

# Mātauranga Māori and the high-tech interface

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## Abstracts

*E tino whai nei a Science for Technological Innovation (SfTI): Kia Kotahi Mai - te Ao Pūtaiao me te Ao Hangarau - kia whakanuia ngā pūkenga i Aotearoa ki te whakamahi i te pūtaiao, i te pūhanga, i te hangarau hoki hei whakatipu ake i te ōhanga. Ahakoa te tokoiti o te hunga Māori e tautōhito pū ana ki tēnā, ki tēna o ngā momo hangarau, kua waihangatia mai e SfTI tētahi mahere whakamahinga – ko Te Tihi o te Maunga – e whakanui nei i te rite ā-hiranga o te āheinga whakawhanaunga me te āheinga tangata e pā ana ki te pūtaiao hou, hei arumoni, hei whakamahinga hoki mā te iwi Māori, me te iwi Māori anō hoki. Mā roto mai i tēnei tuhinga, ka tirohia whānuihia te whakawhana- ketanga o te mahere me ngā whakaaroaro o muri, ka tahi; ngā whakamahinga o te mahere kia ākina te huringa o te whakaaro e taea ai te mahi tahi ki te hunga Māori kia āta panoni rā pea, kia kanorau rā pea te pūtaiao me te hangarau, ka rua; ka mutu, ko te anga whakamua a SfTI.*

*Science for Technological Innovation (SfTI): Kia Kotahi Mai - te Ao Pūtaiao me te Ao Hangarau - has a mission to enhance New Zealand's capacity to use science, engineering and technology for economic growth. Despite the small numbers of Māori with domain-specific technical expertise, SfTI has developed a model - Te Tihi o te Maunga (Mountain Summit) - that emphasises the equal importance of relational and human capacities to commercialise and use novel science for and with Māori. This paper provides an overview of the model's development and the theory behind it; how the model is being used to assist the mental shift required to work with Māori in a way that may transform and diversify science and technology; and, finally some future directions for SfTI.*

## Introduction

In 2014, the first group of what would be 11 National Science Challenges (NSCs) was launched. Designed to 'take a more strategic approach to the Government's science

investment by targeting a series of goals, which, if achieved, would have major and enduring benefits for New Zealand' (Joyce 2013), the NSCs will receive almost \$1.6 billion of government funding over 10 years.

The NSCs initially met with some scepticism from scientists and Māori. In a 2014 New Zealand Association of Scientists 'snapshot' survey, 80% of the 280 respondents disagreed that the NSCs were the best way to organise research to deliver benefit to New Zealand (Ray 2014). Likewise, Māori were disgruntled with lack of representation within the challenges, with claims of being shut out from the process (Prussing & Newbury 2016). However, five years on, such positions have changed, with one commentator noting that there had been 'some great wins from the Challenges' and another stating that 'the most successful NSCs may be those that have learned to cooperate most effectively with other research organisations' (Science Media Centre 2018). Māori too have partially revised their position, with NSCs having Māori as independent advisors (Kāhui), in governance, as researchers and with projects or programmes specifically focussed on Māori concerns. However, some Māori still have reservations. In a 2016 panel discussion (Ruckstuhl *et al.* 2016) participants saw both opportunities and challenges for Māori in the NSCs. While some saw the NSCs as a new research paradigm requiring collaboration with Māori communities leading to transformative outcomes, others questioned the difficulty of mixing science outcomes with social outcomes, given this would require a 'mental shift' of researchers.

This 'mental shift' is the area that has been the focus of Science for Technological Innovation (SfTI): Kia Kotahi Mai - te Ao Pūtaiao me te Ao Hangarau. SfTI's mission is to

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enhance New Zealand's capacity to use science, engineering and technology for economic growth. Despite the small numbers of Māori with domain-specific technical expertise, SfTI has developed a model, Te Tihi o te Maunga, or Mountain Summit, that emphasises the equal importance of relational and human capacities to commercialise and use novel science for and with Māori. Previous research (Ruckstuhl *et al.* 2019) has provided a brief description of the model in the context of broader Māori science and technology capacity. This paper expands on that research, giving a more detailed assessment into the theory behind the model's development and an analysis of how the model, along with SfTI's changes in process, are supporting the 'mental shift' of scientists to work with Māori. The study draws on longitudinal research undertaken by one of SfTI's research streams, Building New Zealand's innovation capacity (BNZIC). Using a multi-method approach suitable for the investigation of complex phenomena (Hunter & Brewer 2015), the researchers present an overview that emerged (Creswell 2005) through analysis of SfTI documents, observations on SfTI organisational activities and practices, and surveys of SfTI researchers. To conclude, some future directions for the SfTI challenge are indicated, as it applies and refines the model in a way that has potential to diversify New Zealand's science and technology knowledge domain (O'Brien *et al.* 2015).

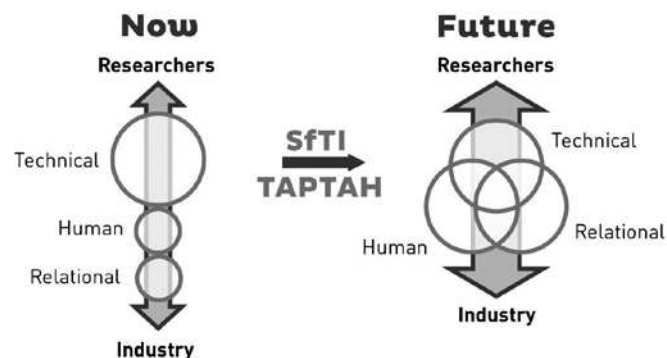
## Aims of Science for Technological Innovation: Kia Kotahi Mai - te Ao Pūtaiao me te Ao Hangarau

Framed within the concept of 'open innovation' (Chesbrough, 2003), the SfTI challenge focus is on 'the processes and relationships needed to acquire, assimilate and exploit knowledge from both internal and external sources' within 'co-created partnerships' (Science for Technological Innovation 2015). The challenge proposal argued that it was the lack of connection between New Zealand's researchers and industry that was undermining the ability to benefit from public spending on physical sciences and engineering. Hence, the SfTI challenge should focus on 'understanding in greater detail how co-innovation actually happens specifically in New Zealand's indigenous Māori context' (Daellenbach *et al.* 2017).

To understand the detail of co-innovation, SfTI has been operating under a three-tier model, to bring into closer alignment researchers' technical, human and relational capacity (Figure 1).

As defined within the SfTI challenge, *technical capacity* is the ability to deliver 'stretch' or novel science and technology; *human capacity* includes understanding business, entrepreneurship skills, and ability to communicate research to industry or end-users; and, *relational capacity* is how researchers and research teams engage with industries, including Māori enterprises and their knowledge systems or mātauranga Māori (Science for Technological Innovation 2015).

An advantage of the three-tier model is that, in line with broader literature on science innovation (Leydesdorff & Etzkowitz 1998; Rogers 1983; Garud *et al.* 2011), it has articulated the dimensions of innovation capacity as more



**Figure 1: Relationships between the three capacities: current and future trajectory**

than just technical science expertise. However, programme implementation that supports Māori innovation aspirations in areas as diverse as sensors, robotics and automation, IT, data analytics and modelling, and materials, manufacturing and design, has required creativity, and 'buy-in' from researchers and the leaders of the Challenge. Through analysis of the role of the Kāhui in leading development of a new theoretical model, Te Tihi o te Maunga, the next section explains how this was achieved.

## Setting SfTI's direction: Te Ao Māori

The Kāhui Māori was established to ensure that Māori world views and principles were embedded across the Challenge with members drawn from Māori business, community and academia. The Kāhui Māori terms of reference identified six foci that would cover SfTI's strategic, operational and scientific activities:

- F1 – Strategic direction of SfTI from a te ao Māori lens;
- F2 – Identifying research and engagement opportunities for Māori;
- F3 – Project assessment to ensure due consideration to the Vision Mātauranga policy throughout a project's development and planning;
- F4 – Capacity and capability building for Māori and non-Māori in the NSC;
- F5 – Knowledge translation, ensuring that there were processes in place to ensure that SfTI delivers tangible benefits for and with Māori; and
- F6 – Gap and risk analysis to anticipate and remove barriers of delivery to Māori.

In the first year, the large science and technology projects were investigator-led, hence incorporating a Māori lens (Focus 1) was not key to the science strategy at that point. However, with development of the 'seed' projects in year two, Focus 3 came to the fore, with 20% of funding assigned to small 2–3 year Māori-specific projects such as:

- development of a low-cost sensor network that provides real-time monitoring of the quality of freshwater supply in the Waikato River, drawing knowledge from western science and Te Ao Māori;
- formulating a framework for next generation Indigenous data and knowledge management in eResearch;
- digitisation of whakapapa into a secure, easily shareable, unalterable form;
- Māori researchers supporting women to cease smoking

during pregnancy by developing 3-D software to model the impacts of smoking on the developing foetus;

- research with iwi to give accurate estimates of kiwi population densities using machine learning algorithms and acoustic microphone arrays and mathematical and statistical methods to estimate the location of kiwi from their calls.

Focus 4, capacity building, has also seen successful implementation. Given that the majority of science researchers were largely new to anything Māori, introductory human capacity development workshops were organised that explained the Māori economy and how science and technology could contribute to it. Feedback from the first year of workshops indicated that of the 29 participants giving feedback, 93% reported that the workshop had provided them with new knowledge and skills, with 79% feeling confident they could apply it. Additional opportunities for knowledge and skill development have included encouraging scientists to attend Māori focussed events such as: the Federation of Māori Authorities annual meeting; the Ahuwhenua (Māori farming) awards; Matariki X – a Māori technology event; and Te Matatini, the national biennial kapa haka competition. Additionally, a wallet-sized guide, He Ritenga, developed by the Kāhui Māori to incorporate appropriate karakia, waiata and greetings within science meetings was provided to all SfTI researchers (Science for Technological Innovation 2018a).

While these might be considered helpful initial steps, Focus 5 – Māori knowledge translation into the science and innovation itself – has required a different approach. To help theorise this, the Kāhui developed a three-dimensional model – Te Tihi o te Maunga, or Mountain Summit (Figure 2) – to assess the extent to which Māori resources, knowledge and talent were being incorporated and utilised for innovation.

The first dimension, is the extent to which mātauranga Māori (Māori knowledge) was being utilised. Encompassed within this axis are Māori values, principles, processes, approaches, knowledge of history and resources, relationships, language and technical knowledge (see for example: Cram *et al.* 2002; Pihama *et al.* 2004). The second dimension is the extent to which Māori participate in the project, with inclusion from inception and co-leadership of the project the most desirable approach. The third dimension is the potential to deliver benefit for Māori: new products, increased efficiencies, positive impacts, training and capability gains, with a higher emphasis on priority areas identified by Māori. It was also viewed that research incorporating all three dimensions in technical innovation – Tihi or summit research – would lead to innovation and new Māori knowledge. The Kāhui Māori used the term tino mātauranga to describe working at the forefront of Māori knowledge generation through the interface of mātauranga Māori with emergent technological innovation.

Te Tihi o te Maunga allows the Kāhui Māori to map projects, from having little or no Māori innovation (viewed as landing on the shore), to incorporating some Māori potential (arriving at the base of the mountain), to high levels at the summit. The model owes much to earlier Māori science and innovation frameworks (Cunningham 2000) which have been adapted by others (Ministry of Business, Innovation and Employment 2019; New Zealand’s Biological Heritage 2019).

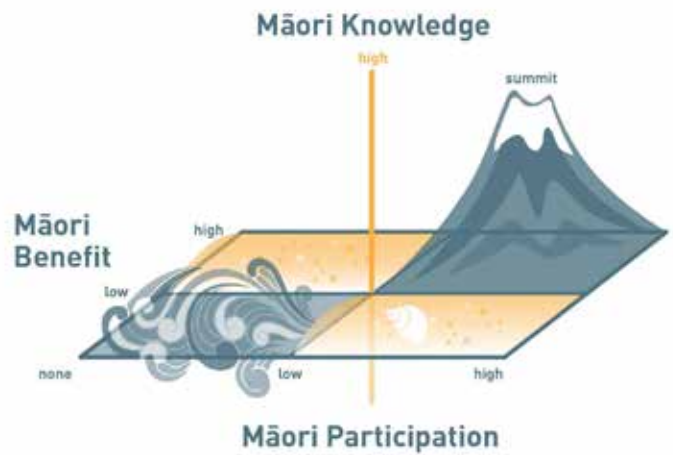


Figure 2. Te Tihi o te Maunga Science and Innovation Model

While the model draws on its predecessors, its novelty lies in its belief that sci-tech innovation and ‘stretch’ mātauranga will occur when there is an interface at the summit. While this may be a bold approach, there is emergent evidence that this is beginning to occur within the high-tech sphere.

### Te Tihi o te Maunga in Operation

This section briefly outlines how the Te Tihi model is being implemented as SfTI research advances into the second tranche of funding. This is exemplified in the convergence of projects under a broader and strengthened mātauranga Māori approach, in the first instance around data analytics. This has involved three concurrent sets of activities:

- Greater engagement with Māori enterprises (iwi, hapū, business organisations);
- Māori-active research design processes – mission lab approach;
- Specific Māori-defined and run programmes.

The first example of greater alignment with Māori derives from a project which was initially the third component of an investigator-led programme under the IT, data analytics and modelling theme. While the two main projects finished, the third – ‘Te Tātari Raraunga: Spearheading economic, social, and cultural revitalisation through Māori Data Science’ – has been extended to focus on applying data analytics to find Māori land shareholders (Science for Technological Innovation 2018b). This is a problem shared by tribal groups and organisations such as Te Tumu Paeroa that manage Māori land with multiple small shareholding owners. This has required a shift from a science-led research project to one requiring a partnership with one of New Zealand’s major Māori enterprise groups, Paraninihi ki Waitotara (PKW). Given that tracing shareholders requires access to and understanding of whakapapa, a tikanga approach has been adopted that is stretching both the science and mātauranga Māori. Along with refocussing of the initial project, new capabilities have been required, including working with linguists and archivists skilled in reading and interpreting Māori text. As well, there has been a need for new analytic tools to analyse the Māori-language archival texts and other data sets, such as whakapapa lists, that form the basis of the project.

The international interest in capturing benefit from large-scale data is both a feature of the Tātari Raraunga

project and the growing awareness amongst Māori of data sovereignty (Te Mana Raraunga, n.d.). As has been identified internationally, data sovereignty is linked with

‘indigenous peoples’ right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as their right to maintain, control, protect and develop their intellectual property over these’ (Tauli-Corpus 2016, p. xxii).

This is a key concern of a second major project, *Ātea*, which aims to support Māori, iwi and communities to connect tribal members to *mātauranga-ā-iwi*, *reo*, *tikanga*, histories and knowledge (Science for Technological Innovation 2018c). Owing to a shift in SFTI’s practices from the investigator-led sand-pit approach to the current mission-lab process, this project took 18 months to develop. A research sand-pit, popularised by MBIE to initiate the NSCs (Science Media Centre 2013), is a workshop process that aims to avoid research silos and to encourage multi-disciplinary collaboration (Collins *et al.* 2013). In SFTI’s case, the first sandpits brought together largely business and scientists and led to projects that were investigator-led. The sandpit approach was adapted to bring together Māori researchers and organisations, along with technical scientists, to workshop pre-developed research proposals guided by a *taumata* (a group of respected Māori experts). While this refined process was useful to give pointers to the direction of a potential research area – a digital *marae* – the process was further refined to the mission-lab process. In this process industry and Māori define the areas of future research, prior to science input, with these areas then tested through an ‘expression of capability’, whereby ‘through a negotiated process, with industry and Māori still in the room, a multi-disciplinary proposal is formed’ (Science for Technological Innovation 2018c). *Ātea* required several iterations and refinements with technical experts, including *mātauranga* experts and community, before being finalised.

The *Ātea* project (Science for Technological Innovation, 2018c) is ambitious and includes:

- expanding a core digital platform to static and dynamic *mātauranga* content; integrating block-chaining to assist with indexing, traceability and control of content;
- integrating text and voice recognition for *te reo* Māori; and
- creating a comprehensive technological, psychological, cultural and socio-psychological model for virtual avatar interactions that incorporate culturally appropriate design features.

The project operates through a collaborative *kaupapa* Māori approach, which will incorporate the use of *wānanga* to assess ‘the impact of AI, VR & AR, mixed realities, and machine learning on space, time and place and its effect on culture, language and knowledge’ (Science for Technological Innovation 2018c). According to Royal (2012) *mātauranga* Māori responds to the ‘great questions in life’ and it is through the process of *wānanga* and expert discussion about *mātauranga* Māori that contemporary perspectives can be derived. Thus the process of *wānanga* creates new knowledge in order to ‘improve the way in which human-kind exists and lives in the world’ (Royal 2012, p. 37).

*Wānanga* as a facilitative process between the science and Māori spheres has been researched previously (Hudson *et al.* 2012), but it is likely that this will be the first time it has been characterised in the digital sphere. Lessons from that earlier research are likely to inform the *Ātea wānanga*, particularly how participants negotiate their relationships with: existing and new knowledge; different systems of meaning; and with groups that identify with different knowledge systems (Hudson, *et al.*, 2012, p. 19).

The mission-lab approach has also been successful in seeding another data-focussed project, *Māori Data Sovereignty*, which is intended to begin early in the second tranche of funded research. Led by experts from the Iwi Leader’s Chairs forum (Iwi Chairs Forum 2018), the aim is to create new technical solutions rather than implement existing technologies. This is because, for Māori, data can be considered a *taonga* and hence subject to both individual and collective restrictions. Hence there will be a need for novel approaches to how data about, by, or for Māori is collected and shared (data management and integration) as well as data access, security and control (Science for Technological Innovation 2018b). The significance of this area for Māori and others is being tested through *hui*. To date, two *hui* in Wellington and at *Te Aurere* in Northland, have attracted almost 200 participants including iwi and *hapū* representatives, Māori researchers and practitioners, *rangatahi*, and data specialists. The intention is to use the new project to act as a catalyst to bring together parallel but disconnected research in this area (Science for Technological Innovation 2018b).

## Looking to the future

As can be seen from the previous sections, human and relational capacities have been a focus of the SFTI approach to working with Māori and across the Challenge more generally. Starting with the more traditional investigator-led science of the early programmes, SFTI evolved its approach to a version of MBIE’s sand-pit that brought together individual’s project proposals, to the novel mission-lab approach whereby the areas of research are defined by business and Māori then enabled by science capability. This ‘flipping’ of the research model has worked well for Māori in that projects that are of real concern (axis three of the *Tihi o te Maunga* model) can be identified and constructed from the beginning (axis two) in order to innovate science and *mātauranga* (axis one). This has been aided by a deliberate strategy of human capacity building to create the ‘mental shift’ of researchers who are comfortable with working within a *mātauranga* Māori paradigm.

The *Kāhui Tihi o te Maunga* model acts as both a guide and as a process for evaluating the opportunities and gaps (Focus 6) for delivery to Māori. For example, how Intellectual Property is assigned and managed between science and Māori partners is still being considered, particularly in light of the *Wai 262* report (Waitangi Tribunal 2011). Another issue is how best to include *rangatahi* in science-led research. Responding to this challenge, a project is being developed spearheaded by three young co-leaders, two of whom are Māori entrepreneurs, including a member from the *Kāhui*. Other research is also in the development phase, with projects around water and bio-security – both areas of high Māori interest.

## Conclusion

SfTI has concentrated not only on technical science but also on the relational and human capacities needed to create innovation that connects to industry and Māori. Within this broader context, the Kāhui Māori terms of reference have provided the framework that has led to a robust model, Te Tihi o te Maunga, that provides operational guidance to SfTI's large and small research projects and capacity development programme. Despite the current small numbers of Māori with technical expertise in the research domains of SfTI, the processes and approaches laid out in this analysis have shown that this need not be a barrier. Rather, these novel approaches have allowed Māori to take a more active role within the Challenge which not only diversifies participation but has the potential to diversify the science and technology knowledge domain itself.

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