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Submission to the Science System Advisory Group – Phase 1

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The Society envisages a future Science, Innovation and Technology (SIT) system in which…

- ✓ Human skills and capability, and intellectual capital in SIT are recognised, nurtured, prioritised, and enabled to flourish as the key assets that will drive all aspects of the system
- ✓ Our tertiary education system delivers teaching and research at the leading edge of global knowledge and practice
- ✓ All elements of the SIT system are strongly and collaboratively interconnected with connections between people and cross-fertilisation of ideas
- ✓ New Zealand attracts and retains the best and brightest minds within the competitive global labour market, and our young people aspire to careers in SIT
- ✓ Local and overseas investment and human capital flow freely into a growing and thriving high-value technology sector
- ✓ Māori are actively involved across the system, in accordance with the principles of Te Tiriti o Waitangi, including in developing the potential inherent in mātauranga Māori, and sharing in the benefits of science innovation and technology
- ✓ The Government has easy access to evidence and publicly funded research to inform policy, service delivery, and decision-making on key issues
- ✓ Communities have easy access to research evidence to support their understanding and decision-making, and to support public trust in science, innovation, and technology
- ✓ Our SIT system is recognised internationally for its success, and overseas institutions want to collaborate and partner with us for mutual advantage
- ✓ All participants in our SIT system are engaged and motivated and have a common and positive view of its purpose and functions
- ✓ Science innovation and technology form part of the larger 'ecosystem' that enables our nation to flourish and are major contributors to our prosperity, the cohesiveness of society and a **future of Aotearoa New Zealand is guided and inspired by science and research**.

Royal Society Te Apārangi: our role in the system

Royal Society Te Apārangi is an independent, not-for-profit organisation, established with the statutory objective of advancing and promoting science, technology, and the humanities in Aotearoa New Zealand.

Our membership and networks include eminent scientists and scholars from a wide range of disciplines, educators, teachers, leaders, and research professionals working across science, innovation, and technology (SIT). The Society is well connected locally and internationally.

We manage investments on the Government's behalf through the prestigious Marsden Fund and a range of fellowships and scholarships, and we provide expert advice on important matters to the Government and wider community. We advance education in science and technology through programmes to support students and teachers, and we celebrate excellence in the SIT system with prizes and medals.

The Society appreciates the opportunity to provide input on the future of the SIT system, noting that the views of our members and stakeholders are many and varied. In this light, we have encouraged individual members and groups to make their own submissions.

Characteristics of the SIT system in Aotearoa New Zealand

Knowledge creation and innovation are now well understood to occur within a complex system of interactions between scientists, scholars, technologists, educators, public institutions, businesses, funders, and entrepreneurs. Initiatives that increase collaborations and interactions within the system, and reduce overheads and competition, are likely to support a stronger and more innovative system over time.

However, New Zealand has natural barriers to overcome; we are distant from collaborators, investors, and markets for our products and services; our population is geographically spread out; and we lack the large cities of overseas nations that attract higher levels of innovation through their deeper networks and interactions. New Zealand also does not have the high-technology industries such as defence through which other countries invest in research and development. Our greater dependence on primary production, which typically has low intensity of R&D compared to the high-technology sectors of comparator countries, also limits our overall R&D performance.

This means that New Zealand will need to invest more, and more smartly, if we want to achieve our aspirations and match the performance of comparator countries.

Notwithstanding the above limitations, New Zealand's SIT system has strengths that should be recognised and retained. Investment in SIT human capital and infrastructure over many years has delivered internationally renowned research and excellence in many areas of science, innovation, and technology that provide significant benefits to the country. Examples of this are evident in successful new global companies; our ability to respond to major crises such as the kiwifruit PSA and *Mycoplasma bovis* outbreaks, major earthquakes and other hazards, and the Covid-19 global pandemic, to name just a few.

We also have universities that compare favourably against international benchmarks, and we have enduring research institutions that have built up world-leading human capability and know-how in many areas of mission-oriented research that are essential to the country's wealth and wellbeing.

The question then is what can we do to move us towards our aspiration in the absence (at least in the short term) of additional funding while ensuring we do not lose the essential human capital and knowhow that we have already accumulated?

The critical importance of human capital as the foundation of the SIT system

A thriving research, science, innovation, and technology system that delivers positive sustainable growth and prosperity for New Zealand is a long-term endeavour and needs to offer sufficient certainty for the high-performing people and organisations working within it, especially if we want to attract and retain the world's best minds.

On its own, New Zealand can only expect to create a very small proportion of the innovation and knowledge generated at the global scale, and it would be a mistake to assume that the application and commercialisation of that small proportion could, alone, generate the growth that would deliver on our country's aspirations for prosperity and wellbeing. Rather, our investment in research and education provides and grows the essential human capital we need to engage effectively within the global knowledge economy, significantly broadening our range of opportunities for growth and innovation.

Building a stronger pipeline of world-class human capability and know-how is, therefore, always going to be a worthwhile endeavour for strengthening the SIT system. It is also an area that can be usefully advanced by building on established mechanisms. For example, the Marsden Fund, as a contest for ideas, is already well established as a major contributor to human capital development and growth over the past 30 years. It follows excellent, tried-and-true processes, is trusted and valued by the SIT community, and has often been an initiator of successful long-term research programmes. It operates at arms-length from government to ensure decisions on investments are free of political influence. Grants from the Marsden Fund also provide opportunities for new researchers and ideas to enter the SIT system and are particularly important to the universities in supporting research-led teaching across a wide range of disciplines.

Fellowships and scholarships that support career development at various stages are also an important part of strengthening the human capability pipeline in STEM and other disciplines and attracting the best minds to work in New Zealand. For example, the Rutherford Discovery Fellowships (now absorbed as part of the wider range of Tāwhia te Mana Research Fellowships) have resulted in a strong cohort of New Zealand's future SIT leaders by providing certainty of funding to our best emerging scientists and helping them establish their careers in New Zealand post-PhD.

Tāwhia te Mana Research Fellowships and grants from the Marsden Fund are two examples where further investment into existing initiatives would have an immediate payoff in strengthening and growing New Zealand's SIT system with minimal further overheads.

The Crown Research Institutes have an important role in building human capital and transferring knowledge and know-how in their areas of specialisation, especially in service provision to government, communities and primary-sector industries.

Callaghan Innovation, which provides grants and services to businesses, can have an important role in growing human capital to support innovation in the system by providing career pathways for post-graduates to upskill and train, and then take their knowledge and R&D skills into long-term employment in the private sector. Callaghan Innovation can also have a role in transferring knowledge into New Zealand's private sector through demonstration of new technologies and training services that encourage uptake of products, technologies and services, and facilitating strategy development and priority setting across emerging high-value sectors.

It will be important to ensure we train post-graduates in areas where they are most in demand, for example, in engineering and other technology-related disciplines.

The Society also notes that human capital in SIT is not necessarily just about maximising the number of PhDs in the system – New Zealand needs to create viable career paths and support for its technical and service providers within SIT who also need to work with world-best knowledge and practice. Such career paths will be clearer and better-aligned if relevant university degrees provide real-world

experience and contact with end-user communities and industries. This helps align the supply of qualifications, including PhDs, with the demands of end-users. For example, previous work by the Society on the important role of technicians within the science system has highlighted a lack of real-world experience to help inform and guide student's career decisions.[1] The Society recommends stronger incentives for researchers to gain experience in industry, government, and community organisations, along with greater support for entrepreneurs and innovators to work within universities.

It is worth noting that SIT capability is lost much more quickly than it is gained. Building world-class capability and achieving impact from it can take decades. While a system with flexibility and agility is an attractive prospect, and one we should aspire to, decisions that impact capability need to be made with care and with a whole-of-system perspective. Capability, once lost, may take years to rebuild, and unnecessary uncertainty in the system can lead to our best and brightest moving elsewhere.

The importance of underpinning infrastructure and data

The health of the SIT system depends on sustained investment in cutting-edge infrastructure. Nationally significant databases and collections, large equipment, buildings, and high-speed computer networks all represent critical assets that need to be funded and managed in the long term.

Scientific data also needs to be collected, managed, and curated to international standards and made freely accessible for public good use, often for the long run. We need to invest in scientific data to understand the status of our land, waters, environment, our health and wellbeing, and our extended economic zone, to manage our resources effectively and respond to emerging opportunities, risks, and hazards.

However, these underpinning capabilities and assets often transcend individual research projects and the Society's perception is that this research infrastructure is often neglected or under-valued in a SIT system historically dominated by contestable project investments. This results in gaps in scientific data for the public good and degradation of capabilities, including the loss of specialised staff. Longitudinal studies that have accumulated years of high-value knowledge are at risk through lack of funding, and the Commissioner for the Environment has previously reported on the significant gaps in the environmental data that is currently being collected.[2]

The Society's view is that there is a lack of strategy and commitment to addressing these issues within New Zealand's SIT system and that New Zealand lags other countries in setting strategy for its major infrastructure and data needs. The Society would like to see a more coordinated national approach to planning, funding, and accessing research infrastructure.

The role of contestability in the SIT system

Contestability has historically been seen as a driver of efficiency and effectiveness in the system and has dominated many of the SIT investments. However, its efficacy is context dependent.

Contestability is useful when investing in short-term projects designed to generate new ideas, such as through the Marsden Fund. Competition in this context drives excellence, new participation and new entrants. Competitive processes for awarding Fellowships and other types of individual career awards also drive excellence and add value.

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[1] Royal Society Te Apārangi (2017) Science Technicians Workforce. https://www.royalsociety.org.nz/assets/documents/Science-Technicians-Workforce-Report-May-2017.pdf

[2] Parliamentary Commissioner for the Environment (2019) Focusing Aotearoa New Zealand's environmental reporting system. https://pce.parliament.nz/media/vjnfu5kl/focusing-aotearoa-new-zealand-s-environmental-reporting-system.pdf [Accessed 12 May 2024]

Contestability for longer-term projects can lead to unintended consequences. For example, in the absence of other sufficient funding, it can mean that organisations and teams compete for funding and survival. Such competition reduces incentives for collaboration and can result in loss of valuable human capital and long-term infrastructure.

Contestability may also bring unintended consequences if there is lack of alignment between priority-setting, funding, and delivery. For example, the strategy-setting and prioritisation functions of governance boards can be undermined if priorities for their activities are set and funded through decisions made elsewhere in government. Crown Research Institutes need to be sustainably funded so they can deliver on their public good roles set out in their Core Purpose statements (including supporting research infrastructure).

Contestable investing in strategic areas of capability also brings significant overheads in terms of the time taken in preparing bids (particularly when they are unsuccessful).

Addressing these issues, in line with the following principles, is likely to enhance collaboration and strengthen the SIT system.

- Decisions on research priorities and delivery should be made where the information-advantage lies – generally with the researchers and their institutions, informed by their stakeholder communities.
- Research institutions should be enabled to set their strategies and priorities in line with their mandates.
- Long-term underpinning infrastructure should be sustainably and directly funded, separately to project funding, with appropriate checks and balances.
- Strategic investments in projects and programmes should have a strong component of negotiation, in line with organisational mandates and informed by relevant stakeholders.
- The Government's main role should be translating national priorities at a high level into broad allocations of investment, and monitoring performance at a system level.
- Contestability should be confined to short-term investments in projects designed to generate new ideas, application of existing knowledge, open to all players, which feed off the existing base of human capital to grow and strengthen it in new directions.

Dividing up the SIT pie

However it is designed, the Society's view is that the structure of the SIT system should acknowledge the different drivers and relationships in different sectors of publicly funded SIT investment along the following lines:

- Investigator-led curiosity-driven research is driven by a contest for ideas and creation of new knowledge across all SIT disciplines. Such research provides an essential foundation for human capital development across the SIT system, especially in universities, ensuring excellence in SIT and connection to global, leading-edge science and engineering. Such research, and the infrastructure to support it, needs to be publicly funded, as it will not be undertaken by the private sector.
- The driver of research and innovation designed to generate innovative high-value products, technologies, and services is economic growth. This activity generally requires tax incentives and/or grants to incentive R&D that would not otherwise take place, and services to businesses that can be provided more efficiently and effectively by government. To grow the economy in this way, the Government also needs to enable a strong pipeline of human and intellectual capital,

especially engineering, and other relevant services and technology, entrepreneurship, supportive regulatory reform for new industries, and policies that attract and make it easy for knowledge workers and their families to come to or return to New Zealand.

- Mission-led research has distinct characteristics which vary according to field, for example:
    - Research on environment and hazards aims to understand and protect our natural environment, ensure sustainable use of our land, water, and natural resources, including in relation to our primary sectors and management of our exclusive economic zone. This is an opportunity to build on New Zealand's core strengths in climate, energy, resilience, and a range of high-tech sectors. End-users include local, regional, and national government, iwi, Pacific Island countries, and organisations focused on emergency management, biodiversity climate change, and other environmental risks. This research, and the infrastructure to support it, should be primarily publicly funded, since the private sector will not undertake this work.
    - Research on social issues, education, health, and clinical practice aims to improve the health and wellbeing of our population. End-users sit in government, the health sector, iwi, and the broader community. This research, and the infrastructure to support it, should be primarily publicly funded as the private sector will not undertake all the necessary work.
    - Primary sector research aims to provide efficiency and effectiveness in developing and distributing valuable intellectual property where individual industry players are unlikely to be willing or able to fund all the necessary research themselves. However, primary-sector industries should contribute some of the cost of this R&D given that they capture value from its ultimate use. Several of the Crown Research Institutes were created to deliver research and development functions for these sectors.

These are just examples of differences in characteristics. The government now has the opportunity to design its system to ensure focus and effective strategies to maximise the benefits of investment into each relevant area based on their specific characteristics.

Growing New Zealand's high-value technology and services sector

Providing an enabling environment that encourages research breakthroughs, new ideas, innovation, and new businesses must be a high priority for New Zealand if we are to address our productivity issues and match the performance of comparator countries. We need more new and emerging entrepreneurs willing to take risks, private financial capital to support them, and acceptance that only a few will flourish in the long run.

This can be addressed with enhanced networking and collaboration that lead to serendipitous interactions and new idea generation; increased numbers of highly skilled engineering and technology-relevant STEM graduates from our tertiary institutions and from offshore; and incentives for overseas experts and entrepreneurs to live and work in New Zealand. This will proportionately grow the volume and quality of successful high-value businesses and help build an environment where we all want to live and where we thrive.

Strengthening the SIT system

There are important issues to address if we are to strengthen our SIT system. We have a system that is not fully inclusive, with a driver around competition for resources that can manifest as an inhibitor of collaboration, precarity for many parts of the workforce, and lack of a long-term strategy and investment in critical infrastructure and related support services. There is gender disparity and continuing under-representation of Māori and Pacific researchers and communities throughout the

system. The future SIT system should better acknowledge and value our obligations to and relationships with our Pacific communities here in New Zealand and within the Pacific Region.

Dedicated mission-led research programs in areas like biodiversity protection, freshwater management, sustainable land-use, and climate change adaptation can help safeguard critical ecosystems and position New Zealand as a leader in green growth. This will require strategic investments to overcome historical underfunding of environmental monitoring and prediction capabilities, as well as novel approaches to weaving together mātauranga Māori and Western scientific knowledge.

Te Tiriti o Waitangi

We envisage an equitable and co-designed SIT system, which recognises Te Tiriti and values mātauranga Māori as a knowledge system unique to Aotearoa, alongside other knowledge systems.

In practice, there must be recognition that Māori researchers carry an obligation to the mana of their ancestors, their people, and their communities. This responsibility is embedded within Māori guiding principles or kaupapa such as mauri, whakapapa, whanaungatanga and kaitiakitanga. Indigenous research is about co-construction and co-creation led by researchers who are cognisant of tikanga and Māori worldview. Mātauranga Māori is continually evolving. Indigenous research excellence is about the production of useful knowledge that is relevant, authoritative, and accessible for the good of the community and the environment.

Māori research prioritises whānau and hapū dynamics alongside iwi aspirations, the success of which can be measured in terms of transformative potential.

Measuring impact

The most significant benefits of research often accrue indirectly, over long timeframes, and at the intersection of multiple projects. Shifting to a more systematic lens, with an emphasis on intermediate indicators such as intellectual and human capital development, can help capture the true "ripple effects" of public research investments.

Importantly, this does not mean abandoning rigorous standards for individual projects. Basic research undertaken solely for knowledge advancement should still be assessed primarily on quality and novelty. Mission-oriented research should be evaluated against long-term measurable goals.

Across all areas of SIT, indicators of skill development, talent mobility and collaborative networks can be used alongside traditional academic metrics.

Investment in our SIT system needs to be reinforced by long-term monitoring and evaluation at a system level to ensure we recognise opportunities and risks as they emerge. This needs to be supported by freely available, comprehensive, high-quality data.

Conclusion

People are at the core of a thriving SIT system. We need vision, strategy, and investment to drive our science, innovation and technology system and create an enabling environment for new ideas and a diverse, highly capable workforce that flourishes.

There are actions we can take as set out above. However, there is only so much we can do with the resources we have. Overcoming the natural barriers that New Zealand faces, while building a much

stronger SIT system, will also require substantial and ongoing new investment, preferably with cross-party support.

New Zealand's spending on R&D as a proportion of GDP continues to substantially lag comparator countries. This will need to be addressed if we are to achieve long-term stability and certainty in the system, to enable it to thrive, and to meet the aspirations we have for the people and place that our SIT system serves.