Science for Technological Innovation (SfTI)
National Science Challenge (NSC)

He hiringa hangarau, he oranga tangata
Innovation in technology for the benefit of people

Spearhead 1: Building New Zealand's Innovation Capacity (BNZIC)

March, 2022

SfTI Mission: To enhance New Zealand's capacity to use physical sciences and engineering for economic growth.

Building New Zealand's Innovation Capacity (BNZIC) is a social science research programme within the Science for Technological Innovation (SfTI) National Science Challenge. BNZIC conducts real-time, longitudinal research into the 'enablers' and 'barriers' of collaborative science and innovation. BNZIC looks at two complementary areas within the science innovation system: *human capacity*, which includes the skills and abilities for activities such as leadership, innovation or commercialisation, and *relational capacity*, which covers the ability to engage across sectors, in this case by scientists connecting and communicating with the broader ecosystem for maximum impact. BNZIC identifies, implements, and evaluates novel processes to address NZ's unique science and innovation research context. In this document, we draw from BNZIC's research findings and insights to inform the recommendations that follow.

11. Priorities design

- What principles could be used to determine the scope and focus of national research Priorities?

A priority means 'that which will be given preference before others'. From a NZ Inc. perspective, key priorities are already well established and expressed *as principles/tikanga* in,

for example, Treasury's *Living Standards Framework* (LSF) and its equivalent, *He Ara Waiora* (HAW).

Such principles are comprehensive, have been complemented by Māori thinking/approaches, and by their very nature address many of the 'big picture' issues that the current RSI systems seeks to address. They also usefully supplement the researcher priorities that guide the research agenda for other funding sources (such as the Marsden Fund - Royal Society of New Zealand).

Such principles – or an iteration of these – might usefully inform priority-setting processes

12. Priority-setting process

- What principles should guide a national research Priority-setting process? And how can the process best give effect to Te Tiriti?

Our research has followed a number of collaborations where research priorities were unclear or disputed at times during the research and hence made it difficult to enact priorities efficiently. At a national level, these observations will be magnified unless there is a formalised method to connect research agendas to the priority.

Our experience has shown that a **transparent process** that carefully designs towards an agreed set of priorities is essential. A transparent process is one that has **a formalised methodology** that is **clearly articulated** to stakeholders and partners from the start. One example is the Concept-Knowledge (C-K) methodology. It is particularly effective when there is a need to generate alternatives to current thinking or approaches,[i] helping to expand existing knowledge, counter rigid allegiance to prior sets of knowledge that can impede insight and surface alternative ways to address a problem, issue or approach. C-K uses a structured three-step methodology that flexes to accommodate different types of participants e.g. technical experts, users, researchers, 'lay' stakeholders, designers. Any process initiated should seek to include Māori, whose notions of transparent process will require a **tikanga-based** approach.

13. Operationalising Priorities

- How should the strategy for each national research Priority be set, and how do we operationalise them?

Our observation of the broad suite of SfTI research is that there has been more 'buy-in' from stakeholders, partners, and the research sector when **priorities and strategies are set by the community [in this case, industry/Māori] in collaboration with researchers**. Our observations are that this approach has:

- Formed national **'best team'** *interdisciplinary* or *transdisciplinary* teams, where researchers may not have collaborated previously as well as adding others from the community of researchers whose involvement is typically not promoted;
- Embedded a process that **regularly engages** key informants/partners/stakeholders/users to co-create and exchange knowledge;
- **infused Māori concepts**/mātauranga into the research design [as judged by Māori];
- involved Māori, women and early career researchers;
- Embedded a process whereby **potential use is factored into the research**, whether as commercial or social product or process.

Each of the bullet points might be considered as elements that could be incorporated into a strategy for priority setting.

Operationally, such an approach has better 'buy-in' but requires **upfront resourcing of people's time** since participation in priority setting does not guarantee involvement/funding in the research subsequently. Having a funding mechanism that encourages and supports relationship building and co-creation of research projects is warranted.

15. Mātauranga Māori

-What are your thoughts on how to enable and protect mātauranga Māori in the research system?

Our survey of 57 New Zealand research institutes [response rate 29%] revealed that while a significant proportion were involved in research using mātauranga Māori, only three of the policies made specific reference to mātauranga Māori or Māori data, and only one IP policy addressed Māori genomic data. There was a low level of understanding of mātauranga Māori generally.

BNZIC research has highlighted that in order to protect mātauranga and taonga a range of approaches are required. This will include:

- **reviewing clauses in research contracts** to better protect mātauranga;

- a **review of how Māori data** is defined (provenance), stored, governed, accessed and re-used. The work of the IEEE Indigenous Standards P2890 Working group (https://standards.ieee.org/ieee/2890/10318/) will be able to inform thinking;

- **extra-legal approaches** such as Traditional Knowledge or Biocultural labels [see https://localcontexts.org/] may also be needed.

16. Regionally based Māori knowledge hubs

- What are your thoughts on regionally based Māori knowledge hubs?

We have observed that where researchers have developed large scale programmes in Māori regional locations, there has been significant buy-in and support for the research. We have also observed that Māori leading research from regions [e.g. West Coast] can face challenges given issues with access to transport, facilities/equipment, and knowledge peers. Such a concept requires testing with Māori in regions.

If such a model was implemented, our research has noted that for full value to be derived it will require **high levels of capability of hub 'managers'** in terms of research, organisational and relational management, as well as training and 'upskilling'. Some regional entities will be better placed than others.

20. Institution design

- How do we design collaborative, adaptive and agile research institutions that will serve current and future needs?

Our research has noted that there are a number of institutional and funding models that currently exist in the NZ RST landscape. When viewed from a science 'lead'/contributor perspective, the following table represents our analysis

Table 1: BNZIC analysis of NZ funding and organisational mechanisms [Adapted from Smart et al.[ii]].

	Scientific specialist contributor	**Non-scientific specialist contributor**
Science-led	Marsden Science Performance-Based Research Fund (PBRF)	Endeavour-funded science CRIs Vision Mātauranga (VM)funded science National Science Challenges Centres of Research Excellence Citizen/crowd science

Non-science-led	Iwi Research & Development (R&D) e.g., VM capability funded science Industrial R&D Technology transfer/spin-out Callaghan Innovation Various funding through Depts (e.g. Ministry of Primary Industries, Ministry for Environment) Wiki-science	Backyard inventor Traditional knowledge practitioner

The table reveals the complexity of mechanisms already in place to ensure that research knowledge is shared with or brought into use with communities, businesses or potential users and implementers.

We might see these mechanisms as adaptive responses to changing needs – whether these are the need to 'join-up' to solve complex problems [temporal organisations such as Centres of Research Excellence, National Science Challenges] or to support individual institutions to do this [both large – Crown Research Institutes - and small – Māori/community].

What is not clear is how this plethora of mechanisms should be managed so that efforts at the micro level of a project, programme or institution can be captured and managed. We describe this as **'open innovation science' (OIS**), defined as '*a process of purposively enabling, initiating, and managing inbound, outbound, and coupled knowledge flows and (inter/transdisciplinary) collaboration across organisational and disciplinary boundaries and along all stages of the scientific research process.* '[iii]

As OIS involves multiple dynamic flows, managing it requires integrated infrastructure across organisations. At an individual researcher level, we see attributes of open science i.e., transparent, accessible, shared and developed through collaborative networks (which should also be dynamic).[iv] At the level of the institution, we see an **enhanced role for university technology transfer offices** to move from university-industry intermediaries to entrepreneurial and innovation ecosystem brokers – either regionally OR collectively at a national level. We see their services as helping to lower barriers to value creation and to accelerate productive entrepreneurship activities in the territories in which they operate.[v] This will require increased as well as new capabilities, including developing understanding of Māori IP/mātauranga.

Our final note on organisational design is that the potential shifts and changes being sought are being designed to encourage new practices. A practice is a "routinized type of behaviour which consists of several elements, interconnected to one another."[vi] These interconnected elements

include physical things, mental activities, knowledge and understanding, know-how and states of emotion.

We should not under-estimate that such changes will create lags, gaps, insecurity, and resistance at many different levels as new routines and behaviours are introduced – internally to an institution or between institutions and government. Some thought should be given to **who are the intermediaries** who will be able to **manage** the myriad processes that such re-organisation will necessarily involve.

Intermediaries may be individuals, they may be sub-units of an organisation, or they may be separate entities. Given such fundamental changes are being considered, we believe there needs to be deep thinking about the role and function of such intermediates to support change. Clear principles associated with use of and access to any shared organisational resources would also be needed and may form part of the role intermediaries play.

21. Role of institutions in workforce development:

- How can institutions be designed to better support capability, skill and workforce development?

Our observation of the RST system as a whole is that it has been shifting for some time from what we describe as Mode 1 science to Mode 2 science. Table 2 identifies some of the features of these different modes that link to the current funding approaches.

Table 2: Mode 1 vs. Mode 2 knowledge production in science [Adapted from Gibbons[vii] & Nowotny et al.[viii]].

Mode 1	**Mode 2**
Theoretically driven	Application oriented
University and institution centred	Subject to multiple accountabilities – university, institute, political, economic, public stakeholders
Discipline based and unidisciplinary	Interdisciplinary/transdisciplinary
Experimentally focused	Multiple and mixed methods
Hierarchical	Mostly heterarchical
Investigator produced	Co-produced with multiple stakeholders
Prioritizes scientific autonomy	Socially distributed, collaborative, transparent
Seeks universality	Embedded in local contexts and cultures

Universities in particular have institutional norms and processes that are more aligned with Mode 1, whereas at a system level, the demand is more aligned to a Mode 2 approach. While

Mode 1 skills are an underpinning foundation, Mode 2 application skills are also vital. Our observation is that some parts of our RST system still privilege Mode 1 in terms of training for technical excellence – in particular PBRF as well as funding sources that expect and privilege 'track-record' as a key determinant.

Our analysis is that **there is need for different developmental models as well as incentives** to broaden the pool of those who have Mode 2 skills. When we have examined the different types of expertise that are required for the new types of collaborative vehicles being proposed, the following figure represents our current thinking.

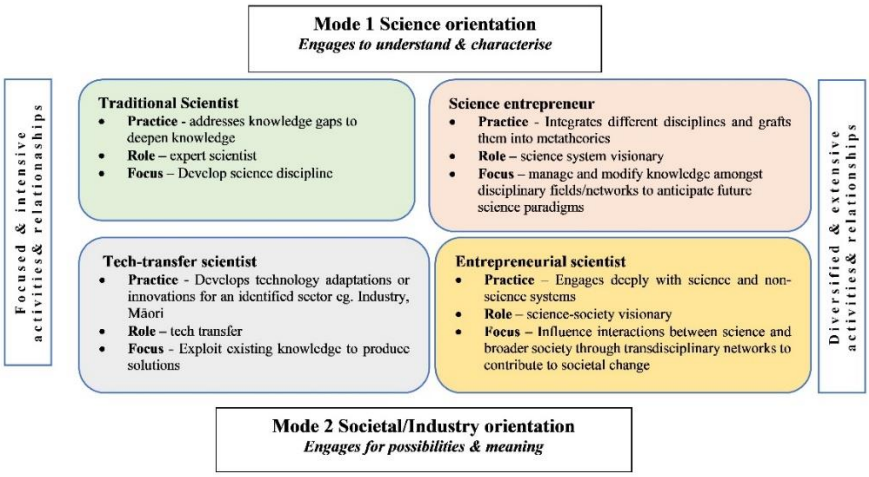

Figure 1: Scientist orientations. Extended from models of Lam (2010); [ix] Casati & Genet (2014); [x] Meyer (2003).[xi]

We believe that **incentives for approaches aligned with Mode 2 are weak at both an institutional and policy level**. This is not to say that Mode 2 scientists are not evident within our system – however, they have largely arrived there from personal drive or motivation and their own ability to develop relationships. In particular, PIs often experience **role conflict** when being expected to operate in across multiple modes. This is particularly the case when researchers work with non-traditional collaborators, such as Māori organisations. This leads to 'transactional' relationships and indeed reluctance.

We have seen the benefits of developmental models being provided outside of current institutional arrangements. We suspect that, therefore, **a national-level approach would have benefit**, over and above any individual institution's programme.

23. Institution design and Te Tiriti

- How do we design Tiriti-enabled institutions?

We observe that most, if not all public organisations have Māori-focussed policies and people whose role it is to enable Treaty aspirations, including implementation of Vision-Mātauranga (VM). These have evolved over the years to meet increasing demand. To enable Te Tiriti and VM at an organisational level will require incentives, training, and funding, as well as enforcement or accountability mechanisms. **Continued focus on VM as critical policy** is warranted. However, at the institutional level, this needs to be complemented with various training packages aimed at both Māori and non-Māori researchers, and intermediaries.

For Māori EC researchers – whom we have observed are more often than not Mode 2-oriented – **additional mentoring, funding, development is warranted**. Māori researchers – even as undergraduates at university – often perform intermediary roles between the science system and Māori. Such roles should be built-into and funded within a research contract or even as particular roles within an institution.

24. Knowledge exchange

- How do we better support knowledge exchange and impact knowledge generation?

- What should be the role of research institutions in transferring knowledge into operational environments and technologies?

Our observations are that, unless organisations and the people who make up organisations are able to develop shared priorities, often at a fundamental 'values' level, then knowledge remains divorced from use. One way to share knowledge is through formalising knowledge impact through IP agreements. We have observed that Māori perspectives on IP challenge organisations' current contracting practice. Likewise, businesses seek IP protection and do not see it as helpful that research institutions construct IP mechanisms as an opening discussion. Our observation is that for publicly-developed IP to create value/impact, **open innovation network vehicles** may be required. We have observed from the aquaculture sector that

developing such vehicles is time-consuming. However, they could offer an approach to balance co-operative and competitive tensions for stakeholders within/across the collaborating sectors. We see value in exploring **virtually networked hybrid open innovation collectives** such as Living Labs[xii] and Knowledge Innovation Communities.[xiii] .

25. Workforce and Research Priorities

We note that one of the impacts of Covid-19 and the inability of PhDs to enter the country is to highlight the lack of resilience in our physical and IT research workforce, given that many projects are dependent on such students. Conversely, this has highlighted the opportunity to develop more targeted innovative career pathways for Māori researchers within institutions. Our observation in relation to the latter is that this has presented an opportunity to more deliberately 'reach-down' into younger cohorts, such as undergraduates, to involve them in Mode 2 science projects to develop pathways less focused on aligning with institutional criteria and more in keeping with Māori community aspirations. While this deliberate strategy is encouraging, it is not universal and there remains a significant shortfall of this critical resource. We see opportunity to make such activities a more 'normal' part of the Research, Science & Technology system.

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