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Government Science and Innovation in the New Normal

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CANADA NEEDS A NEW RELATIONSHIP WITH SCIENCE AND INNOVATION THAT REFLECTS OUR TIME

This is why, in December 2020, the Institute on Governance launched Government Science and Innovation in the NewNormal (GSINN), a multi-year, collaborative research initiative designed to explore the impact of the pandemic on federally performed science and innovation, to support medium-term planning for federal science and innovation departments and agencies, and to provide insights to help rebuild the relationship between science and society.

Throughout the pandemic, anti-vaxxers – joined by anti-maskers – have challenged scientific evidence and public health officials with a mandate to keep us safe and stop the spread of the disease. This is just one example that demonstrates society's relationship with science is under strain.

But society's relationship with science and innovation did not decline overnight. The governance model that underpins Canada's relationship with science is based on a report called *Science: The Endless Frontier* (Bush, 1945). This report outlined a basic compact in which society supports science with public funds and assures the scientific community a great deal of autonomy in exchange for the considerable but unpredictable benefits that can flow from the scientific enterprise.

Today, many of the underlying social, economic, and political assumptions in the postwar compact are outdated. This project examines the relationship between science and society and begins to imagine a new relationship, through nine specific themes:

- Equity, Diversity, and Inclusion;
- Global Research Collaboration and Infrastructure;
- Inclusive Innovation;
- Interdisciplinary Collaboration;
- Indigenous and Other Ways of Knowing;
- Mission-Driven Research and Innovation;
- Science Communications, Outreach, and Public Engagement;
- Skills and Knowledge; and,



- Trust, Integrity, and Science Ethics.

Taken together, these themes suggest elements of a new governance framework for science and innovation in Canada that embraces our current social, cultural and political realities, that recognizes the opportunities and limits of science. Perhaps most importantly, the project reinforces the role of science as part of society, and a tool ready to serve the needs of society.

Findings of the GSINN initiative were developed as a result of extensive research and engagement that included: a hindsight exercise, multiple foresight workshops, eight multisectoral roundtable discussions, and expert consultations that fed into this collection of 10 papers (one for each of the themes above and one capstone paper). Each discussion paper has been peer reviewed and explores a facet of how the relationship between government science, innovation, and society needs to be repaired in order to ensure science remains relevant in the new reality.

IOG extends its heartiest thanks to the eight federal departments and agencies that supported this work: Agriculture and Agri-Food Canada, Health Canada, Innovation, Science and Economic Development Canada, National Research Council, Natural Resources Canada, Public Health Agency of Canada, Public Services and Procurement Canada, and Transport Canada. We also wish to thank all of the individuals who participated in the workshops and roundtables whose input helped clarify and develop the project themes and findings. We acknowledge the following individuals who supported IOG's work and whose thoughtful guidance informed this final, capstone paper: Andrew Atkinson, Matteo Bernabo, John Burnett, Luisa Carter, Lindsay Copland, Nataalka Cmoc, Marc Desjardins, Brianna Graham, Steve Harrington, David Houle, Amanda Hunter, Étienne Lepage, Sandra Lister, Peter Massie, Bryony McAllister, Ashley Mercer, Pascal Michel, Dan Munro, Ken Nakagawa, Robbyn Plumb, Aliza Rudner, Michael Rosenblatt, Jonathan Sabean, John Sharpe, Carrie Taylor, Elizabeth Tompkins, and Kelly Vandeligt. Finally, we express our deep thanks and appreciation to our fellow GSINN discussion paper authors: Ravtosh Bal, Louise Earl, Patrick Galvin, Ezra Miller, and Shelby Torres.

"Science needs to innovate not just for society, but with society."

– Sheila Jasanoff, Pforzheimer Professor of Science and Technology Studies, Harvard Kennedy School



THE RIGHTFUL PLACE OF SCIENCE, IN CANADA

When we think about science, we might think about the chemistry or biology class we took in high school. Maybe we think about non-profit organizations dedicated to saving endangered animals, the nature documentary we watched last weekend, or the museum we visit with our kids on rainy days. Do we think about the society we live in as one based on science? Do we think about the scientific process and how it contributes to improve our health and well-being? It's unlikely. Though Canadians live in a science-based society, the manner in which that information is produced and integrated into our systems – of food production, education, government, resource extraction, etc. – are hidden from plain view.

That science has been deeply embedded in our systems for decades has made it something of which many Canadians are not familiar or even aware. What was initially designed to be a mutually-beneficial relationship has resulted in an enterprise which many Canadians do not realize they are paying for, nor benefitting from. And as we learn more about science and the world around us, we can also better understand the role, value, benefits, and limitations of the scientific enterprise in order to critically analyze the system we have created and modify it to ensure it is fit for purpose.

It's time to reflect on the role, value and purpose of science in Canadian society, and to ask ourselves: What is the rightful place of science, in Canada?

This paper is the capstone of a research project, both capping off and knitting together the nine individual papers that round out the results of this project. It begins to outline a new framework for science in Canada.

WHAT IS SCIENCE? WHAT IS SCIENCE FOR?

Science is a human-made process for creating new knowledge. The process of conducting science serves two purposes: a) to train people (students) to analyze scenarios, identify problems, think critically, gather evidence, test ideas, and develop insights and b) to solve problems – big or small – facing society.

Science – as a type of knowledge and a process for developing that knowledge – has evolved over the last several hundred years from the experiments of a few to a worldwide enterprise with rigid standards and rigorous practices reinforced by requirements for extensive formal study, as is described in the GSINN chapter on Interdisciplinary Collaboration. This disciplinary interpretation embedded in education systems (primary, secondary and postsecondary) in Canada, and which guides our funding agencies, privileges Western science to the exclusion of other knowledge systems and ways of knowing. As Leroy Littlebear has noted, "There is more than one science, there is more than one way to look at things" (Littlebear, 2015). The GSINN chapter on Indigenous and



Other Ways of Knowing explores this concept of knowledge systems, and the beginning of a change recognizing science as one knowledge system alongside others present in Canada.

Kinder (2013) describes science as one type of knowledge alongside other inputs to decision-making that include but are not limited to cultural considerations, social considerations, economic considerations and political considerations. And it must be said that science has a role to play in some decisions, but not others. There are limits to what science can do, and what it can offer. Evidence of these limits is described in the GSINN chapters on Indigenous and Other Ways of Knowing, Science Communications, Outreach and Public Engagement and perhaps most viscerally in the chapter on Equity, Diversity and Inclusion. The scientific enterprise has been driven by a strong culture that promotes notions of universalism, communalism, and repeatability. Historically, that which did not conform to these values was explained away as an anomaly until a crisis occurred. Perhaps this way of thinking is fundamentally flawed. Repeatability does not mean universally true, but true under certain circumstances. In contemporary Canadian society, diversity is recognized as a strength. As the GSINN chapter on Equity, Diversity and Inclusion declares:

“According to business, management, human resource, and innovation literatures, the full participation of diverse groups in the workplace is ethically imperative and has numerous benefits for the employer. Equity, diversity, and inclusion practices have been shown to increase creativity, lead to enhanced efficiency, productivity, problem-solving, customer-satisfaction, and improve morale, teamwork, and organizational performance. Ultimately, equity, diversity, and inclusion drive innovation and growth (Herring and Henderson, 2014; Mor Barak, 2015; Canadian Centre for Diversity and Inclusion (CCDI) and Dalhousie, 2019; Nolan-Flecha, 2019; OECD 2020; Government of Canada, n.d; Government of Canada, 2019).”

If science is to aid in effective decision making, we must ask ourselves...

WHO IS SCIENCE FOR?

Science is for everyone.

As such, Canadians deserve a scientific enterprise populated by people who look like them, who are challenged by their challenges, and who devise solutions that work for all, not some. The GSINN chapter on Equity, Diversity and Inclusion describes the lack of diversity among those who practice government science, and the many policies and directives in place to diversify the practice of science. As Alan Bernstein (Future Economy, 2018) has noted:

"It is critically important that we draw on all the brains on the planet to address the important challenges the world faces, whether it is climate change, terrorism or disease. Inclusivity



encourages the world's best minds to fully engage and, in turn, for society to benefit from the amazing amount of untapped talent. Equality of opportunity is a question of fairness. We have a long way to go to ensure that minority groups – visible minorities, indigenous people, people with disabilities and women – have equal opportunity in society. It's a matter of both fairness and of excellence."

The GSINN chapter on Inclusive Innovation discusses a new approach to designing policies, programs and services that leave no one behind and the chapter on Science Communications, Outreach and Public Engagement explores public engagement as a means to work alongside – to collaborate with – vested parties to identify all facets of a challenge through a manner that gives equal privilege to non-scientific communities in order to better understand the root cause and symptoms of a given problem.

Guiding all of these chapters is the one on Trust, Integrity and Science Ethics which dispels the notion that science is value-free, and reframes how we think about conducting science with integrity, reliability and honesty in order to build and maintain public trust in government science. Because there are misconceptions about science practices. So we ask...

HOW IS SCIENCE DONE?

To address the most pressing needs facing society, how science is done is of ultimate importance. To ensure all voices are heard and reflected in the conduct of science, extra steps are necessary. These include working with society to identify challenges where science has the potential to offer solutions, collecting information and data, testing hypotheses (solutions), sharing findings (results), repeating experiments to validate the findings, and communicating the results and adopting the findings – the learnings – to address the original challenge. These are all steps in the scientific process. These are all steps where society can play a role through engagement, citizen science, open science, inclusive innovation, knowledge mobilization, and science communication.

How science is done also speaks to how priorities are identified, who contributes to those priorities, and how they are funded.

The chapter on Global Research Collaboration and Infrastructure explores the international connectedness of the research enterprise and discusses allocation of resources to support government science at home and abroad. This chapter raises several important questions about allocation of resources and priorities, not the least of which: How can domestic investments be aligned to support international, global priorities?

The chapter on Mission Directed Research and Innovation offers a potential solution that has come into vogue in recent years. The mission – or challenge-based – approach advocates for strategic



priorities in specific areas of public purpose, guided by stable, directed funding, policies and regulations that provide clarity for proponents. Provided a mission-based approach embraces principles of inclusive innovation, it is possible to ensure no one is left behind.

What's left? The skills of scientists. While Canadians demand a new relationship with science, it must be said that the relationship will not improve unless the skills demanded of – and provided to – scientists also change. In a government context, as examined in the GSINN chapter on Skills and Knowledge, this requires reviewing the manner in which scientists are trained and rewarded to ensure it is commensurate with the changing demands of their various roles.

WHY NOW?

Someone once said never pass up the opportunity that a crisis brings. The COVID-19 pandemic might just be the crisis Canadians need to rethink our scientific enterprise and build something that is fit for our contemporary purposes. Responding to COVID has reinforced some valuable lessons about the relationship between science and society:

Trust is hard to measure, easy to lose, and time consuming to rebuild. The crisis of the pandemic showed us what happens when we think we have a stronger relationship than we do. Rebuilding a trusting relationship between science and society will require getting to know each other again. Now that the pandemic has pulled back the curtain on scientific uncertainty and the messiness of the research process, it is time to learn from the experience and (re-)establish good governance for science and innovation.

Communicating complex scientific ideas means developing messages that are meaningful for the audience, not for the person delivering the message. A meaningful message has many facets that include words, emotions, tone, and the identity of the person delivering the message. Strong communication can demonstrate transparency, accountability, leadership, and can help to build trust.

The pandemic brought focus and coordination at domestic and international levels to respond to the crisis. Crisis response took many forms: vaccine development and manufacturing or procuring protective equipment; developing credit programs for people who lost their jobs; and people who (seemingly overnight) launched grocery delivery services and phone trees to check on the infirm and elderly in their neighbourhoods.

Each of these responses required a multiplicity of types of knowledge and skillsets, working together to consider different aspects of the pandemic response. But each had a common goal: How do we keep this kind of focus on the challenge (in order to transfer it to other challenges)? How do we



maintain this level of collaboration among disciplines, between departments and across sectors?
How do we capitalize on these interdisciplinary and transdisciplinary collaborations?

SCIENCE GOVERNANCE FOR THE NEW NORMAL

The governance framework that underpins Canada's scientific enterprise dates largely to the end of the Second World War and is imbued with the social and cultural qualities that were in vogue at that time. This governance is based on the idea of a compact between science and society — put forth in a report called *Science: The Endless Frontier* (Bush, 1945) that positioned science as a type of knowledge with near limitless potential that could be mobilized to solve all of society's problems.

This compelling image of science led to what is generally referred to as a social contract between science and society whereby society — through government — provides public funds and a high degree of autonomy to the scientific community in return for the considerable but uncertain benefits — terms of economic prosperity, health and national security — that arise from the scientific pursuit of new knowledge.

Science has indeed brought about benefits to society in the last 75 years. In fact, the scientific enterprise is one of humanity's most successful creations, and the system we've built has served us well (Annan *et al.* 2019).

But the science-society relationship is under strain.

Science has become a complex enterprise, divided into increasingly narrow and specific disciplines, each with its own language (jargon), community, and driven by a global practice of rewarding those who publish in journals that are inaccessible to most of us (as a result of complex language and paywalls). With the decline of trust, there are worrying signs of a public unsure about the value and authority of science in their everyday lives, and a growing disconnect between what the public increasingly sees as unapproachable, elitist institutions and what scientists see as a lack of public appreciation for the modes and merit of their work (Annan *et al.* 2019).

At the same time, there have been major developments in the processes of science and innovation and their intersections with public policy, communications, and broad societal challenges. In this period of significant social, economic and environmental stresses, the need for science and innovation to be central to society's response is even greater. It is imperative that Canada rethink (and perhaps replace) the postwar social contract and develop a renewed and strengthened relationship appropriate to the challenges and opportunities of this era.



In short, there have been significant changes to the scientific enterprise and to the society within which it operates – we’re in a new normal – and this calls into question whether science is fulfilling its compact with society. Science is needed more than ever but our approach to science – how it’s funded, produced and put to use – must evolve to remain relevant in a ‘post-truth / ‘post-trust’ context.

THE SOCIAL CONTRACT FOR SCIENCE AND INNOVATION

When thinking about science and innovation in the new normal, it's important to understand the broader context that shapes our national science and innovation system.

In Canada and throughout the industrialized world, we have largely tied our future to advancements in science and technology – to support economic innovation, to ensure our health, to protect the environment and our national security. As a result, we spend a lot of public funds – more than \$14 Billion annually at the federal government level – to support science and technology. Not unreasonably, taxpayers expect a solid return for this investment. For this reason, it makes sense to consider the social contract or basic compact that guides the relationship between science and society.

The current social contract emerged in the wake of the Second World War. Prior to the war, there had been limited public funding of scientific research. As part of the war effort, the scientific community was mobilized and contributed major success including radar, the proximity fuse, and of course the atomic bomb that helped end the war in the Pacific.

Then the question became how to best maintain this tight relationship between government and science, to continue to benefit from this mobilization of research to support peacetime objectives after the war.

In the closing months of the Second World War, U.S. President Roosevelt asked his science advisor, Dr. Vannevar Bush, to develop advice on this question. Dr. Bush’s famous report, *Science: The Endless Frontier*, articulated an implicit social contract for science by suggesting that the American public should continue to fund science in peacetime in exchange for the benefits that flow to society in the form of new knowledge, new technologies and new innovations – his “endless frontier” of scientific exploration “would replace the western frontier in the American consciousness” (Smith 1990, p. 5; Guston and Keniston 1994).

Importantly, Bush argued for autonomy for the scientific community within the science-society relationship, with scientists making decisions about what research and which researchers should be



funded and what should count as evidence. In the afterglow of victory, the scientific community was viewed with awe and enjoyed unprecedented levels of prestige. Governments were willing to accept the science community's argument that only science can judge science and that the public should trust the scientific community to select research priorities that are in the public interest.

Bush's landmark report effectively became the blueprint for postwar science. Indeed, Smith (1990, p. 43) states that the report "proved to be one of the most influential policy documents in the nation's history." However, the influence was not only felt in the United States. Through the Organization for Economic Cooperation and Development and other channels, the basic tenets of the report were later promulgated throughout the industrialized world including in Europe and Canada¹ (see Caracostas and Muldur 1998; Doern, 1972; Herzberg and Dufour, 2019).

In the immediate postwar era, Canada did not produce its own science policy blueprint and, given the close integration of our scientific enterprise with the Americans', the Endless Frontier social contract was largely adopted. As Doern relates in his seminal study of science and politics in Canada:

"While the entire object of science policy-making is to make national science policies, this study has stressed the degree to which it appears that Canadian society does not see science as Canadian science...Canada has been especially exposed (albeit, without much objection) to the immediacy of American science and technology. Much of it has been beneficial. Our sin is not that we accepted it, but that we have scarcely thought about its consequences and that we have accepted it all, without any discrimination or determination of whether or not it suits our own preferences" (Doern, 1972, p.197).

At the heart of this social contract is a fundamental tension, at least for democratic societies. Steven Shapin captures this tension well and is worth quoting at length:

"There is a tension that lies at the very heart of the relations between scientific expertise and the democratic...state.... On the one hand, we have the conviction that there are certain conditions in which scientific inquiry can best acquit its intellectual goals and thereby make its most effective contributions to human well-being and national interests...If you want reliable scientific knowledge, the price is a significant chunk of public funding and relief from the accountability to which other recipients of public funding are routinely subject. 'Scientific research,' the physicist Kenneth M. Watson wrote, 'is the only pork barrel for which the pigs determine who gets the pork.'

¹ And continue to inform thinking within Canada's science and innovation system – the Naylor Panel report (Government of Canada, 2017) approvingly quotes *Science: The Endless Frontier*.



“On the other hand, democratic societies have legitimate reasons to worry about such states of affairs. The absence of accountability is a reliable sign of the absence of democracy.

“...The tension is just irresolvable: if we propose to resolve it in favor of minute political accountability, we are likely to stunt scientific development and the free play of creativity; if we exempt the scientific community from normal patterns of accountability, we compromise democracy through a tyranny of the experts, and ultimately create the conditions in which the scientific community comes to be resented and mistrusted” (Shapin, 1999, p. xvi-xvii).

Fast forward 75 years, and the context has shifted. There is growing recognition of the need to rethink the social contract (Barfield, 1997; Gibbons, 1999; Sarewitz, 2020; Showstack, 2019; Stokes, 1995; Sunkel, 2015).

As influential as it was, *Science: The Endless Frontier* was a product of its times...and times have changed a lot since 1945. Many of the underlying social, economic, and political assumptions in the report are outdated. Here are five ways in which our thinking has advanced in recent years.

First, the very metaphor of a social contract may itself require a fundamental rethink. Its use tends to perpetuate the notion that there are two distinct entities involved, that science and society are two opposing parties to a contract, destined for likely conflict and an adversarial relationship. This suggests that science stands outside of society rather than understanding that scientists are within society – a part of society, not apart from society.

Second, the postwar social contract suggests that only benefits flow from science and innovation. We know that new science and technology can often raise challenges and yield disbenefits. For example, the public struggles to keep pace with the disruptions of newly emerging technologies. According to the Edelman Trust Barometer (2020):

- 62% of Canadians think the pace of technological change is too fast;
- 45% of Canadians worry about losing their jobs to automation; and
- 65% of Canadians do not think that government understands emerging technologies enough to regulate them effectively.

The postwar contract provided little guidance for dealing with the ills brought about by science and innovation. In the language of governance, this presents an accountability gap.

Third, this brings us to the issue of autonomy which was central to Bush’s argument. He famously wrote that “scientific progress...results from the free play of free intellects, working on subjects of



their own choice, in the manner dictated by their curiosity for exploration of the unknown” (Bush 1945, p. 12). This view was based on a strong belief in the role of serendipity in advancing scientific discovery. Polanyi (1962, p. 9) argued:

“You can kill or mutilate the advance of science, you cannot shape it. For it can only advance by essentially unpredictable steps, pursuing problems of its own, and the practical benefits of these advances will be incidental and hence doubly unpredictable.”

In Canada, in commenting on what in his view made the National Research Council (NRC) such a successful organization, Gerhard Herzberg, the Nobel prize-winning chemist who spent much of his career at the NRC, reflected the postwar emphasis on scientific autonomy:

“It is primarily the flexibility of the organization, the capacity to depart from rigid lines of departmental organization, and particularly the overriding philosophy that **it is the working scientists themselves who should largely determine what is to be done**” (Herzberg 1965, p. 18; emphasis added).

Herzberg later argued:

“Here in Canada, we should be able to spend a proportionate amount of money for the advance of knowledge without considering, at every step, what it is doing for the economy of the country. This should be particularly so because we know that, in doing so, we will reap a profit of technological knowledge that will later become useful **but which cannot be planned and foreseen in detail and which cannot be improved by more bureaucracy**” (Herzberg 1972, p. 105; quoted in Herzberg and Dufour 2019, p.x, emphasis added).

We know that the science community resists anything that smacks of planning and the bureaucratic control of research. Consequently, the postwar contract privileged bottom-up, basic research conducted at universities where scientists enjoy academic freedom and a high degree of autonomy. Occasional calls for greater public accountability led to criticisms that the public was “anti-intellectual,” “anti-science,” and the scientific community complained that there were too many bureaucratic strings attached to research funding. But it raises questions of how we should pursue more mandate-driven research to address public purposes, for example the type of mission-directed research pursued in government labs.

Fourth, Bush argued for what has come to be known as the linear model of research and innovation, an overly simplistic if not entirely fallacious view of the innovation process. In this model, basic research drives applied research and technology development and ultimately leads to the commercialization of innovations in the market. In addition, the postwar contract privileged the



natural and biomedical sciences and engineering, with little regard for the social sciences and humanities, and had nothing to say about the interdisciplinary approaches we need today. We've learned a lot since those days about how innovation actually happens, including through other forms of innovation – social innovation, organizational innovation, etc. – and other ways of knowing that are not necessarily driven by advancements in Western science and technology.

Fifth, trust is fundamental to the social contract. But trust in Canadian institutions is in decline, there is less trust in government and less deference to expert authority, just as Shapin cautioned two decades ago. Today, according to a 3M survey, 58% of the public view scientists as elitists. In 2020, the Edelman Trust Barometer found that while 78% of respondents have a high level of trust in scientists, disturbingly, 48% of Canadians do not believe that scientists behave as ethically as they should. How do we reconcile these findings? How do we renegotiate a social contract when large segments of society don't trust that the application of science and innovation is necessarily in their interest?

So, while the science community continues to argue for autonomy (see e.g., Government of Canada, 2017), the public is seeking greater accountability, especially given the large expenditures of public funds for research.

In such an environment, it is not persuasive to suggest we simply need to raise the level of scientific literacy among the general public who will then be more supportive of science. Climate change deniers and anti-vaxxers will not be convinced simply by more evidence from the experts. Rather than push for greater “public understanding of science,” perhaps we need to increase the scientific community's understanding of the public. Scientists need to listen to the public's voices; we need to more systematically consider who will be impacted by advancements in science and innovation and how.

“Research cannot fulfill its social contract and reach new horizons by advancing on the same footing into the future.”

– Philip Ball, Science Writer and Editor,
Nature (2019)



CONCLUSIONS

As the global pandemic has demonstrated, government science and innovation are experiencing a new normal. The social contract between science and society is showing strain as trust decreases, with calls for science to be more inclusive and diverse, and as Canada grapples with meaningful reconciliation with Indigenous people. Our approaches to the governance of science and innovation, research funding and performance, and how new knowledge and innovations are put to use must evolve in this 'post-truth' / 'post-trust' era.

Canada needs a new social contract for science and innovation that reflects our time.

The GSINN initiative has examined just some of the possible elements of a new social contract. The postwar contract has served us well for 75 years. It's now time to look ahead to the next 75 years. Whether it's time for a new "contract", a new roadmap (Dufour, 2017) or some other new framing metaphor (Flink and Kaldewey, 2018) for science and innovation, we're clearly at a turning point. As the President of the US National Academy of Sciences and President of Arizona State University have said: "The post-World War II model for organizing science remains powerful, but moving beyond its limits will be necessary for assuring the contributions of science to solving a wide array of societal challenges."

Drawing on the analysis of Sarewitz (1997), a new approach needs to consider how to create the greatest possible compatibility between both the new knowledge that scientists create and the public's capacity to assimilate it for society's long-term benefit.

Canadians deserve a scientific enterprise that addresses our most pressing needs, engages us using language we understand, and is made up of people who look like us, all of us. Canadians require a scientific enterprise that brings different organizations and groups together, not one that reinforces the false boundaries of disciplines or types of research.

Canadians need a scientific enterprise that uses our resources wisely, and coordinates investment in our domestic priorities with our global priorities. We aspire to a scientific enterprise that knows its limits, and works to advance reconciliation with Indigenous people by recognizing and valuing the knowledge systems of the people who lived on this land before colonization.

All of this is possible.



“The post-World War II model for organizing science remains powerful, but moving beyond its limits will be necessary for assuring the contributions of science to solving a wide array of societal challenges.”

– Marcia McNutt, President of the U.S. National Academy of Sciences and Michael M. Crow, President of Arizona State University



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APPENDIX: GOVERNMENT SCIENCE AND INNOVATION IN THE NEW NORMAL RESEARCH THEME SUMMARIES

EQUITY, DIVERSITY AND INCLUSION

The postwar science system has been dominated by white men. There are tremendous biases in much of the scientific data we have accumulated and in much of the technology that forms part of our daily lives. Equity, diversity, and inclusion (EDI) practices have been shown to increase creativity, lead to enhanced efficiency, productivity, problem-solving, customer-satisfaction, and improve morale, teamwork, and organizational performance. Ultimately, equity, diversity, and inclusion drive innovation and growth.

A new contract needs to not only expand the participation of historically underrepresented and disadvantaged groups (including women, people of color, the LGBTQ+ community, Indigenous peoples, and neurodiverse individuals) but also recognize the benefits that EDI bring to the process and outcomes of science and innovation. The relationship between science and society will benefit from diversity across multiple dimensions to address inherent biases (SSHRC n.d.).

Read the GSINN discussion paper on [Equity, Diversity and Inclusion](#).

GLOBAL RESEARCH COLLABORATION AND INFRASTRUCTURE

The postwar contract was couched very much in terms of national science systems advancing domestic interests. Today's challenges and opportunities are increasingly global and require international collaborative approaches. We know the biggest challenges facing Canadians today are the same ones facing the world – the pandemic, climate change, persistent inequalities. At the same time, according to the Naylor Panel (Government of Canada, 2017, p. 119): “Research is a global enterprise...World-leading researchers collaborate with individual colleagues and like-minded groups around the world in addition to participating in large international research projects.”

A new contract will need to better support international science and technology partnerships, science diplomacy, international research infrastructure and governance, and big collaboration to address global grand challenges and opportunities facing society.

Read the GSINN discussion paper on [Global Research Collaboration and Infrastructure](#).



INCLUSIVE INNOVATION

The postwar contract saw no role for non-scientists in the scientific process, and innovation was largely a closed process (OECD 2015). At most, the scientific community allowed a role for the public in helping set broad research priorities and in helping to mobilize knowledge uptake. But the core functions in the middle steps of the research and innovation processes were closed to non-specialists. Today, there is growing recognition that science needs to innovate not just for society, but with society.

The government has been pushing Open Science, emphasizing greater openness with the outputs of the research process – i.e., open access to scientific publications and data. We need to go farther, and with movements toward citizen science, community-based research, patient-centered research, etc., it is apparent that even the conduct of research and innovation can be opened up to contributions from society (Cooper 2016; Frow 2017).

How can we open up the processes of research and innovation to the public? Inclusive innovation is gaining interest here (Kinder and Schillo 2020; ESDC 2018). Early research suggests that broader participation in innovation will not only change who innovates, but what we innovate, how we innovate and why innovation occurs (Schillo and Robinson 2017; Canada2020 2017; Zehavi and Breznitz 2017). Improving how we measure innovation will be critical to advancing inclusive innovation (Earl *et al.* forthcoming).

Read the GSINN discussion paper on [Inclusive Innovation](#).

INTERDISCIPLINARY COLLABORATION

The postwar contract privileged discipline-based approaches, particularly in the natural and biomedical sciences and engineering with little regard for other areas of science. And it had nothing to say about the more integrated approaches that today's challenges require. The Naylor Panel (Government of Canada, 2017, p. 122) found that: "World-leading research often crosses traditional knowledge and disciplinary boundaries and is increasingly multidisciplinary in nature – both in its bridging of previously unconnected fields of knowledge and its development of entirely new disciplines." For the sake of simplicity, the panel chose to employ only the term multidisciplinary and not engage with the important differences between it and adjacent concepts of interdisciplinary or transdisciplinary. These nuances are increasingly important.

A new contract needs to be more inclusive and integrative of the social sciences and humanities, but also acknowledge and reflect the importance of interdisciplinary and transdisciplinary approaches.

Read the GSINN discussion paper on [Interdisciplinary Collaboration](#).



INDIGENOUS AND OTHER WAYS OF KNOWING

The postwar contract privileged Western science approaches over other types of knowledge. Shifting to a culture where multiple ways of knowing are valued is a large task that will require time, training, and leadership. But our collective ability to create spaces where knowledge is created and validated across multiple knowledge systems is an activity in enlightened self-interest. Through identifying and mapping multiple ways of knowing that excel where others are limited – and bridge those systems in meaningful, relevant and respectful ways – we may create new, more rigorous and robust ways of producing knowledge that advance our understanding of our natural world and our place in it.

Building understanding across multiple ways of knowing is fundamentally an act to support good governance and to advance evidence-based decision-making. A new contract will seek to interweave Western science, Indigenous traditional knowledge and other ways of knowing while maintaining rigour, reproducibility and excellence (Alexander *et al.* 2011; Goulding *et al.* 2016; Griwkowsky 2018; IOG 2019; Martin *et al.* 2017; Nicholas 2018; Simonds and Christopher 2013; Stefanelli 2017; Verma 2016).

Read the GSINN discussion paper on [Indigenous and Other Ways of Knowing](#).

MISSION-DRIVEN RESEARCH AND INNOVATION

As we've seen, the postwar contract refused scientific planning and stressed the serendipitous nature of scientific discovery. And that view still holds sway – the Naylor Panel had this to say: “...major breakthroughs in basic research are frequently the result of serendipitous discoveries that were not foreseeable at the outset” (Government of Canada, 2017, p. 24). But serendipity is not a strategy!

Can we better link research to specific grand challenges and public purpose (Hicks 2016; Kaldewey 2018)? Perhaps the UN's Sustainable Development Goals would be helpful here. Mazzucato and others argue for a more mission-oriented research policy (Mazzucato 2016; Mazzucato 2017; Rozenkopf 2019). Others argue for pursuing more highly integrative basic and responsive (HIBAR) research (Seidel 2020; Whitehead 2020) and use-inspired basic research within “Pasteur's Quadrant” (Stokes 1997) or strategic science in the public interest (Doern and Kinder 2007). It is important to emphasize that this is not an argument for increasing applied research at the expense of fundamental, basic research – that's a false dichotomy that serves no one well. A mission-orientation allows for both types of research and may help justify the public expense and rebuild public trust.

Read the GSINN discussion paper on [Mission-driven Research and Innovation](#).



SCIENCE COMMUNICATIONS, OUTREACH AND PUBLIC ENGAGEMENT

Affirmed by the postwar contract, the traditional training of scientists continues to focus on the need to publish findings in academic settings with little obligation to promoting broader knowledge mobilization and uptake by non-scientist users. System incentives do not traditionally reward science communications, outreach and public engagement (SCOPE) activities (Hooke 2015; Jasanoff 2003; Kelly *et al.* 2019; Keohane *et al.* 2014). But without SCOPE, science is not fulfilling its full potential in partnership with society.

Can we engage citizens in better discussions about the scientific process, about what research questions to pursue, about the costs associated with research, as well as the benefits that may realistically flow from science? We need to go beyond improving the “public understanding of science” to authentic engagement with society where both parties contribute to the identification of questions for science to answer and participate in the co-production of knowledge to the mutual benefit of science and society (Arnott 2019; Turnhout *et al.* 2020; van der Hel 2016). Can we reframe our concepts of excellence to include perspectives on social acceptability, utility, need, etc.? A new contract must embrace new incentive systems and funding programs to reward mentoring, community engagement, knowledge co-production and mobilization, as well as traditional research publication.

Read the GSINN discussion paper on [Science Communications, Outreach and Public Engagement](#).

SKILLS AND KNOWLEDGE

The postwar contract emphasized the need for generating highly trained personnel in the sciences, technology, engineering and mathematics (STEM) disciplines. Those trained in STEM now increasingly require additional skillsets to successfully navigate today’s complex world (Duckworth *et al.* 2017; Keeler *et al.* 2017; Lapointe and Turner 2020; Munro 2019). At the same time, data on public scientific literacy suggest that many Canadians are poorly equipped to make evidence-informed decisions on pressing issues (Sachs 2007; Smol 2018).

A new contract must place emphasis on both expanding STEM and other skills and the science literacy of non-scientists. A new contract must seek to rebuild trust and understanding between science and society by providing scientists with the skillset to engage members of society in order to fulfil the full potential of science in partnership with society.

Read the GSINN discussion paper on [Skills and Knowledge](#).



TRUST, INTEGRITY AND SCIENCE ETHICS

As discussed earlier in this paper, the postwar contract called for a high degree of autonomy for “unfettered research”, arguing that the science community’s internal control mechanisms (e.g., peer review) “embody the principal ethical responsibilities of the research system” (Sarewitz 1996 p.10); any ethical breaches or abuses were to be viewed as merely a problem of “housekeeping” (Ibid., p. 57). However, recent media reports of scientific misconduct continue to raise questions about the scientific community’s ability to police itself and suggest that its internal mechanisms may not be enough to ensure scientific integrity (Isai 2019; 3M 2019; World Science Forum 2019).

Meanwhile, the rise of anti-intellectual and populist sentiments, hyper-partisanship and the declining trust in elite institutions exacerbate the feeling that, for many Canadians, the scientific enterprise does not represent them or serve their needs (Edelman 2021; Oreskes 2019; Specter 2009; Waldie 2020; Weber 2019). Peer review and project selection are generally conducted behind closed doors, making decision-making opaque. In the new normal, the public needs a seat at the table – not just because of the billions of taxpayer dollars at stake but because it can make for better research outcomes.

A new contract must demonstrate that science is pursued with integrity and can produce knowledge for the benefit of all Canadians. Science can also help us understand how we internalize knowledge, why we believe what we do, and how to work collaboratively to rebuild trust.

Read the GSINN discussion paper on [Trust, Integrity and Science Ethics](#).

