated in two Indigenization workshops conducted on our campus by Dr. Rose Roberts and Dr. Stryker Calvez, both of the Gwenna Moss Centre. As I prepared for this roundtable, I was struck by the correspondence between Canadians' past and present failures to respect Indigenous peoples' holistic, complexity-based knowledge systems grounded in ecological stewardship described by Rose and Stryker, on the one hand, and our ongoing failure to embrace the very same ways of thinking regarding sustainable planetary health. Indigenization is not only a moral imperative, but also a rich and promising means of rethinking climate research and policymaking.



Theme 2: Creativity (and connectivity) will be at the foundation of successful pathways to sustain our planet

Dr. Creed: Ivar, our University Plan is to be the University the World Needs. Why is creativity so important for both the arts and sciences if we are to achieve the aspirations laid out in our University Plan?

Dr. Ivar Mendez, College of Medicine: Creativity is fundamental for innovation in art and science. The artist and the scientist use both sides of their brains to activate a common processing pathway to create a work of art or to solve a scientific problem. Thinking "outside of the box" leads to original art as well as innovative approaches to scientific research. Stimulating creative thinking in the arts and sciences is a crucial educational mission of our institution. Art and science are not only complementary but are synergistic.

A specific dimension of creativity is the incorporation of aboriginal knowledge in medicine. The ability to use aboriginal healing knowledge as part of our College of Medicine curriculum will provide added value to medical education and practice. "Seeing with two eyes"—the aboriginal healing eye and the western medicine eye—has the potential to provide our University with a competitive advantage at a national and international level as it offers a new and creative approach to medical education, research and health care delivery.

Dr. Creed: Peter, you have worked in research teams that include experts from many different disciplines. What have you found helps or impedes formulating research that draws on the strength of those teams?

Dr. Peter Phillips, Johnson Shoyama Graduate School of Public Policy: Creativity and innovativeness are the buzz phrases of the 21st century. We know it when we see it but often have no good idea of how to encourage and support it.

I often start by drawing a metaphor from our biologist colleagues who assert that selection pressure, forced breeding and hybrid vigor are the basis for sustained and cumulative growth. Stu Kauffman (1995), one of the complexity theorists from the Santé Fe institute, stressed that in evolutionary biology, the rate and scope of change is a function of the number of adjacent potential opportunities. The more that people and institutions are forced to interact with others, both from their own group and from beyond their group, the more likely that the process of hybridization can work.

Universities are particularly challenged in this context. Stephen Shapin, a historian of science from Harvard and our 2007 Whelen Lecturer, reminded us that the academy is at root a medieval, monastic system that is

about conservation and transmission of the stock of knowledge. In that context, our peer review, tenure and promotion, departmentalized structures and disciplinary communities have worked to refine and deepen our knowledge, but in an increasingly narrow and disconnected way. While we have made some effort to rewrite the rules and redesign the academy, most of the underlying structures still encourage conformity and isolation.

Shapin asserts that today's research university emerged from the German model developed in the 1890s, which was then translated around the world at the end of the Second World War. Governments, industry and NGOs, and citizens as a whole, have looked to universities to engage in the exploration and resolution of real-world problems. In this way, we have opened the academy to a much greater mix of adjacent potentials, as most work on real world problems draws on a diversity of theoretical approaches, uses a mix of quantitative and qualitative methods and both develops and analyses a wide array of different kinds of data and evidence.

Over most of my career, I have engaged in this reordering of scholarly pursuit. While I began my training as a classical economist, I deviated into the subfield of international political economy, which is inherently an interdisciplinary problem-based space that lives uncomfortably between economics and political science. I spent the early part of my career in industry and government, both consuming and sponsoring problem-based scholarship. Quite a while ago I jumped the wall and entered the academy, first in an endowed chair in Agriculture (not one of my core fields), followed by a joint appointment with Business in a chair examining technological change, assignment in political studies and now in the interdisciplinary graduate school of public policy.

Throughout my career I have spent an inordinate amount of time building new interdisciplinary structures to increase the adjacent potentials between natural scientists (mostly in the biosciences) and the social sciences and humanities. That has included building two public research institutes outside the academy, the virtual College of Biotechnology, the JSGS, the Global Institute for Food Security and the Centre for the Study of Science and Innovation Policy and working with industry, government and colleagues to build large scale teams to address real-world problems through SSHRC Major Collaborative Research Initiatives and Partnership Grants, through Networks of Centres of Excellence, through strategic research chairs and through Genome Canada (both stand-alone and embedded social-science, GE^{3}LS projects).

Putting together teams with different worldviews and disciplinary backgrounds is both challenging and rewarding. The value we get depends on how we design the systems.

In my ventures, I have learned that we tend to fall into one of four archetypes of collaboration:

1. First, we can take a lesson from Bruno Latour and do arms-length, fly-on-the-wall studies, using a mix of disinterested observation and external evaluation and validation through benchmarking, cost-benefit analysis and other organized project-level tools. In effect, our scientist partners are our lab rats.

2. At times social scientists are included in science teams to ensure the process is responsible and reflexive. The Human Genome Project created this model and now ELSI, ELSA and GE^{3}LS investigators (who study ethical, environmental, economic, legal and social aspects and impacts of new technology) are embedded in many/most large-scale science ventures to act as the conscience and moral compass for the project. In effect, social science research can at worst be an 'indulgence' and at best a sagacious partner.

3. Many science project leads are fully aware that their funders want to see measurable outcomes, in that their scientific advances are taken up and used in the market or society. In that context, social scientists can be enlisted as agents or contracted serviced providers to undertake studies that examine pathways to impacts, assess freedom to operate, offer market analyses or assess the regulatory prospects. Many embedded GE^{3}LS teams in Genome Canada projects end up doing this.

4. Probably the highest level of engagement involves social scientists acting as partners and collaborators, where they both undertake introspective assessments of the research agenda and related policy matters—including policy design, decision-making, implementation and evaluation—and translate their findings to the management of the larger scientific enterprise. The Plant Phenotyping and Imaging Research Centre Canada First Excellence Fund project aspires to that approach.

The key lesson to be drawn from all of our efforts to proactively force together social and natural scientists is that design matters—a lot. Just putting different groups together may not necessarily create real actionable adjacent potentials. Changing how we see each other and engaging in real-time discourse and management is key to realizing new possibilities—and the foundation for creative discovery.

Dr. Creed: Suzanne, you bring a unique perspective to this discussion, as a research scholar, academic leader and active collaborator with the commercial sector. Some are concerned that the intersection of public science and private industry can distort the purpose of the academy. Are you concerned? If not, why?

Dr. Suzanne Kresta, College of Engineering: As someone who has frequently been the only female professional in a room, I have often had to deconstruct comments that seem, at first glance, to be perfectly reasonable but which felt a bit "off" to me. I'd like to take a moment to

deconstruct this question with the audience before answering.

Perhaps we could first consider how this question sounds if we substitute another group for the word "industry." We might choose "women"—who were excluded from science for many years —or "environmentalists"—who fought very hard to win their rightful place at the table—or even "Indigenous peoples" whose voices we are just learning to hear and respect.

At first glance, it seems to me that excluding any specific group from our enquiry leaves us all impoverished, rather than better equipped to deal with a wicked problem such as the sustainable future of our planet.

We might be able to learn a bit more from the question, so please continue with me a bit further.

When we choose our collaborators, we are choosing creative partners as well as funders, and it is important to ensure that the partnership will be respectful and mutually beneficial. Again, I would encourage a question: does industry, or the presence of their funding, actively distort our purpose? In my experience, industry comes to the table with questions for us to consider, with funding to support the costs of research, and with potential jobs for our students. Their funding is invested in solving problems that address their business needs and that are of interest to academics who enjoy those kinds of problems. Academics who do not want to work on problems of interest to industry are not required to do so. In fact, we reward scholars handsomely for obtaining peer reviewed or curiosity driven Tri-Council funding, and for supervising students who have independent scholarships. We cannot honestly say that academics are required to work with industry, or that this is the only available source of funding for research.

Does industry actively distort our purpose? "Industry" is a collection of individual companies and—much like any other group—there are some outstanding citizens, many good citizens, a few unwise citizens, and a very small number of intentionally unethical players. Over 30 years as an academic, I have worked with funders and collaborators from 20 different industrial sectors. All of them raise their families in the same world we all inhabit. All of them have a genuine desire to better understand vexatious problems. I have appreciated their efforts as wonderful mentors for my students, and thoughtful discussions of curiosity-driven data. I have also seen funding repeated when a first set of experiments fails, and the company graciously allows us to start over with no real guarantee of success to ensure that a student can complete their degree. My industrial collaborators have often been more open to results that challenge the status quo than my academic colleagues. They have encouraged me to publish results that change the way people think. These relationships have given my academic work tremendous purpose.

Some might propose that climate change is the sole responsibility of industry and conclude that they cannot be trusted as partners in building a sustainable future. I would suggest that the cause of a wicked problem is likely to be wicked. Climate change is undeniably complex. We have to deal with imperfect knowledge of the universe in the first place and human desires in the second place. Many generations of Econ 100 students were taught that stimulating consumer desire to increase consumption would ensure prosperity. This idea coincided with a period of time when our understanding of the impact of pollution of any kind was nonexistent. Increasing consumer demand accelerates industrial production and drives prosperity for both workers and industry, just like stepping on the gas accelerates a car. The unintended consequences of infinite consumer desire have caused a great deal of difficulty for everyone, but consumer demand, and the role played by macro-economists and marketing departments in generating consumer demand, have only recently been identified as part of the root problem.

What can industry contribute to planetary health? Cars are now close to five times more fuel efficient due in large part to a reduction in weight made possible by plastic car parts. Point-source emissions have been reduced to the detection limit of instruments for many compounds—to parts per million or less. Completely changing over all refrigerants to eliminate the use CFC's in order to protect the ozone layer was a massive accomplishment. These compounds are now essentially absent from the atmosphere and the ozone layer recovered faster than expected. Houses are no longer heated by coal and are much more energy efficient, even without renewables, and we marvel that LED lights consume a fraction of the energy of incandescent bulbs. Paints are now water based rather than oil based, dramatically reducing their environmental impact. These changes have all been accomplished by "industry"—sometimes in response to regulation or consumer demand, and sometimes simply from innovation and curiosity and the desire to do better. Just as industrial emissions have to be regulated, human consumption has to be kept in check if these advances are to have any impact on the underlying wicked problem of planetary health.

I would suggest that industry has a great deal to offer at this table and, if we are to find solutions to the wicked problems we face, we must continue to be inclusive in our debate and courageous in our curiosity about other perspectives. We must understand that academic freedom is only granted to those who are clear in their purpose and driven to pursue their passions. While we might reasonably wish that all of our considerable academic talents and resources could be devoted to solving the urgent wicked problem of planetary health, we actually have many wicked problems to address and many voices inside and outside the academy—including industry—who can enrich our journey.

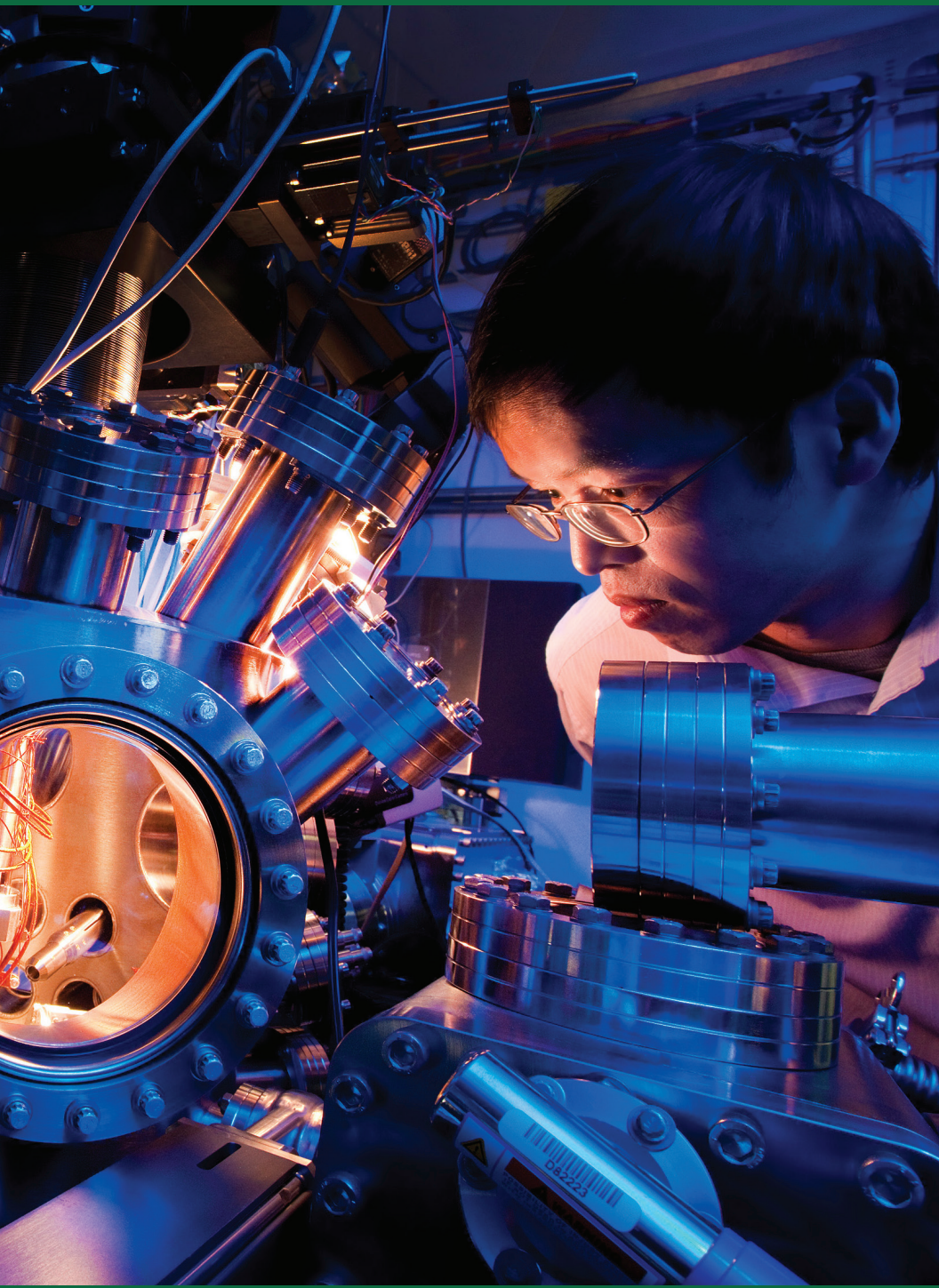


Photo credit: Canadian Light Source

Theme 3: Much needed scientific and technological advances that will lead to sustainability of the planet are already emerging

Dr. Creed: Chithra, the Canadian Light Source was designed to breakdown the barriers of disciplinary science. How have you used the facility to do that?

Dr. Chithra Karunakaran, Canadian Light Source: I am an agricultural engineer by training and did post-doctoral training in neurology. This is in some ways similar to Dr. Bondar, who has training in agriculture and neurology. Agricultural engineering itself is a transdisciplinary science that offers a holistic approach to food production and global sustainability. In agricultural engineering, we study about soils, plants, farm-related impacts from mechanical, structural and electrical engineering, the environment and economic aspects.

I started working with a beamline at the Canadian Light Source built to study polymers. I use that beamline to study plant cells. However, I realized there is a need to study plants in different scales—from the cells to whole plants—and therefore started using different beamlines. We now encourage users to use different techniques or beamlines at the Canadian Light Source to solve their scientific problems rather than simply use a single beamline or technique.

My educational background in different disciplines made me want to explore different beamlines and techniques with enthusiasm. National facilities like the Canadian Light Source can and do act as hubs for transdisciplinary scientific interactions.

Dr. Creed: Markus, your work involves looking at environmental effects of both classical and novel pollutants. What challenges have you faced in discovering the causes and consequences of novel pollutants used by society?

Dr. Markus Hecker, School of Environment and Sustainability: According to a recent report by the Lancet Commission, chemical contamination of our natural ecosystems is regarded as one of the planet's greatest threats, causing over nine million premature deaths in 2015 (three times more than AIDS, tuberculosis and malaria combined or 15 times more than from any violent conflict including wars). On the other hand, modern society is depending on the use of over 100,000 man-made chemicals to combat disease and illness, enabling intensive agricultural production to feed an ever-increasing global population, and otherwise support everyday life. Interestingly, we have toxicological information for less than 10% of these chemicals and there is increasing pressure on governments and industry to ensure the safety of chemicals for human and

environmental health, especially when considering that 500 to 1000 new chemicals enter the market every year.

This constitutes both an economic and ethical dilemma as risk assessment strategies to assess the safety of chemicals under current legislations are expensive, time consuming and require extensive live animal testing. For example, a recent study estimated that chemical testing in the European Union REACH Program alone resulted in an estimated cost of over US$14 billion and tens-of-millions of animals. It becomes apparent that these approaches are not sustainable; alternate concepts are required to ascertain whether chemicals used by society are safe for humans and ecosystems.

Over the past decade we have made significant strides in the areas of biotechnology and computational sciences, such as whole genome sequencing, next-generation 'omics technologies and high-powered computing in support of "big data" analysis. These technological advances and associated science enable us to better understand the mechanisms and drivers of disease and health effects of exposure to contaminants, while at the same time reducing the need for expensive and time-consuming live animal testing.

As such they offer unprecedented opportunities to tackle some of the current key issues in chemical safety assessments; however, they do not address the concerns associated with humanity's reliance on chemistry or, more generally speaking, on advancing technology to solve current issues, and therefore do not address the root issue but rather only address the symptoms.

To truly solve these problems in a sustainable manner requires more holistic approaches that consider both technical and societal factors, which sometimes requires changing people's perspectives and behaviors.

Dr. Creed: Cherie, as one of our national symbols but also an important cause of environmental catastrophes in Canada, beaver are both a source of pride and angst for many Canadians. How can people partner with beaver to enhance water security, restore degraded ecosystems, and combat climate change?

Dr. Cherie Westbrook, College of Arts and Science: Beaver are revered by some and hated by others. They ingeniously alter environments to suit their needs of predator protection and food access. Landscapes re-plumbed by beaver store more water and sometimes carbon, have higher biodiversity, and show enhanced resilience to environmental change.

Beaver might be a Canadian icon, but Canada isn't the only place they live. They are found throughout most of the United States, parts of northern Mexico, and across Eurasia owing to rewilding efforts. There is even a small population of invasive beaver in southern South America.

Beaver are generalist foragers and so live in a wide range of habitats. They are best known for living in streams and building dams across them. Beaver, though, live in a wide variety of ecosystem types, and so create extensive and diverse impacts on a broad range of interlinked hydrological, geomorphic and ecological processes. They live in lakes and peatlands, but they also live in unexpected places like landslides, coastal saltwater marshes, glacial outflows, and even deserts.

As an ecohydrologist, when I think of climate change, I think of hydrological extremes—floods and droughts. Beaver have a role to play in helping mitigate both.

Beaver dams help drought-proof ecosystems. It is for this reason that beaver-related stream restoration has become a popular practice, particularly across the western USA where droughts can be particular severe. There is also growing interest in partnering beaver to reduce drought severity in parts of southwestern Alberta. My research team is providing advice to practitioners on best practices in the use of both natural and artificial beaver dams. As well, a drier future climate means fires will happen more often and be more severe. Valley bottom waterlogging by beaver creates natural fire breaks.

Partnering with beaver to reduce flood severity is an emerging research area. It has long been believed that beaver ponds have little capacity to hold floodwaters and that beaver dams tend to burst during larger flood events, exacerbating their severity. My research team is studying the Alberta 2013 flood, and we are finding that nearly two-thirds of the beaver dams across Kananaskis Country actually continued to hold back water throughout the destructive flood. Our research lends support to the notion that beaver can offer some sort of flood protection.

I think it is time we cast aside our bad feelings and stop thinking of beaver as a nuisance. Instead, let us focus on the many ecosystem benefits offered by beaver, and when and where we should be encouraging their habitation to bolster ecosystem resilience.

Dr. Creed: Regan, many associate electronic gaming with negative health outcomes, but your research explores the positive potential of these scientific innovations including for mental health. How can these popular technologies bring new benefits to society in new or unexpected ways?

Dr. Regan Mandryk, College of Arts and Science: This is a great question. It is true that these technologies are popular. Games are a $137 billion industry worldwide and people spend more money on games than on music and movies combined. Further, they spend a lot of time playing games. Given this time and money that people willingly invest in a leisure activity, my research program looks at how to leverage the motivational pull of games to motivate behaviour, improve health—in particular, mental health—and connect people. And I focus on mental health because depression is the leading contributor to the global disease burden, especially in developed countries. Combating depression is

the super wicked problem that I try to address.

I take two approaches in my work. The first is to understand what compels people to play and then apply that in other contexts. This is sometimes referred to as gamification or motivational design. For example, my recent PhD graduate, Max Birk, looked at how to leverage game design elements and apply them in a different context to improve adherence to digital mental health interventions.

The second approach I take is to look at the value of commercial off-the-shelf games. We know that playing commercial games has benefits for cognition, executive function, reading, coping, dealing with life's transitions like bereavement or loss, and combating loneliness. There is this idea of the stereotypical gamer, isolated and playing alone in his basement, but multiplayer games are huge and gamers now spend the majority of their time playing with others in-person and online. Viewing these in-game relationships as somehow impoverished compared to the bowling buddies of yesteryear is a myopic view of the potential social power of in-game relationships. For example, my recent PhD graduate, Ansgar Depping, looked at how games and communities for gaming facilitate trust development, and what value those in-game relationships provide in terms of social capital and, ultimately, for combating loneliness.

I could talk for days about how I think that games have a bit of a bad reputation, what we need to do to move forward as a discipline, and why a transdisciplinary approach is necessary for progress on this super wicked problem.

Dr. Creed: Ivar, how can technology improve the health and well-being to remote communities (such as in Canada's far north) as well for astronauts going into deep space?

Dr. Ivar Mendez, College of Medicine: We have developed an innovative health care program using remote presence robotic technology. The use of robotic systems to provide real-time health care access to remote communities in northern Saskatchewan has been shown to be clinically effective and cost efficient. We have focused on the most vulnerable populations such as children, pregnant women and the elderly living in remote locations. Many of these locations are aboriginal communities with deficient health care infrastructure and poor health outcomes. Saskatchewan has currently the largest deployment in the world of remote presence robots to distant communities.

The lessons and experience gained by this program have implications for deep space travel. Providing emergency and specialized care to people isolated in a remote northern community especially in bad weather can help with implementing similar strategies for the medical care of astronauts during deep space travel, such as a mission to Mars. We are pioneering the use of sophisticated peripheral diagnostic devices, such as robotic sonography, to provide prenatal ultrasound examinations to pregnant women in the North. With this technology, a pregnant aboriginal woman does not need to leave her community to have a prenatal ultrasound, as the expert sonographer located a thousand kilometers away can perform the test with the assistance of a tele-robotic ultrasound.

The diagnostic and treatment challenges of astronauts in deep space missions will benefit from our experiences using these advanced technologies in remote communities. The technological innovations developed for deep space travel will, in turn, help with providing health care access to underserviced populations in low-resourced and remote communities around the world.

Theme 4: "New" fields of study that transcend traditional disciplines have emerged

Dr. Creed: Vikram, you have thought deeply about the intersection of science and society. What can the academy learn from that venture?

Dr. Vikram Misra, Western College of Veterinary Medicine: I am a supporter of One Health initiative at the University. Interdisciplinary collaboration is at the centre of One Health, a process that seeks solutions to problems at the interface of health of the environment where humans and non-human animals reside. You have asked me about the intersection of science and society. Let me answer your question as it relates to my experiences with One Health.

As a researcher on what makes viruses tick and how they cause disease, I have always been open to collaboration. However, my idea of interdisciplinarity had been extremely narrow. I regarded as distinct disciplines areas that were closely related to mine—such as studies on how our bodies defend themselves from viruses or how the development of vaccines can control infections.

This narrow view of scientists I could work with came to an end about six years ago while a group of friends chatted over beer at a meeting in Berlin. It seemed that we all shared this blinkered approach to interdisciplinarity and collaboration. Our conversations made us realize that this short-sighted view limited our ability to examine complex problems through the lenses of others with skills and expertise completely different from ours. What made matters worse was that our students inherited our biases. Graduates from our laboratories were extremely competent in their own areas and often went on to successful careers in their and our fields of expertise. However, like us they failed to find synergies with other disciplines.

Perhaps it was the excellent German pilsner on offer, but our little group of international colleagues decided to change this.

We were fortunate to obtain an NSERC-Collaborative Research and Training Enterprise grant for our program in Canada. Moreover, the University of Saskatchewan and its various faculties were extremely supportive of our efforts. Our partners in Germany, Brazil and India went on to access resources in their own countries. Our program had the rather unwieldy title of Integrated Program in Infectious Diseases, Food Safety and Public Policy, ITraP for short. We recruited students who were pursuing their Masters' or PhD degrees in any field of specialization. In addition to fields traditionally associated with health, we recruited students from the arts, social sciences, engineering, computer sciences, economic and policy, among others.

Initially, the students came from the universities that were partners in the program. However, as word of our program spread, we were approached by graduate students from around the world. ITraP was an expensive program. Its success depended on the active, motivated and enthusiastic participation of the students but to convince the students (and their research and academic supervisors) to participate, we needed to offer the students stipends while they were in the program.

ITraP ended up being entirely student driven. Instead of expert faculty teaching the students to collaborate, we divided the students into relatively small nationally, disciplinarily, culturally and linguistically diverse groups. Each group was then given the opportunity to study and suggest policy recommendations for a current "wicked" health-related problem. The role of the faculty associated with each group was to gently guide the process and to facilitate any resources the students needed for their work. Each international group met on-line twice a week. We recruited alumni of the program to help with the technical aspects of the meetings and as facilitators. At the end of the semester each group was required to submit their analysis and policy recommendations for peer-reviewed publication in a journal. In addition to this exercise, the students met at an international "school" where they shared their insights with a large group of other professional and graduate students from the host country. Each ITraP student also participated in an internship at an international organization, company or academic institution where they could see how their newly acquired skills in consensus building and collaborative problem solving worked in real-life.

The program was a resounding success. However, the students soon realized that something was missing in their efforts to truly practice the collaborative One Health approach. They had left out a critical component needed to make their proposed solutions actually work, rather than just being an academic exercise. What was missing was any involvement of the people and societies affected by the problem. These were the very people the students needed to accurately frame the problem and to find implementable solutions.

This "a-ha moment" crystalized for us all the critical contribution of society to scientific analysis, and it changed the program. In one example, Indian students in a group analyzing cloth dyeing and concerns about industry's role in polluting a river in the desert in northwestern India travelled to the area and met with the villagers, the migrant workers, the school children, the local university researchers as well as industry owners. Similarly, students analyzing the industrial tainting of beluga meat and how it affected food security of the Inuit took into account the opinions and sensitivities of the local tribes.

ITraP ended last year after the direct participation of almost 150 students from 18 universities in 13 countries. It also influenced hundreds of Asian, European and South American students who joined the ITraP students

in local summer schools. We learned a lot from the program—not the least the critical need to involve the individuals and societies affected by the problems we study not just as passive subjects but also as active participants.

We learned that two qualities critical for the successful implementation of the One Health interdisciplinary approach are “Humility” and “Respect”—humility to realize that one’s own discipline may not hold the answer and respect for other disciplines (and societies) that might.

Theme 5: We need innovations in decision-making processes to translate the benefits of science and technology to achieve planetary health

Dr. Creed: Martin, could reconciliation that leads to a change in our decision-making processes to reflect shared governance between western and Indigenous peoples and their worldviews be our hope for helping us sustain the future of our planet?

Martin Phillipson, College of Law: I have three main points about this challenge from a legal education perspective:

1. This requires patience;
2. It requires key people; and
3. This task requires persistence.

Patience. When I suggest that this task requires patience, I don't mean that we should sit around and mull over the challenge for too long. My belief is that this is a change and a challenge that will be generational in temporal terms. We have to start educating the next generation of lawyers now, so that when they begin to practice and begin to move into positions of authority and influence that they have a grounding in, and an appreciation of, Indigenous legal traditions. Put another way, there is no quick fix. Yes, we can all make efforts now, but I believe that if we are to ensure the long term, permanent reception of Indigenous legal traditions into our consciousness and our work we must begin now. The reason being that this challenge requires a systemic fix, the entire legal system from first year law students through to Supreme Court justices are going to have to adapt and transform their view of the legal system.

I want to draw on one quick example from my teaching to illustrate my point. My first tenure track position was in New Zealand. I arrived there in 1992, shortly after the government had done a total overhaul of all of its environmental laws. It was a remarkable exercise in that many major pieces of long-standing legislation and hundreds of regulations were repealed. A new statute the Resource Management Act was introduced that incorporated a totally different approach of viewing the environment. Also, new legislation on hazardous substances and new organisms was introduced. This was ground-breaking stuff.

A key feature of this new legislation was the incorporation into the legislation of significant concepts of Maori traditional law. These principles were to be taken into account by decision makers when deciding, for example, to approve projects or introduce new organisms into the environment. They were not included as an afterthought; they were given significant prominence in the

legislation. For example, the principle of kaitiakitanga (the Maori ethic of guardianship and stewardship) was introduced, as were sections that required decision makers to take into account the relation between Maori, their cultural traditions and values and their ancestral and tradition lands.

However, when these principles were invoked in litigation in attempts to challenge approvals of projects, it became clear that the decision-makers, lawyers and judges who were adjudicating these issues could not understand or address these concerns in a meaningful way—they simply weren't equipped. Two short quotes from an application determination and an appeal judgment are illustrative:

> The Authority acknowledged that section 6d required them to take spiritual matters into account. They were unable however to assess or give weight to purely spiritual matters in the same way they felt able to assess and give weight to purely physical matters. They acknowledged that the spiritual beliefs were deeply held… they were, however, unable to assess any adverse effects on those spiritual beliefs in the absence of empirical evidence of, for example, likely health consequences.

They continued:

> *The Act* does not provide a sufficient framework within which to address these issues. In brief, the balancing of spiritual issues and scientific endeavor is not a matter solely for judicial weighing up. It is not surprising that the Maori and the applicant were unable to reconcile the issues involved. They do not lend themselves to point-in-time decision-making even though *the Act* requires this. A broader approach is required to provide a context in which *the Act* can operate in regard to these kinds of issues.

So, point one: patience is required because there is no quick fix. You cannot simply add these principles to legislation, stir, and it's fixed. The entire system has to adapt and that will take time.

As time has gone by, it is also clear that Maori researchers and scholars believe that this approach has not worked, and that the incorporation of these spiritual and tradition values into legislation is actually resulting in them being stripped of content and perhaps of meaning. While they acknowledge that this was an attempt by the New Zealand government to honor Treaty and the special status of Maori as Treaty partners:

> The incorporation of Maori concepts into legislation, and the interpretation of these concepts in decision-making, has raised questions about the ability of Western institutions to properly consider and apply Maori concepts in a way that will, as Treaty requires, actively protect Maori culture and allow it to develop on its own terms within an overarching framework of Crown sovereignty. (Arnu Turvey 2009)

Secondly, people matter. This is a simple point, but warrants discussion. Legislative quick fixes are not enough—a systemic approach is required. You need people who understand this material to teach it. I have taught property for over 20 years. At the University of Saskatchewan, we have had a significant Aboriginal law component of our first year property class for a long time. I could teach my students about Supreme Court of Canada cases and how the law in Canada applied to Aboriginal peoples, but I could not teach Indigenous traditional law. As a Dean I am going to have to restructure my faculty complement to address these issues. That will take time, so more patience is required.

Thirdly, we need persistence. As I said, there is no quick fix. If we start now in law schools, we will have a cohort that will in time be able to work with, understand or at least respect these laws, but that will take time. There will also be bumps along the way—resistance, backlash, call it what you will are inevitable, as not all students or professors will be receptive to these issues, or receptive to including them in their classes or in their studies. Nevertheless, we must persist.

In conclusion, if we are to address this challenge effectively it will take a concerted effort, beginning in law schools and moving up and on through the legal system, with the long-term goal of achieving balance. This will take time. However, "patience" should not be read as a synonym for doing nothing or doing far too little and doing things far too slowly. If I am correct in the generational nature of this task, we have to begin now, but I urge patience so that we have the time to do it right and properly.

Concluding comments

Dr. Creed: Dr. Bondar, thank you for inspiring us to meet today to engage on this topic. Do you have any observations about what you have heard today?

Dr. Roberta Bondar: Yes, thank you.

First, please accept my profound gratitude for the presentations and discussion this morning. These are invaluable reflections that need to be captured and considered in more significant ways than our discussion this morning alone can permit.

Having said this, I would like to offer just a few reflections based on what I've heard and on my own experiences as a medical researcher and astronaut who has always worked with others across multiple boundaries of diverse kinds.

We need to better understand human motivations and behaviours so we can help others and ourselves to better recognize and act on the imperative to work together in the interest of our planet and humanity. It is so easy to get entrenched in our own views and perspectives. But we are running out of time and so we need to act nimbly and quickly. We need to change the mindset of researchers, from theorists to practitioners, and change the "currency" of academia, from publications to other rewards and recognitions that incentivize positive transformation and action.

This will require bold, brave and courageous movers and thinkers. It will necessitate and build on the contributions of multiple actors in our society—good people, forward-thinking politicians, as well as strong campaigners and advocates.

And, as is the case with all human interaction, communication will be key. We need new ways to connect with society and to share accessible knowledge through media and other forums. As researchers and academics, we need to be proactive about better training in this regard.

And perhaps most importantly, we have to be better listeners and instill a sense of openness to new ideas and continued learning. We have to pay attention to the natural world for what it teaches us. We need to integrate creativity and to use both the left and right side of our brains. We need to find the common values that can build greater understanding among those with the diverse training, skills and experience who all have a role to play in sustaining our planet. As a researcher, I have found the art of photography a powerful means to convey new insights and perspectives on the plight of various species on our planet.

All of your interventions today bring a message of hope. You have covered much ground, speaking about the importance of Indigenous knowledge, the opportunities provided through novel technologies as well as our better understanding of nature's processes, of taking into account both technical and social factors, and of striving to work more effectively together across the academy and beyond. It is through dialogue like this that we can move forward, benefitting from our diverse knowledge and expertise. It is my great pleasure to be able to spend the rest of the day with you and I look forward to our on-going exchanges.

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