National SCIENCE Challenges

SfTI SPEARHEAD 1:

Building New Zealand's Innovation Capacity. Phase 1 Insights

APRIL 2020

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.

CONTENTS

Executive Summary 02

Introduction 04

Overview: Building New Zealand's Innovation Capacity (BNZIC) 06

Insights for Building NZ's Innovation Capacity 12

BNZIC Researchers – Phase 1 22

BNZIC List of Research – Phase 1 26

Executive Summary

Spearhead 1: Building New Zealand's Innovation Capacity's science is a multi-method longitudinal research programme (2016-2024) into collaborative mission-led, stretch science within the Science for Technological Innovation (SfTI) Challenge seeking to promote new and more effective ways of equitably accelerating physical science and engineering innovation to businesses and Māori enterprises. Insights from Phase 1 relate to 4 key areas.

01

BUILDING OPENNESS IS THE KEY TO COLLABORATIVE INNOVATION

Greater benefits come from innovation when collaborating partners are *willing* and *capable.* This was true for relationships both within research teams and in their connections with external stakeholders. The investment of time, effort, and resource upfront was crucial to building a foundation of trustworthiness for open collaboration. Foundational activities included establishing a shared language, collective knowledge and an agreement on desired outcomes. The value of these processes were particularly demonstrable for non-Māori researchers who were willing to collaborate with Māori, but did not know how to engage effectively with Māori or mātauranga Māori.

02

INTERMEDIARIES ARE KEY CATALYSTS OF VISION MĀTAURANGA

SfTI researchers were positive about engaging with Māori intermediaries emerged very quickly as the key to this engagement. These Intermediaries were skilled in both the science sector and mātauranga, including tikanga and kaupapa. They were heavily relied upon to connect technical science teams and Māori organisations, and to play interpreter for both parties by translating the terminologies, protocols, cultures and philosophies of each domain.

03

SUCCESS REQUIRES BUILDING THE COLLABORATIVE CAPACITY OF STAKEHOLDERS

Research scientists, Māori, industry, vendors, and end users each come to a collaboration with distinct motivations, knowledge and backgrounds. To bring them to an accord, information needs to be translated across different stakeholder groups to cater for different levels of expertise, experience, and worldviews. Intermediaries can guide or provide this translation but developing greater capability within the collaborating stakeholders themselves is necessary as the collaboration progresses and continues.

04

ONGOING COMMUNICATION BRINGS THE GREATEST BENEFIT TO COLLABORATION

Openness to collaboration ebbs and flows across the timeframe of the research, and different types of stakeholders are likely to be more open at different stages of the collaborative cycle, depending on their interests. The greatest benefits can come by identifying ways to enable ongoing collaboration with regular communication touchpoints throughout a research project, rather than primarily at the end or initial stages.

Introduction

The National Science Challenges (NSCs) were established in 2014 with the aim of bringing together the country's top scientists to work collaboratively across disciplines and research institutions in order to apply their skills to some of New Zealand's biggest problems and opportunities. This year marks the halfway point of this ten-year policy initiative, with the Science for Technological Innovation (SfTI) Challenge launched in September 2015.

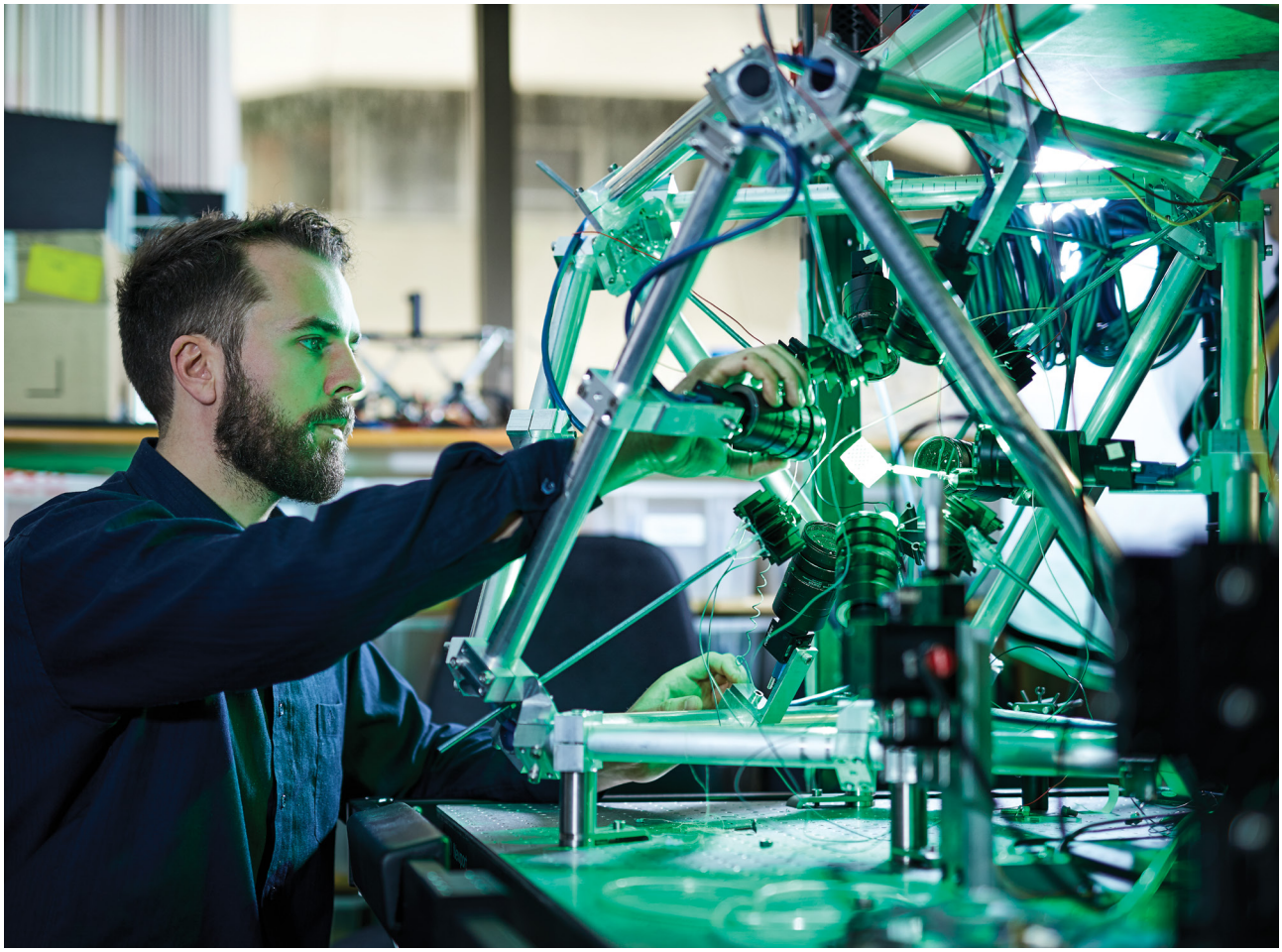


Image photgraphed by Matt Crawford.

All 11 Challenges have progressed into the second phase after having secured a second round of funding from Ministry of Business, Innovation and Employment (MBIE). For SfTI, this means an increased investment to $72.7m for the five years from July 2019 to June 2024; which when added to the first phase's funding gives a total of $106m for the full ten-year programme.

Transitioning to Phase 2 provides an excellent point at which to review the research programme. Each of the large Spearhead projects (7 of which formed research teams in Phase 1) has provided a new five-year plan which includes updates on ensuring stretch (novel science), NZ stickiness (building on NZ's unique capabilities and competitive/cooperative advantages), specific and measurable milestones, and high-quality Māori engagement.

In this report we specifically outline some of the insights gained through the inclusion of Spearhead 1: Building New Zealand's Innovation Capacity (BNZIC) in the SfTI research programme, given its unique to NZ status embedded within a physical sciences and engineering Challenge. In doing this, we explore key aspects of the journey taken and the insights found.

The inclusion of the BNZIC team within a technology-focused National Science Challenge recognises that realising the full potential of the technical endeavours will depend not only on the research funded and the associated skills of the science and engineering researchers, but also on the processes through which these are developed as well as the supporting infrastructure and capacities surrounding them.

All NSCs will have had to decide on a set of processes and support within their Challenge, but specifically researching these (both actively and historically) is not occurring elsewhere within NZ's NSCs and remains rare internationally. The opportunity to track the development of numerous large and small projects longitudinally provides details on the evolving motivations, perceptions and behaviours which ultimately affect the outputs and impact of science.

Overview: Building New Zealand's Innovation Capacity (BNZIC)

The National Science Challenges are tasked with generating innovative new ideas where there is a degree of uncertainty. Ultimately, research funded under this initiative aims for excellence and long-term impact on a national scale. SfTI, the largest of the Challenges, is tasked with supporting a more technology-driven and prosperous economy through carefully focused and connected research efforts.

SCIENCE FOR TECHNOLOGICAL INNOVATION (SFTI)

Our Vision

New Zealand is a vibrant and prosperous technology-driven economy, with new businesses offering high-value services and products that may not yet have been invented.

Our Mission

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

The SfTI leadership team is proud of the way it has experimented with a number of processes, including running Mission Labs to help determine research directions, forming best NZ teams, its capacity development initiatives, relationships with major Māori groups keen to embrace technology, and the high-risk but very productive, mentored seed projects. BNZIC research is a particularly important component of the Challenge.

"Unique to our Challenge is our 'Building New Zealand's Innovation Capacity' team who are using SfTI research projects to understand how we can better do collaborative research in NZ. Their insights are already changing the way we are organising our research, and we will soon share their insights more widely in the innovation community."

(FROM THE CHALLENGE DIRECTORS, *INNOVATE*, DECEMBER 2018)

The SfTI Challenge has grown significantly since 2015, involving 416 past and current researchers across 39 national and 5 international organisations by February 2020. This will continue to expand as we head into the second phase and bring on more research projects.

SCIENCE FOR TECHNOLOGICAL INNOVATION

At a Glance

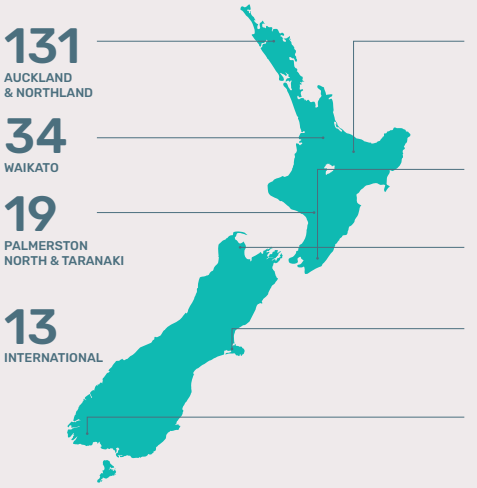
OUR PEOPLE

416 RESEARCHERS
41 have completed their contribution

42 MĀORI | **85** WOMEN

66 EMERGING RESEARCHERS

39 ORGANISATIONS
Including 5 international



OUR PROJECTS

4 THEMES

01 VISION MĀTAURANGA

02 SENSORS, ROBOTICS & AUTOMATION

03 MATERIALS, MANUFACTURING TECHNOLOGY & DESIGN

04 DATA SCIENCE & DIGITAL TECHNOLOGIES

STRETCH SCIENCE

08 SPEARHEAD PROJECTS
Large teams

54 SEED PROJECTS
Small teams

OUR DEVELOPMENT

- COMMERCIALISATION
- INNOVATION
- MEDIA TRAINING
- ENTREPRENEURSHIP
- MĀORI ECONOMY
- BUSINESS AWARDS
- TECHNOLOGY
- LEADERSHIP
- SPEAKING WITH PURPOSE
- PITCHING SKILLS
- MISSION LED SCIENCE

- COMPANY VISITS
- STAKEHOLDER ENGAGEMENT

OUR ATTENDANCE RECORD

359 AT 4 ALL-OF-SfTI WORKSHOPS

493 AT 51 COURSES & WORKSHOPS

90 AT 13 INNOVATION SHOWCASES

123 AT 27 CONFERENCES TO NETWORK

VISION MĀTAURANGA

559 AT 31 EVENTS FEATURING MĀORI & THE MĀORI ECONOMY

SPEARHEAD 1: BUILDING NEW ZEALAND'S INNOVATION CAPACITY

BNZIC is unique in that it does not explore the technical capacity within NZ's physical sciences and engineering per se, but rather, looks at two complementary areas within the science innovation system: human capacity, which includes people skills and abilities for activities such as leadership, innovation or commercialisation; and relational capacity, which covers the ability to engage across sectors, in this case by scientists connecting and communicating to, as well as being connected with, the wider ecosystem for maximum impact.

The Aim of BNZIC's Research Programme

Through cutting edge research, there will be new and more effective ways of equitably accelerating physical science and engineering innovation with businesses and Māori enterprises.

The Research

This multi-method programme provides a unique opportunity for real-time, longitudinal research into the 'enablers' and 'barriers' in collaborative mission-led, stretch science. Internationally, there is extensive research into how to enhance the benefits from science, so an important focus for BNZIC is on why the transformation of research inputs into outputs might differ in New Zealand compared to other countries. Our approach has been in part to identify, implement and evaluate a suite of internationally robust innovation processes, while at the same time adopting and adapting novel processes to NZ's distinctive science and engineering research context. The work completed so far has confirmed a range of factors that constrain, as well as some new methods that support, collaborative co-innovation relationships between the science community and external stakeholders.

The next five years will enable SfTI to identify at a finer level the distinguishing characteristics of enabling research processes in New Zealand across different commercial and cultural landscapes.

To date, our efforts have focused more on scientists, but as we move into Phase 2, we will develop a more holistic understanding by investigating the industry, Māori, early career scientist and entrepreneur perspectives on what leads to successful collaborative engagement between stakeholders.

Ultimately, we envisage that the resulting insights and models will be used by researchers, funders, industry, and Māori alike to support cross-sectoral engagement in ways that enhance New Zealand's capacity to use physical and engineering sciences for economic growth.

Vision Mātauranga (VM) at the Core

VM, as a policy, is a priority within BNZIC's research programme when studying all SfTI projects for understanding both enablers and barriers, as well as the potential of mātauranga (knowledge), tikanga (practices) and kaupapa Māori (ideology), for generating new insights. BNZIC includes both specific VM researchers and specific VM projects. From a national implementation perspective, New Zealand may be leading the world in some aspects of indigenous innovation research: international comparatives will test this proposition and identify how well NZ's unique approach translates.

Vision Mātauranga's aims to:

Unlock the innovation potential of Māori knowledge, resources and people to assist New Zealanders to create a better future.

SOCIAL SCIENCE IN A PHYSICAL SCIENCES AND ENGINEERING NSC

New Zealand has an impressive endowment of science leaders and scientists doing outstanding research, in part evidenced through the high level of academic publication coming out of universities and research organisations. While MBIE's (2018) Science & Innovation System Performance Report [1] again noted that NZ's scholarly output is growing, is cost effective and has high quality and citations relative to its size, like some other countries NZ lags significantly in the translation of these science inputs into economic outputs. This suggests that business, Māori and community groups within NZ are not tapping into that science sufficiently to produce economic success and social wellbeing to the extent we might expect.

[1] https://www.mbie.govt.nz/dmsdocument/1499-research-science-and-innovation-system- performance-report-2018

During the process of forming SfTI, MBIE acknowledged that implementation of VM and capacity development should not be an afterthought, but rather, should be much more embedded into the Challenges. The SfTI development team were given the mandate to expand these aspects and explore how customised, unique to NZ ways could enhance the science system to collaborate in more productive modes.

So, it made sense to explore in greater depth:

- why the gap between science inputs and real world outputs existed; and
- what we can do to narrow that gap so we can expand the value and growth from this science.

BNZIC researchers have been working alongside physical science and engineering researchers to learn lessons from 'how' they interact with industry and Māori. There is a general view that the process of undertaking science research can benefit from engagement with external stakeholders, but is this likely to happen effectively without support and guidance on how to do it well? The BNZIC Spearhead acknowledges the importance of giving scientists opportunities to acquire personal skills such as how to learn to establish and build such relationships. We believe there will be a variety of ways to encourage more fruitful engagement between NZ's science community and myriad stakeholders.

Further, in order to capitalise on one of NZ's unique assets and ensure Māori are sharing the benefits of science and technology, it is equally important to push forward the VM agenda. To date, the VM policy requirement has not necessarily been influential in supporting genuine engagement with Māori. There is arguably a lack of skilled leadership to both build and then enhance science capacity of and for Māori in NZ, but there are opportunities to build new ways forward:

> "It's about understanding and disrupting the traditional science system in a constructive way."

We are interested in understanding the barriers and enablers that underpin success. We want to know why people do what they do, what underlying beliefs about other stakeholders come into play, and how these beliefs influence activity across different situations. In order to transform science inputs into real world outputs, we need to discover what supports science translation in multiple ways, most effectively in New Zealand.

There are a number of questions to be answered through BNZIC research:

1. What is the best way to instigate and manage co-innovation projects early in the commercialisation process involving stretch science, inter-disciplinary scientific teams, and engaged businesses?
2. What processes enhance (or hinder) the building of the relational and human capacities needed in both research teams and businesses to create value from physical sciences and engineering?
3. Can action research, in the form of facilitated reflexive experiments and interventions, improve these capacities in real time?
4. How do these best practice co-innovation processes need to be adapted to work in the Māori context?
5. What can be learned and adapted more widely from Māori engagement processes?

HOW HAS THE BNZIC RESEARCH DEVELOPED THROUGH PHASE 1?

Since inception, the research has evolved through several stages as the team sought to progress this novel project and refine their research foci.

The first 18 months included a mapping phase where the team sought to understand a breadth of aspects about the project teams they were observing. Each science Spearhead was contracted separately, and in one or two cases before BNZIC researchers became involved. Science Spearheads were advancing in different ways, pursuing novel stretch science through different processes, with different leadership styles and approaches to team management, engaging external stakeholders in diverse ways, and most crucially with different levels of human and relational capacities to draw upon. This phase required trust in and adaptation of the research from the BNZIC team members given uncertainties about how the science projects would play out:

> "It was important to see what unfolded, both the good and the bad, and then develop some insights."

BNZIC researchers started by observing the science teams they were tracking and interviewing project leaders to develop broad understandings, augment current theory or propose novel interventions that could lead to enhancements in collaborative innovation processes.

Part of the early challenge was understanding what the science project being tracked was setting out to achieve scientifically and commercially as well as existing and planned engagement with external stakeholders. Team formation processes also needed to be identified and recorded. BNZIC researchers learned early on that there may be discomfort on the part of some science researchers they were observing, requiring trust to be built over time with these teams.

By employing a range of methodologies including literature reviews, observation, interviews, quantitative baseline surveys, and qualitative ethnographic approaches, initial research questions were refined.

These refined research questions and focus areas during Phase 1 included:

- How have you been engaging? What enables/ constrains your engagement with external collaborators?
- What does Vision Mātauranga mean in this context, and are teams enabling VM (or not)? What are the impacts of different approaches to VM?
- Who is involved in engagement, for example, are there intermediaries who can speak both 'languages'?

Ways to build science researchers' capacity to engage with those outside their research discipline or community, including Māori and industry, emerged as a significant part of the SfTI programme. This appears to be beyond what would be occurring in other stretch science research. Novel capacity development included offering annual workshops for all SfTI researchers focused on building the SfTI community, its core values and individual capabilities; bringing industry views on promising directions to the fore via Mission Labs; and providing opportunity and funding to attend external workshops, courses, conferences, showcases, secondments and mentorship programmes – all aimed at enhancing human and relational capacity that would benefit SfTI projects as well as NZ's science system more broadly beyond the Science Challenge.

Heading to Phase 2, the BNZIC researchers have further refined their investigation areas to address:

- Science team formation and leadership processes. If multidisciplinary research including industry are being pursued, are there better processes to speed up/facilitate their collaboration and progress?
- Intellectual Property management, particularly Māori IP, during stretch science. What is the difference between Western legal frameworks and Māori perspectives, and how can these differences be resolved or accommodated equivalently and appropriately?
- Facilitating initial engagement by science researchers. The role of intermediaries has come through prominently, whether these are theme leaders within the SfTI management team, those with established knowledge and relational capacity with Māori, or experts who might facilitate researchers' development with new skills or techniques.
- Moving from the focus on understanding NZ scientists in Phase 1 to incorporating a corresponding perspective of the enablers and barriers for external collaborators, including business, Māori and younger scientists and entrepreneurs.

Another development as Phase 1 progressed was the continuing shift from observation to a greater action research orientation, that emphasised enhanced practical implications and impact.

Three such facilitated experiments are:

1. Relational Leadership Development, which involves researchers participating in learning activities and then reflecting on impact.
2. Making a Project Manager available to work with selected Spearheads and observing impact (some earlier Spearheads have not had a dedicated Project Manager).
3. Introducing new facilitated commercialisation processes into upcoming engagements.

BNZIC Insights – Phase 1

With Phase 1 concluded, a number of **enablers** and **barriers** to enhancing NZ's capacity to use physical science and engineering, have been identified. At this stage, many of the findings are at the point where we know these things are important and we have some initial options for addressing them. We have more work to do to understand the specifics around what, how and when certain actions should be taken to encourage best outcomes. Phase 2 will also allow further refinement of what has worked and approaches to address what hasn't.

SO, WHAT ARE THE INSIGHTS TO DATE?

The BNZIC team aims to generate the best advice for funders, scientists, industry and Māori to harness scientific research for economic success and community wellbeing. The relationship between science research and commercialisation outcomes is complex and multi-faceted – there are many steps and variables in between:

"Pumping money into A does not automatically lead to an increase in B. There is a chain rather than a direct link."

(BNZIC RESEARCHER)

Image. Chris Cornelisen, SfTI Spearhead 'Precision farming technologies for aquaculture' project leader, and coastal science lead at the Cawthron Institute in Nelson examines the progress of wired up sentinel mussels.

BNZIC researchers are already identifying some key factors in the chain, including:

01 **Open Innovation (OI) and Absorptive Capacity (AC)**

02 **Advancing Vision Mātauranga**

03 **Intermediaries**

04 **Timing**

This provides us with a valuable starting point to inform current practice, but there is much more to learn about this complex area and part of this will require more active intervention.

"To have a better society we have to find better ways to ensure the benefits arising from research are shared – there has to be diversity in participation."

(BNZIC RESEARCHER)

This section outlines some Phase 1 findings from the BNZIC research.

1. OPEN INNOVATION (OI)

The concept of Open Innovation (OI) is foundational to BNZIC. It supposes that enterprises will be more successful in innovating and creating value if they acquire, assimilate and exploit knowledge from both inside and outside their organisation.

The terminology started being used in the early 2000s to promote more openness to deal with a quickening pace of change and the resulting uncertainties, and to support the growth of transdisciplinary teams and cross-sectoral collaboration. Inter-organisational knowledge sharing between entities is at the heart of the concept, which in NZ includes Māori organisations.

Existing OI research remains firm-centred and lacks a systematic investigation around who is involved, how they achieve Open Innovation and what costs and complexities are involved; these are areas BNZIC has started to explore.

SfTI has already engaged in several initiatives aimed at supporting Open Innovation. The Challenge's Mission Lab approach has involved listening to its Mission participants, industry, Māori and younger scientists and entrepreneurs, and then deriving a set of topic areas for scientific exploration. Facilitated experiments involving active interventions and reflection have also created a new dynamic amongst scientists – they have learned what businesses want, trialled new processes for team formation and how to pitch their ideas, for example.

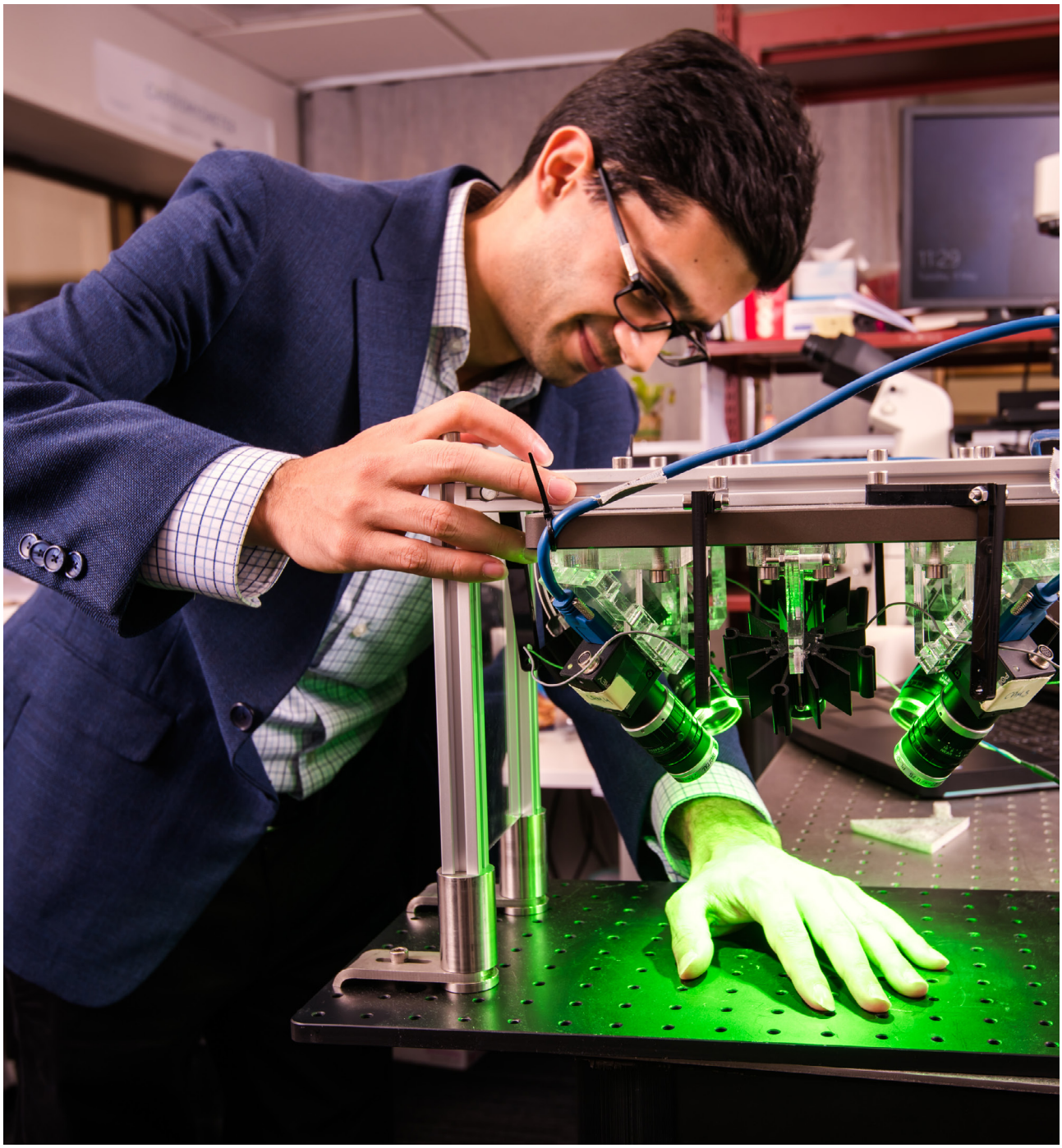
Through primary research, the BNZIC team has examined the interplay of factors that affect Open Innovation. Early insights are interesting and lead on to more questions that will be explored throughout Phase 2:

- Choosing partners and establishing relationships: mutually understood frames of reference that remain latent, but may morph slightly over time, affect the process of selecting potential innovation partners and establishing relationships. 'Language' is a foundation of creating common understandings. What language best resonates with one another?
- Cost of complexity: the cost of searching out novel relationships for OI may be so high it lessens the likelihood of innovation relationships being established. Instead, researchers and organisations may select familiar, nearby partners, to have a stronger base from which to build. But this may in fact lower the impact and potential of OI. What specific factors will make it easier for dissimilar parties to work together?
- Science and innovation in NZ relies on social capital, that is, existing networks. There are benefits associated with this, especially in the short term, but in the longer term there are potentially bigger disadvantages. Connected networks and links are less likely to exist across diverse groups, whether science disciplines or from science business. How can we encourage heterogeneous groups to seek out one another?
- There appear to be hierarchies of engagement, where one stakeholder is prioritised over others by researchers. Why this occurs is not always apparent or identifiable. Will engagement within, and across, stakeholder groups ever be truly open? Is prioritisation the best way to handle the potentially complex task of working collaboratively?
- Achieving successful product innovation for businesses relies on a complex interplay of R&D engagement, absorptive capacity (the ability to integrate and use external information to improve performance), and entrepreneurial orientation (innovation, risk-taking and being pro-active). This is a context-specific process rather than a linear relationship between inputs and outputs. Some of these combine effectively with partnerships to enhance innovation whereas perceptions of high human capital internally are associated with less collaboration. What drives these views that limit collaborative R&D? Can we create models to guide successful greater Open Innovation across contexts?
- Our initial surveys of businesses match the MBIE report in that about 60% of NZ businesses are not using R&D partnerships. Those that have partnerships, however, report experiencing significant benefits in terms of innovation outcomes relative to those without. More often, smaller firms are those not seeking R&D collaborations. Given they have fewer internal staff, shouldn't collaboration be a primary option for them?
- Organisations with higher internal intellectual capital (made up of human and relational capital – which includes knowledge, skills and networks within an organisation available to create value) are less likely to seek out external R&D relationships. This highlights the necessity of businesses' motivation and capacity to engage, and that it must align with researchers' motivations and capacity too. Can we try to disrupt this tendency and if so, how?

- Consideration of why businesses are actively collaborating for R&D suggests a combination of structural influencing factors (such as firms being larger, facing tougher competition, having export sales, and a better educated and unionised workforce) offsetting the effects of high internal human capital. Neither current levels of performance nor having an entrepreneurial orientation had a systematic effect on the extent of collaboration. When asked why, those with no partnerships indicated "not needing any", seeing insufficient value, and a management bias against its use. How can science researchers change managerial perceptions within firms so that they recognise how R&D generates value?

"Organisational routines around knowledge (AC) help to build the intellectual capital of a firm, which in turn can support the culture around entrepreneurship and risk taking, which ultimately enhance product development."

Image. SfTI researcher Amir HajiRassouliha is part of an Auckland Bioengineering Institute team within Auckland University working on a 2016 SfTI SEED project titled 'A giant leap for small displacements'.



ENABLING OPEN INNOVATION WITH MĀORI

As already noted, absorptive capacity (AC) is a key factor enabling groups to use external information, including science. However, to date there has been little research into the AC of indigenous peoples. Equally there is a dearth of investigation into how high-tech scientists can work with indigenous peoples on the journey to commercialisation; this applies to science feeding into indigenous communities, and also to scientists absorbing indigenous knowledge to integrate into the innovation system.

Mātauranga Māori (Māori knowledge) knowledge continues to be built upon with each new generation. It is based on the expectation that indigenous knowledge should be used to benefit those who have contributed to it. This is relevant to issues such as science-related Māori IP.

BNZIC researchers have found that while non-Māori scientists often express positivity about the compatibility of mainstream science and mātauranga Māori, they seldom possessed the level of knowledge and experience to properly connect with Māori; to bring mātauranga Māori into their own science projects; or to appreciate how their own science could benefit Māori on social, cultural, environmental and economic terms.

"Including Indigenous people in a sci-tech commercialisation programme is internationally unique."

The SfTI Challenge initially identified a need for a better balance between technical, human and relational capacity to facilitate more effective collaboration. In order to support OI that includes Māori, BNZIC researchers have reframed SfTI's three-pronged capacity approach to getting science out of the lab and into NZ's economy and community, by aligning it to a Māori orientation. This outlines the knowledge and understandings, skill sets, and practices that are important for researchers to adopt when working within a Māori-oriented approach.

Image below. Mangopare (Hammerhead shark): Uniting Māori knowledge with western science.

Mātauranga (Technical Capacity)

Is a technically complex system that generates theories through practices and protocols

And intertwines physical and metaphysical knowledge, and the animate and inanimate, in a system of relationality – whakapapa – that reflects and incorporates Māori values and ethics

For the benefit of whānau, hapū and iwi.

Tikanga (Relational Capacity)

Involves Māori specialists early in the innovation process where possible or necessary

And uses Māori approaches (e.g. wānanga, te reo Māori, use of Māori places/spaces) to co-construct innovation proposals within a Māori values framework

While also ensuring the protection and acknowledgment of collectively-held knowledge.

Kaupapa (Human Capacity)

Means adopting a more holistic approach to science innovation that encompasses the commercial, social, cultural, environmental and spiritual

Highlighting opportunities and risks, from a Māori perspective

As well as looking to identify where mātauranga might expand options for novel science and innovation to benefit Māori and others.

Such recognition moves beyond the potential of the VM Policy, to a pathway of enactment that draws on tikanga (guiding customs and principles) to inform meaningful engagement between researchers and any partner (not just Māori). Furthermore, this highlights the value of research that draws from, or contributes, to kaupapa Māori aspirations and capabilities.

"SfTI aims to build the capacity of non-Māori scientists and science systems to engage with industry, and more specifically Māori enterprises, to activate Māori knowledge to help address the Challenge's objective of economic growth."

2. ADVANCING VISION MĀTAURANGA (VM)

There is a nascent recognition that 'mainstream' science is not the only approach to understanding the world, and a concurrent awareness that Māori are not passive bystanders that will eventually become beneficiaries of this knowledge.

What is VM and why is it necessary?

Vision Mātauranga (VM) is a policy that is increasingly being applied with integrity. Essentially, it is a tool that guides researchers on how to integrate mainstream science with mātauranga Māori (Māori knowledge) to explore new opportunities to build a prosperous, technology-driven economy.

A VM policy is necessary due to several factors within New Zealand's innovation ecosystem that negatively impact Māori:

- Given the current dearth of Māori Science, Technology, Engineering and Mathematics (STEM) experts, Māori need to engage with scientists in order to access expertise to create benefits through physical science and engineering. There are national policy initiatives to combat this, and similarly, various institutions are also making efforts to meet Māori research needs. However, these initiatives are scattergun and their efficacy not well understood. *How do we create innovative pathways for Māori in STEM?*

- Western legislation and commercial practice are not equipped to deal with a Māori perspective of IP. *How do we protect Māori IP and data sovereignty through the commercialisation process in ways that enhance Māori participation?*
- There are unequal power dynamics in NZ between Pākehā and Māori that stem from our history, and these extend into the science and innovation ecosystem. *How do we encourage and support those with technology power, to recognise then address this long-standing power imbalance by actively and genuinely entering into dialogue with Māori?*

Benefits of Two Knowledge Systems

New Zealand is unique in that mātauranga Māori belongs here and can sit alongside Western science in a way that unlocks huge potential. Determining how this can be fruitfully achieved is one of BNZIC's big research questions.

In terms of creating space for two knowledge systems, there may be little benefit in diluting the strengths of each, but rather, it is about synergy. Research coming from that synergistic space would be more robust and novel with each worldview ideally learning from the other.

A Kaupapa Māori approach to research can offer a new perspective to mainstream scientists. It requires thinking beyond the immediacy of the research to ensure the wider context and perspectives are taken into account. Ways to incorporate this approach include maintaining participant relationships after the research has finished, and highlighting connections between researchers and others involved.

"The intersection of science and indigenous knowledge offers a new way of thinking about science that is 'fundamentally different' to dominant logics."

Scientist Perceptions

BNZIC researchers have been exploring scientists' perceptions of VM, seeking to understand where mātauranga Māori is (and is not) currently being incorporated into science practice.

The research team is interested in how scientists can be encouraged to think more deeply, not about 'if' VM could be incorporated into their research, but rather 'how' it can be.

BNZIC researchers have observed a full range of scientist feedback about VM as a policy tool and engagement with Māori in their own research. These range from 'it is tokenistic' through to 'it's useful, but not relevant to my current research' and on to 'bringing together diverse perspectives is where cutting edge discoveries come from.' But even for those who are already positive about the concept of collaborating with Māori, they are seldom culturally equipped to do so. This suggests that developing tikanga (protocols) for science-Māori engagement will be an important task for SfTI's capacity development programme.

Supporting a VM Approach to Research

There is evidence that the capacity development training run by SfTI has increased understanding by scientists of the benefits of taking a VM approach to innovation, and it has enabled some non-Māori to enjoy interacting with Māori to explore ideas.

Successful outcomes of SfTI's approach indicate there are real benefits from supporting science-Māori engagement and collaboration. Some outcomes include:

- a machine learning project to identify Māori landholders for a large Māori land trust with applications more broadly to the traceability of Māori land;
- a robotics project using the concepts of 'whānau' and Māori intergenerational communication based on non-written information exchanges using icons and symbols for communication of complex situations; and
- a project to develop, amongst other things, a te reo 'engine' integrating block-chaining to assist with indexing, traceability and control of content, integrated text and voice recognition for te reo Māori.

Despite these encouraging examples, other measures are also required. For example, it has been suggested that when scientists spend time in Māori spaces, such as marae, there is greater impact on the science produced given that this is *"where Māori language is spoken; where tikanga (Māori norms) govern relationships; and where mātauranga, traditional and transformative Māori knowledge, provides the underpinning framework for science innovation."*

"The objective of this programme is to expand human and relational skills so the almost exclusively non-Māori technical specialists can connect and co-innovate with industry and Māori to create new, high-value, high-impact products and services."

3. A NEED FOR INTERMEDIARIES

Moving beyond recognising that it is typically harder for researchers to engage with external stakeholders, we want to understand the enablers and barriers at all levels. At this stage, we know that intermediaries – key individuals, teams (e.g. tech transfer offices) or institutions (e.g. Kiwinet) – can have a significant impact, although we still need to better understand exactly how and why.

There are myriad types of intermediary, and they draw on a range of skills and resources depending on context and timing. Part of what is yet to be revealed is where the gaps are, whether particular alternatives offer equivalent outcomes, and what capacities are being duplicated. This is a focus for Phase 2.

Observing the role of the intermediary at work in bringing together researchers, industry and Māori, was noted by several researchers as being of particular interest. When people with different knowledge and backgrounds attempt collaboration, information needs to be translated to cater for different levels of expertise, experience, and worldviews; this appears to hold true regardless of domain.

During the upstream (beginning) research phase, intermediaries can create connections between the technical uncertainty scientists may be dealing with and the downstream expectations of end-users. Within SfTI, this role has proven to be extremely useful for bringing the scientists outside of their science-focus so that they can genuinely engage with external stakeholders to co-create knowledge and a way forward with their research programme.

The research to date suggests this role should not be considered an optional extra. Science and technology is a very complex environment and without someone making connections and links, making connections would be problematic. This is important from both an industry point of view and also for Māori.

With regard to Māori, some of BNZIC's surveys show there is a willingness by non-Māori scientists to engage, but there may be reluctance due to feelings of cultural incompetence. In this case, an intermediary who can guide cross-cultural engagements is invaluable.

The roles of intermediaries include:

- Research/science translation
- VM translation
- Bringing up important questions, concepts and ideas – this exposes participants to different ways of doing things.

Intermediaries can be useful for developing empathy during engagement; this has been found to be far more impactful than simply listening to each side's point of view. *"'Empathy intermediaries' are not only a 'nice to have' at the start of a science process, but can play an important role throughout the innovation process enabling industry to have early insight into the science."* The risk of not supporting the human and relational side of collaboration is that participants are left feeling frustrated and unable to see or pursue opportunities.

Intermediaries also work to establish trust or provide initial perceptions of trustworthiness, an important element of positive stakeholder engagement. In terms of what supports the establishment of trust, the research shows two pathways: through past relationships and other connections; and through knowledge sharing, such as creating common meaning. It is not always possible for science teams and stakeholder groups to achieve either of these alone, but the right intermediaries can. For knowledge sharing, intermediaries should have a good understanding of the relevant domains and an appreciation of different sets of worldviews and language used by the different groups; importantly, being able to translate in a way that allows for mutual understanding is crucial. Findings to date highlight intermediaries as incredibly important to achieving real-world, science-based innovation, and it is an area for further investigation in Phase 2.

Image. A nurse, Georgia, demonstrates the blood glucose control system based on the same foundation models used in SfTI Spearhead project, 'Home and community based care – Type 2 diabetes', in Christchurch hospital intensive care unit. Image courtesy of University of Canterbury.

4. TIMING

The best timing of science-stakeholder relationship building is an important area of investigation at all stages of research from early stage development to commercialisation (upstream, midstream, or downstream). The BNZIC team have revealed a few insights around this, but at this time, more questions than answers have been generated. But overall, it is clearly not one-size-fits-all process.

There is a great deal of literature exploring downstream (closer to commercialisation) stakeholder engagement by science teams, but much less attention has been paid to upstream (early) engagement. We have some insights on how science teams might manage their engagement efforts:

1. At early stages of the innovation process, science teams' engagements with multiple external stakeholders are fluid in their form, purpose and nature;
2. There is an interplay of stakeholders at the early stages, where differing roles and power mean that engagement with one set of stakeholders can be influential on how a second stakeholder group is prepared to interact with the science team. Some of this interplay stems from bringing together expertise from multiple and diverse organisations and scientific disciplines (e.g. when best multidisciplinary teams are identified);
3. Relational capacity plays a key role in successful upstream engagement in terms of skills required to establish trust and develop relationships. One way this happens is through using existing and familiar stakeholder networks. Part of the art here is knowing enough about a stakeholder group to correctly presume when engagement will ideally take place, that is, earlier or later in the process;
4. Engagement seems less prevalent during the mid-stages of the science research project. This could be because the imperative is to progress towards a successful research outcome(s) or because such interactions would add uncertainty and complexity and may even point toward re-designing the science project. Some Spearheads viewed engagement with Māori as something that could best be added once aspects of the science programme (e.g. lab testing) were more advanced.

A better understanding of timing from differing actor perspectives will be useful in future efforts to support Māori participation in the innovation system as it has impacts on final outcomes. While further investigation is required to produce guidelines, the timing might be guided by who the intended beneficiaries of science outputs are, for example, is a project related to a specific iwi/location or might benefits be more generally applicable, and to what extent will scientists want to draw from Māori knowledge or other artefacts.

This will be explored in finer detail in Phase 2.

WHERE TO NEXT?

While it is likely that all National Science Challenges in New Zealand have innovated within the processes and practices they have utilised, having the resources, time and capability to reflect on these innovations marks BNZIC research as different and likely unique within New Zealand. Growth in the SfTI Challenge (in part due to the funding increase for the second phase) will require choices about what to consider and where sufficient knowledge has now been generated.

Beyond the areas noted above in the report, BNZIC researchers perceive great potential for both further developing and disseminating the insights above (and new ones) as well as emphasising how our insights can be used to shape future practice and innovation with NZ's science innovation system. This should help to create impact beyond the SfTI Challenge but will undoubtedly raise additional complexities that can be understood and addressed best through similar action-research approaches embedded in broader research programmes.

BNZIC Researchers – Phase 1

DR KATHARINA RUCKSTUHL
(NGĀI TAHU, RANGITĀNE)

Associate Dean Māori at the Otago Business School, University of Otago, Dunedin. Her role in the Business School focuses on strategic empowerment of Māori students and staff with a particular focus on Māori entrepreneurship. She has strong connections to her tribal group of Ngāi Tahu, with whom she has governance and commercial director roles. Dr Ruckstuhl co-leads the BNZIC research team of the 'Science for Technological Innovation' National Science Challenge. She is also the Vision Mātauranga (Māori knowledge) leader, a "Theme" that crosses all of the Challenge's research activities. She has published in the areas of: Māori language; resource extraction in Māori territories; Māori SMEs; Indigenous Science and Technology and Indigenous Knowledge.

DR URS DAELLENBACH

A Reader in Management at Victoria University of Wellington's business school. His research interests have focused on value creation and capture, drawing on the resource-based view of the firm, with specific emphasis on contexts associated with strategic decision making for R&D and innovation. His research has been published in leading journals including Strategic Management Journal; R&D Management; Long Range Planning; Industrial & Corporate Change; and Strategic Organization. He is a Fellow of the International Society for Professional Innovation Management. With Dr Katharina Ruckstuhl, he is a co-Leader of the BNZIC research team.

DR MARIA AMOAMO
(WHAKATŌHEA)

A Research Fellow in the School of Business (Management) at Otago University. Her research draws on organizational management theory to examine elements of Māori social and economic development with the intention of understanding the modes of economy and innovation capability within which Māori enterprises operate. She also has research experience in cultural and indigenous tourism and in the area of social anthropology. Since 2016, Maria has contributed to the Vision Mātauranga research theme of Building New Zealand's Innovation Capacity.

DR RAFAELA COSTA CAMOES RABELLO

Works as a Research Fellow to the Building New Zealand's Innovation Capacity Spearhead. Rafaela holds a PhD in Social Investment in the energy sector and a Master's degree in Education, awarded by the University of Otago, New Zealand. She also has a degree in Psychology from the University Centre of Brasilia, Brazil.

Rafaela has worked within the fields of corporate social responsibility and education for more than 10 years and her expertise lies in the fields of corporate social responsibility and social investment, responsible innovation, design-led approaches for innovation, and higher education (good teaching and effective learning methodologies).

DR SALLY DAVENPORT

A Professor of Management at Victoria University of Wellington and the Director of the SfTI National Science Challenge. Her academic life began as a research chemist, but has shifted to cover commercialisation of scientific research, growth of high-tech firms, innovation strategy and policy. Sally has previously led major research projects on competitive advantage in NZ firms, organising and networks in biotechnology, and firm-level productivity. She has been a Commissioner with the NZ Productivity Commission (2011-2020), is also an Adjunct Professor the Australian National University's College of Business and Economics and a Fellow of the International Society for Professional Innovation Management. In 2018, she was made a Member of the New Zealand Order of Merit for her services to science.

KIRSTY DE JONG

An early career researcher based out of Victoria University of Wellington's business school. Her research focuses on the behavioural aspects of the 50+ Seed projects and the larger Rangatahi, or youth-led Spearhead project involved in the SfTI Challenge. Prior to joining the Challenge, Kirsty was with The Behavioural Insights Team: a social purpose research company who advise on, and redesign public services using behavioural science.

She has a Master's in Museum and Heritage Practice from Victoria University of Wellington and Undergraduate degrees in Marketing and Art History, receiving Dean's Awards for Academic Excellence from both of these Faculties.

LAWRENCE GREEN

A sought-after professional speaker, author, and leadership specialist with over 20 years experience in developing people and 15 years experience in working directly with leaders. He has worked extensively with the university, government, community and SME sectors. In his consulting practice, his focus is on delivering long-term leadership development programmes and executive coaching for senior leaders. Lawrence brings a diverse range of perspectives to the challenge of leadership success. These include his own experiences as a leader, his early work as a sport psychology consultant, his hands-on work as a leadership specialist, and 10 years as a postgraduate management lecturer at Victoria University of Wellington.

DR JARROD HAAR
(NGĀTI MANIAPOTO, NGĀTI MAHUTA)

Dr Jarrod Haar is a Professor of Human Resource Management (HRM) at Auckland University of Technology (AUT). His research focuses on (1) work-family and work-life balance, (2) Māori employees and mātauranga Māori, (3) leadership, (4) wellbeing, and (5) R&D, entrepreneurship, and innovation. Professor Haar is ranked world-class (PBRF); has won Industry and best-paper awards; research grants (Marsden, FRST); and currently researches on a National Science Challenge (Science for Technological Innovation), a Marsden grant (Living Wage), and a Ngā Pae o te Māramatanga grant (Māori HRM). He has over 380 refereed outputs (94 articles) and convenes the Economics and Human Behaviour Marsden Panel.

MAUI HUDSON
(WHAKATŌHEA, NGĀ RUAHINE AND TE MĀHUREHURE)

Deputy Chair of the Whakatōhea Maori Trust Board and Associate Professor in the Faculty of Māori and Indigenous Studies at the University of Waikato. Associate Professor Hudson has co-authored a number of ethics guidelines including Te Ara Tika: Guidelines on Māori Research Ethics, Te Mata Ira Guidelines for Genomic Research with Māori, and the He Tangata Kei Tua Guidelines for Biobanking with Māori. He is a founding member of SING Aotearoa and Te Mana Raraunga Māori Data Sovereignty Network, helped establish the Global Indigenous Data Alliance, and co-led the development of the CARE Principles for Indigenous Data Governance.

DR MERATA KAWHARU
(NGĀTI WHATUA, NGĀPUHI)

A graduate of the University of Auckland and of Oxford University. As a Rhodes Scholar she undertook research on kaitiakitanga. She has undertaken research projects for various Treaty claimant groups and the private sector and has been a consultant to the U.N. and to UNESCO. She was a member of the NZ Historic Places Trust Board and Māori Heritage Council; the New Zealand Rhodes Committee; a Treaty claims advisor and member of other local committees. She has been a Director of Research at the James Henare Māori Research Centre at The University of Auckland, and is a Professor at the Centre for Sustainability at Otago University. She was awarded the Member of the New Zealand Order of Merit for services to Māori education in 2012. Her more recent research has focused on Māori entrepreneurship and climate change.

DR CONOR O'KANE

A Senior Lecturer in strategy and innovation in Otago Business School's Department of Management. Current areas of research include the role of principal investigators in publicly funded science and research commercialisation. Conor has a particular interest in role identity in academic entrepreneurship and stakeholder engagement during upstream innovation. His research has been published in leading international journals such as Research Policy, Technovation, Long Range Planning, Industrial Marketing Management, R&D Management and the Journal of Technology Transfer. Conor teaches strategic management and entrepreneurship and is Director of the Otago Business School's Master of Entrepreneurship programme.

DR DIANE RUWHIU
(NGĀPUHI)

A Senior Lecturer in the Department of Management at the Otago Business School. Diane has a background in logistics having worked previously in the Royal New Zealand Airforce before completing a BCom, PGDip(Tourism), MCom and PhD at Otago University. She now teaches in critical management studies, particularly in relation to Indigenous/ Māori management and organisation. Her research interests include: Understanding the dynamics of Māori economy and enterprise and exploring the intersection of mātauranga Māori with science and innovation. A recent thread of research focuses on institutional racism within the changing nature of work/the workplace.

DR JORDAN TE ARAMOANA WAITI
(NGĀTI PIKIAO, TE RARAWA, NGAATI MAAHANGA, NGĀTI HAUPOTO)

A lecturer within Te Hautaki Waiora Faculty of Health, Sport and Human Performance at the University of Waikato. Previously, he was a Māori Health Consultant based out of Whaingaroa/ Raglan. In 2015 Jordan completed a PhD at Massey University which focused on Māori notions of 'Resilience' and how they are utilised by whānau who had experienced adversity. With Honours and Master's degrees from Otago University, his research expertise has been broadly based in the area of Māori Health. For the past 10 years he has been a volunteer facilitator for the Te Taitimu Youth Trust in the Hawkes Bay.

DR PAUL WOODFIELD

After a decade traversing the property industry in consulting, contractor, and engineering roles, Paul is now in the International Business, Strategy, and Entrepreneurship department at AUT. He is part of the National Science Challenge: Science for Technological Innovation, Spearhead One "Building New Zealand's Innovation Capacity." Paul carries out research on entrepreneurship and innovation, with interests in traditional industries and the family business context. He holds a Master of Business Innovation and Entrepreneurship (MBIE), and a PhD in Management from the University of Auckland.

BNZIC List of Research – Phase 1

TITLE	AUTHOR(S)	BOOK/JOURNAL/ CONFERENCE	DATE	DOI
Rethinking Absorptive Capacity for Open Innovation Contexts	Daellenbach, U., Davenport, S., Hyland, M., Leitch, S. & Ruckstuhl, K.	*ISPIM Innovation Summit Brisbane*	December 2015	
University Researcher Capacity Development for Open Innovation Contexts	Davenport, S, Daellenbach, U, Hyland, M, Ruckstuhl, K. & Leitch, S.	*Technology Transfer Society Conference. Phoenix, Arizona*	November 2016	
National Science Challenges in Aotearoa New Zealand: Opportunity or business as usual?	Ruckstuhl, K. et al.	*Ngā Pae o Te Māramatanga Conference. Auckland*	November 2016	
Indigenous intersections with Science, Business and Entrepreneurship	Haar, J., Ruwhiu, D., Ruckstuhl, K., Mika, J., Hudson, M., Hunia, R. & Sloan, T.	*ANZAM Conference Brisbane [Symposium]*	December 2016	
Research scientists' role transitions and capacity development: A focus on New Zealand's Science for Technological Innovation Challenge	O'Kane, C., Davenport, S. & Ruckstuhl, K.	*ANZAM Conference Brisbane [Symposium]*	December 2016	anzam2016.com/
Evaluating measures of social capital and their relationship to innovation	Daellenbach, U., Davenport, S. & Mann, D.	*ISPIM Conference Vienna*	June 2017	
Panel: Indigenizing the Innovation System - Aotearoa New Zealand's National Science Challenges	Ruckstuhl, K.	*Politics of Māori Science and Innovation, NAISA (Native American & Indigenous Studies Assoc.) Conference, Vancouver*	June 2017	naisa2017.sites.olt.ubc.ca/files/2016/08/Final-Program.pdf
University Researchers as Nascent Entrepreneurs: Do They Fit the Stereotype?	Davenport, S., Mann, D. & Daellenbach, U.	*in J. Cunningham & C. O'Kane (eds) Technology-Based Nascent Entrepreneurship. Palgrave Macmillan, New York.*	August 2017	www.palgrave.com/la/book/9781137595935
Developing Absorptive Capacity for Midstream Science in Open Innovation Contexts	Daellenbach, U., Davenport, S. & Ruckstuhl, K.	*International Journal of Technology Transfer and Commercialisation, 15(4): 447-462*	December 2017	
Exploring product innovation in New Zealand firms: A path model approach	Haar, J., Daellenbach, U., Davenport, S. & Woodfield, P.	*ISPIM Connects Melbourne*	December 2017	
Are indigenous businesses different? A study in Aotearoa	Haar, J., Ruckstuhl, K. & Daellenbach, U.	*ANZAM Conference Melbourne*	December 2017	
Willingness to Collaborate	Daellenbach, U. & Ruckstuhl, K.	*ISPIM XXIX Conference Stockholm*	June 2018	
How different are Indigenous businesses? A study of Aotearoa organisations	Haar, J., Ruckstuhl, K., & Daellenbach, U.	*Gender, Work and Organization 10th Biennial International Interdisciplinary Conference*	June 2018	

TITLE	AUTHOR(S)	BOOK/JOURNAL/ CONFERENCE	DATE	DOI
Conceptualizing (multiple) stakeholder engagement(s) at early stages of the innovation process	O'Kane, C., Haar, J., Daellenbach, U. & Davenport, S.	*R&D Management Conference 2018*	June 2018	
Engineering Indigenous Science in Aotearoa-New Zealand: A Global Template?	Ruckstuhl, K., Keegan, T-T., Waiti, J. & Tapsell, P.	*NAISA Conference, Vancouver*	June 2018	www.aisc.ucla.edu/naisa2018/program/NAISA 2018 Abstracts.pdf
Developing trust with stakeholders: Case-based evidence from a national scale research programme	Woodfield, P., Daellenbach, U. & Haar, J.	*University-Industry Interaction Conference London*	June 2018	
The Dark Side of Corporate Entrepreneurship: The Links to Mental Health and the Potential Saving Grace of Organizational Trust	Haar, J., Daellenbach, U., Davenport, S. & Ruckstuhl, K.	*Academy of Management Conference Chicago*	August 2018	
The Role of R&D Partnerships and Firm Size in Product Innovation: A Study of New Zealand Firms	Haar, J., Daellenbach, U., Davenport, S., Ruckstuhl, K., O'Kane, C. & Ruwhiu, D.	*Academy of Management Conference Chicago*	August 2018	
The future is now: Māori knowledge at the science and technology cutting edge	Ruckstuhl, K., Hudson, M. & Whaanga, H.	*Ngā Pae o Te Māramatanga Conference. Auckland*	November 2018	
Hangarau Ngātahi Hei Oranga mō te Motu – Vision Mātauranga and Technology. Science for Technological Innovation National Science Challenge.	Keegan, T., Ruckstuhl, K., & Whaanga, H.	*Cross National Science Challenge Pre-Conference Workshop - Ngā Pae o Te Māramatanga Conference. Auckland*	November 2018	
Unpacking 'openness' while innovating within an academic engagement context	de Jong, K., Daellenbach, U., Davenport, S. & Ruckstuhl, K.	*ISPIM Connects Fukuoka*	December 2018	
Conceptualizing (multiple) stakeholder engagement(s) at early stages of the innovation process	O'Kane, C., Haar, J., Daellenbach, U. & Davenport, S.	*ANZAM Conference Auckland*	December 2018	
What role does trust play when engaging with stakeholders?	Woodfield, P.	*ISPIM Connects Fukuoka*	December 2018	
Does risk taking beget undesirable behaviors? Testing a duality paradox from entrepreneurial orientation to worker behaviors	Haar, J., Daellenbach, U. & O'Kane, C.	*Academy of Management Journal Workshop*	February 2019	
Research and Development Absorptive Capacity: A Māori Perspective	Ruckstuhl, K., Amoamo, M., Hart, N. Martin, W-J., Keegan, T-T. & Pollock, R.	*Kōtuitui: New Zealand Journal of Social Sciences*	February 2019	doi.org/10.1080/1177083X.2019.1580752

TITLE	AUTHOR(S)	BOOK/JOURNAL/ CONFERENCE	DATE	DOI
Building Entrepreneurial Behaviours in Academic Scientists: Past Perspective and New Initiatives	O'Kane, C., Zhang, Y., Daellenbach, U. & Davenport, S.	*In M. McAdam & J. Cunningham (eds.), Entrepreneurial Behaviour: Individual, contextual and microfoundational perspectives (pp. 145-166). Palgrave Macmillan, New York*	April 2019	doi.org/10.1007/978-3-030-04402-2_7
Navigating boundaries in additive manufacturing through action research	Ruckstuhl, K., Rabello, R. & Davenport, S.	*Technological Innovation Management Review*	April 2019	
Bringing visibility to digital communication: The affordances of 3D and 4D printing	Davenport, S., Ruckstuhl, K., Daellenbach, U., Rabello, R. & de Jong K.	*14th Organisation Studies Summer Workshop: Technology & Organisation*	May 2019	
Effectuation behaviour of researchers: Evidence from a National scale research programme	Woodfield, P., & Ruckstuhl, K.	*Manufacturing and Design (MaDE) Conference*	May 2019	
Reforming innovation science systems through a choice architecture lens	de Jong, K., Daellenbach, U., Davenport, S. Haar, J. & Leitch, S.	*ISPIM XXX Florence*	June 2019	
Understanding R&D in New Zealand firms: A mixed methods study	Haar, J., Daellenbach, U., Davenport, S. & Alexander, A.	*ISPIM XXX Florence*	June 2019	
Does Positive Relational Management Benefit Managers Higher Up the Hierarchy? A Moderated Mediation Study of New Zealand Managers	Haar, J., di Fabio, A. & Daellenbach, U.	*Sustainability, 11, 4373 (16 pages)*	June 2019	doi.org/10.3390/su11164373
The role of relationships at work and happiness: A moderated mediation study of New Zealand managers	Haar, J., Schmitz, A., di Fabio, A. & Daellenbach, U.	*Sustainability, 11, 3443 (15 pages)*	July 2019	doi.org/10.3390/su11123443
Does risk taking beget undesirable behaviors? Testing a paradox from entrepreneurial orientation to worker behaviors	Haar, J., O'Kane, C., Daellenbach, U. & Martin, W-J.	*Academy of Management Conference Boston*	August 2019	
Giving Science Innovation Systems a 'Nudge'	de Jong, K., Daellenbach, U., Davenport, S., Haar, J. & Leitch, S.	*Technology Innovation Management Review*	October 2019	doi.org/10.22215timreview/1275
Recognising and valuing Māori innovation in the high-tech sector: A capacity approach	Ruckstuhl, K., Haar, J., Amoamo, M., Hudson, M., Waiti, J., Ruwhiu, D. & Daellenbach, U.	*Journal of the Royal Society of New Zealand, 49(TUIA250) (17 pages)*	October 2019	doi.org/10.1080/03036758.2019.1668814
Mātauranga and High-Tech Science	Ruckstuhl, K. & Martin, W-J.	*Special Issue of NZ Science Review Mātauranga and Science in Policy and Practice*	December 2019	

CONTACT US – WHAKAPĀ MAI

Science for Technological Innovation
National Science Challenge
c/o SfTI Programme Office
Callaghan Innovation
PO Box 31310
Lower Hutt 5040
Wellington, NZ

e-mail
SfTIChallenge@callaghaninnovation.govt.nz

twitter
@sftichallenge

LinkedIn
Science for Technological Innovation (SfTI)

SFTICHALLENGE.GOVT.NZ

Online ISBN: 978-0-473-52354-1