SCIENCE FOR TECHNOLOGICAL INNOVATION

Kia kotahi mai –
Te Ao Pūtaiao me
Te Ao Hangarau

National SCIENCE Challenges

NATIONAL SCIENCE CHALLENGE (NSC)
DIRECTORS DISCUSS

The Mission-led Approach to Science and Research

01

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What is Mission-led research in an Aotearoa New Zealand context, and how does it lead to real world impacts? The decade-long National Science Challenge initiative is rich ground from which to explore these questions. Drawing from interviews and discussions with key NSC personnel and two international experts with Mission experience, the current report has teased out a number of key features that are commonly seen across our 11 Challenges, but may be much less evident throughout the rest of this country's research, science and innovation system. We also suggest some fundamental similarities and differences between the NSC Mission experience in this country, and Missions elsewhere.

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CHARACTERISING, ENABLING AND OPERATIONALISING A MISSION-LED APPROACH TO RESEARCH.

As a way of better understanding the nature of Mission-led research, we have focused on how we characterise, enable and operationalise, this approach to creating real world impact. How to meaningfully measure impact is somewhat less clear.

Characterising a Mission-led Approach

Several themes emerged within NSC Directors' descriptions of a Mission-led approach. Overall it is seen as: goal-oriented towards public good; working across traditional boundaries; elevating relationships and collaboration; and creating wider benefits and new responsibilities compared with non-Mission-led research.

Enabling a Mission-Led Approach

Several factors were identified as enablers that set the scene for Challenges being able to operationalise a Mission-led approach at the level of structures and processes, although there is some variance with how these have been applied. These four factors are interrelated and include: targeting the Mission through all planning and decision-making; setting up independent governance; implementing flexible funding and contracting; and investing in communications. These enablers were in part a result of MBIE directives, and partly introduced by Challenge leadership.

Operationalising a Mission-Led Approach

In terms of how the Challenges have actually brought Missions to life, most Directors described Tranche 1 as involving a relatively long lead-in time to build relationships, refine Challenge directions and develop impact-supporting processes, which together created an environment by the beginning of Phase 2 where effective new ways of working had become embedded into normal operations.

Four common operational practices can be seen across Challenges: centring Te Ao Māori and Māori (co) leadership; utilising co-design; establishing projects iteratively; and investing in capacity development.

Measuring the Impact of Mission-led Science and Research

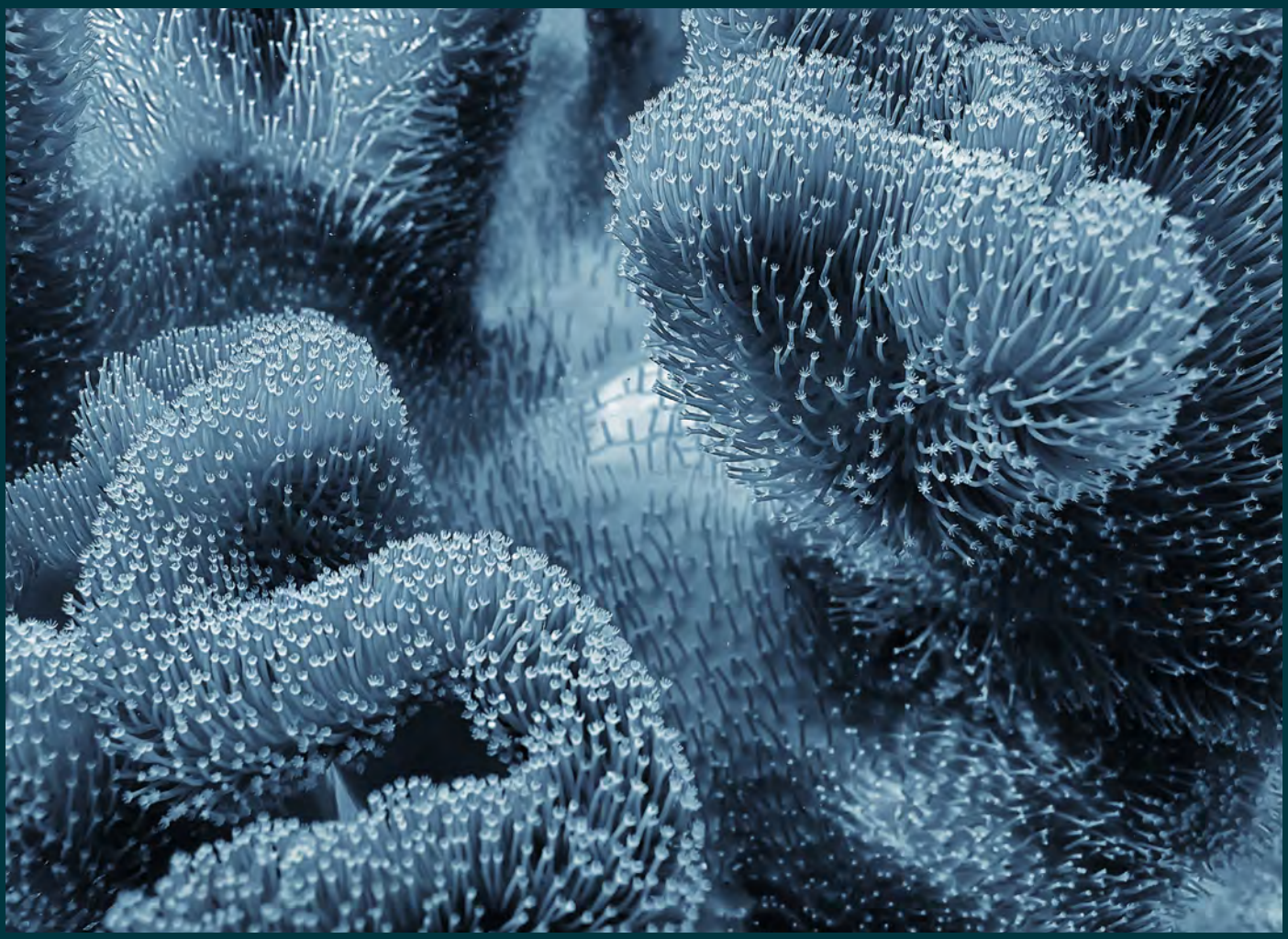
In terms of measuring the success of Mission-led research carried out by the Challenges, there has always been a tension between two key requirements of the NSCs; they were to create both science excellence and impact, but it can be challenging to achieve both with budget limitations. Further, the line between inputs and impacts is not an easy one to draw when we are talking about the big challenges around which Missions are formed. Directors have also pointed out that many of the most positive aspects of the Challenges are simply not measured by MBIE and so certain successes have not been formally captured. Further, a significant amount of the impact from the Challenges will occur after the Challenges conclude in June 2024, and so ideally, it would be useful to try to measure impact in three to five years from now.

While no definitive solutions for these issues are offered, taking a more narrative-based approach to evaluating success may provide a way forward.

Aspirations for the Future

Finally, when thinking about the RSI system post-NSC, Directors thought that many of the key structures, processes and foundations applied under the Challenges should be continued into the future. This was due to their positive and increasing impacts over the preceding nine years, but just as importantly, because they had taken a significant amount of time, thinking, relationship-building (both amongst researchers, and between researchers and Māori and industry partners and stakeholders) and investment to establish; it would be disappointing and wasteful for these gains not to be extended.

As a way of better understanding the nature of Mission-led research, we have focused on how we characterise, enable and operationalise, this approach to creating real world impact.



1. Introduction

The decade-long National Science Challenge (NSC) initiative is rich ground from which to explore the nature of Missions. Mission-led approaches are being employed around the world in a bid to meet some of humankind's biggest and most complex challenges. Aotearoa New Zealand's 11 NSCs are coming to a close in mid-2024; now is the time to capture wisdom around how this broad methodology has worked in an Aotearoa New Zealand context, and how it can lead to real world impacts. Ideally, these insights can help inform what replaces the Challenges to enable maximum participation in, and benefit from, the research, science and innovation (RSI) system.

In August 2023, we brought together National Science Challenge Directors and other key personnel[1], as well as two guest speakers with international experience in Mission-led approaches, to contribute to a conversation around Mission-led science and research in an Aotearoa New Zealand context. The ensuing discussions generated clear signals about Mission-led science and research as it has been applied within the Challenges.

The current report has teased out a number of key features that are commonly seen across our 11 Challenges, but may be much less evident throughout the rest of this country's RSI system. We also suggest some fundamental similarities and differences between the New Zealand experience to date, and how Missions are being approached elsewhere.

This report first describes how we might usefully characterise a Mission-led approach at a general level; what are the elements that stand the Challenges apart from mainstream research institutions in terms of what they aim to do and how they do it? Essentially, Missions aim to create public good outcomes through working across traditional boundaries and elevating collaboration.

We then move to exploring what enables this type of approach; what are the foundations that, when present, allow us to bridge the gap between Mission-focused intentions and effective action? Aspects of operationalising this approach are then presented; what specific actions are needed to bring Mission-led research to life in ways that create positive, real world impact?

We also touch upon the measurement of Mission-led research impact, and finally, include Directors' thoughts about the post-NSC RSI system. There are clear concerns about how ending the Challenges will impact on those working both inside and alongside the Challenges, but those who contributed to this report are agreed that whatever comes next should build on the lessons learned and relationships established over the past decade, particularly if this country's science investment is to deliver maximum return and leverage Aotearoa New Zealand's unique advantages.

1 Further details on the process used for this piece of work can be found in Appendix 1.

2. The National Science Challenges (NSCs)

The 11 National Science Challenges were established as cross-disciplinary, Mission-led programmes of work aimed at tackling Aotearoa New Zealand's biggest science-based challenges. Collaboration between researchers from across organisations was a key operational directive as was the involvement of stakeholders and the public.

The government originally planned to fund this initiative for 10 years. Each Challenge was allocated a different level of funding, ranging from $31.3m to $106m, with Tranche 1 referring to the first five years of the Challenges (2014-2019)[2], followed by a Mid-way Review, and then a second Tranche taking the Challenges through to mid-2024.

2.1 CHALLENGE PRINCIPLES

At their inception, the Challenges represented a new way of carrying out and funding research, initially being guided by 20 Principles set out by MBIE, which have subsequently been refined down to just five:

1. Mission-led

Each Challenge is mission led and focuses research on achieving the Challenge objective and outcomes. Each research plan provides a credible impact pathway of research and related activities to achieve the outcome of the Challenge.

2. Science Quality

Each Challenge is dynamic and includes mechanisms to bring in new ideas, researchers, and research providers to refresh the Challenge. Each research plan involves identifying and selecting the best science to address the Challenge. Critical research capabilities including Mātauranga knowledge need to remain dynamic and must continue to be built and evolve to maximise outcomes for New Zealand.

3. Best research team collaboration

Each Challenge involves purposeful collaboration between researchers, across a number of research providers. Each Challenge is clearly linked with international research activity that supports the achievement of the Challenge.

4. Stakeholder engagement & public participation

Each Challenge involves public outreach and exhibits strong engagement between researchers and intended end users of the research activity, including, in some cases, obtaining investment from end users in the Challenge's research.

5. Māori involvement and mātauranga

All Challenge research gives effect to the Vision Mātauranga policy.

2 Although most Challenges started later than 2014.

2.2 THE 11 NSC CHALLENGES

The 11 Challenge Objectives or Missions were simply stated, with additional detail created and refined by each Challenge throughout the early period of the first tranche:

A Better Start

$34.7m

To improve the potential of young New Zealanders to have a healthy and successful life.

High Value Nutrition

$83.8m

To develop high-value foods with validated health benefits to drive economic growth.

Science for Technological Innovation

$106m

To enhance the capacity of New Zealand to use physical and engineering sciences for economic growth.

Aging Well

$34.9m

To harness science to sustain health and wellbeing into the later years of life.

New Zealand's Biological Heritage

$63.7m

To protect and manage New Zealand's biodiversity, improve our biosecurity, and enhance our resilience to harmful organisms.

Sustainable Seas

$71.1m

To enhance utilisation of our marine resources within environmental and biological constraints.

Building Better Homes Towns & Cities

$47.9m

To improve the quality and supply of housing and create smart and attractive urban environments.

Our Land and Water

$96.9m

To enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations.

The Deep South

$51.1m

To understand the role of the Antarctic and the Southern Ocean in determining our climate and our future environment.

Healthier Lives

$31.3m

To reduce the burden of major New Zealand health problems.

Resilience to Nature's Challenge

$59.4m

To enhance New Zealand's resilience to natural disasters

2.3 MISSIONS ON THE INTERNATIONAL STAGE

Two experts with international experience were invited to the NSC Directors Mission Forum in August 2023 to share some of their insights gathered through involvement with Mission-led initiatives around the world; Rowan Conway across multiple projects in Europe, and Alex Cooke with CSIRO in Australia.

The Missions they described share similarities with Aotearoa New Zealand's Challenges, particularly in terms of their aims. But equally, there are some fundamental differences in how they have been enabled and operationalised that are interesting to reflect upon.

The Grand Scale of Missions – Rowan Conway[3]

Rowan Conway has worked with Marianna Mazzucato, the economist who developed the concept of Mission Economy to give materiality to planetary level challenges and provide a framework for organising innovation that addresses these challenges. This approach brings together science, technology, knowledge transfer and impact, enabling big science to contribute to addressing big problems.

Where once there were Moonshots, we now talk of Earthshots. The UN Sustainable Development Goals provide a strong steer on the range of complex global problems that require complex solutions, such as countering inequality or tackling climate change. Missions provide directionality for people and organisations trying to solve these grand scale challenges.

Where they are being implemented successfully, Missions are part of a wider context including geopolitics and government policies. A key assumption in a Mission-led approach is that the private sector cannot alone address the world's challenges, and in fact, Missions go beyond technology or creating start-ups; they have a political element in that governments have a role in market-shaping.[4]

How can a government engage and influence the market? For one, the remit to do this is only possible alongside new ways of talking about big challenges across the whole of society. Changing the debate and the conversation is important so that as a country you move on from **'if'** anything can or should be done, to talking about **'how'** such an urgent challenge can be met.

Additionally, when it comes to big science, there is generally not a pre-existing set of customers for the outputs, and the government may be the only potential buyer for any products and services developed through Mission-led science. Without signals related to government interest, the market will not follow automatically. Everything a government does sends a signal and will affect the market, so the idea that the government cannot intervene in a market is nonsensical; and in terms of climate change, for example, a lack of intervention in the current trajectory would lead to catastrophe.

Rowan provided an example where the Danish government had a long history of taking its people on a climate journey which has ultimately enabled their national scale green industrial transformation:

In 2019, Denmark launched an ambitious plan to phase out oil and gas production by 2050. To achieve this, heavy investment was made into climate innovation across four green research and innovation Missions. Supporting these were science, large scale public and private financing, and the building of a mature innovation ecosystem.

This Mission approach was initiated within the context of Denmark having started to phase out their reliance on oil and gas in the 1990s because of their proximity to Russia, meaning they already had a more advanced renewable energy infrastructure and a populace who was comfortable with this direction.

Rowan points out there are always geopolitical roots and financial foundations for Mission success, and that these will be reflected in national narratives. It is not easy to launch these kinds of ambitious, large scale initiatives quickly, and generous Mission funding alone will not lead to goals being achieved. There is always an enabling context whether that be appropriate infrastructure, a supportive national psyche, and/or other pre-existing conditions specific to the time and location.

3 Rowan Conway is a Policy Fellow and Visiting Professor of Strategic Design, leading the Transformation by Design module of the MPA in Innovation, Public Policy and Public Value at UCL's Institute for Innovation and Public Purpose (IIPP).

4 The process of influencing and even creating markets based on the problems we are trying to solve and with the aim of creating public good outcomes.

In another example from Finland, a Mission has not reached its full potential.

MISSION

Helsinki is carbon neutral by 2035

MARKET SHAPING GOAL

Build new Circular Economy Plastics Market for Finland.

This initiative had a timeframe of ten years or less. It was a bold and ambitious programme to bring everyone together to work on the Mission, but it did not have enough time to be successful. The commercial sector did not take it on board once the funding ceased, and in part this was because there was no strong articulation of the end goal to get people and organisations involved.

This illustrates that for Missions to be successful, they must be founded on an interconnected effort and a society-level remit:

"It is not the same as commercialising a series of single startups. You're not taking people through technology readiness levels, you have to build a new articulation of what it looks like at the end of the funding mechanism."

ROWAN CONWAY

In terms of measuring the success of Missions, Rowan advises against looking purely at financial or other static metrics. When evaluating whether innovation is working, "You want to look at problem resolution rather than commercialisation" - have you solved a problem?

CSIRO Using Missions in Science – Alex Cooke[5]

Alex Cooke, Director of Strategic Delivery for CSIRO, presented to the NSC Directors Forum on his organisation's experience of introducing a Mission-led approach.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's national science agency. It is one of the world's largest multidisciplinary science and technology organisations, employing over 5600 staff across 50+ sites in-country and overseas, and delivering AUS$10.2B of benefits to the nation during FY22. Taking on multiple roles of convenor, funder and doer of research, CSIRO has a long history of impact research and commercialisation, and has achieved this success in large part as a result of their strong mandate to work with the private sector on R&D co-investment.

Missions are an important, relatively new approach for CSIRO, particularly in the face of large-scale, complex and urgent problems that can only be met through systems-level change. The move to Missions is a way of transforming a fragmented innovation system into one where coordination, collaboration and cross-sectoral partnerships are the norm; creating shared goals in the form of Missions is key.

"For us, Missions connect our strategic vision to our science, and they allow us to step into the role of a National Science Agency that's both a convener across the innovation system, as well as a partner in research, and we follow the principle of seeking to crowd-in rather than duplicate or crowd-out the work of others in the innovation system."

ALEX COOKE

Mission-Oriented Innovation Policy informs CSIRO's Mission design through:

- being focused on big challenges of national importance;
- communicating specific, time-bound impact objectives;
- ensuring outcomes are the key success measures;
- and bringing together multiple actors who work in concert to achieve shared goals.

Currently, CSIRO is working on 13 Missions at different stages of development[6], from 'In development' (5) to 'Launched' (4) and 'Scaling up' (4), each of which has a life expectancy of 5-7 years.

In terms of funding, CSIRO takes a stage-gate approach, starting with small packages of seed funding for Mission establishment. Research teams are expected to work closely with government ministries who are mediating the views of stakeholders and the public to inform policy development and interventions.

5 Alex Cooke is the Director - Strategic Delivery within CSIRO, where he leads the CSIRO Missions Program along with other strategic programs to support CSIRO and the Australian innovation system.

6 *In development:* Smart Energy, Critical Infrastructure Protection and Resilience, Infectious Disease Resilience, Renewable Energy Powerhouse, and Catalysing Australia's Biosecurity. *Launched:* Ending Plastic Waste, Towards Net Zero, Minimising Antimicrobial Resistance, and AquaWatch Australia. *Scaling Up:* Hydrogen Industry, Drought Resilience, Future Protein, and Trusted Agrifood Exports.

3. Characterising a Mission-led Approach

How might we characterise a Mission-led approach in relation to Aotearoa New Zealand's National Science Challenges?

The particular Mission-led approaches taken by the National Science Challenges have been highly influenced by the Aotearoa New Zealand context, and have at times been quite different to traditional science BAU and the constraints inherent within the RSI system. Of particular importance here is Te Ao Māori, which shares some natural alignments with the Mission-led approach, particularly in terms of prioritising positive real world benefits and utilising collaboration.

Several themes emerged as NSC Directors' talked about Missions. Overall they are seen as: goal-oriented for public good; working across traditional boundaries; elevating relationships and collaboration; and creating wider benefits and new responsibilities (relating to collaboration and maintaining relationships, for example) compared with non-Mission-led research.

In this section we explore the nature of Missions, while in sections 4 and 5, we drill down into how a Mission-led approach was enabled within the Challenges, and reflect on specific practices used to operationalise this way of doing research.

1	2	3	4
It Aims to Create Public Good	**It Works Across Traditional Boundaries**	**It Elevates Relationships and Collaboration**	**It Creates Additional Benefits and Responsibilities**
Creating Public Good relies on authentic development of the Mission itself, and then prioritising impact-making.	The cross-boundary, cross-discipline, multi-knowledge (including Mātauranga Māori) nature of Missions ensures all relevant perspectives and expertise contribute to solution-making.	Unifying people and organisations to fruitfully bring together multiple knowledges and resources for positive impacts is an act of collaboration based on trusting relationships.	While doing science and research in a Mission-led way has many positive benefits, it does create a responsibility to nurture relationships during research and into the future.

3.1 IT AIMS TO CREATE PUBLIC GOOD

"Mission-led science is more about the outcomes and impacts rather than the scientific intrigue. Rather than following where the science takes you, the interesting bits or increasing our knowledge, it's much more applied."

A Mission is essentially a goal to address a public good[7] need, and this strongly guides new knowledge creation. Two aspects of Mission-as-a-Goal were highlighted by NSC Directors: the Mission development process and ensuring an impact focus.

A. How a Mission Priority is Identified and Developed Matters

Broadly speaking, Aotearoa New Zealand's Challenge Objectives were developed using a mix of crowd-sourcing and government panel-refinement. While this may have resulted in useful general focus areas, the devil has definitely been in the detail. For example, at its inception, the initiative had failed to include the Māori research community in any meaningful way, either to explore investing in a specific Māori Challenge or to ensure a Te Ao Māori lens was applied across all Challenges. After a group of Māori academics highlighted the inherent lack of equity, some moderate changes were made in the direction of greater inclusivity.

Once partner and stakeholder engagement began in Tranche 1, it became clear to each Challenge that additional key stakeholders, such as Māori communities and industry, had also had little or no input into Challenge development, despite holding valuable insights. As a result, the stated objectives did not necessarily resonate with these groups, and some reimagining of the Missions was needed to ensure the science could filter through to application via collaboration and partnership:

"The Themes we were given didn't work for us because they were based on submissions sent in during the development of the Challenges, which was based on what research institutions wanted to explore, but that was not highly matched with what we discovered in the first Phase from community and industry."

"Once we started working with those with interests in the Challenge objective, i.e. end users and Treaty partners, we realised that the way the objective was written was problematic, and that to secure partner and end-user engagement in the Challenge, we had to take a very broad interpretation of our objective."

Across the board there were extensive efforts to engage with new partners, stakeholders, next-users[8] and/or end-users[9] to refine the broader Challenge goals, and this approach was also commonly employed during development of specific impact-focused research programmes and projects. This engagement was vital for more finely orienting Challenges in the right directions.

7 It may also create economic good.

8 Next-users include those who use or modify research outputs in order to create products or services for end-users, for example, a high-tech manufacturer or consultant.

9 End-users include individuals or organisations who will themselves use or apply research outputs.

B. Focusing on Mission Impact is the Secret Sauce

"Missions provide you with this ability to have policy direction that takes from this large scale remit and then turns it into something quite concrete through this targeted Mission."

ROWAN CONWAY

From the outset, MBIE required the Challenges to produce both 'excellent' science (commonly assessed through achieving publication in top ranking journals) and accessible, impactful research. This creates a tension because it can be difficult to find the time and/or the resource to do both well.

Nevertheless, elevating an impact imperative is the second foundation for creating goals that address public good needs. A strategic emphasis on creating positive, real-world benefit is considered by NSC Directors to be non-negotiable, and something that would ideally be better prioritised across Aotearoa New Zealand's mainstream RSI system. An impact focus requires us to think beyond the bounds of science excellence.

"The excellence of the science in Mission-led research cannot be the top priority. The priority has to be that the science can help solve a problem. For that, it simply needs to good, robust science."

"Currently, 95% of research doesn't change anything."

"Part of the problem with scientific research has been that we tend to do applied science in a silo. We address problems and come up with solutions, and then we sit around being slightly shocked that nothing happens as a result of that."

Participating Directors were clear that taking a Mission-led approach enabled their research to make the leap beyond the lab:

"It's not necessarily the science, it's that add-on. It's: 'How do we get information out of the papers and into the hands of people who need it, in a useful and useable manner?'"

"I think there is recognition now that you need to make science-informed solutions accessible, meaningful and useful, and that requires integration with economic, social and cultural considerations."

"I think if it is too technical it loses those creative aspects of a Mission, it doesn't have that added emphasis on the societal aspects."

It has not been an easy pathway, particularly for those Challenges with objectives that could be described as *"very science-y"* rather than being tightly framed around real world impact, or even a clear focus on the science-policy interface.

"The connection between science, policy and practice has been very interesting to negotiate."

As one Director described their experience, a concerted effort and careful thought was needed to shift beyond a singular science imperative:

"There was a realisation as we worked with end-users that it wasn't so much just a physical science problem, it was much more social science and then to bring in Mātauranga much more explicitly in its own right as well as trying to integrate it into other things."

3.2 IT WORKS ACROSS TRADITIONAL BOUNDARIES

"Mission-oriented innovation was once described as 'big science solving big problems'. It is now being reimagined as a mobilisation of coordinated and sustained efforts across disciplines and sectors, incorporating a broad range of perspectives and interests, to deliver impact and build innovation system capability for the long term."

CSIRO[10]

A Mission is a call to work across traditional boundaries and include a range of knowledges, rather than remaining within traditional Western scientific siloes and/or using only mainstream methodologies.

The cross-boundary, cross-discipline, multi-knowledge elements of a Mission-led approach adds something special to the research process, not least because they draw diverse threads together, thereby directly supporting impact-making. The potential for bringing these practices into BAU across the whole RSI system would be valuable according to Directors, and smooth the way for more impactful science:

"We're trying to operate in this complex Mission or grand challenge-led approach... but the system doesn't support it so we struggle to do that."

A. Crossing Traditional Boundaries

Many Directors noted that their particular focus areas are extremely complex and call for solutions that mirror that complexity. This has required: working across traditional 'science' domains and institutions; including Mātauranga Māori as an equally valued knowledge system; and purposefully bringing in community and industry expertise, which also creates an opportunity to broaden accepted ideas of who can legitimately be considered researchers[11]:

"We realised it wasn't just about doing good science, it was about doing multidisciplinary research."

"The National Science Challenges were established very much within the science domain, seeking to deliver on a Mission that was bigger than science and bigger than the boundaries of the collaborating science organisations. So ideally, if it was truly Mission-led you should be working across those boundaries. It requires partnership and collaboration with policy agencies, government, community – the whole of society really."

B. Incorporating Knowledges

Directors varied in the extent to which they use the term 'Mission' to discuss their Challenges, however, there was general agreement that the term Mission-Led Research is far more appropriate and accurate than Mission-Led Science for describing what they have been doing. This languaging reflects one of the cornerstones of the Challenges: they are about so much more than 'science'.

"Research is much broader than just the science. We have brought in Indigenous Knowledge and that has been very innovative, and we can see it across the Challenges, albeit in different ways. That knowledge is unique to New Zealand."

"You have to think about what knowledge you incorporate in the research, and science is one knowledge."

"You should be treating industry and Māori as holders of knowledge just like any researcher is a holder of knowledge."

Holding to Te Tiriti values must be a requirement of Mission-led research in Aotearoa New Zealand. Challenges, in taking a Mission-led approach, have been able to prioritise Te Ao Māori, exceeding by quite some margin one of the NSC founding principles of 'giving effect to Vision Mātauranga'. Operationalisation of this mandate has evolved over time, with the first 5-year Tranche described as a time of learning and establishing relationships, processes and structures, and Tranche 2 seeing these new ways of operating being embraced, embedded and supercharged.

"The Vision Mātauranga policy was part of the mandate, and it had quite a narrow scope. Through collective action and the leadership that's come from Māori in the Challenges, and others, they've broadened the understanding and pushed the RSI system a long way. That's been a massive cultural shift enabled by the Challenges."

10 Olsen-Boyd A, Cooke A , Pring R, McBride C, Battaglia M (2023). Convening missions: A playbook for collective implementation of mission-oriented innovation. Brisbane, Australia: CSIRO.

11 Challenges have variously involved policy practitioners, hapū representatives and commercial operators as researchers either leading or working alongside the science and mātauranga to ensure the aims, objectives, outputs and outcomes are fit for end-user purpose.

"It's the importance of being Tiriti-led, and how we bring the worldviews of tangata whenua and tangata tiriti together. It takes so much time but also presents opportunities in terms of being transdisciplinary."

"The thing that jumps out to me is the Tiriti vehicle. It's something the New Zealand science system hasn't done well in the past."

The collective of NSCs has arguably created a critical mass for systems influence in terms of elevating the place of Mātauranga Māori within Aotearoa New Zealand's RSI sector, but there is still some way to go:

"A lot of our iwi-led projects in the Challenge are about reclaiming, restoring and revitalising Indigenous Knowledge. And for the moment, while we're going through that process, actually we need to be a bit selfish with the knowledge – that needs to be led and done by Māori. Once we've built up that knowledge and our capability with that knowledge, then we can share it and others can utilise it appropriately under the guidance of the knowledge providers. That's been a really interesting realisation for me."

3.3 IT ELEVATES RELATIONSHIPS AND COLLABORATION

"The Challenges have unique foundations: New ways of approaching problems and a real commitment to collaborative work."

As one Director commented when reflecting on how the Challenges were originally conceived:

"We were clearly sitting in the science space, but the outcomes we were seeking to achieve went beyond science, and so that has required building partnerships and connections, and trust, confidence and credibility through that.

The creation of Challenge impacts has relied upon unifying people around Missions and establishing deep and trusting relationships with partners and stakeholders, next-users and end-users, which have taken time to build, and these have been strengthened through genuine co-design, co-development and co-implementation. This work has to be carefully managed and adequately resourced, and has evolved over time:

"When the Challenges began, they were expected to hit the ground running, and to turn water into wine in Year One, and that was never realistic. Mission-led research requires a totally different mind-set – it's co-creation."

"We had to constantly remind the Board that it was important to act slowly and purposefully during the co-design stage for 'forming, storming and norming', so that we could accelerate at pace later."

"We continue to invest in these relationships because at the end of all this we want to be able to implement some change, we want the research to be empowered."

This Mission characteristic will be further expanded in section 5 in terms of operationalisation.

3.4 IT CREATES ADDITIONAL BENEFITS AND RESPONSIBILITIES

"There's been a lot of valuable new science and new knowledge, and new tools which are now coming to bear on things, which is great. But there are also a whole lot of system and cultural benefits – connections that have been made across disciplines, a cohort of researchers who are comfortable or even incentivised to work collaboratively, and some really deep relationships that have developed with certain communities."

The relationships established, capacity built and the new processes and structures developed, are arguably as valuable to Aotearoa New Zealand as the science and technology generated by Challenge research. This capacity development work has continued to strengthen during the past nine years, and is critical to bringing science out of the lab in ways that create useful, useable and used outputs.

However, what happens to these additional benefits at the conclusion of Tranche 2? And what responsibility do we have to ensure that the $750 million dollar NSC investment realises its full potential to deliver positive impacts into the future? Amongst Directors, there was a strong sense of risk to NZ Inc. during the transition from NSCs to the next iteration of our RSI system.

Given that the Challenges were originally established to meet some of this country's biggest, most complex, long term challenges and opportunities, how do we ensure longevity of the NSC contribution when these real world issues continue to exist from 2013 to the current time and beyond?

4. Enabling a Mission-Led Approach

Four factors in particular have been identified as enablers that set the scene for Challenges to operationalise a Mission-led approach at the level of structures and processes, although there is some variance with how these have been applied. These four factors are interrelated.

1	2	3	4
Target the Mission Through All Planning and Decision-making	**Establish Independent Governance**	**Implement Flexible Funding and Contracting**	**Invest in Communications**
All Directors report taking a strategic approach in that their Missions are always top of mind in their decision-making.	Across the Challenges, governance is independent of the leadership team, the funding source, and those contracted to undertake the research.	Having flexible funding and contracting arrangements has supported Challenges to apply novel approaches to achieving their Mission.	A greater emphasis on communications has enhanced partnership opportunities and supported research translation for impact.

4.1. TARGET THE MISSION THROUGH ALL PLANNING AND DECISION-MAKING

The initial Mission refinement process each Challenge engaged in during the beginning of the first Tranche served to highlight what was actually wanted and needed by partners and end-users, and helped to establish a pathway to impact and (arguably) a greater resolve to achieve the identified goals.

Challenge Boards and leadership teams have been focused on maintaining a clear line of sight towards what activities would advance their Missions, and what would not. This approach has guided all decision-making across the Challenges, and a range of strategies have been employed to achieve it.

The language used, for example, has differed between Challenges, and reflects the slightly different approaches taken. One Director described not using the term 'Mission', but rather, chunking the larger purpose into smaller 'strategic goals'; another uses 'Objective' for their Challenge's focus areas; yet another has a small group of themes to direct the work, but very much references their original Mission statement.

Now, as the NSCs approach their end, there is concerted effort being expended to show how the Missions have been realised.

"Missions give a focus to the underpinning research in a way that helps it deliver impact. The Challenge is much more than a series of disconnected research projects with academic publications, it must involve work to synthesise and integrate learnings into solving the objective. It is about creating impact that is greater than the sum of the parts."

4.2. ESTABLISH INDEPENDENT GOVERNANCE

Challenge Governance Boards are generally appreciated as sources of wise counsel, and this has been enhanced by their independent structure, that is, they are not attached to any particular organisation with its own priorities, such as an external funder, or organisations receiving funds to carry out research.

Independent governance was baked into the NSCs from the very beginning as outlined by MBIE:

Sound governance and management arrangements are required for all research activities and are particularly important for the Challenges since there are so many different organisations involved, requiring careful co-ordination of the various research activities and organisations involved.

Each Challenge has established a governance entity that is responsible for managing the delivery of the research and funding to address the Challenge research goals. This entity is accountable for the fulfilment of contractual and performance requirements as agreed with the Science Board.[12]

By all accounts, Boards across the Challenges have been strong advocates for Mission achievement, and have generally worked to enable novel approaches that have at times been quite different to what occurs in the wider science system. Several Challenges have a minimum Māori representation for their Board, and most (eight of the 11) have merged their Kāhui Māori and Governance Boards; careful consideration has been applied to the decision to merge or not.

"They've been very supportive of a Te Ao Māori-centric approach, and to placing a greater emphasis on research impact and communication in the later stages of the Challenge. It's not just about fantastic research design; it's about making sure the research counts for something."

On the other side of this coin, one Director talked about the difficulty of refining their Challenge objective to be more impact-oriented in the face of very diligent governance:

"We had these objectives set out up front, and a governance group who were trying to stick to the mandate they'd been given, that's their job, but it was really hard to try to shift that."

Additional advisory groups have been put in place to support governance groups, including Kāhui Māori (most of which eventually merged with their respective Boards), Independent Science Panels and Stakeholder Panels (and a combination of the two), and VM Leadership Teams. Each Challenge also has a host organisation, with these relationships appearing to be generally collegial, and in some cases, directly supportive.

12 [Source: https://www.mbie.govt.nz/science-and-technology/science-and-innovation/funding-information-and-opportunities/investment-funds/national-science-challenges/]

4.3 IMPLEMENT FLEXIBLE FUNDING AND CONTRACTING ARRANGEMENTS

"It's given us great flexibility to bring together the expertise and experience that we want."

Utilising the autonomy afforded to Challenges, for example, to establish flexible contracting arrangements or using funding in non-standard ways, has supported Challenge Directors to achieve their Missions.

The Challenges have also created an array of new processes and structures that constitute a framework for carrying out research in inclusive, collaborative and impactful ways. Useful artefacts include culturally relevant IP contracts and values-based recruitment and assessment criteria, while new processes for writing proposals and forming best teams, for example, have been tested and refined.

Given that, as NSC Directors have often pointed out, the existing RSI system has presented barriers to the Challenges functioning as intended, these novel innovations could be extremely effective in supporting Mission-led research if widely adopted across the system.

Funding Evolution

Initially, the Challenges were seen by many in the science system as simply a new source of funding that would replicate the status quo, and some earlier projects appeared to progress in this manner. But relatively quickly, new ways of funding projects were experimented with:

"In the traditional system, once people get money they are virtually left alone. Whereas we did much more monitoring, much more support, much more 'go and do capacity enhancement', much more 'what have you done?', and 'we'll give you more money to accelerate it'. So quite a different relationship."

"We used devolved funding, and this has been key for our Challenge, to ensure we had time to build relationships. At times it felt like, from an MBIE point of view, the driver jumps in the car, puts their seatbelt on and puts their foot on the accelerator as everyone else is trying to get in the door let alone put their seatbelts on. But with our communities we were able to make sure we were all in the car, we were all comfortable, we all had our water bottles, we had agreed who was going to sit in the front seat. Not, 'Oh my God the foot is on the accelerator before the door's even shut!'."

How budgets were invested differed across Challenges, for example:

- One Director talked about 'going hard and early' to allocate as much funding as possible in Tranche 1, in large part to provide certainty to teams. It was only possible to do this effectively, however, because of good relationships with end-users and well established teams. This approach did have a downside, in that there was less flexibility to bring new people into the programme later on.
- Another Director reported having set aside money for a contestable round, but ultimately using the money to fund hapū participation in research, and this was driven by their governance group.

Through leading by example, the Challenges' novel approaches highlighted to researchers, partners and stakeholders, that they were not simply going to fund science in the usual ways; they were determined to create impact.

Extending Reach

As a result of the Challenges' ability to reach out past large, institutional providers, Tranche 2 saw the number of contracted research providers expand to include private research organisations/entities (e.g. iwi and hapū-led entities), community organisations and consultants. This fitted well with the NSC Establishment Principle of 'Stakeholder engagement and public participation', and allowed Challenges to work meaningfully across traditional organisational and domain boundaries to truly achieve impact. Further, empowering other groups to be involved in projects means they may be more likely to continue with the science and research mahi after the Challenges conclude.

Contracting with groups such as iwi and industry organisations was initially difficult because research institutions did not recognise them in this context, and they could not easily be fitted into standard legal documents used by Research Offices. There was also a capability gap in terms of smaller organisations' ability to be fully compliant with regulatory requirements such as Health and Safety and HR. Consequently, there was work to be done in developing these partners' internal capability:

"We decided that wasn't a good enough reason not to contract them, we just need to support them to build that capability."

"Why did we invest the time and money? And why did we have to, particularly with Māori organisations? They aren't funded by alternative pathways for the kind of things we were asking them to do. We have been dealing with volunteers. Often our hui work was in the weekends as people work elsewhere. They have no 'overheads' funding to draw from."

"We were quite keen to get Māori-led research within the community, and Māori community-based researchers aren't that familiar with MBIE or National Science Challenge funding systems, for example, particularly at that time. I think all the Challenges have done some really good work and shifted that a little bit."

The ability to fund Māori directly to undertake research is seen as a particularly positive outcome of the Challenges:

"There is some amazing research going on that is Mātauranga-led, being led by iwi themselves, and then they contract science into their research. It really is creating innovative, cutting edge stuff."

"The ability to contract a wide range of organisations has been absolutely critical, because the skill base we needed didn't necessarily exist in the big organisations, particularly in the Māori space... but it's also critical to bringing in co-development partners as well. It's also critical in getting from the research to impact."

Protecting IP

Managing IP, particularly in terms of protecting Mātauranga, has required the development of legal agreements that can be at odds with standard CRI and university Research Office contracts. Most Challenges have already arrived at acceptable solutions, while others are still working through this as Tranche 2 enters into its final months. Providing assurance to Māori partners and stakeholders has several implications, such as creating a safe environment in which to fully contribute to, and benefit from, impactful research.

"Our team has built relationships with these research teams so they've shared a lot of information with us that they would not have with MBIE or a big machine of an organisation. So what happens in June 2024 when we cease to exist? We want, where appropriate, the tools and data and information that we've acquired to still be freely available, but from a Mātauranga perspective there is a lot of information which those teams probably wouldn't want shared."

"For our Challenge, it is up to the providers of Mātauranga to determine what and how Mātauranga-led outputs will be shared."

Flexibility to Manage and Adjust Projects

Taking a strategic portfolio approach has allowed Challenges to prioritise Mission achievement while also recognising that not all individual research projects will achieve the same level of technical success or real world applicability. This has influenced how research is managed. Challenges have at times: cut funding, split projects apart, engaged in difficult conversations, and/or applied additional management oversight. The reasons for taking these steps have generally come down to sub-par science, a failure to progress collaboratively and in partnership, and/or not working to achieve the Mission.

"The team were saying the right words but weren't actually operating in a co-creative, Mission-led way, so we decided the Mission was more important than the project."

"The key to that for us has been relationships. Building a really strong relationship with the teams, being able to have the conversation 'I'm not too sure about that,' or for them to come to us to say 'that's not really working'. Some of those conversations are hard, but the value in the things that haven't worked is just as important as the value in the stuff that does work. It's shifted the narrative from, 'would this earn a gold star on a traditional evaluation?', to giving us really good information about impact, positive and negative."

4.4 INVEST IN COMMUNICATIONS

One reason why communication is so important is that language use differs between science and policy circles (and is different again for communities and for industry). Translators help groups understand one another, thereby increasing the likelihood of real world impact..

The Challenges have had the flexibility to utilise the skills of knowledge brokers and communications professionals to enhance their ability to communicate activities and approaches at both the macro (media, policy-facing reports) and micro (interface between individuals and organisations) levels. Increased communications capability has strengthened relationships and resulted in greater NSC influence on the government.

"In transitioning science to impact, communication is needed – this is an extra step that the NSCs have done but tends to be missing in the rest of the RSI system where journal papers are the 'outcome'."

"The Brokers have been incredibly valuable, and we've learned they need to be properly resourced. We've given researchers a different experience."

"Some people work part of their week in government and the rest working for us and they help get the conversation going between scientists and policy."

"It's the flexibility in the Challenges, that devolved funding to be able to make those decisions that that's where we're going to spend the money because it's critical."

"At the start we had two imperatives, and we said, 'To achieve our objective we needed to move to Ecosystem-based Management (EBM) of our marine environment, and we need to move to a blue economy.' We started talking about EBM, and now policy and industry are both starting to use this term – how much influence we have had in this now being used is hard to measure. The changing conversation hasn't changed us, but rather has affirmed our direction. We've gone from fighting the wave to riding the wave."

Challenges have also drawn on Māori communications expertise to achieve optimised relationship management, support appropriate knowledge sharing, provide for tikanga around what knowledge is shared and how it should be shared, and ultimately achieving uptake by Māori audiences.

5. Operationalising a Mission-led Approach

Having now explored some concepts that characterise Missions, as well as the factors that have enabled this approach, it is useful to discuss how the Challenges have actually brought Missions to life.

Most Directors described Tranche 1 as involving a relatively long lead-in time to build relationships, refine Challenge directions, and develop impact-supporting processes. By the beginning of Phase 2, effective new practices had become BAU. Four common operational practices can be seen across the Challenges:

1	2	3	4
Centre Te Ao Māori and Māori (Co)Leadership	**Utilise Co-design**	**Establish Projects Iteratively**	**Invest in Capacity Development**
Creating space for Te Ao Māori approaches and sharing leadership and decision-making roles has seen an uptick in research that is relevant for Māori.	Co-design ensures multiple voices and knowledges are involved in the research process, and this requires careful attention to establishing and maintaining relationships.	Bringing together the right researchers who can work collaboratively with each other, as well as with Māori partners and other stakeholders, enables a Mission-led approach.	Assisting researchers, partners and organisations to gain the skills, experiences and tools they need to build relationships and participate in research, leads to real world impacts.

5.1. CENTRE TE AO MĀORI AND MĀORI (CO)LEADERSHIP

"Being Tiriti-led is absolutely fundamental to the Mission, to the collective practice… to understanding the space, understanding the people, understanding the nature of it. So [co-leadership] is fundamental to the partnership, the why, and the commitment of our Māori partners, that's essential."

There has been a clear evolution across the Challenges in terms of Te Ao Māori leadership and being Tiriti-led, and this is something that has made the NSCs so unique. It can be seen, for example, in the refining of respective Missions resulting from dialogue with Māori researchers and communities, in greater leadership by and participation of Māori in the research, and in the high value placed on Mātauranga Māori and kaupapa Māori approaches alongside Western Science.

As several senior NSC people noted, it is incredible to see how Te Ao Māori has been elevated across the individual Challenges, particularly with regard to co-governance and high representation of Māori amongst researchers, and this is in stark contrast to what is happening in other parts of the RSI system:

"It was phenomenal when you compare it to our CRIs and the universities who are still bogged down in their own bureaucracy and not moving forward properly in terms of our engagement with Māori capacity and capability development."

"What's been so helpful is that having the support of the Challenge's Theme leaders – everyone is very supportive of things Māori. That's unique and powerful, and means there are no bottlenecks."

A key initiative led by Māori scientists, research leaders and managers from across the NSCs and Ngā Pae o te Māramatanga is the Rauika Māngai. It has focused on high level strategic issues of importance to Māori and bringing Māori researchers together. It is responsible for several important documents including A Guide to Vision Mātauranga, which provides guidance for good practice and policy. The role of the Rauika in bringing Te Ao Māori and Te Tirit-led approaches to the fore has been significant:

"The Rauika Māngai were giving the message about the extra cultural work that Māori researchers are asked to do. They have functioned as an advocacy group providing really helpful guidance, plus a flea in the ear of government, and MBIE seems to have listened and this is reflected in Te Ara Paerangi."

A. Applying a Māori lens

The opportunities afforded by Te Tiriti provide an obvious and persuasive reason for bringing a Māori lens to bear upon science and research. In addition, Māori hold significant rights and interests in our oceans and land, particularly for primary production where research and innovation can make a strong contribution.

Nevertheless, the existing needs of Māori communities are not necessarily being addressed by the RSI system at large despite the Vision Mātauranga policy having been in effect since 2005. The Challenges have recognised that being truly Mission-led and aiming to solve Aotearoa New Zealand's larger complex problems can only be achieved through applying a Māori lens to the mahi.

"The Mission changed from physical science focus towards impact on the ground so there has been a marked change in Mātauranga focus for our Challenge."

Across the Challenges, clear and distinct spaces have been created for Māori, which began by simply asking Māori researchers and communities what they wanted from research, science and innovation.

"I was impressed when I came into this role that our team has gone to Māori communities and asked what their needs were, and put the decision into their hands. What was important to them?"

"The reason why we leant towards a partnership right from the beginning was because when you boldly step into a space and you have a hui with 20 or 30 Māori researchers and they say, 'we don't want to do it if it's just VM tacked on the end.' Well, we started this process as a full partnership right from the beginning."

A number of Challenges have allocated greater investment for Māori-led research over time. One strategy to achieve this has been to increase the number of Māori researchers participating in and leading research projects, in part achieved through increasing the FTE proportions and ensure Māori team members were not merely 'add-ons'.

"A really important aspect of the Challenge was the opportunity for Māori researchers to lead projects. Before the Challenges, the only time Māori could do this was through Nga Pae [o te Māramatanga] - elsewhere they were highly fractionated. [We] made a firm commitment to enabling Māori researchers to spend chunks of time on projects. Having Māori researchers, leaders and communities at the table enabled research that was important to Māori to be undertaken, an important contributor to achieving the Mission."

An additional approach has been to invite community experts in Mātauranga into the research process; these are people who may have no formal science or research training, but who possess specific knowledge and are heavily invested in impact-making.

"We have had some big projects that have been Māori led, of importance to Māori, and using kaupapa Māori approaches... so this is heartfelt for us even though most non-Māori don't understand why it's so important."

"Bringing Māori into the Challenges as decision-makers, researchers, respecting Mātauranga etcetera has been prioritised in [our Challenge]. I think it's one of those things that's been treated as lip service previously, but the direction from MBIE around this was much stronger – we had to really take this on board. Working from the top down meant we were able to look across the sector to identify capability and that has enabled us to do things differently."

Some Challenges also engaged specialists to support collaboration between non-Māori researchers and Māori communities; these people constituted a bridge between the two groups, while also raising the capability of non-Māori researchers in these interactions:

"In the case of Māori communities we try to bring in the appropriate Māori resource to build those connections rather than trying to do it as non-Māori, that's been a really big part of the success there. Also taking the burden off Māori researchers to do all that cultural labour. So resourcing things appropriately."

Given the novelty of these types of partnerships within the RSI system, administrative pathways had to be created:

"The RSI system is not set up for that, it's quite different to how our funding has traditionally worked. It created additional workload for us, and we don't want to put too much burden on those community researchers to engage with the system, for example, in terms of meeting MBIE reporting requirements."

"It was almost in a way subverting the system to make it work for Māori communities."

B. Co-leadership[13] adopted by some

A great deal of energy was expended, and some administrative obstacles had to be travailed, in order to achieve formal co-directorship and co-governance arrangements now peppered across the Challenges. But the importance of co-leadership cannot be overstated: it has underpinned the elevation of kaupapa Māori research; it has been essential to fostering the potential of emerging Māori leaders; and it is crucial for gaining buy-in from Māori partners and stakeholders.

"It showed Māori were important enough to be at the top."

"At the beginning we were more implicit around Treaty partnership – I'm not sure we quite knew what that meant, but we structured our Governance so that we had at least two Māori people on it, which wasn't enough but better than being non-inclusive. And then over time we moved to making our governance group co-governed and balanced, and now we have more Māori than non-Māori."

"To start with we had no co-leadership in projects, and advisors with no Tiriti lens, to now having co-leaders and co-chairs after merging the Kāhui and Board. The programmes themselves reflect Māori leadership and they are engaging Māori communities. Our Challenge experienced huge changes between Tranche 1 and 2 and we are proud of that."

"Co-governance is largely about trust and confidence in how we're perceived. And our stance is much more appropriate in terms of reflecting a range of views and shows, as science evolves, an attempt to move towards 50-50 partnership with Māori."

Having co-Directors (tangata whenua and tangata tiriti) and a Tiriti model is perfect for Mission-led research and has distinct benefits in an Aotearoa New Zealand context. As one co-Director noted, it takes more time for two leaders to come to agreement than for one to decide unilaterally, but this is simply part and parcel of the approach:

"You have to codesign, which is not the same as consensus. You have to dig down and get to the 'why' you're doing things or not doing things, and I think that has made us better in terms of Mission-led."

C. Observable Outcome: Influencing the System

Encouragingly, some of the Tiriti-led behaviours exhibited by the Challenges are now being adopted by others within the RSI system, although this is not currently being measured via any formal metrics.

"Within the NSCs, the Directors are talking about the importance of kaupapa Māori research and other things, and this is a great signal that there are some changes happening within the science system and the influence of that is beginning to flow out to the CRIs and academic spaces as well. I have gratitude. I used to think I would never want my kids to work in science, but that is no longer the case."

Of course, in terms of establishing a space for Te Ao Māori within research, science and innovation, whether we confine ourselves to the National Science Challenges or think in terms of the wider system, this might best be considered a journey and we have not yet reached the end:

"We haven't achieved complete success, but have taken small steps. There are many small steps yet to be made."

5.2 UTILISE CO-DESIGN

"One thing we learned, and I hadn't given it much thought before the Challenge, is how much time and resource needs to be put into that co-design, co-development process. It's easy to write on paper that we will co-design, but actually making it happen in an effective way needs a real commitment."

13 Governance has already been covered in section 4.2.

In addition to centering Te Ao Māori, co-design and co-development are considered to be critical to operationalising a Mission-led approach because bringing together a range of voices, knowledges and interests, and involving next-users and end-users, increases the likelihood that resultant solutions will be fit for purpose. Equally though, this approach is time-consuming.

"Taking a whole system view [is important], taking in different sectors, players and actors across the innovation pathway."

"MBIE did not understand the slow and steady pace of co-production because they wanted everyone accelerating."

Directors described a range of collaborations involving a variety of organisations, including with iwi and Māori businesses, representative industry organisations, mainstream businesses, NGOs, and central and regional government.

A. Prioritising Relationships is Vital

At the heart of collaboration are relationships, and these have been described as both one of the hardest and most rewarding aspects of the Challenges.

"You need to form the relationships before you ever get to the proposal, and that's the co-design thing... This is particularly true in Te Ao Māori – you have to have the relationship before you get to the proposal, you can't do it the other way around very successfully."

"The Challenges have had the opportunity and the funding to work on that relationship formation prior to getting a project going, and that is totally absent in the current system."

"Missions are easy to write, now how do you pull it off? We involved many people with different skills from different places including community and industry, and soft skills were required, especially for achieving impact. We explored shared values and aspirations, and what's the fundable bit to get there. This process had to involve a wide inclusion of skills and talent outside of just science."

To appropriately prioritise relationships, some Challenges elevated existing relationships within their Tranche 2 research plans. Recognising the NSC time constraint (i.e. the approaching end date), some Challenges adjusted their investment criteria to favour projects that utilised established relationships that could increase the likelihood of the intended outcomes being achieved. To maximise impact opportunities more broadly, a focus was also given to the creation of knowledge and outputs that could be shared and used by project partners and other interested partners (i.e. transferable).

B. Relationship Barriers to Consider

Specific hurdles and contexts have impacted on the Challenges' ability to establish and maintain fruitful relationships, so strategies have been developed in response, and these have had mixed results. Specific challenges include:

- **Non-aligned priorities**, making it necessary for Challenges to try to find points of commonality from which to build relationships and projects, and/or focus energy on where synergies are already obvious, dubbed Coalitions of the Willing:

"Working with the willing has been our approach. For us, trying to get a shift in environmental management – some companies are further ahead than others and we like to work with those in the middle and those further along."

"It's been difficult to engage with them – we haven't been able to articulate the 'what's-in-it-for-me' for them. So it's been a difficult for us."

- Many of the spaces (e.g. water, biosecurity, environmental protection, farming) in which the Challenges have been working are politically charged and have a range of competing philosophies and interests, different levels of public concern, and can vary enormously in terms of resource availability. These factors combine in different ways to impact the authorising environment and levels of buy-in of potential partners. For example, in some cases potential end-users have **strong investment in the status quo**, which can preclude them from engaging with outputs that would enable positive change:

"Industry bodies don't want to change. So it's important to note that siloing isn't only occurring in science and government, it is also evident in industry."

"I had just assumed they would be keen to access research which should be hugely useful to them. I have been a bit surprised that we don't seem to be able to get a good connection."

"We have to think about the social aspects alongside the adoption of new technology, so we're still prepping the ground for future impacts."

- **Staff churn and high workloads** in partner/ stakeholder organisations, sometimes meaning that organisational contacts had to be rebuilt repeatedly:

"Often we find we are playing the role of joining up inside the Ministry itself, connecting the components of departments together, and inter-department connections too."

"We finished the project and that was great, but it didn't land anywhere because the champion had left [our partner organisation]. Take-up is very difficult when those champions go away."

"Sometimes what doesn't work relates to the whole issue of maintaining relationships as they keep turning and turning and turning over... The replacements, they are certainly not up to speed, they have no idea, and they may not have the same views and attitudes either, so you're back doing the same dance, negotiating, winning over and courting. You're not just switching people and picking up again – you might be starting all over again."

- **Contracting outside of traditional research institutions** has at times required developing new processes and artefacts, and/or building the organisational capacity of partners, and this has been commented on elsewhere in the report.
- The **range of systems** and structures of (potential) partner organisations has required some learning and bringing in external experts to assist in making connections has been helpful at times:

"We have learned a lot about engagement. How do you interact with central and regional government, and at what levels? It's hard! How do you feed in at the DG level, and the director level, and the manager level, and the scientist-on-the-ground level? How do you get information to Ministers? There are a whole lot of layers in that engagement, and it's the same in Māoridom."

"We have to tread carefully and that is time-consuming. With each engagement with a person or stakeholder group we have to work out how to approach in the best way we don't want to create friction, we want to work together."

- **Changing agendas and capacities** in partner organisations has meant they are not always ready, willing or able to use Challenge outputs:

"We work across two areas that get a different reception from policy makers, and there is an uneven capacity for organisations under these two banners to pick up what we're putting out. System level changes are needed to achieve our aims rather than focusing on individual [targets] within individual projects."

"Some Ministries are pulling us in certain directions to change what we fund. Ministries do and then don't want information from us. And there is a difference between 'useful' and 'precise', and we and Ministries have different levels of focus."

"Ministries have gone from sitting back to saying, 'Yes, we'll collaborate and partner with you because this is now part of our mandate. We've got work programmes in this space and we need your help to bring the science through'. That's been significant for us."

Various practices have helped overcome these barriers, for example:

- **Workshops, hui, wānanga and Mission labs** have been used effectively to help orient the Challenges in the right directions and encourage participation by both researchers and those outside of the scientific community.
- Using **engagement specialists** to serve as navigators for the relationships between scientists/researchers and collaborating partners and stakeholders, and/or to help partners navigate the RSI system.
- An important enabler of co-design is to **properly resource the process**, including paying otherwise unpaid partners and stakeholders for their time as deemed appropriate.

"Establishing and building genuine relationships requires time and resources – there is a long lead-in time for co-designed research programmes to gain traction. Further, relationships need maintaining, so it isn't just a commitment at the beginning. As new research projects come on line, the full process is needed again with a new group of stakeholders and it is easy to become over-stretched."

C. Observable Outcomes

Ultimately, all Challenges have been able to establish effective, impact-making relationships with partners, stakeholders and end-users, and these have supported Mission achievement:

"What we found in the Challenge was that if you did that part slowly and purposefully with investment and support, then when teams launched they launched much faster than anyone else would have, and they made progress very quickly."

"There is a tension between working with the willing v working with everyone – it's hard to solve, so we do a bit of both."

5.3 ESTABLISH PROJECTS ITERATIVELY

"I call it the alchemy step, figuring out which group of people, because it's never just one person, it's usually several people, when they get this notion of thinking about a Mission and forming one team that's quite diverse."

Closely connected to the co-design approach, and relying heavily on it, is how research teams have been formed, and research plans prepared, to ensure a Mission-led approach is used.

A. An Evolution

Despite the NSC Principles calling for *purposeful collaboration between researchers*, there was no practical template to draw from. Similarly, there is no template for working with Māori communities; local knowledge is needed, as is some tikanga knowledge – *"It's not plug and play"*. The Challenges have had to learn how to set up projects that are genuinely collaborative and Mission-led, and they have improved at this over time.

In the early days, well-established competitive behaviours were the norm amongst scientists vying for project funding:

"High performers are not necessarily good at collaboration, they aren't trained for it."

"Moving on from that learned behaviour of competition was key."

Many Challenges funded established individuals and projects in the beginning, but then deliberately introduced ways to include additional voices. It took time for researchers to understand this new way of doing things, and many early proposals did not fit with the Mission style, for example, by not bringing together new combinations of researchers, or failing to prioritise impact.

"There was a lot of us setting down expectations of what was involved. It was at the halfway mark that we pivoted from specific project-based programmes to 'actually what's the impact you're trying to make?' and it was much more about design and negotiation. That took a lot more time."

B. Bedding in the Right Project Establishment Practices

As the Challenges have become more comfortable and skilled at operating in a Mission-led way – and this was definitely by the start of Tranche 2 – iterative, non-competitive research design approaches became the new norm, with each Challenge taking its own path. Directors described various practices:

1. Recruiting people who can collaborate to deliver research was a key task, and one enabled through developing research management and governance skills. There is a particular set of people who have the ability to keep the Mission front of mind, but are also able to pivot and evolve to do the right thing as necessary. Developing recruitment assessment criteria with Tiriti-related questions being non-optional has been useful in ensuring the right people are involved from the beginning.

"We have seen a real shift. In our very early co-creation, collaborative workshops, hui and wānanga, they were all a bunch of people sitting there clutching for dear life onto their idea waiting for someone to take a breath to throw their idea in, but their ability to listen wasn't there. I think we cut them too much slack. Now, that co-creation phase is really important – if you can't listen, if you can't grow our idea, if you can't see other people's ideas and join up the knowledge, that would be a massive red flag for me."

2. Across the Challenges, in addition to early discussions with Māori partners and other stakeholders to better define the general Mission directions, a co-development approach was also used to identify specific research areas and projects that would contribute to meeting Mission priorities from the points of view of these groups.

"We implemented co-design project by project because Māori groups, experts and other stakeholders, all have their own areas of interest and they don't want to be talking about the full range of areas we are focused on. So we created opportunities to co-design within narrower research project areas."

"Developing a research project proposal and working with [stakeholders] to deliver it invariably involved establishing relationships, often new relationships, and they take time. You can't just develop a relationship with one Zoom meeting and think you now have this close working relationship with these other entities. It takes time."

3. Some Challenges sent out a call for individual researcher capability and launched a team-forming process from there, while others invited interested parties to propose a team. Bringing people together who had not previously collaborated was highlighted by some as being particularly important for Mission-led research.

"The way we've done it is to call for capability and that means that anybody can step forward. So you're agnostic to where the ideas come from."

4. The use of relatively short proposals in the first instance, which could be built upon using peer review, was another strategy used to good effect. Instead of competitive funding, it was common to take a negotiated approach. For example, for one Challenge this involved writing a research brief, approaching a potential project leader to put together a provisional team and brief proposal, which was then critiqued by Challenge leadership, governance and advisory groups. Feedback might result in team changes before a full proposal was invited to again be critiqued and edited in an iterative co-creation process.

"You're not wasting a lot of researcher time, and you're not wasting your co-developers' time when you're co-developing proposals in a negotiated space rather than a competitive process. They knew that as long as that proposal is up to scratch, it's going to be funded."

"There was also a degree of self-selection that evolved in that people who didn't find that they could work in that way tended to drift out."

C. Observable Outcomes:

While there are costs associated with establishing research projects using this type of collaborative approach, the benefits are clear, including:

- Building stronger researcher and stakeholder relationships.

"Teams that knew each other before they get the project, they get up to speed really quickly, but I'm not entirely sure you get new thinking. Whereas if you've got a new team that hasn't worked together before, they have to gel together and really get that sense of Mission before they can start producing."

"So the startup isn't efficient, it looks like it's slow and takes a lot of effort but the idea is that longer term it is worth that initial effort."

- Ensuring the people and teams become Mission-focused.

"People are drawn to Missions because they have greater importance beyond your lab group and networks."

- Involving diverse voices and knowledges.
  - Having the opportunity to bring together best teams, including researchers, Mātauranga experts and consultants from across multiple organisations, removes the disadvantages inherent in funding research teams from single institutions. For one, a project is not constrained by the expertise and experience limitations that inevitably exist within a single location, rather it allows participation of the right people, including those from outside of academia.

"Being able to bring everyone together and get them thinking outside of the quite small boxes that they were having to operate in has led us to places that we didn't anticipate in the beginning. It has also allowed us in some areas to move into quite transdisciplinary research... We now have some teams where you could sit in a room with them and you wouldn't know which discipline they came from."

5.4 INVEST IN CAPACITY DEVELOPMENT

The fourth important practice involved in operationalising a Mission-led approach is investing in capability-development to enhance the skills of:

- researchers and scientists (e.g. human and relational skills), including the development of Early Career Researchers (ECRs), to work across disciplines and with a variety of stakeholders
- experts and researchers working outside academic institutions (e.g. Māori research capability, and confidence)
- commercial and community-based partner organisations operating outside of Aotearoa New Zealand's RSI sector (e.g. help to engage with the system or meeting contractual Health & Safety requirements)

More generally, the Challenges have worked to raise capability across the entire system itself in myriad ways.

A. For Researchers

While technical expertise is essential to carrying out high quality science and research, so too are the human and relational skills (for example, leadership, listening, influencing, collaboration, or uncovering end-user needs) required when relationships are so integral to the Mission-led process:

"There was capacity enhancement in terms of individuals' opportunities to develop their capacity, that's one thing, and that's been very important, I think that's been missing in the system... I think the more subtle capacity enhancement has been around: how do you form these sorts of projects that have a strong goal with multiple disciplines and multiple stakeholders? And I think that's the change."

Cultural upskilling has been a specific requirement for centering Te Ao Māori within the Challenges, and although some researchers have not wanted to continue working in this environment, others have thrived. One impact of such cultural training has been to remove some of the cultural load experienced by Māori researchers:

"In the past it's often fallen to the Māori researchers in the team to provide that cultural support to the non-Māori researchers, so we were really conscious not to do that. The effect of that is to stifle the development potential of those Māori researchers because they're spending a big chunk of their time helping non-Māori researchers to engage with Māori communities or to understand the context they may be working in."

"That particular shift for scientists... has been, even for myself, I think quite spectacular. I don't think that people don't want to do this, it's just that it's so unfamiliar, and as soon as you give them the opportunity to experience this in a safe way, it becomes much more meaningful."

Many Directors spoke of focussing their capacity development efforts on ECRs, particularly through providing leadership opportunities and access to training. There is frequent mention of a new wave of leaders emerging as a direct result of their involvement with the NSCs, and this includes Māori and Early Career Researchers in particular.

"A focus for us was growing PhDs, including them as AIs or co-PIs, and we haven't discriminated if they lacked experience, rather we looked at their competence and the support they have around them."

Commercialisation was not a primary focus across the NSCs, nevertheless, this was a consideration for some Challenges at times. In Aotearoa New Zealand, there is not a strong culture of researchers engaging with 'the market', but this is one key way to create the impact expected of Mission-led research.

"There isn't a lot of incentivisation in the system to do a lot of commercialisation, so you really have to inspire people to do it, and that's the 'working with the willing', and it's also the younger people who are really keen because they can see this as an alternative pathway. We had to get our projects closer than might normally be expected to, so we do more of the market research and investor readiness stuff than you might normally do."

"We're good at doing the research and closing it and publishing and celebrating and then stopping. But arguably, if you want to implement, that's just the first step of the journey, because the next step is to actually effect change. Do the dance with agencies, government, whoever, and shepherd through the change and then measure how that's done. We are generally less experienced at that back end, and arguably that's something that researchers need more training and experience in, and funders need to better recognise that costs money and time."

B. For Those External to the Challenges

Enhancing the capacity and capability of individuals and organisations outside of the RSI system has also been part and parcel of forming relationships and facilitating co-design, co-development and co-implementation. This has been discussed elsewhere in the report.

"It's not just about being involved in co-design, it's about helping them more broadly to interact with the innovation system if they haven't done so before, so sometimes you're just a conduit to help them access other things."

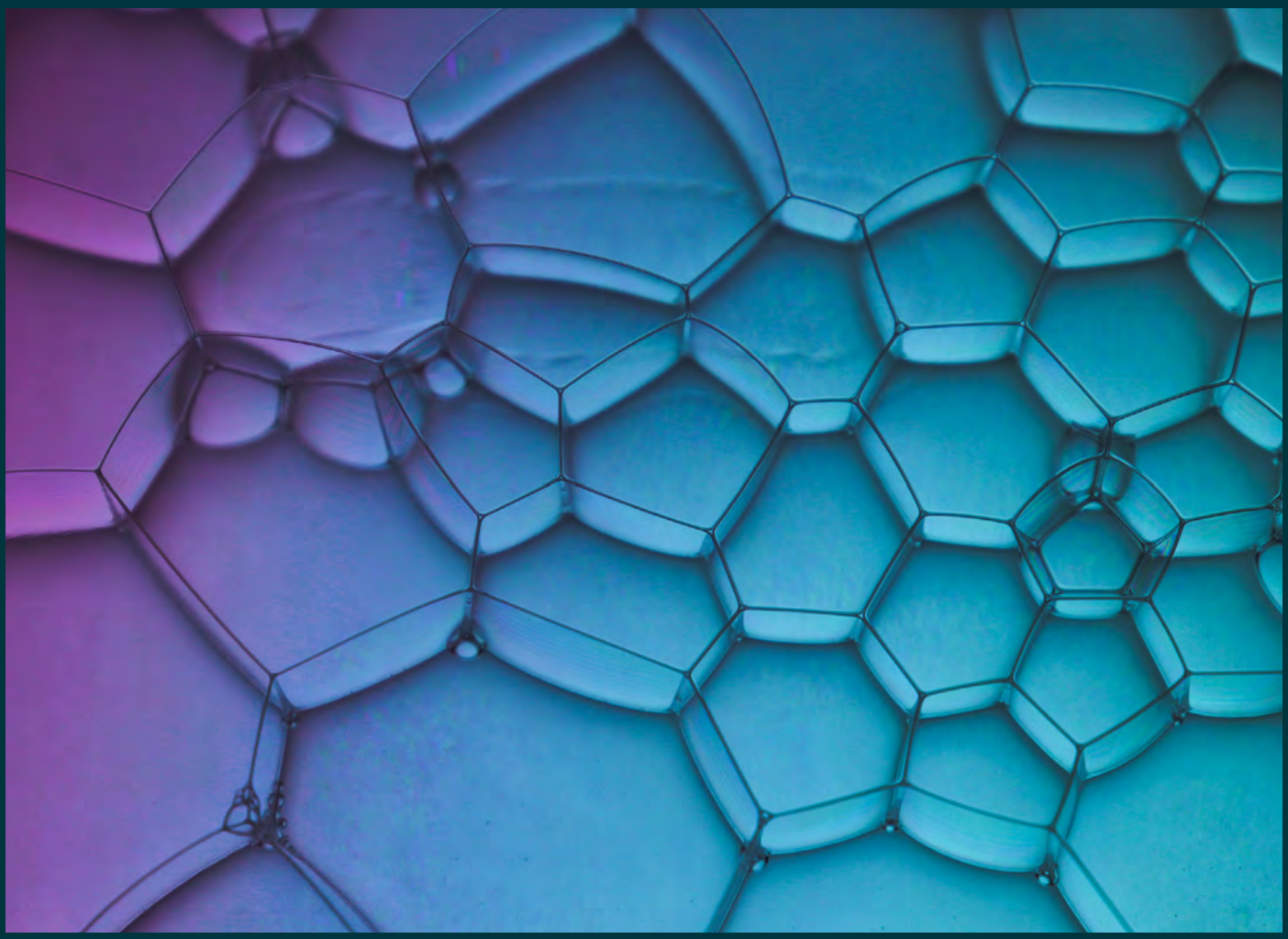
C. Observable Outcomes

There have been a number of positive outcomes of capacity development, from giving researchers the skills to learn about next-users' and end-users' needs, and raising basic cultural knowledge, to enhancing the ability of researchers to communicate with and influence others, and to take on leadership roles. Whether the ultimate aim of a particular piece of research is commercialisation or direct community or environmental benefit, researchers who have worked within the Challenges have developed skills beyond technical excellence that can help them elevate impact potential.

So too, as NSC researchers and leaders move on to other roles within the RSI sector, government, community organisations and industry, they have the potential to teach others how to operate differently to facilitate real world impact from science and research endeavours..

Those outside of traditional research institutions have begun to see the potential for science and research partnerships. For example, new opportunities have been created for researchers to become more involved in government processes. One Director talked about community-based researchers working within their Challenge contributing to a Waitangi Tribunal Claim:

"What's more important is those community researchers have found a very loud voice in policy, processes and other things… A number of our community researchers were involved, and one of our community research programmes actually instigated the Inquiry."



6. Measuring the Impact of a Mission-led Approach

There is no doubt that measurement is important; there needs to be a clear understanding of what value Aotearoa New Zealand has received from the quantum of Challenge funding invested. However, the line between inputs and impacts is not an easy one to draw when we are talking about the big, real world challenges around which Missions are formed.

6.1 CHALLENGE GOALS V REQUIRED METRICS

One practical difficulty is the tension created by the requirement that Challenge research be at once impactful and excellent. Some Directors raised the issue of how Challenges could be appropriately evaluated when it can be difficult to achieve both aims simultaneously, while some other Directors noted this as a challenge that had to be navigated as best as possible.

"There is a tension between science excellence and impact – we were set up to have both but have found that with limited funding you can't have both. We simply don't have time to write for top journals AND relate properly with stakeholders to build strong relationships that lead to impact."

"We talk about things being useful, useable and used... We are measured on the 'used', but we're not actually resourced for the 'used' bit, but that's the partnership with the people who will take it up where that's needed."

MBIE conducted a midway review of the NSCs at the end of Tranche 1, but as one Director noted, if there was any basic adherence to Mission logic, then the Challenge leaders would have had the opportunity to co-create appropriate metrics with those carrying out the evaluations. This did not happen, and can be considered a missed opportunity to more fully explore what Mission-led research is and has achieved in Aotearoa New Zealand.

6.2 DIFFICULTIES IN MEASURING CHALLENGE SUCCESS

Measuring success is about identifying cause and effect. How can we draw a causal link between Challenge activities and particular outcomes? This can be difficult to do when we are talking about the large and complex Missions being addressed, while the long time lags between applying an intervention and observing positive changes can also muddy the waters, especially with myriad other interventions acting in concert. Evaluation practices typically used within the RSI system today are insufficient for identifying, reporting and linking cause and effect over time; alternative approaches are required.

"Time lags make evaluation difficult and that is why we've used intervention logic – discovery, new data, through to people scaling up – we can document what we've done, but it is hard to draw a strong straight line between our activities and impacts. That's where the narratives come in."

A. Invisible Outputs

Many of the important activities that are foundational to Mission-led research simply do not filter through formal measurement practices. For example, the bibliometric database, Dimensions, is well respected in academia, however, many Māori publications are less likely to appear in it alongside leading science journals and so don't count. Nor do non-traditional but genuine research partners, such as Māori or clinical hospital sites, 'count' in measures of domestic collaboration. In addition, many of the Challenges' most impactful outputs have been in the form of grey literature, which again is not considered worthy of counting.

Cross-Challenge events and publications, such as the Guide to Vision Mātauranga put together by the Rauika Māngai, have been incredibly influential, but again are not formally attributed to the National Science Challenges when evaluating Challenge success.

Similarly, community organisations don't appear on MBIE lists so they are not counted despite being highly enabling of collaborative projects. MBIE collects co-funding information but not koha or 'in-kind' contributions from industry, which makes invisible the huge amount of value these organisations bring.

"Our communities we work with, the agencies we work with aren't lavishly funded, but the amount of hours and time and knowledge and awhi and everything we get from our communities, we don't necessarily count it. There needs to be a way of capturing this."

"We don't want to require these numbers - it's people doing things on the ground, but we don't have an easy way of reporting that."

6.3. POTENTIAL SOLUTIONS

What specific metrics might bring us to understanding the reality of NSC impact? There are a number of ideas about what could work. As one panelist noted during the Forum, "the input measures are more important than the output measures," and these can include: hui, community collaborations, infographics development, 'how to' guides, and knowledge transfer etc.

"When you build a genuine relationship or collaboration with an organisation or set of individuals we need to be able to measure that and report it."

"How we put our teams together to ensure diversity is another thing that could be measured but isn't clearly measured currently."

"Our own measure of collaboration is co-authorship. It's very easy to gain through a directive to your researchers to multi-author the papers emanating from the research."

Impact narratives come in all shape and sizes and are an important output in themselves that should be counted as evidence of success. Evaluation by Māori partners and stakeholders may be one way to seek out their perspectives.

"We could probably do a better job at those narratives. We haven't done enough surveys asking people what they found useful, or what they valued about being included, internal and external."

One Director shared an example related to a specific large scale environmental challenge being experienced in this country: while the national response to this serious issue could be described as having been somewhat fragmented, work by their Challenge aimed to rectify this by bringing the subsector together and developing research programmes collaboratively:

"This doesn't show up in the metrics, but as a story to say, here's how we tackled a problem collectively, it's really important."

7. Aspirations for the Future

Over the (almost) ten years since the Challenges were established, deep insights have been gained about how to carry out Mission-led science and research. Those who contributed their thoughts about a Mission-led approach shared the view that this way of working has been successful in bringing science and research out of the lab and into the real world where it can make a lasting contribution to Aotearoa New Zealand.

While Te Ara Paerangi had signalled a central government interest in maintaining and building on Mission-led partnerships and capabilities at governance, leadership, management, research and communications levels, via a new wave of National Research Priorities (NRPs), the incoming government has signaled their opposition to Te Ara Paerangi, and the post-NSC environment remains unclear.

7.1 THE END OF THE NATIONAL SCIENCE CHALLENGES

A. Capitalising on NSC Research, Insights and Relationships

The end of Tranche 2 is a time for bringing together Challenge research learnings via a process of synthesis and communications. Each Challenge has their own approach to this task, but there is acknowledgement that few examples of this type of synthesis work exists in Aotearoa New Zealand and so to an extent, this too is an experiment.

"In the design of the Tranche 2 Strategy, we recognised that we needed at least the last year to pull together all of the threads from across the Challenge to produce outputs and outcomes that were greater than the sum of the parts. There are insights and findings that can be brought together that just lift the game even higher around the translation of knowledge."

Several Challenges are actively working on managing the transition into a post-NSC environment with Māori partners and stakeholders, but the best course of action is not always clear:

"How do we respectfully end with Māori communities and help them plan their next steps?"

"We're currently looking at how we maintain a kaupapa-led community of practice, looking at what the host and Challenge partners can contribute. We want to transition those relationships appropriately. This is crucial for Māori communities."

"We are using the last of our funding to support a large project of importance to Māori to help them develop their long term plan beyond us."

B. The Right Timeframe?

There are differing opinions amongst senior Challenge personnel about whether the ten-year timeframe has been sufficient, or whether at least one more tranche of funding would be beneficial.

Those that favour a time extension point to the evolving nature of Mission-led research, which accelerates and improves over time:

"It's turned out to be a little bit too short term, and I think if we had a third funding period you would start to see the potential and impact of Mission-led research. We all went from a standing start, and the behaviour change that the whole system needed to make, including researchers, just wasn't quite appreciated, and there wasn't a pathway for it – we had to forge it. If you really want to set up a Mission, you have to dedicate some years at the beginning, not some weeks or months, to build your Mission team, to really understand your Mission and what it's going to do, and I think we did that through Phase 1. In Phase 2 we had a massive step change – we were much more adept at Mission-led research, we were much more adept at identifying and recognising what was going to work in that space."

Those that are satisfied with the current timeframe note that an open ended term risks institutionalisation and a loss of Mission-focused urgency. There is also some positive expectation that the experience of working in these new ways can be carried forward by the individuals involved, which could in effect have a wide-ranging positive influence on the system at large.

7.2 POST-NSC SCENARIOS

Directors were asked for their thoughts about what will, or should, follow after the Challenges conclude in mid-2024.[14]

Directors thought that many of the key structures, processes and foundations applied within the Challenges should be continued into the future. This was due to their positive impacts over the preceding nine years, but just as importantly, because they had taken a significant amount of time, thinking, relationship-building and investment to establish; it would be extremely disappointing if these gains were not built upon.

In terms of what should replace the current National Science Challenges, a number of specific recommendations emerged:

A. Foundations

It matters how any new National Research Priorities (NRPs) or other new directions are developed, just as it did with the Missions. Based on what has worked well within the Challenges, the new Priorities would ideally:

- Be based on what society thinks is important, and this can be achieved through taking a stakeholder-led approach rather than focusing on what the government or research institutions want. Specific areas of application or domain, and/or values could found these new priorities.
- Maintain an impact focus

"There is also a risk of losing the impact focus too, which we achieved in part through reducing the imperative for academic publications, and prioritised communication that would help research translate into real world benefits."

- Be founded on Te Tiriti (in addition to the VM policy) to ensure full Māori participation and benefit. A Tiriti-led approach is needed to serve Māori needs, and this must be done in partnership with Māori. Operationalising partnership at the leadership levels of governance and management was seen as crucial.

"Eurocentric perspectives almost preclude a real Mission-led approach, even in terms of setting the right priorities."

14 These thoughts were shared as the Labour Government's National Research Priorities (NRPs) were in development prior to the 2023 election. The newly elected government has signalled different plans for this country's science, innovation and technology sector.

"With the [NRP] process not being Tiriti-led, I worry we will lose the commitment of the collective, we'll lose the collaboration, we'll lose the knowledge of Te Ao Māori that should be contributing to these priorities."

"I have a real concern about the lack of Tiriti o Waitangi evident in the design and process [of the NRPs]. This process is not learning from the establishment phase the Challenges went through."

- Have a level of independence and flexibility to develop, rather than being controlled at both input and output levels by MBIE or the large research institutions. This would be well-supported via independent governance.
- Take a portfolio approach to ensure a safe space to fail, and allow space for both fundamental and applied research.

B. Collaboration and Co-Creation

Within the RSI status quo there is a significant culture of competition, which is to an extent propped up by competitive funding processes; Directors recommend finding a place for collaboration within a reimagined RSI system given the many advantages of this approach.

"If competitive behaviours are incentivised across the system, many of the important gains made by the Challenges would be lost."

"For more mature researchers, they may stick with the co-design process and an emphasis on creating impact – they already selected for wanting to work interdisciplinarily, to collaborate, and wanting to make impact."

Benefits of collaboration include bringing diverse teams together to address complex problems, and ensuring Māori, including Māori communities, and end-users, are leading, partnering and/or fully participating in research.

"It's critical to carry through the practice of partnership, co-design, and co-development , both at the strategic level and to underpin the research itself."

"A clearer mandate to work across boundaries and to bring partnerships with those who will be drawing on the science to actually solve the problems by actioning the solutions."

"I hope that we move beyond primarily supporting science institutions to contribute to the new [National Research] Priorities, and that other organisations can easily be involved, as they currently are within the Challenges. We need to go beyond the science."

Relationships are extremely relevant here. There is wide agreement that, in the period after the Challenges end, relationships that have taken so much to establish and maintain, should remain highly valued and resourced.

"Relationships left un-nurtured will eventually die."

Te Ara Paerangi looked promising to Directors in that it discussed NRPs in a way that was similar to NSCs, for example, bringing Mātauranga Māori and Te Ao Māori strongly into the research and innovation space. However, the original openness signalled in the whitepaper appeared to dwindle.

"What is going to happen in the future in terms of by Māori/for Māori beyond 2024?"

"We need a smooth and honourable transition, so it's not: one thing stops and then in 12, 18 months there's a completely different process. We will lose these connections and trust."

Of course, one of the greatest risks is likely to be a lack of prioritisation and funding to nurture collaboration and co-creation, particularly with Māori as leaders, partners and participants in research. If the shifts created by the Challenges are not solidified, researchers may well revert to old, well-established habits and become focused on their new projects and normal work stressors. Ensuring longevity of equitable, innovative and uniquely Aotearoa approaches to research will rely on reinforcing the lessons from the Challenges in this space.

"The funding cliff – we lose time, we lose trust, and it will take double the time to rebuild that trust and those relationships, as there isn't a smooth pathway to transition out."

"Volunteers and collectives require funding – they have to see the benefit. Part of that benefit is knowing that we're co-creating and delivering to them, and if there's nothing to delivery on, it's up to those scientists to keep adding value through their day jobs."

"In terms of our relationships with Māori communities, it is a real concern for us in terms of the respectful continuation of the relationships, especially with no funding. How will this happen? I hope our researchers will progress respectfully and conduct themselves properly. It took a long time for these groups to gain trust with our organisations."

In addition, there is tension around the future of relationships already built up amongst researchers themselves, as well as the strong links established between researchers and iwi, industry and government. A great deal of power lies with universities and CRIs to formally reward collaborative behaviour by researchers.

"There needs to be a systemic change and it needs to be a change across the sector including universities. If we're going to reward people in their research careers for doing things differently, the whole promotional system and the concept of what a great researcher is, needs to change."

There is a risk that industry relationships will be negatively affected past June 2024 too, but arguably in a different way than for Māori communities. These connections may naturally fall away at the conclusion of specific projects but are seen as potentially more easily revivable if and when future co-research opportunities arise. How relationships with government organisations can be maintained, particularly with their shifting and politically-led priorities, is uncertain.

C. Embedding Te Ao Māori

Involving multiple knowledges and disciplines, organisations and people, has been a key to the Challenges' success, and Directors are keen to see this continue beyond the life of the NSCs. Te Ao Māori could, and should, be embedded across a range of practices within a reimagined science system, such as:

Supporting Māori communities to interact with the science system, for example, by creating community-focussed funding pathways, recognising Mātauranga Māori experts and practitioners, and ensuring a space for Mātauranga within research scopes.

- Recognising that while co-design, co-governance and co-leadership are all important, Te Tiriti does not mean that all research has to be carried out in partnership. Māori must have sufficient space and resourcing to undertake separate work.

"Māori need to be empowered and enabled to progress their own priorities because ultimately those priorities benefit the nation as a whole."

- Developing culturally relevant evaluation metrics and establishing Māori Assessment Panels.
- Directors expressed a strong preference for the Rauika Māngai to continue past the life of the Challenges. Ideally, it would be funded by MBIE and be enabled to provide advice into the development of any new National Research Priorities, but also to become an integral advisory body to the RSI system moving forward.

D. Flexible Funding

The level of independence experienced by the Challenges has allowed them to take new approaches to research, and Directors recommend this structure is replicated elsewhere as the RSI system is reviewed. At a more foundational level, science organisations should be able to interact with MBIE as an enabling funder rather than as an auditor.

Funding structures have the power to incentivise either collaborative or competitive, siloed behaviours; funding opportunities will dictate which approach thrives. Endeavour and Marsden funds, for example, have been identified as encouraging competition. However, one co-Director has observed an evolution in large scale funding proposals where there has more recently been greater motivation amongst applicants for achieving both impact and science excellence, as well as an emphasis on end-user partnering within methodology. This is encouraging.

"The transition out of the Challenges will show whether we were genuinely being Mission-led as we thought, or not. How fast we revert back to investigator-led and industry-led, Endeavour-fund type of processes will be revealing."

E. Building Researchers' Wider Capacities

Directors support capacity development of researchers, communities, and other organisations as a way of strengthening the RSI system and increasing the likelihood of science impact. There is some anecdotal evidence that skills learned within the Challenges are being used in the wider RSI system already:

"We are seeing with ECRs and students coming through the Challenge - the way they are doing their research and then that they are taking our thinking and approach with them into their post-Challenge jobs. There is a real impact."

Further, the expectations of those working outside of the RSI system's traditional infrastructure, particularly Māori organisations and industry, have changed. They have been exposed to the ways in which science and research can create beneficial impacts for them, and many now have first-hand experience of how they can be actively involved in it. For science and research to translate into real impact, exactly this kind of confident participation is required.

"There's a heightened expectation from them about what's achievable and the influence that they can have on the way research is undertaken in New Zealand."

The big fear is that the ability of non-traditional research partners to contribute to, and benefit from, research will wither after the NSCs conclude.

"Enthusiasm and commitment that is not harnessed will evaporate."

"We come to an end in June – what happens to those relationships? Particularly with iwi there is a real tension and concern from Māori groups that we've partnered with. We've only just got things going, we've got these relationships built, there's a real concern about that, and a frustration with it."

In summary, in thinking about RSI life after the NSCs come to a close in mid-2024, Directors have a collective vision of fruitfully bringing forward the best features of Mission-led research, but equally, understand the very real possibility that the foundational improvements to how research is done in this small corner of the science ecosystem will be lost and forgotten.

8. Conclusions

MISSION FOUNDATIONS

Being Mission-led has put science and research impact top of mind for the 11 National Science Challenges, and with that, the need for useful, useable and used outputs. Directors agree that early public consultation was a useful start in developing the Missions, but that process suffered from insufficient consultation with Māori researchers and communities, as well as other interested parties. Further refinement work was needed to ensure Missions had strong relevance for partners, stakeholders, next-users and end-users.

It is clear that the particular areas of focus within the NSCs are extremely complex and call for solutions that mirror that complexity. This has required: working across traditional 'science' domains and institutions; including Mātauranga Māori as an equally valued knowledge system; purposefully bringing in community and industry expertise; and collaborating with central and regional government. Challenges have worked hard to establish and maintain relationships that make this kind of networked collaboration happen, but have had to traverse myriad barriers to do so.

The three characteristics of the NSC Mission - creating public good, working across traditional boundaries, and elevating relationships and collaboration - can be seen in Missions from other parts of the world too, where complex problems are attacked through unifying a range of people, organisations and knowledges around a common goal. However, it may be that in other locations, Missions enjoy a more systems-level network of supporting actors such as: enabling policy applied across multiple government arms; large infrastructural and industry scale contributions; and carefully crafted, supportive national narratives. In contrast, Aotearoa New Zealand's systems-level influence has remained more tightly focussed within the RSI sector in terms of how science and research can be performed for greater impact, and has only involved the Challenges' researchers and the immediate partners most willing and able to engage.

This should not be considered a failing of the Challenges, but rather, suggests a missed opportunity for the government to offer its wider resources and influence to contribute to meeting the NSC Missions. Having said that, the NSC journey has in effect been an evolution of learning how to do research differently (in Tranche 1), and then amplifying these new approaches. As a result, a stronger, impact-focussed and collaborative science and research foundation has been created which is ready to connect in with a much wider network of people, organisations and resources for greater effect at a national (or even international) scale in the future if an enabling environment is created.

As an additional comment, there are specific benefits and responsibilities created by the Challenges that may not have been fully appreciated at the initiative's inception. In particular is that Challenges have each evolved to elevate the place of Te Ao Māori within organisational structures and processes, as well as in the research itself. This aspect of the NSC journey, specific to the Aotearoa New Zealand context, has fostered greater engagement with research and real world impact, but also highlights the issue of how relationships can endure after Challenge support comes to an end. If these extremely valuable networks and relationships are not fostered, they will inevitably wither and die, and this will be an opportunity lost for this country.

ENABLING MISSION-LED RESEARCH

The level of independence experienced by the Challenges has been particularly enabling for approaching science and research in a Mission-led way. Governance that is independent of funders or other governmental pressures has led to a more focused pursuit of Mission goals across the Challenges, and has ensured that the Missions would be the basis for all planning and decision-making.

In terms of investment, CSIRO has firm control over how its funding is applied. Stage-gating has been instituted across the board, with small amounts initially made available for development, before further investment is given for launching and scaling up the initiatives. The National Science Challenges have had more flexibility to award larger and smaller amounts, and use different timeframes. Further, a key benefit for the Challenges has been choosing to invest in activities that are not necessarily well funded in other parts of Aotearoa New Zealand's RSI system, such as team-building hui or remunerating community experts with no formal tertiary qualifications; some of these novel activities have required creative contracting solutions.

It would be interesting to know whether this level of flexibility is evident in Mission-led initiatives taking place elsewhere in the world, and what effect it has on impact-making. There may be a fine line to tread in terms of how closely to work with governments - to integrate with the full suite of resources available in pursuit of Mission achievement (and have closer ties to policy and decision-making) - or how independent to remain - so that Missions can stay separate from changing political interests.

Given the high degree of interdisciplinarity and extensive collaboration with multiple types of partner, a greater emphasis has been placed on communications than might be necessary under the more competitive models common within science and research ecosystems. These careful communications have been important on multiple levels, including: between the different subgroups within Challenges; between Māori and non-Māori working within and alongside Challenges; between and amongst researchers generally; between researchers and partners; between researchers and stakeholders, next-users and end-users; between Challenge leadership and government organisations; between Challenges and established research institutions; and to inform the public about what the Challenges were doing. Directors agree that investment here has had a significant positive impact on what the Challenges could achieve.

OPERATIONALISING MISSION RESEARCH

There has been a clear evolution throughout the two Challenge tranches, with the first five-year span being a time for setting up structures, bringing in the right people, experimenting with different processes, and observing what worked well and not so well. For most Challenges, by the beginning of Tranche 2, there was much greater clarity about the 'what' and the 'how', and progress accelerated.

Māori have been front and centre in terms of building organisations that could approach the Missions authentically. Co-leadership and co-governance showed Māori communities that their interests, concerns and expertise, would be taken seriously. This set the scene for partnership within research programmes and projects so that topic areas were co-designed, methodologies were appropriate, and Mātauranga Māori could be confidently shared in certain cases. It was outside the scope of the current project to conduct a thorough investigation of international Mission-focused initiatives, however, it would be interesting to understand the extent of indigenous involvement and leadership elsewhere.

The larger Challenge projects tended to be established iteratively, with myriad benefits of this approach including the exploration of a range of approaches supported by different knowledges, and the creation of research plans that were firmly Mission-focused.

Capacity Development has been an important part of the Challenges. It has resulted in a number of positive outcomes, from giving researchers the skills to learn about next-users' and end-users' needs, and raising basic cultural knowledge, to enhancing the ability of researchers to communicate with and influence others, and to take on leadership roles. Whether the ultimate aim of a particular piece of research is commercialisation or direct community or environmental benefit, researchers who have worked within the Challenges have developed skills beyond technical excellence that can help them elevate impact potential.

MEASURING MISSION-LED RESEARCH

In terms of measuring success, one practical difficulty is the tension created by MBIE's establishment requirement that Challenge research be at once impactful and excellent. This can be difficult to do when approaching the large and complex Missions being addressed, while the long time lags between applying an intervention and observing positive changes can also muddy the waters, especially with myriad other interventions acting in concert. Further, many of the important activities that are foundational to Mission-led research simply do not filter through formal measurement practices, especially those using bibliometric measures as a proxy for science excellence. Ultimately, more investigation is needed to land on the best approaches, although two potential methodologies include: focusing on non-financial inputs, and generating impact narratives.

FINAL THOUGHTS

We might confidently conclude that there is more benefit to be realised from the NSC investment, which has included the government's significant financial outlay, as well as the time, expertise, effort and willingness to try something risky that has been contributed by the individuals involved.

As we move closer to the NSC's disestablishment, we might usefully ask several pertinent questions:

- How might the novel enabling structures, processes and artefacts developed by the Challenges be applied across the rest of the RSI system to boost innovation?
- What is needed to ensure the connections already established with Māori partners and stakeholders are nurtured to further unlock the science and innovation potential of Māori knowledge, resources and people, and the ability of Māori to participate in the Research, Science and Innovation system into the future.
- How can the government practice Mission-style collaboration to support science and research to better contribute to the national good? How can government policy and national narratives wrap around science and research for maximum impact? And equally, how can research influence policy and decisions making.
- How might we move closer to the large, national-scale, connected Missions that Rowan Conway and Alex Cooke described in order to leverage all of our people, resources and knowledges in solving this country's big complex challenges?

Ultimately the government can choose to capitalise on what has been created by the Challenges through putting in place enabling policy and resourcing, and utilising its network influence, which could supercharge the potential for a Mission-led approach to solving our biggest and most complex problems. Or simply hope that anything worthwhile will be kept alive by individuals and organisations on an ad hoc basis.

Appendix 1: Methodology

During July 2023, ten online interviews were conducted with a total of 11 Directors across eight of the 11 National Science Challenges.[15] Careful notes were produced and interviewees had the opportunity to edit the content.

Four specific topics were explored during these hour-long interviews:

1. How would you describe Mission-led Science in an Aotearoa New Zealand context? And how is this relevant to the current Te Ara Paerangi: Future Pathways reform taking place in our research, science, and innovation system?
2. How has your Challenge put Mission-led approaches into action? What has and has not worked?
3. What have you learned about implementing co-design for your Challenge's Mission?
4. How has your internal Management/Governance structure worked? What has the relationship with your host organisation contributed to achieving your Mission?

A one-day forum was subsequently held on Wednesday 2nd August in Wellington, where two guest speakers, Rowan Conway and Alex Cooke, presented their respective experiences of Mission-led approaches and contributed to answering questions from attendees. Directors and other Challenge leaders were also invited to participate on a panel where they could discuss specific questions offered by the mediator, Helen Anderson and via the Slido app. Attendees included MBIE staff and senior NSC personnel.

Unless directly attributed to an individual, the quotes used through this report and have come from key NSC personnel, having been drawn from both the pre-forum interviews and discussions during the forum itself.

15 Wayne Cutfield, A Better Start; Ruth Berry, Building Better Homes, Towns and Cities; Melanie Mark-Shadbolt & Daniel Patrick, New Zealand's Biological Heritage; Jenny Webster-Brown, Our Land and Water; Richard Smith, Resilience to Nature's Challenges; Sally Davenport & Stephen MacDonell, Science for Technological Innovation; Julie Hall & Linda Faulkner, Sustainable Seas; and Phil Wiles, The Deep South.

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