

SCIENCE FOR
TECHNOLOGICAL
INNOVATION

Kia kotahi mal –
Te Ao Pūtaiao me
Te Ao Hangarau

Te Ara Paerangi Future Pathways: Green paper consultation

Science for Technological Innovation National Science Challenge submission

Programme Office
Callaghan Innovation Asteron Centre
Level 14, 55 Featherston Street, Wellington 6011

E: sftichallenge@callaghaninnovation.govt.nz
T: 0800 422 552
www.sftichallenge.govt.nz

Illustration designed by Tyler Dixon, Waikato-Maniapoto, Ngāti Porou, Ngāi Tūhoe, Ngāi Tahu depicts a Mangopare (Hammerhead shark). It symbolises the strength in duality to be found in uniting Māori knowledge with western science.

Key points: Summary answers to submission questions

Note: See page 5 for full answers

1. (1.2.2) Priorities design

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

Key Points:

- i) **Priorities should be capability or platform-based, not sector-based.**
- ii) **Sectors are vehicles for demonstrating and adapting priority research technology for wider dissemination.**

2. (1.3.2) Priority-setting process

- What principles should guide a national research Priority-setting process?

Key Points:

- iii) **Priority-oriented research should balance, not replace, existing funding competitions.**
- iv) **Priorities should not be set by a panel of experts alone, nor by international experts.**
- v) **SfTI's mission-lab and mission-design process is a tested model for priority-setting.**

- How can the process best give effect to Te Tiriti?

Key Points:

- vi) **Māori priorities should be determined by Māori, for Māori, and implemented by Māori.**
- vii) **Addressing Māori priorities will bring huge benefits to Aotearoa-NZ.**

3. (1.4.2) Operationalising Priorities

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

Key Points:

- viii) **Building one multi-disciplinary team to address a priority/mission requires a different approach to mission design than traditional proposal development.**
- ix) **Co-creation of the priority/mission with industry/Māori is essential.**
- x) **Upfront expenditure on mission design processes is necessary, but likely small in comparison with un-costed aspects of competition funding, borne by institutions.**
- xi) **Proper resourcing of relationship-building, prior to proposal development, is absent in the current RS&I system.**
- xii) **Priority/mission governance and operationalisation should be at arm's-length from government.**

4. (2.1) Engagement (and Q.5 and Q6)

- How would you like to be engaged?

Key Point:

- xiii) **With respect to Te Tiriti, mātauranga Māori and Māori aspirations, we refer to the submission prepared by the SfTI Kāhui Māori.**

7. (3.2.1) Core functions

- How should we decide what constitutes a core function and how do we fund them?

Key Points:

- xiv) **Core functions and infrastructure are not distinct and relate strongly to essential capabilities/platforms.**
- xv) **Government should see itself in 'shaping' or 'nudging' roles in the system (including taking on some risk).**

8. (3.3.2) **Establishing a base grant and base grant design**

- Do you think a base grant funding model will improve stability and resilience for research organisations, and how should we go about designing and implementing such a funding model?

Key Points:

- xvi) **Base grant funding may improve stability, but the detail of its implementation needs to be modelled (including the impact of reduced overheads) and widely consulted upon.**
- xvii) **A gap exists in our current system whereby there is no orchestration of 'progression' of successful projects towards impact once funding is completed.**
- xviii) **'Lumpy' short-duration approaches to research funding exacerbates barriers to relationship building.**

9. (4.4.1) **Institution design**

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

Key Points:

- xix) **Institutions (rather than individuals) are unlikely to collaborate unless the right incentives are in place.**
- xx) **Agility and adaptation are more likely in organisational forms that are at arms-length from government, with appropriate governance and controls.**
- xxi) **Alternative (temporary) collaborative vehicles, such as CoREs and NSCs, have played innovative, experimental roles in supporting pan-national collaboration on important issues.**

10. (4.4.2) **Role of institutions in workforce development**

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

Key Points:

- xxii) **A capacity development approach to workforce development is generally piecemeal.**
- xxiii) **Capacity development opportunities should be coordinated nationally and funded separately, potentially as its own set of priorities.**

11. (4.4.3) **Better coordinated property and capital investment**

- How should we make decisions on large property and capital investments under a more coordinated approach?

Key Point:

- xxiv) **A coordinated strategic approach to property and capital investment is timely.**

12. (4.5) **Institution design and Te Tiriti**

- How do we design Tiriti-enabled institutions?

Key Point:

- xxv) **With respect to Institution design and Te Tiriti, we refer to the submission prepared by the SfTI Kāhui Māori.**

13. (4.6) **Knowledge exchange**

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

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

Key Points:

- xxvi) **Knowledge exchange/transfer are dyadic concepts and do not reflect the more creative co-design approach to the mutual generation of new knowledge.**

- xxvii) Impact generation needs to acknowledge that there are multiple ways in which impact is generated and primacy given to economic impact may be mis-placed in comparison with behavioural change.
- xxviii) TTOs, despite their best efforts, are not engaged early enough in research planning and are 'lean' (ie under-resourced). Coordinated efforts such as Kiwinet and Return on Science are very welcome but need to be resourced to scale.

14. (5.2) Workforce and research Priorities

- How should we include workforce considerations in the design of national research Priorities?

Key Points:

- xxix) Workforce considerations must be a major element of priority operationalisation, focusing on the precariat nature of ECRs.
- xxx) Traditional narrow emphases on track-record and bibliometrics hamper the development of a more diverse and equitable workforce.
- xxxii) Other diversity support mechanisms need to be introduced to balance the 'strong cv' dominance embodied in the competitive funding regime.

15. (5.3.1) Base grant and workforce

- What impact would a base grant have on the research workforce?

Key Points:

- xxxiii) In principle a base grant will have a positive impact on the research workforce, but any impact will depend greatly on the detailed grant design.
- xxxiv) Consideration should be given to an inverted base grant design such that ECRs are funded at a higher % of their salary than experience PIs that attract large amounts of external funding.
- xxxv) The impact on the research workforce of any base grant dimensions should be included in any modelling of changes to the current funding system.

16. (5.3.2) Better designed funding mechanisms

- How do we design new funding mechanisms that strongly focus on workforce outcomes?

Key Points:

- xxxvi) A major gap in our current system is the ability for capable ECRs to propose and lead their own projects.
- xxxvii) Building in capacity development opportunities to develop leadership competencies is essential for such workforce development.

17. (6.2.2) Funding research infrastructure

- How do we support sustainable, efficient and enabling investment in research infrastructure?

Key Points:

- xxxviii) Facilitated access to what should be national infrastructure is a key barrier to research collaboration and impact.
- xxxix) Open access requires appropriately tailored service models for specific infrastructure.
- xl) As per core function, base grant and workforce development, a national approach to funding, and access to research infrastructure should be a priority.

Full response to Te Ara Paerangi Future Pathways questions

1. Research Priorities

1 (1.2.2) Priorities design

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

Key Points:

- i) **Priorities should be capability or platform-based, not sector-based.**
- ii) **Sectors are vehicles for demonstrating and adapting priority research technology for wider dissemination.**

Priorities (or challenges) should be future focused and have the scope to embrace flexibility and build resilience. They should be largely capacity/platform focused, not just sector focused. While sectors have historically been a priority focus for Aotearoa-NZ, and each sector will certainly have specific challenges, many capabilities are generic across sectors. For example, it is quite likely that every sector and institution is trying to build capability in robotics, AI, sensors, data analytics etc, be it agriculture, horticulture, seafood, forestry etc. Yet many of these skills are ubiquitous and the nation must make sure there is critical mass in such capability.

As a National Science Challenge (NSC), Science for Technological Innovation (SfTI) has embraced UCL Professor Marianna Mazzucato's notion that priority setting (through mission-led challenges) is not about 'picking winners', but 'working with the willing'. SfTI is agnostic to sector but, as the 'technology for' NSC, uses a project in a willing sector as an exemplar to develop and demonstrate technological applicability that could then potentially traverse within a sector (e.g., mussel aquaculture to salmon farming) and across different sectors (e.g., forestry to horticulture). Whilst it is not surprising that those within a sector prefer a sector focus, and some of the Industry Transformation Plan's consolidate this arguably siloed approach, a platform/capability focus that can then service multiple sectors (even those not envisaged now) will enable the RS&I system to be more resilient and flexible.

The more specific priorities (or missions) that SfTI undertook to design had to be 'stretchy', in that they were looking 5-10 years out for implementation, as well as 'sticky', in that there is a logic for them to be tackled in Aotearoa New Zealand. The mission should be a particular issue for NZ, such as SfTI examples 'biosecurity technology' or 'digital marae', and that any results would underpin a new, or significantly enhance an existing, export industry, or could be diffused more widely for environmental, cultural or social impact.

Prof Mazzucato gives more guidance about her ideal challenge/mission-design processes that we describe with examples from SfTI, in answer to the next question. Where we diverge slightly from her suggested stages, is the interpretation of what counts as the democratic priority-setting process. SfTI proposes that an entirely citizen-led approach is not necessarily going to surface future challenges, and a more diverse range of views from thought leaders and government itself (obviously still citizens but with important contextual views) is necessary. The government cannot take an entirely hands-off approach to setting priorities (see comments in section 3 about the 'nudging' role of Government), and it is important that 'optionality' is preserved in the priority-mission development process. That is, SfTI notes the importance of the 'dynamic capabilities' stage to ensure it embraces the flexibility to shift/pivot to other options/priorities as they surface. (See M Mazzucato, 2017. Mission-Oriented Innovation Policy: Challenges and Opportunities, IIPPWP

2017-01. www.ucl.ac.uk/bartlett/public-purpose/sites/public-purpose/files/moip-challenges-and-opportunities-working-paper-2017-1.pdf; Mazzucato, M. (2018). Mission-oriented innovation policies: challenges and opportunities. *Industrial and Corporate Change*, 27(5), 803-815.)

2. (1.3.2) Priority-setting process

- What principles should guide a national research Priority-setting process?

Key Points:

- iii) **Priority-oriented research should balance, not replace, existing funding competitions.**
- iv) **Priorities should not be set by a panel of experts alone, nor by international experts.**
- v) **SfTI's mission-lab and mission-design process is a tested model for priority-setting.**

To be bold in the priority setting process and to balance, not replace, the traditional bidding-type funding competitions, SfTI respectfully suggests that we do not look to a panel of purely scientific experts and, especially, not a think-tank of international experts. Despite how forward thinking they may think they are, the former experts will be well entrenched, possibly unconsciously, in the current system and in their own historical expertise silo as that is how they have succeeded. The latter may be well versed in the international situation (which is useful but not exclusively) but are likely to have very little understanding of Aotearoa-NZ's challenges and/or capability.

SfTI has put considerable effort into designing and trialling our mission-lab and mission-design processes for mission definition, and believe it to be a validated approach, rather than an expert panel driven process. These mission setting processes are based on facilitated co-design conversations whereby industry/Māori leaders take a 'NZInc' view of what Aotearoa New Zealand needs, rather than just what 'I need for my organisation/sector'. SfTI noted in our 2019 submission to the draft RS&I Strategy "SfTI suggests priorities should be governed by a researcher/stakeholder/Māori consensus. If it was achieved, then any priorities should have some longevity (hopefully with bi-partisan political support). Not surprisingly, SfTI would recommend a more diverse version of our Mission Lab and Mission Design processes, with the former potentially being run by Callaghan Innovation, and the latter run in conjunction with the research organisations".

SfTI has an overarching mission to 'enhance Aotearoa-NZ's capacity to use physical sciences and engineering for economic growth' and we would add 'for prosperity'. The Challenge sets its priorities, or missions, loosely based on Professor Mazzucato's seven stage model from stage 2 onwards (stage 1 being the crowdsourcing of the 11 National Science Challenges in the first place). Professor Mazzucato argues that the stages aren't necessarily sequential, but all are important.

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

(SfTI Director, Professor Davenport, describes SfTI's approach to this model in a keynote speech transcript available here:

<https://www.triplehelixassociation.org/helice/volume-8-2019/helice-issue-4/changing-the-way-we-innovate-mission-led-challenges-and-capacity-development>)

SfTI has also experimented with different methodologies for defining missions, such as C-K (Concept-Knowledge Theory <https://www.ck-theory.org/c-k-theory/?lang=en>), which shows great promise for bringing diverse knowledge sets to bear on a mission (Hatchuel, Armand & Le Masson, Pascal & Weil, Benoit. (2017). C-K Theory: Modelling Creative Thinking and Its Impact on Research. 10.1007/978-981-10-7524-7_11.) During the pandemic, we have also successfully run a mixed in-person/virtual mission design process (for the Biosecurity Technology Spearhead) and a fully virtual process (Veracity Technology), with no apparent loss in creativity/collaboration.

More details of SfTI's Mission processes are available here:

<https://www.sftichallenge.govt.nz/for-researchers/funding-and-get-involved/spearhead-project-development-process/> SfTI's full submission to the 2019 draft RS&I Strategy is available here: <https://www.sftichallenge.govt.nz/news/our-submission-mbies-draft-research-science-and-innovation-strategy/>

How can the process best give effect to Te Tiriti?

Key Points:

- vi) Māori priorities should be determined by Māori, for Māori, and implemented by Māori.**
- vii) Addressing Māori priorities will bring huge benefits to Aotearoa-NZ.**

SfTI supported the development of the Rauika Māngai's Guide to Vision Mātauranga and whole-heartedly endorse the challenge to empower Māori knowledge, resources and people. Māori priorities should be determined by Māori, for Māori, and implemented by Māori, potentially in a partnership Tangata Whenua-Tangata Tiriti mode. The fulfilment of Māori priorities will also be of huge benefit to NZ if they benefit Māori. Māori organisations will be (some already are) our multi-nationals of the future as selling to overseas ownership by trade sale is highly unlikely. They should, and will, be our tech powerhouses of the future.

SfTI has long had a close relationship with the Federation of Māori Authorities (FoMA), supporting their development of a Chief Advisor Innovation & Research role for the Authority and, more recently, with the appointment of FoMA Chair, Traci Houpapa, to SfTI's Board. In SfTI's 2019 submission, we outlined what our "Māori research and enterprise partners tell us:

- The *Treaty of Waitangi* and *Te Tiriti O Waitangi* should provide the overarching mandate and framework for the relationship between Māori and the RSI system.
- The RSI system needs to support the development of the Māori STEAM capability pipeline to grow more graduates, postgraduates and PhDs etc.
- The RSI system needs to be aware the current system is structured in such a way that creates silos which increases the transaction costs for Māori organisations to engage given Māori enterprises operate in multiple sectors simultaneously.
- The RSI systems needs to create the settings for success that support a 'quadruple bottom line approach' to delivering better outcomes for Māori and for all of Aotearoa-NZ.
- Māori enterprises do not have the resources to engage with the complexity that it is the NZ RSI system, hence many are now partnering with offshore research providers as it's easier (eg: <https://gspp.berkeley.edu/global/international-partnerships/taupo-new-zealand>)

- When the RSI system wants to engage, consult and meet with Māori enterprises, no compensation nor reimbursement of actual and reasonable costs are offered for this engagement. It is taken for granted travel, meeting fees and time will be offered by Māori free of charge. This is a barrier to quality engagement.
- The RSI systems does not provide policy settings that encourage international *indigenous to indigenous* research collaboration and engagement, again a missed opportunity for Aotearoa-NZ, given we lead the world in this.”

Whilst MBIE has made great strides since this 2019 submission, particularly with the appointment of the inaugural Director of Māori Research, Science & Innovation, there is still a long path ahead for the RS&I system that needs enhanced resourcing and capability. The best approach that SFTI has found for working closely with Māori, is to go to where Māori feel comfortable to express their needs and what they can bring to mission co-development. SFTI’s two Māori Data Futures hui are cases in point. Reports from the two hui are available here:

<https://www.sftichallenge.govt.nz/news/what-does-ideal-future-maori-data-look/>

Given the alignment of values, Māori enterprises have expressed a desire to partner with other indigenous peoples such as in the Pacific where there is a whakapapa connection and with Australian Aboriginal and Torres Strait Islanders, open to the opportunity to collaborate on RS&I where this makes sense.

3. (1.4.2) Operationalising Priorities

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

Key Points:

- viii) **Building one multi-disciplinary team to address a priority/mission requires a different approach to mission design than traditional proposal development.**
- ix) **Co-creation of the priority/mission with industry/Māori is essential.**
- x) **Upfront expenditure on mission design processes is necessary, but likely small in comparison with un-costed aspects of competition funding, borne by institutions.**
- xi) **Proper resourcing of relationship-building, prior to proposal development, is absent in the current RS&I system.**
- xii) **Priority/mission governance and operationalisation should be at arm’s-length from government.**

SFTI’s experience in priority/mission operationalisation suggests that several stages are needed, as outlined in the description of our Spearhead project development process on the website linked previously. Once a high-level mission has been decided, it needs to be scoped more thoroughly to provide direction on what might be included/excluded in a project. SFTI does this by interviewing relevant experts, often using a professional writer. Once the broad scope is decided, SFTI calls for researchers, through an Expression of Capability (EoC) process, to attend a facilitated mission-design workshop that includes the original industry/Māori thought leaders – they stay in the room, and the project.

Of particular importance in this stage, is that SFTI specifies that researchers should bring their relevant capability to the workshop, not their pet projects. Māori priorities/missions may involve non-Māori researchers but only if they understand the mission kaupapa and tikanga and are willing to be led by Māori. A small leadership group is then identified and tasked with putting a proposal together under the mentorship of SFTI Theme Leaders before approval by the Board.

This is not a traditional contestable process; it is about forming the best multi-disciplinary team likely to be able to tackle the mission with the support of a sub-set of the SfTI Leadership team. The funding is already indicated (in SfTI's case, usually \$1m p/a for up to 3 years) so the outcome will be determined by participant's enthusiasm and willingness to adapt and work in a brand new team. This process is not for everyone – many would prefer their own ideas to be funded, but this is the role for our traditional bottom-up investigator-driven funding vehicles. The mission-design process is a blend of top-down orchestration with bottom-up percolation of ideas.

Effectively the priority/mission operationalisation process is resourced prior to the proposal formation. The resourcing of such relationship building is a significant gap in our RS&I system; yet such relationships are expected to exist in many of our current funding modes, prior to the submission of a proposal. This is anathema to how genuine and fruitful collaborations are initiated and maintained. As indicated above, this is a particular issue for building relationships with Māori who, quite rightly, have become deeply cynical about any approaches to be involved in research projects as such contact is often last minute and therefore disrespectful. The resourcing of relationship building is not an explicit part of the current RS&I system (apart from the mātauranga capability fund), so any such activity is effectively a tax on institutions and projects already funded that may use some of their existing research funding to support deeper relationship building in preparation for the next application deadline.

We acknowledge that SfTI's mission design process requires additional expenditure in that SfTI funds these upfront workshops separately to the actual research projects. Excluding participants time, recent SfTI mission development processes for five Spearhead projects (prior to contract) has cost \$336,500 for an investment of \$15m, or 2.2% of the funding. In comparison, there are many un-costed aspects of the current peer review/bidding approach which, if properly accounted for, would highlight the full economic (let alone social) costs of Aotearoa-NZ's RS&I system.

A US study (2008) indicated that academics spend at least 4 hours a week on proposal preparation (Link, A. N., Swann, C. A., & Bozeman, B. (2008). A time allocation study of university faculty. *Economics of education review*, 27(4), 363-374). A 2013 Australian study showed that 550 years of research time, estimated at Aus\$66m in salaries, went into one year's ~3700 applications to the National Health and Medical Research Council. With a 20% success rate, that reflects four centuries worth of 'wasted' researcher time! (Herbert, D. L., Barnett, A. G., & Graves, N. (2013). Australia's grant system wastes time. *Nature*, 495(7441), 314). As research funding has become more scarce and increasingly competitive, it is likely these are a gross underestimate of the cost in 2022.

This 'hidden' expenditure is compounded by the notional 'free' costs of peer reviewing which have been shown to significantly impinge on the quantum of funding being bid for let alone received. A study at KU Leuven estimated that applying and reviewing for external funds, cost the institution between €8-16m for a total budget of less than €50m (<https://www.veto.be/artikel/opnieuw-debat-over-basisfinanciering-aan-ku-leuven-beter-dan-het-huidige-model>). And then there are the well documented vagaries of the peer review system in terms of its ability to select the most worthwhile projects, which is beyond the purview of this review to 'fix' but must be acknowledged as introducing further inefficiencies.

Operationalisation also encompasses identifying gaps as SfTI noted in our 2019 submission. "For example, one of the issues SfTI has noted is that, while we have a sophisticated tech-implementation demand from frontier firms in some sectors, eg Sanford, Wakatū in Aquaculture, the sector does not have the feeder manufacturing capacity to deliver the technology to be implemented, with the added deficit that this technology, if manufactured, could also be exported". This is "the sort of gap which is not really the responsibility of any particular player in the RSI system. Risk capital investment, such as experienced angel and intermediate

funding before Series A Venture Capital, is also another area that is not yet at a scale to support acceleration.”

Following our experience over the last 8 years, SFTI suggests that oversight and governance of priority/mission operationalisation should be at arm’s length from central government agencies. With appropriate reporting and controls, this distance enables experimentation and adjustment when needed. This capability is important for managing the risk associated with a more top-down approach to research which, along with promoting fruitful research, must include ‘pivoting’ or stopping projects that are not progressing towards mission resolution. SFTI developed our Spearhead and Seed project management as a continual improvement approach, whereby regular and on-going monitoring of projects by the assigned SFTI Leadership Team members, rapidly identifies where adjustment is needed. Such an approach would be impossible for a government agency to do at scale. It is extremely rare for a project granted through the traditional bidding process to be stopped as there is little real-time evaluation during the project. It is with respect to this role, that is, the need to make tough continuation decisions, that SFTI has particularly valued the experience and wisdom of our independent Board.

2. Te Tiriti, mātauranga Māori and Māori aspirations

4. (2.1) Engagement

- How would you like to be engaged?

Key Point:

xiii) **With respect to Te Tiriti, mātauranga Māori and Māori aspirations, we refer to the submission prepared by the SFTI Kāhui Māori.**

5. (2.2) Mātauranga Māori

We refer to the submission prepared by the SFTI Kāhui Māori.

6. (2.3) Regionally based Māori knowledge hubs

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

We refer to the submission prepared by the SFTI Kāhui Māori.

3. Funding

7. (3.2.1) Core functions

- How should we decide what constitutes a core function and how do we fund them?

Key Points:

xiv) **Core functions and infrastructure are not distinct and relate strongly to essential capabilities/platforms.**

xv) **Government should see itself in ‘shaping’ or ‘nudging’ roles in the system (including taking on some risk).**

Core infrastructure (as discussed later) is obviously a core function. What is the difference, though, between infrastructure and function? Infrastructure doesn’t have to be physical (databases are not physical in and of themselves although storage of them certainly is). Perhaps functions would be better thought of as capability platforms that are essential to the ‘functioning’ not only of the RS&I system but also to the resilience of our nation. Aotearoa-NZ’s gene sequencing/pathology capabilities for the pandemic are

obvious recent examples, as are the pandemic modelling and other related (water testing) capabilities. All these capability platforms have risen to the fore recently but might be equally 'core' as the world moves into future unknown environmental and health challenges.

Deciding what are core capability platforms should be a cross government/pan-national process. In SFTI's submission on the 2019 draft RS&I strategy, we stated that "MBIE (and all govt agencies) should see themselves in a 'shaping', as well as 'steering', role in our system.... A paper that our Spearhead project 'Building NZ Innovation Capacity' (BNZIC) has published in the TIMReview might be informative. It has been downloaded globally and received coverage on social media within innovation communities. Based on behavioural science observations of the experiments in SFTI, it is titled 'Giving Innovation Systems a 'Nudge'". <https://timreview.ca/article/1275>. Some of the 'nudging' roles could easily be played by public sector organisations." Note that Professor Mazzucato alluded to government needing to take a shaping role (and taking on more risk) to address challenges in her recent RNZ interview (<https://www.rnz.co.nz/national/programmes/ninetonoon/audio/2018829001/mariana-mazzucato-governments-must-collaborate-with-private-sector>)

8. (3.3.2) Establishing a base grant and base grant design

- Do you think a base grant funding model will improve stability and resilience for research organisations, and how should we go about designing and implementing such a funding model?

Key Points:

- xvi) **Base grant funding may improve stability, but the detail of its implementation needs to be modelled (including the impact of reduced overheads) and widely consulted upon.**
- xvii) **A gap exists in our current system whereby there is no orchestration of 'progression' of successful projects towards impact once funding is completed.**
- xviii) **'Lumpy' short-duration approaches to research funding exacerbates barriers to relationship building.**

In principle, a base grant funding model would improve stability, particularly for CRI researchers and Early Career Researchers (ECRs). However, the 'devil is in the detail'. The current ubiquitous use (at least in universities) of one overhead formula, seemingly based on the most expensive research in the institution, and one that is calculated according to pay level, does not account for the nuances between the sciences let alone humanities and social sciences. In addition, a professor does not always need more lab/room space, nor necessarily draw more heavily on support staff and services, than a senior lecturer, yet is charged at a much higher rate.

We recommend that international models, particularly those in Australia and Canada, should be investigated. Our understanding of the Australian situation is that it may have gone too far by removing not just overheads but also FTE components of research grants, so that research funding can only be applied to equipment and other direct resources – chemicals, PhD students, which

means that researcher time is no longer part of the funding equation. This is a physical/biological science framing of research project expenditure which omits understanding of other forms of research, such as theoretical sciences, less 'lab-based' sciences, social sciences and humanities, none of which need the equivalents of 'chemicals' and often do not use doctoral students to 'do the work'. In these disciplines, time removed from other roles through FTE funding is absolutely essential for such research.

The other core function we see missing in the RS&I system is any 'nudging' notion of active 'graduation'/progression of projects and research results through our system in a more holistic way. Again, as we commented previously in our 2019 submission on the draft RS&I strategy, "there seems to be a missed opportunity in the system when projects funded at one stage do not progress to the next, even though they have not "failed". This leads to a very disjointed system of project stages and a lack of 'progression' for promising projects. Not that this should be automatic, of course, but there must be some constructive intermediate position whereby promising research supported at the early stage has some hope of 'making it all the way'." It is assumed the commercialisation expertise at our institutions will support this progression but, in general, SfTI's experience is that they don't have the capacity to do this at scale.

In addition, any relationships formed with industry/Māori stakeholders, along with their expectations of impact from the project, are suddenly curtailed. This must be hugely discombobulating for those stakeholders that are not used to the 'stop-start' nature of the competition-based funding system and greatly increase cynicism and disinclination to engage in future. It should be noted that the NSCs, all of which have invested heavily in building relevant engagement/relationships, face this with our now-definite end-date of June 2024, which can only hamper our goal to have impact legacies. More coordination in the system, possibly with Callaghan Innovation involvement as our innovation agency, might generate a truly system-wide collaborative approach with some longevity.

4. Institutions

9. (4.4.1) Institution design

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

Key Points:

- xix) Institutions (rather than individuals) are unlikely to collaborate unless the right incentives are in place.**
- xx) Agility and adaptation are more likely in organisational forms that are at arms-length from government, with appropriate governance and controls.**
- xxi) Alternative (temporary) collaborative vehicles, such as CoREs and NSCs, have played innovative, experimental roles in supporting pan-national collaboration on important issues.**

The need to collaborate is seen as necessary across many of our wider institutions, not just in the RS&I system. SfTI observes that individual

researchers are usually willing to collaborate, but that it is institutions that impose explicit or implicit barriers. Unless the incentives are in place to support such collaboration, it is just paid lip-service. Usually, the approach in the public sector to collaboration is: 'sure we will collaborate, but it has to be on our terms'. As we stated in SfTI's 2019 submission to the draft RS&I draft strategy: "Research funding is relatively scarce, so it's not surprising that researchers are naturally parochial about who they might work with. Teams tend to consist of researchers who have worked together before, so they have a strong track record of producing, which is then reinforced by project selection processes. Even though there are no regulatory barriers to cross-institutional teams or collaboration, prior research has found that there are perceptions that permission is needed to visit, and potentially collaborate with, people in other institutions (see <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1467-8551.2010.00713.x>)".

The careful design of targeted incentive systems for our institutions is key to changing collaborative behaviour. SfTI does not claim to be an expert in this but does believe that temporary, alternative institutions, such as CoREs and NSCs (or future incarnations), have played a very important role in supporting pan-institutional, pan-national collaboration on particular issues, despite the current incentives. For example, SfTI's over-arching emphasis on capacity development, rather than project funding, delineates it from formal institutions. Temporary organisations are important for process experimentation as they are relatively independent of the government (albeit with appropriate governance and accountability) so can be agile and embrace the opportunity to try new approaches to research projects and processes.

10. (4.4.2) Role of institutions in workforce development

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

Key Points:

- xxii) A capacity development approach to workforce development is generally piecemeal.**
- xxiii) Capacity development opportunities should be coordinated nationally and funded separately, potentially as its own set of priorities.**

Because SfTI's mission includes the directive to 'enhance capacity', we have also focused on where the current system has capacity gaps, with a particular emphasis on our theme areas and ECRs. It might be presumed that it is the home institution's responsibility to enhance their internal capacity through workforce development programmes. However, our experience is that historically any leadership training, for example, is focused on the institution's managerial needs and not on that of ECRs, especially if the latter are not in permanent roles. Tradition has it that ECRs learn how to lead research teams and manage large projects by apprenticeship to their PhD supervisor or a senior PI. However, the quality of this apprenticeship would very much depend on the leadership capability of the master, which is never assessed or questioned, and likely to be highly variable, if not totally lacking.

Some institutions will negate this and, certainly, we have observed recent institutional efforts aimed at ECRs, but it will only change slowly as long as such training is just a 'nice to have' and likely to be reduced in times of austerity. Our Capacity Development Programme is funded separately from the research programmes, and everyone supported by SfTI (even senior PIs) is expected to participate in some form of capacity development. Our most popular modules are relational leadership training, which SfTI took online in 2021, and our Vision Mātauranga (VM) related opportunities.

As is evident in this description (and that in section 5), all of SfTI's workforce capacity development activity is separate to, and over and above, the funding allocated to research projects. If it was assumed that such capacity development was to be an implicit part of research programmes, it would probably not happen. This points the way to the development of a more wide-spread national approach to workforce development incentivised alongside, or even as a separate set of, priority initiatives.

11. (4.4.3) Better coordinated property and capital investment

- How should we make decisions on large property and capital investments under a more coordinated approach?

Key Point:

xxiv) A coordinated strategic approach to property and capital investment is timely.

As an entity that does not own such assets, SfTI will defer to others more experienced with property and capital investments. However, a more strategic, nationally led assessment of assets and potential future needs, across all of our research institutions would be timely. SfTI's observations is that such discussions at individual institutes are often about trying to extract minimal remaining value of assets that are well passed their use-by dates, rather than investing in the future. This reluctance to acknowledge when an asset really does need to be written off, has also been observed on Aotearoa-NZ's companies as well. It is not surprising because no institution wants to be left with stranded assets, although arguably depreciation should support renewal. Lumpy asset investment as a strategic issue is not just a topic for the RS&I sector.

12. (4.5) Institution design and Te Tiriti

- How do we design Tiriti-enabled institutions?

Key Point:

xxv) With respect to Institution design and Te Tiriti, we refer to the submission prepared by the SfTI Kāhui Māori.

13. (4.6) Knowledge exchange

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

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

Key Points:

- xxvi) Knowledge exchange/transfer are dyadic concepts and do not reflect the more creative co-design approach to the mutual generation of new knowledge.**
- xxvii) Impact generation needs to acknowledge that there are multiple ways in which impact is generated and primacy given to economic impact may be mis-placed in comparison with behavioural change.**
- xxviii) TTOs, despite their best efforts, are not engaged early enough in research planning and are 'lean' (ie under-resourced). Coordinated efforts such as Kiwinet and Return on Science are very welcome but need to be resourced to scale.**

Knowledge 'exchange' is a very 'dyadic' view of what happens in collaborative projects, as if a parcel of knowledge is passed from one partner to another, a notion probably left over from the linear view of innovation. Ditto 'transfer'. Our view is that a better perspective is to support a co-design approach whereby knowledge is generated by and between research stakeholders. This is the principle underlying our mission-design process.

SfTI has integrated a broader notion of impact into our assessment of projects. Our impact rubric includes an array of impacts, from capacity impacts (technical, relational, human, partner/behavioural) and broader NZ impacts (economic, environmental, social, cultural/Te Ao, benefit to NZ). Behavioural change is arguably the most impactful (see 'A Process Approach to Research Impact' here:

<https://www.sftichallenge.govt.nz/about-us/documents-and-reports/>). An issue with thinking about impact in our system is that it depends on the perspective taken as to how to assess it.

SfTI's experience is that TTOs in general are not approached soon enough, and not resourced well enough, to be involved in crucial early discussions with potential implementers. The word 'user' implies they are the add-on at the end and, again, embodies the traditional research push model. SfTI's capacity development initiatives targeting impact generation, such as the collaborative pre-accelerator programme with Kiwinet, Rewa, can enable significant changes in the nature of the research before it starts (<https://www.sftichallenge.govt.nz/?s=Rewa>).

Knowledge co-generation reflects that many different knowledge sets are needed early in the process, not in a linear 'pass the parcel' mode. In SfTI, we have, over time, made conversation with our Commercial Development Manager an encouraged, then compulsory, part of proposal development and contracting. Our CDM works as closely as he can with the relevant TTO, but capacity in this part of the system is lean. SfTI has been very pleased to work closely with Kiwinet and Return on Science as critical collaborators in the RS&I system for impact generation.

5. Research workforce

14. (5.2) Workforce and research Priorities

- How should we include workforce considerations in the design of national research Priorities?

Key Points:

- xxix) Workforce considerations must be a major element of priority operationalisation, focusing on the precariat nature of ECRs.**
- xxx) Traditional narrow emphases on track-record and bibliometrics hamper the development of a more diverse and equitable workforce.**
- xxxi) Other diversity support mechanisms need to be introduced to balance the ‘strong cv’ dominance embodied in the competitive funding regime.**

It is in the operationalisation of research priorities that workforce considerations must be integral. The pandemic has highlighted the perennial issue of the precariat nature of academic work for the ECR workforce, captured well in the recent TEAGA publication ‘Precarious Academic Workforce Survey 2021 – Interim Report

(<http://www.teaga.co.nz/precarius-academic-work-survey-2021-interim-report/>)

. The issue is largely caused by, or at best strongly exacerbated by, the imbalance in our RS&I system towards a total reliance on competitive funding modes.

As noted in the Green Paper, the competition for funding is probably one of the strongest incentives in the RS&I system for institutions. Thus, researchers who can amass multiples grants and support large teams are more highly valued (at least in the university system). However, these grants usually only support ECRs on short-term, often part-time, contracts which do not enable a sustainable living, let alone career. SfTI acknowledges that CRIs tend to take a more corporate approach to workforce development so ECR precarity may be less of an issue.

As we noted in our 2019 submission to the draft RS&I strategy, the gross imbalance in the system works against diversity on many dimensions and further entrenches the success of those privileged to have gained and maintained a strong track record of grants-personship. “The traditional process of contestable funding where a Principal Investigator (PI), with a strong ‘excellence’ CV, bids with a team of less experienced researchers, is not always conducive to achieving diversity, unless that PI purposively seeks to have a diverse team. Given citation counts take time to build up, the citation view of excellence also reinforces the ageist nature of the RSI system.

SfTI has observed that we are enabling more diversity serendipitously through our Mission Design Process. We send out an EoC on a specific mission (eg. ‘Intelligent oceans’ or ‘flexible robots’) and ask researchers to bring their capability to be a part of one project team. Anyone, from whatever discipline, can make EoC so SfTI has seen more diverse teams form this way – both demographically, as well as in terms of disciplinarity.”

SfTI also supports workforce diversity in other ways. As noted in our 2019 submission: “SfTI has also encouraged demographic diversity by prioritising funding of Seed projects that propose ‘strong’ linkages to VM, and with emerging researchers as the lead PI. We also assess our Seed project applications as either fundable or not and, once that hurdle has been reached,

the fundable projects go through a ballot process. This is not new to the NZ research scene (eg. in use by HRC) but appears to be very well accepted by researchers who are unsuccessful in the ballot, and possibly works to correct any conservative bias in any more detailed ranking assessments, given SfTI wants to support 'risky' research."

SfTI's approach gets around the vagaries mentioned early in the peer review system, especially once a certain quality level is achieved. SfTI has seen a remarkable improvement in the quality of VM proposals that enter our separate VM ballot, so much so that in 2021, SfTI's Board approved extra capacity development funding so that two further excellent VM projects were supported. Once selected, all Seed project PIs are mentored by our experienced Leadership Team Theme Leaders, for example, to develop achievable milestones, which we have also found has accelerated progress and is a much-appreciated capacity development activity.

Because the barriers to engagement in the research system by ECRs is often hampered by issues other than the opportunity to apply, SfTI implemented Seed 'Proposal Development Grants' in 2021. These small (up to \$3000) grants were to be used to support the applicants to ameliorate time or skill issues, for example, by obtaining help with editing or childcare.

15. (5.3.1) Base grant and workforce

- What impact would a base grant have on the research workforce?

Key Points:

- xxxii) In principle a base grant will have a positive impact on the research workforce, but any impact will depend greatly on the detailed grant design.**
- xxxiii) Consideration should be given to an inverted base grant design such that ECRs are funded at a higher % of their salary than experience PIs that attract large amounts of external funding.**
- xxxiv) The impact on the research workforce of any base grant dimensions should be included in any modelling of changes to the current funding system.**

As indicated earlier, SfTI's answer is 'in principle, yes', but it very much depends on how such a base grant is designed and implemented. Such a system could be thought of as a 'Universal Basic Income' for researchers and might reduce the huge amount of un-costed effort that goes into proposal formation which, at the moment, is borne by individuals and institutions.

If the base grant has the primary intention of supporting and developing succession in the workforce then consideration should be given to constructing an 'inverted' base grant scheme. That is, SfTI considers that a system which allocates a larger base grant (as a proportion of salary) for an employed ECR researcher but a lower % of salary for those PIs that have a good track record of attracting fund and bringing in significant overheads, could support a more equitable and diverse workforce. This might also encourage senior PIs to

consider other important leadership roles in the system, rather than staying on the proposal treadmill, potentially freeing up more space for succession.

Design options need to be consulted upon separately, with appropriate in-depth scenario modelling to assess likely impacts on the system. A base grant scheme that works to entrench the current inequities in the workforce and RS&I system, would be a folly at best. Such an inverted base grant system would need to be adjusted for/matched to any changes to the graduated scale of overhead charges, and the latter be part of the modelling.

16. (5.3.2) Better designed funding mechanisms

- How do we design new funding mechanisms that strongly focus on workforce outcomes?

Key Points:

xxxv) A major gap in our current system is the ability for capable ECRs to propose and lead their own projects.

xxxvi) Building in capacity development opportunities to develop leadership competencies is essential for such workforce development.

As part of our SfTI Seed project process, SfTI has learnt how greatly ECRs (post-PhD) appreciate the opportunity to lead their own programmes – which can be small to start with – with guidance from senior researchers when requested. In the current system such opportunities are few and far between, for example, Fast Start Marsden grants. ECRs do not necessarily want, nor need, to join a senior PI's established group, or at least might relish the chance to be able to do both at the same time to build independence.

It is SfTI's experience that supporting the fresh, sometimes risky, but usually exciting, ideas of ECRs provides huge benefit both to the ECRs themselves but also to their mentors and the system at large. Senior PIs can become quite entrenched in their approaches and methods which is why, as mentioned previously, they have strong track-records and attract most funding. Some post-PhD ECRs won't have the experience or confidence to do so but enabling ECRs with their own ideas, who are capable, is a way to bring not only fresh perspectives into the research portfolio, but also bringing in new talent that can then enhance well-established teams as well as allow them to build their own track records for innovation and project management.

The RS&I workforce funding infrastructure needs to include a well-designed ECR pathway with (living-level) funding but also capacity development opportunities planned with a succession ethos. A recent exchange on social media acknowledges and reinforces this as a major gap in our system. A mature and independent researcher finishing her PhD, stated "[w]hile I'm incredibly clear that I'm not looking to stay in the university system, all postdocs I see offered in NZ are based in ongoing research areas, be that with people or groups. Not having the (potential) post-docs lead the funding. We're missing out on new ideas/areas".

6. Research infrastructure

17. (6.2.2) Funding research infrastructure

- How do we support sustainable, efficient and enabling investment in research infrastructure?

Key Points:

- xxxvii) **Facilitated access to what should be national infrastructure is a key barrier to research collaboration and impact.**
- xxxviii) **Open access requires appropriately tailored service models for specific infrastructure.**
- xxxix) **As per core function, base grant and workforce development, a national approach to funding, and access to research infrastructure should be a priority.**

Important research infrastructure should be nationally owned with open access, to allow it to be used maximally to generate value for New Zealanders. Access to equipment in other institutions has been found to be one of the best ways to encourage collaboration and putting an ECR or migrant researcher in charge of the equipment helps them build their networks at a much faster rate. (See <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1467-8551.2010.00713.x>).

But open access infrastructure is complex and costly to put into practice, which is partly why the 'user pays' model is the default approach across research organisations. Though providing access for a fee may be reasonable, charging large sums can be an added impediment to collaboration and lead to poor rates of utilisation. Open access has implications for scheduling systems, health and safety, maintenance of core business, priority user access, facilities management, HR policy, floor space, insurance, certifications etc. This provides a management challenge that goes beyond the cost of technician time and laboratory operating costs.

First and foremost, open access requires an appropriate service model for accessing any particular infrastructure, that is supported by all relevant functions of the organisation within which the infrastructure is situated. The service model needs to meet the needs of external parties: even if infrastructure is free to access, it may be impractical to do so under certain conditions like time and certainty of availability. Furthermore, the service model needs to be practically feasible for internal infrastructure users and the infrastructure provider.

This in practice means that there will inevitably be specific types of infrastructure in specific locations that will have a valid demand on it beyond the internal user group, which justifies the development and resourcing of a service model for accessing that infrastructure. Along with a service model is the need for the capability to develop it and adequately resource and execute it.

Important infrastructure should be treated in the same discussion as the 'base grant', in that hosting infrastructure, including the support of staff and technicians should be a base grant element. The way this element is factored

into the determination of the grant requires careful consideration to recognise the specific rather than generic requirements of open access infrastructure and the need to incentivise the proper development of capability in service model provision.

Of course, the infrastructure issue, as indicated previously, has an inherent ambiguity about what infrastructure is critical, which can change over time as has happened during the pandemic. Ideally, the nation needs a universal agreement defining priorities for new infrastructure, which would include guidelines for the sharing of equipment and facilities (existing as well as new). The guidelines should cover access priorities, so that if a host invests, for example, they will maintain priority, but if spare capacity is identified, it be made available to external users.