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# Mission-driven Research and Innovation

## Government Science and Innovation in the New Normal

### Discussion Paper

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# ABOUT GSINN – CANADA NEEDS A NEW RELATIONSHIP WITH SCIENCE THAT REFLECTS OUR TIME

In December 2020, the Institute on Governance launched *Government Science and Innovation in the New Normal (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Today, many of the underlying social, economic, and political assumptions in the postwar compact are outdated.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. Finally, we want to acknowledge the following reviewers whose thoughtful feedback improved this paper: Rob Annan, Peter Massie, Bryony McAllister, Dan McPhee, and Kelly Vandeligt.



## INTRODUCTION

The purpose of this discussion paper is to explore the concept of mission-driven research and innovation in the context of government science and innovation. The paper is divided into four sections: the first section defines the concept of mission-driven innovation, the second section further explores the concept through the example of the Apollo moon mission, and the third section attempts to build on this high-level thinking to describe how the concept works in practice and highlight associated governance challenges. The final section offers several questions to guide further research.

## THE CONCEPT OF MISSION-DRIVEN RESEARCH AND INNOVATION

Although much of the current discussion of mission-driven innovation has been influenced by the work of economist Mariana Mazzucato, it is important to situate missions as part of a much older tradition—we can point to the Apollo lunar mission, the Manhattan Project, or even the British government’s Longitude Prize in the 1700s. But the mission idea has reached its modern expression and been organized into a systematic approach to innovation by Mazzucato. In her most recent book, *Mission Economy: A Moonshot Guide to Changing Capitalism*, Mazzucato (2021) argues that the public policy problems we are facing in the 21<sup>st</sup>-century—from climate change to global health to inequality—are highly complex, wicked problems not susceptible to simple solutions. To overcome these problems, she argues that we need to think bigger and bolder and mobilize resources in a way that is as inspirational as the Apollo moonshot was in the 1960s. Furthermore, in Mazzucato’s (2021) view, we can only begin to find answers to these questions if capitalism itself is restructured so that it is more inclusive, sustainable, and driven by innovation. And, she argues, if the economy is to be restructured, this will necessitate governments to be much more proactive, competent, and entrepreneurial in addressing these problems.

Critics of Mazzucato’s thinking claim that it is possible to delink mission-driven innovation from the grander project of restructuring capitalism, thus allowing mission-based innovation to take place within the framework of capitalism as it currently exists. Mazzucato would disagree. In Chapter 10 of her earlier book *The Entrepreneurial State: Debunking Public vs. Private Sector Myths* (2014), she issues the following warning: “Unless we challenge the numerous ‘myths’ of economic development, and abandon conventional views of the State’s role in it, we cannot hope to address the structural challenges of the twenty-first century, nor produce the technological and organizational change we need for long-term sustainable and equitable growth” (Mazzucato 2014, p. 12-13).



Mazzucato calls this new way of tackling societal problems mission-oriented innovation. But what does she mean by a mission-oriented approach? In her view, it starts with government.<sup>1</sup> According to Mazzucato (2021), a mission approach requires government, through civic engagement, to identify a “grand challenge” and design specific missions to address it. To achieve a mission, governments in collaboration with multiple actors, design policies that catalyze investment, innovation, and collaboration across a variety of sectors in the economy, involving a wide array of players, and engaging business as well as civil society.

In a mission approach, governments make use of a wide variety of policy instruments such as direct investment, loans, grants, regulatory change and procurement to drive the most innovative solutions around problems like climate change or solving the digital divide. A mission-driven approach asks the right question about money and budgets. Mazzucato (2021) believes the wrong question to ask is: How much money is available and what can we do with it? The right question to ask is: What is the problem to be solved, and how can we structure budgets to meet this goal?

To accomplish all of this is a huge task because Mazzucato (2021) states that we live in an era when capitalism is in crisis. That said, she reminds us that “a time of crisis is exactly the moment to reimagine what type of society we want to build, and the capabilities and capacities we need to get us there” (Mazzucato 2021, p. 8-9). In her view the state can and should play a much larger role in reimagining what type of society we want to build.

Here she is developing themes from her earlier book in which she describes the state as entrepreneurial because “most of the radical, revolutionary innovations that have fueled the dynamics of capitalism—from railroads to the Internet, to modern-day nanotechnology and pharmaceuticals—trace the most courageous early and capital-intensive ‘entrepreneurial’ investments back to the State” (Mazzucato 2014, p. 3). In Chapter 5, “The State Behind the iPhone,” she argues that all of the technologies that made Steve Jobs’ iPhone so ‘smart’ were government funded: the Internet, GPS, touch-screen display and the SIRI voice activated personal assistant. Such “radical investments which embedded extreme uncertainty,” did not happen because of venture capitalists but came about through “the visible hand of the State”. This innovation would not have happened “had we waited for the ‘market’ and business to do it alone,” or by expecting government to “simply stand aside and provide the basics” (Ibid.).

Closely related is what Mazzucato refers to as the “flawed ideology about the role of government [that] has infiltrated our expectations of what it can do, and thus what other actors can do in

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<sup>1</sup> Others, including some of the roundtable participants, argue that missions need not be driven top-down from government but can also be business-driven. See Rozenkopf *et al.* (2019) for the argument that business must take the lead on missions.



partnership with government” (Mazzucato 2021, p. 8). This “flawed ideology” sees the role of the State as simply fixing market failures. She disagrees with such thinking, arguing that big visionary projects “like putting ‘a man on the moon’, or creating the vision behind the Internet required much more than the calculation of social and private returns” (Mazzucato 2014, p. 4; Mowery, 2010). Such challenges require a different vision about what the State’s role is to be in the economy. She quotes economist John Maynard Keynes who argued that “The important thing for government is not to do things which individuals are doing already, and to do them a little better or a little worse, but to do those things which at present are not done at all” (Ibid. p. 4). And when the government does set direction for innovation, it is important that it reap the benefit of its high-risk investments in early-stage innovation; Mazzucato argues that under the current system, early losses are socialized, while later-stage profits are privatized. But if the state is to fulfill its role in the economy, and achieve scale in early-stage investments, then it should have a stake in the enterprise and re-invest the ensuing profits. She encourages us to question who the real risk takers are within the innovation process (Ibid.).

In Mazzucato’s view, mission-driven innovation means changing capitalism, changing how government is structured and how business is run because it means changing how both public and private organizations interrelate.

One reviewer has referred to her new book as “a bold and persuasive call to action” (Ghosh 2021, p. 350). Whether or not Canada wants to go as far as Mazzucato in reconceptualizing capitalism, she helpfully highlights that driving innovation through a common notion of *public purpose* is the real key to a mission-driven approach (Mazzucato, 2021). We can develop a better understanding of how this can happen by looking at the innovation and risk-taking that took place within the Apollo program.



# INNOVATION, RISK-TAKING, AND EXPERIMENTATION IN THE APOLLO PROGRAM

In September 1962, President John F. Kennedy spoke about the American space effort at Rice University in what one historian has referred to as an “oratorical masterpiece” (Brinkley 2019, p. 362). The speech very well captures the inspirational aspect of bold missions. As Brinkley puts it:

“In winged words, the president delivered one of his most timeless sentiments, placing Apollo among mankind’s noblest aspirations: **‘We choose to go to the moon...we choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard,** because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win” (Brinkley 2019, p. 363-364, emphasis added).

Kennedy concluded that the US would set out “on the most hazardous and dangerous and greatest adventure on which man has ever embarked,” landing a man on the moon and bringing him back safely to earth (Brinkley 2019, p. 364). At the time, the US lagged behind the USSR in space technology. As Mazzucato (2021, p. 64) relates, “the giant Saturn V rocket was under development; computer power was meagre. Above all [when the initial commitment was made], there was not even a plan for how to get to the moon.” Yet despite all these limitations, the US successfully landed two men on the moon just seven years later. All of this begs the question: How was the US able to achieve this mission despite these limitations? The answer is that the Apollo program was one of the riskiest public sector projects ever, involving a great deal of experimentation and innovation.

The extent of these risks was very clearly shown to the world with the Apollo 1 disaster in 1967, when three astronauts—Gus Grissom, Ed White, and Roger Chaffee—were killed during a routine test of the command module. Many technical problems were responsible for this tragedy, ranging from problems with the coolant system to a lack of effective radio communication. But it also drove home the point that “to carry out the Apollo mission, hundreds of complex problems had to be solved; some solutions worked, many failed” (Ibid., p. 65). However, the solutions emerged out of a close partnership between government and business, and it was a partnership with a purpose (Mazzucato, 2021).

After the Apollo 1 fire, the Chief Flight Director, Gene Kranz, concluded that critically important problems were not being addressed decisively. It was essential to reform NASA’s management so



that solutions could be found by people willing to experiment, and “not by picking supposedly good solutions in advance and trying to make them work” (Mazzucato 2021, p. 74).<sup>2</sup>

As Mazzucato (2021) states in her book, running a mission-driven system of innovation requires leadership like that found in Apollo-era NASA, along with experimentation and the adoption of reasonable risk-taking, as well as having the ability to attract the best talent to the mission. It is also important that agencies carrying out missions have sufficient autonomy to take risks. Agencies that are engaged in missions need to have organizational flexibility so that they can respond quickly to changing conditions and the development of new technologies. If implementing agencies have a combination of autonomy, flexibility, experimentation, and support from high levels of government, they can empower their staff to embrace risk and push forward their projects so they can achieve the mission (Mazzucato, 2021).

Apollo was led by government but in close partnership with the private sector. This dynamic partnership with business produced many important innovations, not only in aerospace engineering but also in many other sectors such as microbiology, medicine, geology, food, electronics, and computing. The risk-taking and innovation in the Apollo program generated many spillovers. One of the most important was the wave of miniaturization in the computer sector, given the need to fit the Apollo guidance computer into a small lunar module. This innovation in electronics and computers has ramifications to this day. The development of the Apollo program’s computer hardware and software set the stage for the IT revolution, and with it the social, economic, and political upheavals we are still trying to resolve (Mazzucato, 2021).

Innovations in the Apollo program resulted from the cooperation of researchers from different disciplines and sectors to solve problems. “While there was a top-down direction..., the way different problems were solved was left to individual organizations rather than micromanaged, which would have killed innovation from the start” (Ibid. p. 85). The approach taken by NASA stimulated new types of risk-taking, and the combination of “setting clear goals while allowing bottom-up experimentation stimulated creativity and innovation and produced a winning formula” (Mazzucato 2021, p. 85, 88).

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<sup>2</sup> According to one reviewer of this paper, this type of thinking is also reflected in the organization known as the Transition Accelerator, a pan-Canadian charity that works with groups across the country to build “viable transition pathways to a net-zero future for fossil fuel emissions by working on projects as diverse as Canada’s hydrogen economy to electric vehicle market penetration and grid integration.” Their approach to solving these problems underscores the need to run many experiments to identify low carbon configurations that could scale to accelerate the transition (The Transition Accelerator, 2021).



## FINANCING THE MISSION

As important as risk-taking, experimentation, and innovation were to the Apollo mission, and to any mission today, missions will never succeed unless they are properly financed.

The Apollo program cost \$25.8 billion in 1960s dollars, but when we put this into perspective vis-à-vis the costs of some other government expenditures, most analysts would argue that, given all of the technological spillovers, the program did provide good value for money. For comparison, Mazzucato (2021) relates that

the total interest payments on the US federal budget debt between the years 1959 to 1972 was \$140.3 billion, and the cost of the Interstate Highway System between 1956 and its completion in 1991 was \$114 billion.

That said, some prominent Americans such as Dr. Martin Luther King, Jr. and Ralph Abernathy questioned the spending of such a vast amount of money, given the poverty and lack of opportunity that existed within African American communities. Mazzucato (2021) argues that missions should address inequality, so that all share the benefits of the mission. In *The Entrepreneurial State*, Mazzucato (2014) devotes a chapter to the problem of the socialization of risks and the privatization of rewards. She argues that a better understanding of risk “gives credit to the role of the public sector in innovation activities. Doing so makes it immediately logical for there to be a more collective distribution of the rewards, given that the presence of innovation is a result of a long-term cumulative, collective, and uncertain process” (Mazzucato 2014, p. 184).

Congress also questioned the program’s expense, and given the resources needed, President Kennedy called the Apollo program “an act of faith and vision.” But he thought that achieving the mission (and its technological spillovers) would be worth the budget and risks involved. Clearly, other geopolitical factors also entered into the equation, such as the Cold War tension with the Soviets which propelled the United States to be first in the ‘space race’. But according to Mazzucato, “Kennedy was effectively saying that missions should be judged by outcomes, not costs in a normal budgetary sense”. (Ibid. p. 90) If the Apollo program had been evaluated the way government finance departments evaluate projects today, using the method of cost-benefit analysis, then Neil Armstrong may never have set foot on the moon, she argues. This is why she calls for outcome-

### Key Attributes of the Apollo program:

- vision infused with a strong sense of purpose
- risk-taking and innovation
- organizational dynamism
- collaboration and spillovers across multiple sectors
- long time horizons and budgeting that focused on outcomes
- a dynamic partnership between the public and private sectors

(Mazzucato 2021, p. 60)



based budgeting to place more emphasis on outputs and outcomes rather than inputs (Mazzucato 2021, 90-92).

## HOW MISSIONS WORK

To this point our discussion of mission-oriented innovation has largely reflected the high-level ideas contained in Mazzucato’s recent book, *Mission Economy* (2021). However, in 2017-18 Mazzucato began working with the European Commission on the practical aspects of seeing how a mission-oriented approach to innovation could actually work. The result was her development of the so-called Mission Map (see Figure 1).

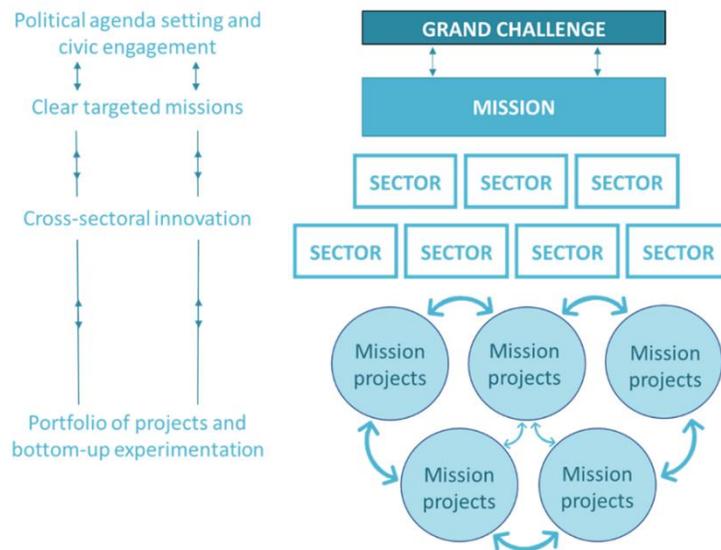


Figure 1: A Mission Map

The idea behind a mission map is to begin the quest for innovation by asking what is the problem that you want to solve? Then you frame the problem as a goal - the grand challenge that guides your mission(s). The mission serves to catalyze investment and innovation in many different sectors, working with many different actors, and all of this inspires new collaborations at the project level leading to innovation. The arrows joining each mission project represent those interactions (Mazzucato 2021).

Within the European Union’s Horizon Program, missions became a legal instrument. Five mission areas have been selected for development: (1) cancer, (2) climate change, (3) healthy oceans, seas, coastal and inland waters, (4) smart cities, and (5) soil health and food. Specific missions are now being framed within each area, but it is still too soon to collect any data that would illustrate how successful each mission area has been given the early stage of this research. (Ibid. p. 112)

In Mazzucato (2017, p. 31), the author acknowledges that for the implementation of a mission-oriented approach “the changes in mindset, theoretical frameworks, institutional capacities and policies required are by no means trivial.” Unfortunately, she does not go very far in charting a path



forward. Her suggested approach is to consider four key sets of questions – to which she ascribes the acronym ROAR:

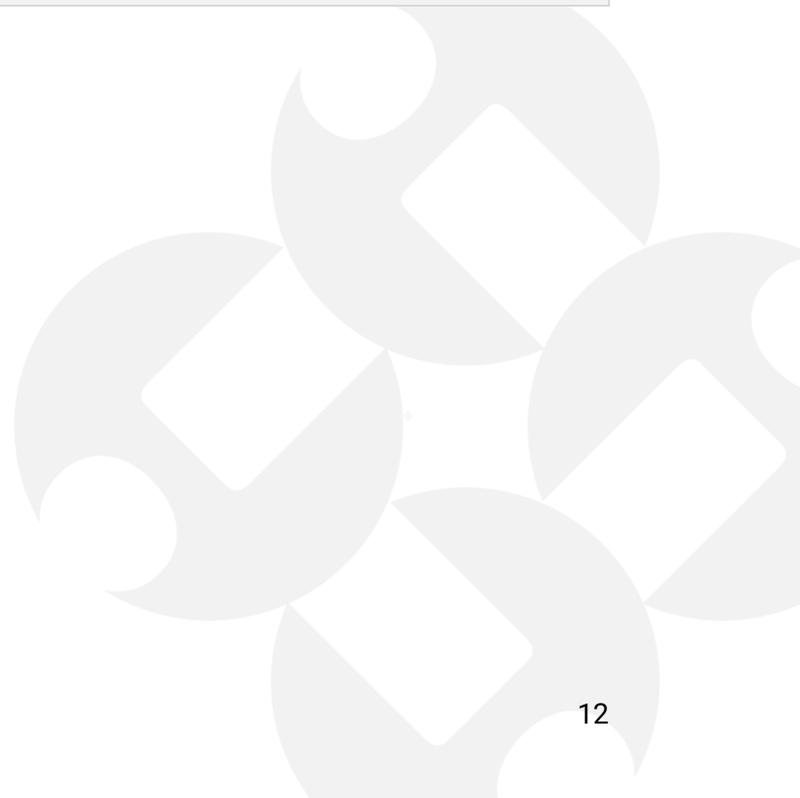
- **Routes and directions:** how to use policy to actively set a direction of change? how to foster more dynamic (bottom-up) debates about possible directions to ensure enduring democratic legitimacy? and how to choose and define missions concretely, but with sufficient breadth to motivate action across different sectors of the economy?
- **Organizations:** how to build decentralized networks of explorative public organizations that can learn-by-doing and welcome trial and error, with the confidence and capability to lead and form dynamic partnerships with private and third sector partners? how to manage and evaluate progress, learning and adaptation? and how to use a portfolio approach to balance inevitable failure with success?
- **Assessment:** how to evaluate the dynamic impact of public sector market-creating investments, going beyond the static ideas embodied in cost/benefit analysis and ideas of ‘crowding in’ and ‘crowding out’, based on a richer conception of public value creation? how to develop new indicators and assessment tools to aid decision-making?
- **Risks and rewards:** how to form new deals between public and private sectors so that rewards as well as risks are shared?

These questions can provide a starting point for adopting a mission-oriented approach.



**Figure 2. Practical Steps for Mission-Oriented Organizations**

Mission selection	How to select missions that have enduring and democratic legitimacy
Co-production	How to engage public, private and third sector actors in mission selection, implementation learning and evaluation processes
Mission definition	How to define missions concretely but with sufficient breadth to motivate action across multiple sectors of the economy, enabling new types of interactions between public, private and third sectors, and over different time horizons.
Dynamic capacities	How to develop new competencies and capabilities for dynamic change: ability to envision new futures and to accommodate risk-taking, experimentation and underlying certainty of the discovery process.
Decision tools	How to develop new indicators and assessment tools to aid decision-making and evaluate impact, beyond the static cost/benefit framework.
Managing failure	How to manage inevitable failure as well as success by taking a portfolio approach.
Sharing rewards	How to ensure rewards as well as risks are shared so that growth is inclusive as well as smart.
Adapted by IOG from Mazzucato, 2017.	



## CHALLENGES FACING GOVERNMENT SCIENCE AND INNOVATION IN THE NEW NORMAL

As important as the theoretical discussion around mission-driven research and innovation is, there are some real challenges facing its implementation. These challenges were clearly articulated in both an IOG-hosted workshop of federal public servants and a roundtable discussion with participants from multiple sectors.

Participants identified six challenges of great importance: (1) the divide between basic research and applied research, (2) risk aversion in government, (3) the silos that exist between intellectual disciplines, government departments, other levels of government and internationally, (4) the need for greater government, industry, and academic collaboration, (5) the need to improve the science/politics interface, and (6) the Apollo paradigm itself.

Regarding the first challenge, a mission focus may seem to privilege applied research over basic research, but a closer examination reveals that this is not the case. Basic research, often referred to as Blue Sky research, is critical to the long-term success of mission-driven innovation and the importance of both basic and applied research to missions cannot be overstated.

Perhaps of particular importance to mission-oriented innovation is a hybrid type of research that both seeks fundamental understanding (like basic research) and seeks to solve a particular problem (like applied research). Stokes (1997) referred to this as Pasteur's Quadrant, as Louis Pasteur's research exemplified this hybrid type of research by both contributing to our fundamental understanding of microbiology and addressing a societal problem of food spoilage.

Mazzucato (2021) argues that mission-oriented innovation involves both basic research and applied research. The Apollo mission could not have succeeded without "a bedrock of invention that pre-existed and had derived from curiosity-driven or blue-skies science" (Mazzucato 2021, p. 66). One workshop participant stated:

"We have learned a lot about the importance of science, but even more about how science needs to be deployed broadly and with full force if we hope to tackle the most challenging societal problems. Sometimes that might mean supporting an individual or team that is studying what looks to be esoteric, but will not prove to be so in a decade. Other times, it means highly focused support to take on a grand challenge. **One is not more important than the other; they feed off each other.**" (emphasis added)

Lautens (2021)



“We need a mix of mission-driven and follow-your-interests-driven, or curiosity-driven...research. Large scientific advances tend to come from strange research. CRISPR, a gene-editing technology, is changing health, agriculture, etc., but it came from studying the immune system of bacteria.”

This example goes to the heart of the concept of knowledge spillovers and their importance. A main challenge of spillovers is that we can only know they are valuable in hindsight; it is essentially impossible to predict their value in advance. The participants also expressed a concern that in Canada we do a poor job of educating researchers how to translate from basic research to applied research and innovation, from ideas to impacts.

Participants concluded that missions can't be done without basic research, but the question remains as to what the right balance is between basic and applied research in missions.

The second challenge that demands attention is the problem of risk aversion in government. One workshop participant framed this issue by stating that “within the government, we need to accept risk and ...become more comfortable with the innovation process”. Another workshop participant was more emphatic saying that “risk aversion in government can't foster a mission-driven approach. We have to step up to the plate and do a lot of critical thinking now on this issue”. Another participant pointed to the rise in recent decades of neoliberalism and the New Public Management which have tended to decrease governments' capacities to implement policies and has shifted the balance of power from governments to the private sector.

Mazzucato (2021) argues that governments today are so risk averse because they have bought into the ideology that their role is to simply fix market failures and not to achieve bold objectives. Moreover, this current thinking by government ignores the massive role that governments have played in taking great risks. DARPA, the U.S. Defence Advanced Research Projects Agency, is the classic example of a government agency taking risks in the early stages of development of high-risk, high-impact technologies. She argues that it is in fact a risk averse private sector that often shies away from these disruptive innovations. She believes that governments are capable of taking great risks; they just have to believe in their capacity to do so (Mazzucato 2021, p. 20, 28-29). Mazzucato suggests that if governments stood to directly benefit from a stake in early-stage investments, perhaps they would be more inclined to make them.

A third challenge is the problem of silos that exist between disciplines, government departments, levels of government and countries. As one workshop participant stated “government departments are not set up to work together; there are too many silos. It is a leadership question but for complex questions it doesn't work at all.”. Another workshop participant stated that we need to “break down



silos between researchers,” and a third workshop participant thought that, to make good decisions, we need “Open Science, Open Data, Microsoft Teams, but we need to connect with each other”.

Since a mission can span ministries, departments, and regional, local and international governments, it is essential that we break down these silos. However, this is not easy to achieve because of what is known as the complexity paradox of modern public policymaking. The paradox states that the more complex policy issues are, the more compartmentalized policymaking becomes. Therefore, breaking down silos means setting up a more horizontal relationship between departments, for example, so that each department retains responsibility for its contribution, with synergies arising from coordination from the top of government that stimulates innovation from below (Mazzucato, 2021).

Other workshop participants thought that addressing wicked problems required multiple countries working together, and pointed to the UN’s Sustainable Development Goals. Part of the concern about comparing today’s wicked problems with the Apollo mission is their global nature, involving many governments not internal to just one state. Participants highlighted that, with climate change, we now have a truly global mission for the first time, one that will require collective action. Government policy will need to empower the science and innovation ecosystem to fulfill its role, along with other actors. The steering capacity of scientific institutions will be key.

The fourth challenge is the need for greater government, industry, and academic collaboration. As one workshop participant noted, “we need to have government, industry, and business come together to solve problems.” Yet another workshop participant said that “university researchers need to partner with government and business more.” However, the call for more government/industry/academic collaboration is not new. Mitacs, for example, has for years been promoting the triple helix approach to innovation (Leydesdorff, and Etzkowitz, 1998). Their model has been very simple: connect industry and academia, let industry guide areas for research, co-fund these collaborations from Mitacs’ government support, and allow academic researchers to work directly at companies so that new products and services can be developed more quickly. While Canada strives to retain leadership across a dynamic global landscape, we should think more carefully about using the triple helix approach to better foster innovation and achieve more economic growth (Mitacs, 2022).

One participant stressed that determining the level of ambition of a mission is a key role for the state, given the broad range of stakeholders involved. Accordingly, the Nordic countries allow for the co-development of roadmaps that get all sectors involved in the governance and orientation of the mission. As we have seen during the pandemic response, governments can work horizontally in a



crisis; the question to be asked now is can governments replicate this cooperation when there is no crisis?

## DRIVING MISSIONS IN CANADA

There are several examples of federal government initiatives that are seeking to address the challenges described. Three of these are: (1) The Industry Strategy Council; (2) NSERC's Alliance grants; and (3) The Impact Canada initiative.

The Industry Strategy Council is a forum that brings together experienced business leaders to work in partnership with the federal government. The Council was created in May 2020 to develop a collective understanding of the scope and depth of the COVID-19 pandemic's impact on business and industry, and then inform government about specific sectoral pressures facing the Canadian economy. The Industry Strategy Council is built on the foundation established by the Economic Strategy Tables and now represents nine sectors that account for about half of Canada's GDP: (1) Advanced Manufacturing, (2) Agri-Food, (3) Clean Technology, (4) Digital Industries, (5) Health/Bio-sciences and (6) Resources of the Future, (7) Tourism and Hospitality, (8) Retail, and (9) Transportation (Government of Canada, 2020).

Another initiative is the Natural Sciences and Engineering Research Council's (NSERCz) Alliance Grant program that encourages university researchers to collaborate with partner organizations in non-academic sectors to generate new knowledge or technology to address complex challenges, and to contribute to Canada's long-term competitiveness. Alliance grants support projects of varying degrees of complexity with the program's Option 2 offering additional support for projects that demonstrate strong public impact value (NSERC, 2021).

Finally, the Impact Canada Initiative was announced in Budget 2017. Housed within the Impact and Innovation Unit of the Privy Council Office, this government-wide effort is designed to help departments accelerate the adoption of innovative funding approaches to deliver results to Canadians. It allows departments to issue challenges on a common site and reach a diverse group of problem solvers and innovators (Government of Canada, 2017).

A fifth challenge is the need to improve the science/politics interface. One participant stated that "political change can set the science priorities and that does not advance innovation." One participant said that Canada is a small country and needs to focus and another said that "we have to have more strategic planning for our mission-driven research." Yet another workshop participant suggested we need to choose a priority and "make a long-term commitment to that area and stick to it."



All these comments imply that our political thinking on science and innovation policy is too short-term. Other countries are planning strategically for the long-term. For example, the Chinese government is thinking 50 years out when it comes to developing innovation policies for their aerospace sector in the 21<sup>st</sup> century. (Aerospace Industries Association of Canada, 2019, 5) One could argue that Canada needs to adopt similar long-term thinking if we are to compete successfully in the global economy.

The sixth and final challenge is the Apollo paradigm that Mazzucato (2021) examines in her book. One participant thought the moon mission a “problematic example” for solving today’s wicked problems that involve social as well as technological challenges. Other participants agreed that they were not sure how the Apollo paradigm addressed societal concerns. As one book review put it “these ‘Earthshots’ are much harder to accomplish than literal Moonshots” (Ghosh, 2021, p. 350). The reviewer offers four reasons these so-called Earthshots are harder: their goals are harder to define, they can involve collective goods and global commons, they exhibit social and political complexities, and they are often characterized by competing interests and concerns about inequality and justice (Ghosh 2021).

This concern is not new, as highlighted by another heterodox economist, Richard Nelson. In his famous 1977 book, *The Moon and the Ghetto*, Nelson “tried to figure out why a society that could put humans on the moon couldn’t provide safety, health, and good education to significant proportions of its populace” (Nelson, 2021).

In response to this line of criticism, Mazzucato herself is keenly aware that “lessons from the moon landing cannot just be cut and pasted onto any challenge” (Mazzucato 2021, p. 6). What Mazzucato is trying to illustrate by invoking the lunar mission is the need to resurrect the ambition and vision that inspired the Apollo program, to put that back into our policymaking today to solve our greatest public policy problems. The

## THE GLOBAL BATTERY VALUE CHAIN

The ‘Earthshot’ challenge to transform our transportation sector to zero-emission vehicles is an example of a complex challenge nations are currently facing, where jurisdictions are racing to seize opportunities in the global electric vehicle battery value-chain. Those jurisdictions that attract battery manufacturers now and accelerate innovation in battery technology (e.g., solid-state battery development) will win the economy of the future. It is, however, not easily done, as the access to critical minerals, building partnerships across sectors (mining and automotive), and ensuring environmental and social issues are creating hurdles in the global race.

Source: IOG, 2022.



times are very different than they were in the 1960s: the politics have changed, the regulatory landscape has changed and needs attention, and the need for more citizen engagement has never been more important (Galvin, 2021). Since today's problems are more complex than sending a person to the moon, it is essential that different voices participate from the beginning and help think through a mission's implications for ordinary people, so that every citizen can benefit as much as possible (Mazzucato, 2021).

“The Moon and the Ghetto stands unanswered; if innovation is to defeat problems such as poverty and inequality, it will need to be of a very different kind than that which took humans to the moon” (Nelson, 2021). As Mazzucato (2021, p. 130) concludes, missions offer opportunities “to put citizen participation at the heart of innovation policy and connect R&D and broader policy measures to issues that matter to people.”<sup>3</sup> In addressing who decides the grand challenges and identifies the missions to address them, participants concluded that it is imperative to be inclusive and address both technological and societal concerns.

## DISCUSSION AND QUESTIONS FOR FURTHER RESEARCH

While mission-oriented innovation may have a great deal of appeal, it is not without its critics. At this stage in the development of Mazzucato's thinking there are several major points that can be critiqued. First, Mazzucato does not explain in any great detail how mission-oriented government action can overcome the immense difference between the highly technical, militarily-relevant mission of space travel, and the controversial, deeply societally and economically entangled wicked problems of global poverty and climate change, to name just a couple. Although she acknowledges the differences in these types of missions, greater attention to the implications of these differences is required.

Second, beyond some discussion of the Apollo management structure, Mazzucato does not explain in detail how to implement mission-based approaches. While the Mission Map is a start, a finer-grained analysis and more detailed roadmap are needed.

Third, there is to date no systematic analysis of the outcomes of the European mission-oriented programs she references. The EC has spent a great deal of time investigating the mission-oriented innovation concept, and they are sufficiently confident in its efficacy to have made it a key part of their Horizon program. Once the five missions have time to mature, much more empirical data will be

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<sup>3</sup> See also GSINN discussion paper on Inclusive Innovation.



available to evaluate this innovation policy approach. As one participant put it, there is much to be learned about missions from existing experiments. It is important to obtain more empirical data because COVID-19 recovery is top of mind in Canada and across the globe, and now more than ever, mission-driven research and innovation can play a key role in reimagining our economies.

Assessment of directed innovation spending (such as in clean tech) has proven that it does indeed generate higher GDP multipliers, outpaces public consumer spending, and provides a longer-term impact (Deleidi et. al., 2019). To accelerate impact, mission-directed innovation spending generates a 'super multiplier effect', around 10 times that of standard government spending that is not related to R&D because it 'crowds in' private investment. We need to challenge our politicians to not only think long-term on R&D but to envision it as an infrastructure investment (Deleidi *et al.*, 2019).

Finally, there is more hyper-partisanship in legislative assemblies today all over the world. This makes consensus-building around identifying and implementing missions very difficult, and the consistent, multi-year political leadership required of a mission-oriented approach will be difficult to achieve in many jurisdictions, to say nothing of across jurisdictions.

This discussion of a mission-oriented approach to innovation raises a number of questions for further research:

- Is it necessary to reform capitalism to the degree that Mazzucato suggests to effectively engage in a mission-oriented approach to research and innovation? Or, is a mission-based approach compatible with different varieties of capitalism?
- In Canada, where does the federal leadership role for mission-driven research and innovation reside -- at the political level, the individual Deputy Minister level, at the level of the Chief Scientist? At what level do we apply the mission-driven approach -- could a given department adopt missions, or a subnational government? How does this approach scale?
- How can we challenge decision makers to think differently about government R&D and innovation investments? How can we demonstrate the impact of government science and innovation and their contribution to society and the economy? How can we encourage decision makers to take the necessary risks, and time, to achieve those benefits?
- How applicable is the mission concept to the Canadian context of science and innovation policy and economic development? How applicable is the Apollo mission to the current context? What needs to be modified going forward to address the grand challenges that we face today?



- How can global resources and efforts be crystalized into directional goal-driven action for problems that extend beyond national boundaries? Looking forward, what decisions need to be made in the near term to achieve the desired long-term outcomes?

We can question whether or not the Apollo mission concept needs to be modified to meet the grand challenges of today. What is not open to question is that the status quo is no longer acceptable. The COVID-19 pandemic has shown us that we “must have the courage and the conviction to lift our gaze higher ...aiming for something far more ambitious than sending a man to the moon” (Mazzucato 2021, p. 206).



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