MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
AgResearch Limited	High-value New Zealand pigs for transplantable biomaterials	3	$1,000,000	There is a huge gap between the number of organs needed and the number of human donor organs available for transplantation. Despite decades of concerted efforts to improve conventional donor management, there is still a severe world-wide organ shortage and transplant waiting lists continue to grow. Thus, new and alternative sources of organs need to be found. Animal-to-human transplants ("xenografts") are a promising solution to close the widening gap between organ supply and need. The animal of choice for growing xenoorgans is the pig. It is anatomically and physiologically similar to humans, breeds easily and its use is relatively socially acceptable. However, two problems delay clinical application of xenotransplantation: rejection by the human immune system and potential pathogen transmission from the porcine graft. We propose to overcome both challenges by genetically enhancing a unique breed of NZ-based Auckland Island (AI) pigs. AI pigs are free from virtually all modern pig diseases and exceptionally well suited to xenotransplantation. Housed in designated pathogen-free facilities, these medical-grade pigs are the only approved source of transplantable pig cells for human clinical studies by the NZ medical safety authority. Importantly, a new target for the human immune system has been discovered that is implicated in rejecting pig organs. The underlying gene will be genetically inactivated, producing clean xenografts that are better protected against immune rejection. Following preclinical validation, we will deliver proof-of-concept for a scalable platform technology that produces cells, tissues and organs, all safely sourced from a new generation of NZ-owned AI pigs. Harnessing NZ's geographical isolation, excellent biosecurity systems and high health standard for farm animals, we will develop a new high-value agrimedical industry that meets the global need for transplantable biomaterials.
	Novel discriminatory tests for E. coli to improve water quality assessments	3	$999,999	Escherichia coli are bacteria that live in the gut of warm blooded animals and birds. When E. coli are found in waterways, their presence suggests that faecal contamination has occurred. Regional authorities have a responsibility to undertake water quality assessments to ensure that recreational users and Maori are aware of the risks of potential illness associated with microbes from faecal contamination during swimming or the harvesting of, for example, eels/tuna or koura/crayfish. However, recent work has identified E. coli -like bacteria that are not able to be distinguished from faecal E. coli using the standard water quality monitoring tests. These 'naturalised' E. coli -like bacteria grow and multiply in soil, water and sediment, but are rarely found in faeces. Recent discoveries of these 'naturalised' E. coli -like bacteria in New Zealand's waterways suggests that the current water quality monitoring test results may cause some monitoring sites to fail when there is no, or very little, faecal contamination. This project will bring together scientific researchers, Regional Council staff, the dairy industry, iwi and local community groups to undertake sampling to discover whether naturalised E. coli -like bacteria are more common in undisturbed predator-free mainland island sites, and whether dilution with faecal E. coli occurs as waterways pass through farmland and through wastewater contamination. Potentially, the naturalised E. coli -like bacteria could be biological markers of ecological health, so we will isolate them from our different sampling sites and use their DNA sequence information and specific growth activities to develop tests which permit their identification from environmental samples. These tests will assist Regional Councils, the pastoral industry, and other similar international regulatory bodies overseas, to more accurately undertake water quality assessments and agricultural mitigation strategies.
Auckland University of Technology	A new measurement principle for accurate non-invasive blood pressure	3	$1,000,000	Measurement of blood pressure (BP) is everywhere in healthcare. It is a key vital sign in hospitals and is used to manage treatment at the GP and in the home. Automated BP devices can be quite inaccurate in some people and these errors in measuring BP can affect how people are medically treated. It is thought that tens of millions of patients each year receive an incorrect diagnosis due to this inaccuracy. The problem arises because today's technology can't account for the differences in size, shape and firmness of people's arms. We propose an entirely new measurement principle which is based on well-established physics but isn't affected by differences in people's arms. This will significantly reduce the error in BP measurement for any individual and should greatly improve BP measurements used throughout healthcare. Our research will aim to show the new principle can measure BP at the upper-arm, which is clinically the most used measurement site. We will initially use computer simulation and experimental models of blood, bone, muscle, fat, and skin to investigate how well our new measurement principle could work and to help design the BP measuring device. This prototype BP measuring device will then be compared against the gold-standard: invasive BP measurement, to see how much more accurate it is than other non-invasive techniques. Our team includes experts in blood pressure measurement technology, computer modelling of humans, and cardiovascular medicine. We have strong links to people and organisations that can help commercialise this research.
Blue Carbon Services	Carbon Sequestration and Mussel Productivity in Integrated Multi-Trophic Aquaculture	3	$1,000,000	Inspired by new research from North America and China on the productivity benefits of kelp-mussel co-culture, Blue Carbon Services Limited, in association with the University of Auckland Institute of Marine Science, the University of Otago Department of Marine Science and Universidad de Los Lagos, Chile; propose to undertake research on the economic and environmental benefits of growing a variety of New Zealand kelp with Greenshell mussels in the Hauraki Gulf and Marlborough Sounds. Kelp have the potential to increase mussel productivity through provision of direct nutrients to mussels and through mitigation of ocean acidification which inhibits shell formation of all forms of shellfish. Importantly kelp also have potential for water bioremediation through removal of nitrogen and other fertiliser chemical run-off from land-based farming activities. This may reduce the occurrence of toxic algal blooms which result from eutrophication of coastal waters. This exciting research is being undertaken in collaboration with leaders in the Greenshell mussel industry; Wakatu Incorporated, Whakatohea Mussels and Apex Marine Farm Ltd. It represents a highly productive partnership between New Zealand's leading research institutions and both iwi and non-iwi owned aquaculture business. Kelp aquaculture also holds the promise of providing a very significant carbon sink through the near permanent sequestration of kelp-derived carbon into deep ocean waters. With the inevitable transition of mussel aquaculture to off-shore locations, this is likely to further enhance the potential for deep-water carbon sequestration.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
Cawthron Institute	Natural compound manipulation for therapeutic applications	3	$1,000,000	Algae have a range of interesting properties, not the least of which is that millions of years of evolution enable them to produce highly complex bioactive compounds that confound current laboratory synthesis, meaning algae are an abundant source of compounds with great potential as pharmaceuticals. There is a broad range of health disorders—including cancer, allergy, diabetes, neurodegenerative diseases and inflammation, against which algae have been used. There is growing interest worldwide in pharmaceuticals based on natural compounds, including compounds of algal origin – indeed many current pharmaceuticals were isolated from microorganisms and plants. Cawthron has more than 30 years of expertise in algae research, from microscopic level through to the impact of algae in marine ecosystems, and is one of only a few organisations worldwide to specialise in extracting high-value bioactive compounds from algae. Cawthron also has one of the largest living algae collections in the world, which underpins international research. Recently Cawthron received funding from the government's Provincial Growth Fund to build a National Algae Research Centre. This will be a bridge from science to industry, connecting Ramp;D to commercial application. There are no other initiatives like this in New Zealand, and Cawthron will have increased opportunities to connect with commercial entities that make important products from algae. The Centre will support up to 30 new local jobs, and it is hoped construction will begin by October 2020. This programme will further explore the potential for pharmaceuticals derived from algae, drawing on the unique collection of multi-disciplinary skills and resources of the Cawthron-led research team. We will design proof of concept compounds derived from algae that display commercially relevant functionality, with potential to be the basis of global products.
GNS Science	Nano-catalytic surfaces for efficient, stable fuel cells and eco-friendly hydrogen production	3	$999,987	Hydrogen is a non-polluting, high density energy carrier that will play increasingly important role in the global energy arena. Unlike electricity which when stored in batteries suffers from low power density, limited storage capacity and long charging times, hydrogen offers an alternative to fossil fuels without such compromises. A major barrier that is currently limiting realisation of hydrogen economy is the high cost of electrolysers and fuel cells that rely heavily on platinum catalysts. A family of compounds, known as transition metal carbides were discovered to mimic platinum's catalytic properties in 1973. Since then several reports have confirmed this similarity and have proposed these compounds as replacement for platinum in hydrogen technologies. However, till date a commercially viable method to manufacture these platinum-alternatives is lacking. The challenge lies in the very high temperature required to form metal carbides. The problem is, at such high temperatures the metal carbides formed, agglomerates into large particles losing their performance. We propose to overcome this challenge by applying a physical approach based on ion beam engineering. Our approach utilises the energetic interaction that occurs between transition metal ions with a carbon substrate to produce the desired nanoparticles for catalysis. The challenge lies in designing and optimising the synthesis parameter setting to create the environment ideal for formation of highly efficient nanocatalysts. Our strong national and international research network will aid in testing and demonstrating the performance of our newly developed catalysts. If successful, this research will provide a new commercially viable pathway to manufacture catalysts that can replace the highly expensive and scarce platinum in hydrogen technologies.
Lincoln University	Multifunctional nano-coatings for sustainable agriculture applications	3	$999,909	Our research will help increase agricultural productivity and reduce environmental impacts of agriculture through development of a novel technology. We will create a ground-breaking nano-coating that can be applied to fertiliser to control the rate of release into soil, and to seeds to control timing of germination. Controlling fertiliser rate of release is important because release that is too rapid can result in excessive nitrogen being lost into the soil and into waterways, causing significant pollution and other negative environmental impacts. Rapid release can also result in greenhouse gas emissions. When nitrogen is lost to the soil, waterways, or atmosphere, farmers must apply more fertiliser to achieve desired results, which increases farming costs. While some controlled-release fertilisers are currently available, they have significant limitations, including lack of robustness (reducing their effectiveness) and a high coating-to-fertiliser ratio. Our technology, using a novel, revolutionary coating, will solve these limitations. Additionally, our new technology can be applied to seeds to control the timing of germination. The benefits of delayed germination are manifold. For example, farmers could sow crops traditionally sown in autumn several months earlier, when weather conditions are more conducive to sowing. Farmers could sow two crops at once: one with uncoated seeds, and the other with coated seeds to delay germination until after the first crop has matured or been harvested. Delayed germination could also allow farmers to control weeds that grow after sowing, so that the coated seeds germinate after weeds have been sprayed. This will increase crop yields because competition from weeds can be significantly reduced. Our technology will be a New Zealand-specific solution that increases sustainability, enhances productivity, and helps improve yield and export revenue.
Massey University	Monoamine oxidase inhibitors from tobacco smoke: from Nicotine Replacement Therapy to Tobacco Replacement Therapy	3	$999,999	We have made a breakthrough in our understanding of why people find it so hard to quit smoking. Our team, comprised of researchers from Massey University and Victoria University of Wellington, have shown that there are chemical compounds in tobacco smoke called monoamine oxidase inhibitors, that enhance nicotine's addictiveness. Our first step will be to confirm which of these compounds affect how addictive nicotine is. Then we will test ways in which to use these chemicals to make a new and improved version of nicotine replacement therapy, in either inhaler or vape form. The therapy we will develop will help us lower New Zealand's smoking rates in line with the NZ Government's commitment to bringing it below 5%. Instead of increasing the pressure on smokers to quit, we can make it easier for them to do so. We suspect that the same compounds may also be effective in treating anxiety, depression and Parkinson's disease and can test this at the same time. Our development of an effective cure for smoking has the potential to be a world-wide game-changer for New Zealand's burgeoning pharmaceutical industry, with vast economic and health benefits for all people battling with smoking addiction.
Meteorological Service of New Zealand Limited	Machine learning for advanced coastal storm surge predictions	2	$1,000,000	Significant portions of NZ's population and infrastructure are at risk from coastal flooding, with ~150,000 people living in the low-lying coastal areas most at risk. The cost to defend the associated buildings, infrastructure and assets is of the order of $10 billion. The effects of climate change are already increasing this risk profile, and greater exposure is expected in the future. Storm-surge is a critical component of coastal flooding. Numerical models can be used to simulate storm-surge; however, existing models are coarse resolution and computationally expensive. Modifying them to the required resolution to accurately capture the complex NZ coastline for real-time civil defense applications at a national scale is cost-prohibitive. A novel approach is critically needed to deliver accurate and timely storm-surge predictions suitable for risk mitigation and informed decision making. We will develop an innovative method for the prediction of coastal storm-surge, applying state-of-the-art machine-learning techniques to link evolving weather patterns to storm-surge. We will train and verify our algorithms using local water-level data, and then develop a spatial learning component using satellite and model data, thereby extending high-resolution predictions to cover the entire NZ coastline. This project unites four innovative NZ organisations: Metservice, Oceanum, UAuckland and UWaikato that are uniquely placed not only to conduct this innovative science, but also to move it rapidly into applied application and ensure that the outcomes of the project are firmly absorbed into emergency response and hazard management in New Zealand. Applying machine-learning to storm surge forecasting is a world first, we propose that NZ be part of developing it, and be the first to reap the benefits.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
National Institute of Water and Atmospheric Research Limited	Novel high-tech underwater selection tools for environmentally and economically sustainable fishing	2	$1,000,000	Both globally, and for New Zealand fisheries, the bycatch of undersize fish and unwanted species can have a major impact on the sustainability of fish stocks, ecosystem health and public perceptions of the commercial fishing industry. Unwanted catch increases the total catch and the time to process it, reduces the quality of the target species caught, and (in New Zealand) can result in large deemed value penalty payments if catches exceed quota. This project will build on ideas for highly selective trawl gears developed by New Zealand inshore fishers and combine them with state-of-the-art video camera, computer vision and underwater engineering technology. We will develop methods by which fish size and species can be identified when entering the trawl and automatically retained or released at the seabed by a "drafting gate" mechanism. This will ensure that only the desired species and sizes are retained, providing inshore trawl skippers with unprecedented control over what is retained in their nets, thereby maximising quality and price and minimising undesired impacts. The size selective gear will ensure juvenile fish escape, while the drafting mechanism will divert undesired species out of the net, which may be large, and so would normally be caught. Releasing unwanted catch, including juveniles at the seabed, will maximise their survival, and, as they grow to commercial size, will improve the overall productivity and economic value of fish stocks. Working closely with local fishers, fishery managers and overseas experts, we will ensure designs tested are practical and robust to commercial fishing operations, and meet legislation requirements, to develop a highly selective, minimal bycatch trawl gear to fish commercially in New Zealand inshore waters.
	Better sea ice predictions for shipping via wave-ice forecasting	3	$1,000,000	Antarctic waters are a remote and inhospitable environment for ships. Of all the hazards for Antarctic vessel operations, sea ice is the greatest risk. This was highlighted in 2007 with the sinking of the tourist vessel MV Explorer after striking hardened pack ice, which had been misidentified as thin first-year ice. Recent research by our team has demonstrated that ocean waves play an important, and underestimated, role in the evolution of sea ice. Waves can penetrate many kilometres into fields of floating ice, losing energy gradually, in a way that depends on ice thickness. Sufficiently energetic waves can break the ice into smaller ice floes (as experienced by Shackleton's 1914–17 Antarctic expedition, forcing them to take to the lifeboats after HMS Endurance was crushed in pack ice). Smaller floes have more exposed ice at their edges, leading to changes in the rate that the ice freezes or melts. And ice floes influence wave conditions by scattering the waves in different directions. We will create a model of this complex interplay between waves and ice floes that is capable of simulating the statistical distribution of floe thickness and floe size, and of how these parameters are influenced by wave conditions. We will combine this with the latest wave modelling technology to account for the way ice conditions in turn affect the waves. This will create a world-first: a fully coupled wave and ice model that accurately represents sea ice and ocean wave conditions. Our wave and ice model will produce forecasts of wave and sea ice conditions in Antarctic waters out to six days into the future, aiding safe vessel operations for scientific research, fishing and tourism.
	Broadband acoustic characterisation of free gases in the ocean water	3	$1,000,000	This project will, for the first time, develop a cost-effective methodology that uses broadband acoustic technologies to detect gas bubbles seeping at the seafloor into the ocean water, characterise the nature of the gases and quantify their fluxes. The applications are wide ranging, and include seafloor resources assessments, pollution control and environmental management. Data we acquired during a recent R.V. Tangaroa survey has provided evidence that the physical and chemical complexities of seafloor bubbles can be unravelled using broadband acoustic methods, and that C0 2 and CH 4 released at the seafloor can be differentiated from their acoustic properties. We will design a prototype of low frequency broadband systems, which does not exist on the market today, and develop numerical models of the behaviour of bubbles in the water. We will compare our results with data acquired offshore to ground-truth our findings. This will enable us to estimate gas fluxes, which can be used in models to understand the impacts of seafloor gas discharge on the oceans and atmosphere, including estimates of the ocean's contribution to greenhouse gas emissions and monitor anthropogenic activities. We will address the challenge of moving beyond visualising ancillary data in relation to bubble plumes acoustically imaged in the water column. Ancillary data will be used to constrain and predict bubble source (pre-discharge) and fate (past imaging). We will test if these ancillary data can be used as a proxy for bubble classification at local and regional scales. The team consists of experts in marine acoustic, marine geology, geophysics, and spatial analysis and benefits from the extraordinary strong congregation of specialists brought together for a R.V. Tangaroa voyage in July 2018.
	Numerical simulations to identify river width that minimises flood-risk on alluvial fans	2	$1,000,000	Braided rivers flowing on alluvial fans at the feet of mountain ranges are notorious for flooding and rising bed levels. Bed levels rise when flows are incapable of transporting all the gravel supplied from the steep mountains upstream. Rising bed levels compound the flood risk because they reduce the capacity of the channel to contain and convey floodwaters. The classical engineering response to this problem is to narrow river channels by confining them between stopbanks, concentrating flood flows and increasing velocity. There is an expectation that the modified hydraulics will induce bed down-cutting, thereby reducing flood risk, but in practice this does not happen. In many rivers, confinement has accelerated bed level rise and increased the flood risk. Examples are the Waiho River (Westland), which flooded Franz Josef township in March 2016, and the Kowhai River (Canterbury) where increased flood risk is expected due to gravel loading following the Kaikoura earthquake. We propose that current engineering responses fail because they inadequately recognise and account for the processes whereby braided rivers transport their bedload; and that incorrect channel confinement may actually inhibit key processes, such as sudden channel path-shifts, which would effectively help sediment flushing. We will investigate this using an innovative computer simulation approach that will uniquely allow us to detect and measure morphological changes during floods. The product will be a new theory relating gravel transport efficiency to the imposed channel width, which we will use to devise guidelines for designing optimal river width. Uptake of these guidelines by river managers should reduce flood risk, benefitting New Zealand generally. The project will be managed at NIWA in Christchurch.
Scion	Harnessing photoheterotrophic metabolism to convert methane into biopolymers	3	$999,999	Methane resources are squandered in huge volumes each year in New Zealand. From the oil and gas to agricultural sectors, all methane which is uneconomical to recover is either flared or vented. Our intention is to convert methane into biopolymers, utilising naturally-occurring microbes. The biotechnology platform will couple together the function from two types of bacteria, those that can utilise light and those that can consume methane. Our research will show whether this novel coupling can efficiently convert methane to products of value, such as a bio-based and biodegradable plastic. This bioplastic, called polyhydroxyalkanoate (PHA), has appealing properties and can be used in diverse applications such as biocompatible medical devices, food packaging and textiles. Our process is flexible and other biomass products such as feed protein may also be feasible. This proof-of-concept project will establish the potential for growing this light-driven, methane-consuming bacterial community, and its tunability towards PHA production. Reactors will be designed to best exploit this. Ultimately, this will lead to the generation of economic value from a new waste - and greenhouse gas - mitigation technology

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
	A living "factory" for the production of high-value terpenes	3	$999,999	Terpenoids (isoprenoids) are the largest and most ancient class of specialized metabolites on the planet. They have an amazing structural diversity associated with a plethora of biological roles including diseases resistance and attracting pollinators. The unique bioactive and structural properties of plant-derived diterpenes, of which ~12,000 are known, are increasingly being exploited in high-value pharmaceuticals, nutraceuticals, fragrances and other speciality chemicals where they support a multi-billion US dollar industry. The use of these valuable products is often limited because their natural availability is low. Many accumulate at low amounts, are found in rare or difficult to cultivate plants, or in specialised tissues, e.g., the bark from several 200-year-old Pacific Yew trees is required to produce 1g of the anti-cancer drug Taxol. Because of the lack of availability of many diterpenes, much effort has been put into alternative methods of producing them. These have included synthesising them chemically, expressing them in microbes or different species of plants. All these methods are challenging because diterpene structures are complex, they require specific precursors, which are only available in low amounts, and the finished diterpene can be toxic to microbes. Conifers, such as pine trees, are naturally able to make and safely store huge volumes of diterpenes as part of the resin they produce when a tree is attacked or damaged. We will engineer pine trees to produce and store new valuable diterpenes which can then be extracted and used. As well as being useful for making things things like pharmaceuticals, many diterpenes can replace chemicals currently produced from petrochemicals providing a sustainable alternative that will help reduce emissions and help New Zealand tackle climate change.
The New Zealand Institute for Plant and Food Research Limited	Targeting Specialty: Taxonomically restricted genetics for faster selection	3	$999,999	Accelerated breeding pipelines are critical for New Zealand's horticultural industries to remain lucrative, providing cultivars with novel properties, that respond to climate change, and deliver nutrition to a growing global population sustainably. To deliver these new cultivars at speed, our breeding pipelines need to be quicker and smarter. This means expanding the knowledge of the underlying genetics of plant breeding material. Currently, our deepest understanding of the genomes of plant crops is focused around genes that are well conserved across species, particularly where these are also present in highly-researched model plant species. However the DNA that makes each crop unique is an area that has not yet been explored in any detail. The areas of the genome that result in differences between even closely-related species are an opportunity for differentiating New Zealand cultivars from those of other breeding programmes. To fully understand the secrets of this genomic "dark matter", this project will focus on Solanum, a group of species that includes potato, to develop methods for identification of species-specific DNA regions, particularly those involved in the control of important production traits. This knowledge will inform and improve the efficiency of breeding new cultivars with species-specific traits that offer novelty or sustainability characteristics for growers and consumers.
	Understanding spore/host recognition to prevent plant infection from ascomycete fungal pathogens	3	$1,000,000	Ascomycete fungal plant pathogens cause large economic losses in many New Zealand crops. These include Botrytis cinerea in the wine industry; Sclerotinia sclerotiorum in kiwifruit; Venturia inaequalis in pipfruit; fruit rots in avocados; and Monilinia fructicola in stonefruit. Diseases caused by these pathogens cost more than $NZ50M per year from lost production and chemical controls. Fungal resistance to these chemicals limits their effectiveness. These diseases typically result from primary infection by spores, spread by rain or wind, which recognise they have landed on an acceptable host and initiate infection of the plant. Mechanisms for host recognition is thought to be conserved in many fungi families. By finding a way to block the fungus from recognising it has landed on a host plant, the diseases would not develop, saving growers $millions in control costs. This research aims to identify the pathways that are activated in the fungus during host recognition and develop inhibitors to disrupt the fungus in this early infection phase, stopping the disease from establishing. The project will identify, design, synthesise and test these inhibitors in the lab to determine their potential effectiveness in the field against the horticultural diseases of economic importance listed above. Application of this new biological control science to manage fungal pathogens is supported by Horticulture NZ and Maori companies in the horticulture industries.
	Cellular agriculture of fish: premium seafood from immortalised cell lines.	3	$1,000,000	Cellular agriculture, the production of agricultural products from lab-grown cells, is at the cutting edge of alternative protein technology worldwide. By "growing" food in the laboratory, there are opportunities to use fewer resources, and improve the environmental impact of food production through the reduction of greenhouse gas emissions and carbon footprints. Cellular agriculture research has focused primarily on meat alternatives based on bovine (cow) cells. This project would explore whether fish-meat cellular agriculture is possible and viable as an alternative to traditional meat production. The research will explore some of the technical challenges of growing fish cells in a laboratory, including how to grow the cells into 3D structures supporting ideal texture and mouth-feel characteristics. Fish cellular agriculture is a new field of research. This project would provide opportunities for New Zealand to be a leader in the development of fish cellular agriculture production systems, as a part of a diversified premium protein offering for export markets. It will also develop concepts that would inform a debate around their potential use as part of New Zealand's sustainable food offering.
	Sex pheromones of social wasps: From discovery to population disruption	3	$999,999	The invasion of NZ's 1.2 million hectares of indigenous beech forests by Vespula wasps represents one of the better researched ecological disasters caused by any invasive species, with major impacts on iconic endangered fauna. This Smart Idea will identify the sex pheromones of the two main Vespula species in NZ, which can then be developed and exploited as an effective, additional management and control tool in beech forests on a large landscape scale. Sex pheromones are species-specific and an environmentally friendly method to control insect pests, with almost no impact on other species or native fauna. Trials using sex pheromones to control such social wasps in the natural ecosystem will be the first of their kind and will inform the identification of the sex pheromones of other species that post a threat to NZ's natural ecosystem. In doing this work, we are therefore contributing to wider NZ and international scientific efforts in biocontrol as a research model. The use of sex pheromones for control will be a game changer in wasp management, intended to have a significant and positive long-term impact on the environment, the economy and health of NZ, with implications for cultural wellbeing and kaitiakitanga of Maori. Four complementary research groups, Maori pest expertise and the NZ Department of Conservation will join forces, combining their specific knowledge, expertise, personnel, equipment and infrastructure to unlock this challenging task and ensure a positive outcome for the proposed research.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
	Using plant-microbe interactions to manipulate dormancy for increased post-harvest value	3	$1,000,000	We will take a novel approach to investigating dormancy in potato tubers with a goal of finding new methods for managing dormancy. Most plant species have evolved a dormant state, commonly as seeds, bulbs, tubers or dormant stems, to survive periods of adverse environmental conditions. Gaining control of the specific dormancy system of each crop is central to horticultural productivity. Manipulation of potato tuber and onion dormancy is required for a continuous supply of quality product for fresh consumption and industrial processing. Foods made from dormant potatoes are tastier and more appealing than if sprouted potatoes are used. Dormancy and sprouting are complex physiological processes regulated by both environmental and endogenous factors, and involving comprehensive changes in many biochemical pathways including carbohydrate and phytohormone metabolism. Dormancy of potatoes and onions is currently managed through environmental methods such as cold storage, and by use of chemical suppressants. Both of these methods have disadvantages so there is a need for new solutions. We will use gene expression and biochemistry data to identify candidate compounds and processes for dormancy control. These will be tested for efficacy using sprouting assays. We will work with VM partners to explore the interface between traditional Maori knowledge and modern science by researching traditional cultivation and storage practices and validating these using scientific methods. Our vision is to find a novel sprouting inhibitor that is superior to existing methods in terms of efficacy, safety and cost. We envisage our research leading to new dormancy management techniques, providing safe, effective and socially and environmentally acceptable dormancy management for future domestic and export opportunities. While our immediate target is potatoes (including taewa), our research will have relevance to other crops.
Unitec Institute of Technology	Assessing Reidentification Risks with Bayesian Probabilistic Programming	3	$998,504	Sharing data is at the core of society and industry; it enables efficient and reproducible process, and a vibrant data-driven economy. Areas like the pharmaceutical and health research and industry benefit tremendously from the ability to share and analyse patient data, as do social networks for creating revenue through advertising. As these examples show, the value of sharing data comes at the price of a latent risk to privacy protection, as acknowledged by legislation like the GDPR in Europe and the upcoming revision of the New Zealand Privacy Act, which control how 'personal information' may be collected, used, disclosed, stored, and accessed. To protect the privacy of individuals and to minimize the risk of re-identification, data is often anonymized before sharing. Current methods are mostly based on indirect mathematical approaches that are difficult to evaluate. This hinders data sharing, as neither scientists, lawmakers, nor data subjects can appreciate the guarantees provided. This project develops novel methods to measure the quality of anonymization of data. The proposed measure is the probability of re-identification of a subject by an attacker in the presence of yet unknown data. Probability is a commonly understood measure of risk. The project will provide a new theoretical framework for measuring anonymity of data before sharing, improving on existing, established solutions, and efficient inference algorithms and effective tools to demonstrate the applicability of the resulting approach. Beneficiaries of the project results will be public agencies, companies, iwi groups and citizens. These groups will be empowered to understand the risk of sharing data, or to choose an anonymisation algorithm that fulfils certain criteria. In the long run, this could have influence on data sharing policies and privacy acts.
University of Auckland	Personalised medicine for movement disorders	2	$999,948	Disorders that affect movement, such as stroke, manifest in many ways, making prognosis and treatment challenging. Clinicians currently diagnose and treat movement disorders by qualitative assessment and interpretation using knowledge and intuition. We propose a paradigm shift towards personalised medicine for movement disorders, in which we replace qualitative assessment with quantitative assessment and interpretation using biomechanical models and data-driven classification. We will create an anatomical and functional atlas of the musculoskeletal system that will enable clinicians and others to rapidly generate biomechanical models of the muscles and bones of an individual. Our functional atlas will include muscle coordination patterns and a machine-learning approach to classify a stroke patients' walking gait. In addition we will develop a novel 3D scanner using depth-sensing cameras and a new biosensor capable of measuring muscle activity without the need for skin preparation and conductive gel. These novel bioengineering tools will be commercialised via: licensing with commercial partners ; a Software as a Service business, offered to end users such as physiotherapists, orthopaedic surgeons, and human movement researchers; and new startup company to manufacture our novel biosensor.
	Realising Children and Young People's Participatory Rights in Child Protection Services	3	$982,854	The United Nations Convention on the Rights of the Child requires signatory states to ensure the right of all children to meaningful participation in decisions affecting their lives and wellbeing. Achieving this goal is particularly difficult for children involved with statutory child protection services. Indeed care-involved children and their families report having little meaningful involvement in key life-changing decisions. In New Zealand, this lack of full participation is of particular concern in relation to Maori children and families. In the 12 months to 31 December 2018, 65,000 New Zealand children were reported for child maltreatment, of which 34,000 were referred for investigation. Almost half of these children were Maori. Further into the system, 68% of New Zealand children currently in statutory care are Maori children. These children and families face distinctive challenges to full participation in care planning and decision-making, related to intergenerational histories of colonisation and understandable cultural mistrust of the statutory child protection system. To address these challenges our research will use Kaupapa Maori participatory methodologies, informed by Oranga Mokopuna , a decolonial child wellbeing model based in Te Ao Maori and collective indigenous rights, to co-design a Kaupapa Maori protocol for more effectively realising Maori children's participation in the child protection system. We will also co-design training materials to strengthen the capacity of the child protection workforce for effective, culturally responsive practice with Maori children and their families. The adoption of Kaupapa Maori practices within the care system will lead to increased engagement and improved wellbeing of Maori children and families accessing social services. The project will also contribute knowledge to international efforts to improve services to indigenous children and families involved with child protection services.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
	Engineering microbial enzymes for plastic recycling and environmental remediation.	3	$997,191	Plastic waste is a world-wide problem, and a current headline issue, highlighted by the recent discovery of a plastic bag at the bottom of the Mariana Trench. Plastics are resistant to degradation, they accumulate persistent organic pollutants, and can enter the foodchain as microplastic particles. Most plastics are used in short-lived products such as packaging, and in New Zealand, more than 25,000 kg of plastic waste is discarded daily. The national importance of plastic waste is highlighted by the New Zealand Government's recently proposed mandatory phase out of single-use plastic shopping bags. Only 25% of the plastic the average New Zealander uses will be recycled, and those that do get recycled are mostly used in lower-value products that are not again recyclable after use. For example, only 7% of PET (polyethylene terephthalate, the polyester plastic widely used in drink bottles marked with recycling symbol #1) is recycled bottle-to-bottle. Innovative technologies to improve the recycling of plastics and to reduce the consumption of non-renewable fossil fuel feed stocks are urgently required. Recently, two bacterial enzymes were identified that can biodegrade PET to its environmentally benign constituent parts. However, a key challenge is that the enzymes are not efficient enough in biodegrading the highly crystalline forms of PET that are in wide use. We therefore propose to use protein engineering to make better versions of the enzymes that will break down PET effectively. We will link heat-stable versions of the enzymes to other proteins that will improve their surface contact with crystalline PET using a bio-scaffold that we have developed. The result will be an industrially viable, non-GMO product that will be capable of biodegrading PET waste.
	Augmented Nutrition	3	$1,000,000	Nutrition is a key component of health. When we are unable to obtain sufficient nutrition we sometimes need to be fed directly by tubes that carry liquid food directly into our gut. This can happen when we are very unwell or unable to eat for some other reason. The current methods of delivering this extra nutrition are not very efficient. We are developing an alternative product that will provide a better way to ensure that the sick and infirm receive optimal nutrition. The augmented nutrition system will be developed in New Zealand and is expected to offer a number of benefits ranging from new knowledge about nutrition, through to employment in the sector and then eventual direct health benefits for the patients.
	Novel boron carriers for Boron Neutron Capture Therapy, a non-invasive cancer treatment	3	$999,000	Radiotherapy an important treatment for cancer and is used in almost 60% of cases, therefore is a vital tool to eradicate cancer. Most radiotherapy techniques result in the killing of cancer cells but also affect healthy tissue, leading to unpleasant side effects, lengthy hospital stays and impact on patients quality of life. Boron neutron capture therapy (BNCT) has shown to be an extremely effective way to treat cancer and only relies on 2 components, a neutron source and a chemical compound containing a boron atom; the chemical compound accumulates only in cancer cells, is treated with a neutron beam which causes only the boron atom to decay to high energy particles that kill the cancer cell and are restricted to the cancer cell only. This spares radiation damage to healthy cells. The problem of using BNCT as a frontline therapy is i) the requirement of a nuclear reactor to generate the neutron beam and ii) the identification of a chemical compound that can carry boron into cancer cells only. This research will identify new compounds that can directly target cancer cells and can carry boron into these cells, whilst leaving healthy cells alone. Coupled with new NZ-based non-nuclear technology to generate neutrons and expertise in medicinal chemistry, BNCT is poised to change the way cancers are managed and NZ can lead a nuclear-free way to treat cancers.
	Testing a post-normal approach to consensual technological evaluation and adoption	2	$978,782	In the coming decades, New Zealand will face major challenges and transitions that will have significant social and economic impact. Policy decisions on how to deal with these challenges will often be contentious. The transition to a low carbon economy and the digital transformation will confront different perceptions of risk and precaution with regard to the use of novel science and technology. It will also challenge firmly held beliefs and world views. Political institutions do not have a good record of public discussions around novel and contentious technologies. The challenges are compounded in the global atmosphere of decreasing trust and growing antidemocratic movements. Participatory approaches similar to those embedded in the Resource Management Act have been shown to be both inequitable and too rigid for the fast moving world. Internationally, there is a recognition that models of democratic decision-making based on open and ongoing dialogue – termed "deliberative democracy" – are needed. Our team, consisting of academics in science, humanities, and education, policy specialists and Maori researchers, has experience and interest in the processes of engagement. We propose to develop and test a novel, New Zealand-adapted model to assist mutual understanding and help move forward in public policy issues involving emerging technologies of high potential social and economic consequence. We will draw on Kaupapa and Matauranga Maori, participatory and deliberative democracy research and practical experiences in New Zealand and overseas, and test the model using scenarios on (1) life science technology related to climate change mitigation and adaptation in agriculture and (2) digital technology and data use in public policy. Our model is expected to have benefits ranging from economic to increased Maori participation and improved policy and governance processes.
	Making New Zealand homes quieter, a sound investment	3	$991,095	In a world of population densification, increased traffic flows and high power home entertainment systems, noise pollution is becoming a large problem. There is increasing concern in New Zealand and overseas about inadequate sound insulation in buildings and the implications for occupants' health and well-being both in the public and private sector. The problem is particularly evident in medium-high density housing, which are projected to become 30 percent of Auckland's housing by 2050. Irritating acoustic intrusion frequently occurs at low frequencies, below 500kHz (eg; bass beat from music systems). Sound within this frequency range is often found at home and in the work-place and, and can cause loss of concentration and reduced productivity. Achieving effective isolation in this range is both challenging and expensive with conventional solutions, which require significantly increasing the density, mass or thickness of the partition through which the sound is transmitted. This introduces additional weight and costs as well as a reduction in usable floor space. Through previous research and preliminary experiments conducted at the University of Auckland's Acoustic Research Centre we have shown a combination of acoustic metamaterials and multiple helmholtz resonators can improve the acoustic insulating properties of conventional New Zealand intertenancy partition systems. By targeting the two poorly performing frequency regions, known as the mass air mass resonance and coincidence frequency, we believe our smart idea solution will significantly improve the sound transmission loss performance of the partition systems whilst adding negligible mass or volume to the wall. In summary, we aim to produce a lightweight partition system made from conventional materials with significant performance improvements at the 60-100Hz subwoofer frequency and 2500Hz coincidence frequency regions.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
	Drinking-Water Pathogen Monitoring in Real-Time	3	$999,999	Reliable, equitable access to safe, clean water for drinking, recreation, agriculture and culture is essential to the people of New Zealand and the rest of the world. Clean water is central to achieving wai ora, a safe, healthy living environment for Maori and all New Zealanders, and to the values of kaitiaki, or guardianship. Population growth, intensified food production and inventions like plastics have polluted this critical human resource. In New Zealand, 1-in-4 people do not have access to safe drinking water. Our 100% Pure brand is threatened by our increasingly polluted waterways, and gt;80% of New Zealanders express concern about our water quality. To address this challenge, we must have widespread water testing, and current technology is not fit for purpose. This Smart Idea will create an instrument that can provide in situ , autonomous, label-free, inexpensive water monitoring for biological and chemical contaminants. It will provide industry, communities and governments with an essential tool for achieving and maintaining safe, clean water. We anticipate economic benefits to New Zealand through (1) high-value manufacturing, New Zealand sales and export; (2) reduced water testing costs; and (3) reduced social and healthcare costs associated with poor water quality. Utilisation of our innovative technology will deliver broad environmental and social benefits as well. A NZ best team has been assembled with complementary strengths in photonics, spectroscopy and complex data analysis, biology and the environment, alignment with the ideals of Vision Matauranga, and with award-winning experience in translating university research into economic impact. We will work throughout with relevant stakeholders (councils, government agencies, water technology companies, consultants) to ensure that our innovative water testing solution is fit-for purpose.
University of Canterbury	Development of a multi-axis spin-coating system to coat curved surfaces	3	$1,000,000	What do smartphone displays, solar cells, electronic circuit boards, and Compact Disks have in common? They all tend to be flat, rigid structures. The reason for this feature relates to the fact that most of the manufacturing processes involved in the production of these objects have been optimized for flat, rigid surfaces. The corner stone of these processes involves covering the substrate with a thin coating layer and a common technique, known for its effectiveness and low-cost, is spin-coating. In this process, the liquid is first deposited on the surface and then spun off it to leave a thin film which eventually solidifies, producing a solid coating layer. To this day, spin-coating is only effective for flat, rigid surfaces because curvature on the surface leads to undesirable and uncontrollable coating unevenness. The research we are proposing will deliver an innovative system able to coat complex-shaped objects with a coating of desired thickness distribution. The machine will be informed by a computer simulations able to predict the evolution of the coating layer and determine the optimal processing parameters. The ability to spin-coat curved objects will bring disruptive technologies such as electronics on curved surfaces or solar cells embedded on corrugate panels one step closer to mass consumption.
	Integrated biomass gasification with chemical looping and oxygen uncoupling for H2 production and CO2 capture	3	$999,999	This proposed research aims to develop a new process and new materials to produce bio-hydrogen and capture CO 2 by utilisation of New Zealand (NZ) woody biomass resources. The bio-hydrogen can be used as transport fuel, for future fuel cells and as a chemical feedstock for methanol, ammonia and oil refineries. At present 95% of the hydrogen used in these industries is produced from fossil fuels. CO 2 captured from this process will be used in plant nursery greenhouses, fertiliser manufacturing and methanol/ethanol production. Every year NZ exports over 17 million m 3 wood which has very low profit. In addition, over 3 million tonnes of wood residues are generated from log harvesting and wood processing which are not efficiently used at present. The technology to be developed will support a new industry of bio-hydrogen production and CO 2 capture which will add values to NZ waste woody biomass resources and wood from plantation forests. This research delivers to MBIE's National Statement of Science Investment for investing in excellence science that will transform New Zealand both economically and environmentally. The future value, growth and critical need are aligned to NZ's Energy Strategy to 2050 and NZ Biofuels Roadmap.
University of Otago	Diagnosis by light: An endoscopic probe for biopsy-free diagnosis of gastrointestinal diseases	3	$999,999	Gastrointestinal health is an increasing point of focus in the New Zealand healthcare system, as evidenced by the recent implementation of the National Bowel Screening Programme. Endoscopes are an invaluable tool in the gastronenterologist toolbox. Endoscope-based diagnoses of gastrointestinal illness currently rely on the visual inspection of the gastrointestinal tract surface or from microscopic assessment of removed tissue samples. Our Smart Idea is to accessorise current endoscopic technology to enable point-of-care diagnosis of gastrointestinal illnesses, removing the need for blind biopsy collection. We will combine lasers, fibre optics, the study of light-matter interactions, and machine learning with clinical knowledge to develop new technology which will objectively diagnose gastrointestinal illness. The team developing this new technology is inter-disciplinary (chemists, physicist, information science and clinician) and inter-generational (early career to experienced). Hence, this project will benefit New Zealand not only through the revenue generated by the sales of this device, and the impact it will make to health outcomes, but also to the development of New Zealand's knowledge economy. The sophisticated diagnostic tool developed in this Smart Idea will benefit the hauora of Maori, though improved health outcomes due to earlier treatment of gastrointestinal illnesses.
	Cultivating resilient marine forests to rebuild productive coastal ecosystems	3	$1,000,000	Kelp-forest habitats are in decline along New Zealand's coastlines, echoing global patterns of loss. A key symptom of kelp-forest decline is a collapse of valuable coastal fisheries that are reliant on the services that they provide. In New Zealand this impact is being felt within the two most lucrative inshore fisheries, rock lobster (~$800 million p.a.) and paua (~$160 million p.a.). We will develop the infrastructure and methodology to genetically select and reseed climate change resilient strains of Macrocystis pyrifera into areas where kelp-forests have been lost or are threatened by warming. This project will safeguard and stimulate fisheries value in a changing ocean and deliver economic and cultural benefits to the communities that rely on them. It will also initiate research around a nascent seaweed aquaculture industry in New Zealand which shows significant economic potential, but is currently hindered by a lack of knowledge regarding culturing practices. This project brings together national and international scientific experts, commercial fishing representatives from New Zealand's rock lobster and paua industries and members of Te Runanga o Ngai Tahu's customary fisheries management team to rebuild and buffer these valuable ecosystems against climate change related stressors. The research team will leverage international expertise and apply it in a New Zealand context to achieve success. They will undertake marine reforestation which complements terrestrial restoration efforts to produce an example of true ecosystem-based management.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
	Enabling possum fertility control and eradication	3	$999,970	We will deliver the first method to modify brushtail possum fertility through gene editing, resulting in a pathway for the development of genetic biocontrol technologies for possum eradication from New Zealand. Possums are a serious economic and environmental threat to New Zealand, making eradication a national priority. Gene editing is extremely promising for pest eradication: genetic changes- for example, female fertility disruption- can be engineered to spread through a population in a self-sustaining way, ultimately resulting in local eradication. Currently, no method exists for marsupial gene editing. Our project will provide the missing link for genetic editing to be used for possum biocontrol development for the first time. We will target immature sex cells of possum pouch young, rather than embryonic cells, before they develop into eggs or sperm. Our research will be a laboratory-based proof-of-concept only, and will not involve field trials or release. Whether gene technologies should be used for possum biocontrol is hotly debated; our project will identify whether they could . If so, we aim to deliver a method for applying them that could be utilised, should there be policy support and social licence. Our project involves a core team of experts in marsupial reproduction and genetics, and predator control, capable of successfully delivering the ambitious outcomes. Critically, our research will be overseen and guided by a strategic advisory panel involving representatives from a wide spectrum of pest control end-users and stakeholders, including representatives of Ngai Tahu, specifically to mitigate social, cultural and policy risks associated with gene editing. This panel will thus ensure that what we develop is socially responsible, fit-for-purpose, and meets the needs and expectations of end-users and stakeholders.
	Modelling the cracks, chills and feedbacks that will control Auckland's next eruption	3	$1,000,000	The presence beneath Auckland, New Zealand's major population and economic centre, of a volcanic field poses significant risks to the city, region and country. An eruption will have an economic impact that is nationwide, and infrastructure impacts that are at least regional because all major Northland lifelines pass through Auckland. Auckland-style eruptions can last for years, and impacts can best be minimised, for example by focused evacuations and targeted monitoring with specific techniques, if we can predict how an eruption is likely to change after it has begun. The proposed work will leverage overseas investment through collaborating with the leader of a major field-scale volcanology experimental facility in the US and an experienced eruption-response leader in Iceland. Results of the study will be applicable not only for Auckland, but for all newly forming volcanoes in volcanic fields worldwide, and for many eruptions that take place in New Zealand (e.g. the 1886 Tarawera-Rotomahana eruption), or on volcanic islands such as Hawai'i (USA), Tenerife (Spain), and Iceland. These all share the common feature of eruptions that begin with opening of long cracks in the ground, which can then extend, have volcanic cones developed along them, or experience explosive eruptions that produce large craters and dangerous 'ash hurricanes' that race outward from the crater sites.
	Generating non-heading ryegrass	3	$1,000,000	Farm productivity relies on a steady supply of feed for grazing animals. In NZ this mostly comes from ryegrass. However, in late spring ryegrass undergoes heading (flowering), which reduces feed quality, causing a drop in productivity across the pastoral sector. The goal of this work is to generate non-heading ryegrass so that the quality of feed is maintained through summer and autumn. To deliver elite non-heading ryegrass to NZ farmers, we will generate the tools and understanding required to develop elite ryegrass cultivars that do not head in most NZ field conditions but can be induced to head for seed production. These non-heading ryegrass cultivars will increase feed quality and provide environmental benefits by improving land-use efficiency, thus aiding moves to more sustainable agriculture.
	Computational platform for phylogenetic analysis of somatic evolution	3	$1,000,000	Phylogenetics provides crucial information that is relied upon in almost every field of the life sciences, and is particularly important for evolution, ecology, conservation, and infectious disease research. New sequencing technologies are expanding the scope of modern phylogenetics to include developmental biology, somatic mutation, and cancer biology, with applications in agriculture, biotechnology, and biomedicine. However, traditional phylogenetic models do not reflect the biological processes or the vast scales of data involved in understanding these new areas. Furthermore, new single-cell sequencing methods create fundamentally new modelling challenges. As such, the field currently lacks the comprehensive software platform necessary to facilitate accurate and widely-applicable phylogenetic analyses. New Zealand is a world leader in phylogenetics, with the Royal Society Te Aparangi currently including at least 12 phylogeneticists as Fellows. These scientific capabilities are being successfully transferred into commercial products -- New Zealand bioinformatic companies, for example Biomatters, successfully deliver data analysis services worldwide. Our team's computational methods and efficient algorithmic solutions are recognised by top meltidisciplinary journals and used every day all around the globe. We hence are ideally placed to design new mathematical models to accurately reflect the developmental biology, somatic mutation, and oncogenesis implement the models within the phylogenetic platform BEAST2, using state-of-the-art algorithmic solutions such as online algorithms produce exemplar data analyses and insights on novel datasets from multiple kingdoms of life engage with potential users by running tutorials, workshops, and code clinics. These activities will result in a new bioinformatic technology available to a wide range of users, including universities, biotechnology companies, and healthcare providers. We will also deliver free and open-source bioinformatic tools, tutoring services, and support to the wide range of New Zealand users.
	Phage-inspired custom antimicrobials to target bacterial pathogens	3	$1,000,000	Bacterial pathogens have a significant effect on agriculture, food safety and human and animal health. The increase in drug-resistance in bacterial pathogens is a significant threat to food production and human health. In addition, environmentally friendly antimicrobials are needed for sustainable agriculture. Therefore, new antimicrobials are required to meet these global challenges. In NZ, Pseudomonas syringae pv. actinidiae (Psa) is a bacterial pathogen that has significantly impacted the kiwifruit industry. Psa strains are emerging that are resistant to the standard agrichemical treatments, such as copper, and there is a need for specific, environmentally friendly, sustainable alternatives. We will establish phage-inspired antimicrobials for the generation of antibacterials against significant bacterial pathogens. Overall, these phage-inspired antimicrobial products will be valuable to the NZ and international kiwifruit industries. Future markets in food safety and human medicine are envisioned.
	Quantifying environmental resources through high-resolution, automated, satellite mapping of landscape change	3	$1,000,000	The Earth is a dynamic system—Trees grow, alpine snow melts, landscapes erode, and tectonic plates collide, sometimes with dramatic consequences. These environmental changes produce measurable variations in surface elevation, but current topographic maps are mostly stationary in time. As a result, subtle but important changes remain undetected. Were these topographic signatures revealed, environmental managers and the New Zealand public could make more informed decisions with respect to managing our precious natural resources in a safe, sustainable, and efficient manner. This project will develop a novel way to make 3D-change maps with unprecedented detail and sub-metre accuracy. We will produce 3D-change maps for the Southern Alps, with uptake by our early adopters to ensure communities are resilient to geohazards and to improve hydro-generation potential. At the completion of this project, 3D-change maps focused anywhere in the world will be will be available on-demand through an online web-service.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
	Contact-free sensing of high voltages using a laser electrometer	3	$1,000,000	New Zealand is a country with a very diverse energy landscape - where in addition to traditional sources, hydro and renewables play a crucial role. The country also has a unique geographical topology, which makes transmission and distribution of electricity challenging to many remote locations. Our smart idea will lead to a novel monitoring technology for the national grid and will be ideally suited to be deployed in many remote areas. This will reduce power interruptions and ensure better monitoring of the high electromagnetic fields from, for example, power stations. But, it will also improve the working conditions of the workforce, for Transpower or associated sub-contractors. This will have significant benefits to manage the health and safety risks associated with the monitoring and repairs to the electrical grid in NZ. In addition, our technology will contribute to making NZ power infrastructure more cost-effective, reliable, easier to maintain and extend the life-expectancy of valuable electricity grid assets. It will also contribute towards the transition to a low-emission economy inherently reliant on electric energy.
University of Waikato	Evaluating earthquake risk using liquefied volcanic-ash layers in lakes	3	$1,000,000	Newly-discovered hidden faults in the Hamilton lowlands - an area thought devoid of active faults - pose a potential seismic risk, as shown by the shocking 2010-11 Canterbury earthquakes. But their lack of surface expression hinders direct assessment of the frequency and intensity of activity on the faults. However, liquefied volcanic-ash layers, which we call 'tephra seismites' ('tephra' means ash/ashes), have been found preserved in lake sediments in many small lakes (e.g. Lake Rotokauri) scattered amidst the faults in the lowlands. From preliminary sediment-core studies, we have identified four tephra seismites, implying that at least four major earthquakes occurred in or near Hamilton since 20,000-years ago. Our goal is to find out where and when they (and possibly others) occurred so that we can develop a reliable seismic hazard-risk map for the lowlands. How? (1) We will map the tephra seismites spatially and temporally using the lakes as a giant 'prehistoric seismometer'; (2) measure their properties; (3) develop a mechanism for their generation; and (4) assess seismic risk. Because no one has ever identified tephra seismites before, we will devise a new methodology, including use of (i) tephrochronology, a method of transferring known accurate ages on tephras from one place to another; (ii) medical CT-imaging and physical and geotechnical analyses to characterise the tephra seismites; (iii) geomechanical testing to develop a cyclic resistance model (CRM); and (iv) cone-penetration testing on lakes to validate the CRM. From the CRM we will derive minimal paleoseismic intensities that triggered the liquefaction of the tephra seismites, and hence generate paleoseismicity and earthquake-risk maps to enable hazard planners, policy makers, and engineers devise ways to mitigate the effects of potential future earthquakes in the region.
	User-friendly deep learning	3	$1,000,000	Deep learning (machine learning methods based on artificial neural networks) technology can support organisations to develop their own software applications, but the development process requires expert knowledge in deep learning architectures and algorithms, and complex models that are labour- and time-intensive to set up for new domains outside standard application areas such as object recognition, text classification, and speech recognition. We propose to design a software platform that engages an end-user in the deep learning process through an interactive graphical user interface, automates model structuring and parameter tuning as much as possible, and does not require any user programming. This platform will unlock access to deep learning technology for a much wider sector of the economy. Moreover, enabling end-users to build predictive models directly without requiring outside expertise will yield more accurate solutions in less time. This will be achieved by building on work in human-computer interaction, model visualisation, meta learning, active learning, semi-supervised learning, and automatic machine learning. Many economic, environmental, and social questions require accurate decision-making based on data consisting of a large number of highly correlated variables, such as orchardists wishing to estimate crop yield, fertiliser companies wishing to measure the quality of their products, paediatric neurologists wishing to identify cognitive disabilities in children from an analysis of their physical movement, and conservationists wishing to estimate species abundance in streams and rivers. In such applications, deep learning can dramatically reduce time and cost. However, most organisations face significant barriers to the use of this technology because of the set-up cost involved and the lack of expertise in New Zealand. We believe that we can develop a user-friendly software platform that removes this bottleneck.
	A new method for measurements of muddy suspended sediments in aquatic environments	3	$1,000,000	Muddy sediments entering rivers and estuaries are a significant environmental concern in many places worldwide and New Zealand is no exception. These sediments can smother marine life and damage ecosystems. Unfortunately, land-use changes mean the amount of sediment entering our waterways is increasing. In order to implement better environmental management strategies, it is crucial that we can accurately measure how much sediment there is in the water and also reliably predict where the mud will end up. However, currently, we cannot easily measure mud concentrations in water. For sandy particles, measurements over large areas are routinely made using acoustic instruments, which emit and receive sound from a transducer (in a similar manner to a police speed radar). The problem with using a similar technique for mud arises because mud particles stick together (flocculate) with bits of organic matter in a very irregular manner, which changes how the sound reflects. Our team of leading researchers will try to overcome previous difficulties by utilising new technology to 3D print very small nano-particles of known shapes and sizes. We will then conduct laboratory experiments to learn how sound bounces off these complex but well-defined particles, to help us quantify the interactions between sound and particles. We will then test our new knowledge in the real word in a field experiment. The end goal is to develop a new tool, which will be able to accurately, quickly and easily measure and monitor the amount of mud suspended in our rivers and estuaries.
Victoria University of Wellington	Developing a synthetic biological platform to access the chemical diversity of New Zealand microbial communities	3	$1,000,000	Less than one percent of the earth's microbial diversity has been successfully cultivated in a laboratory setting, however the natural products biosynthesised by this small fraction have provided some of the most important antibiotics, anticancer compounds and immunosuppresants in clinical use today. Locked in the DNA of uncultivated microbes, are the instruction sets for building an untold wealth of new medicines. We have developed a new approach for unlocking these instruction sets. Using DNA sequencing and synthetic biology, our team will take a deep dive into uncharted microbial space, and discover the genetic blueprints that direct production of new drug candidates. We will then re-build these blueprints in laboratory cultivable hosts in order to characterise the compounds that they encode.
	Rational design and synthesis of novel pharmacological chaperones to treat Krabbe disease	3	$1,000,000	This program aims to treat Krabbe disease, an inherited disorder that results from the build-up of a particular type of fat, in the brain. This fatal neurodegenerative disorder for which there is no treatment is caused by a defective enzyme. We will use a unique technology developed in New Zealand to deliver a specific type of drug for chaperone mediated therapy innovative approach. Our drug will reversibly bind to the active site of the defective enzyme involved in Krabbe disease and rescue it from a premature degradation which will prevent the disease.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 SMART IDEAS

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
	Measuring income inequality, poverty and mobility in New Zealand	3	$999,459	Evidence on income inequality among New Zealand individuals and households is increasingly important to many analyses of social wellbeing and government policy. But to evaluate income inequality more fully, it is important to know how incomes change over time , relative to other individuals. Income mobility influences longer-term income inequality, and income changes (or 'dynamics') are crucial in determining movements into and out of poverty. For example, a series of cross-sectional inequality 'snapshots' and longer-term inequality measures need not move in the same direction. However, very little is known about the extent and nature of these dynamic income processes among families in New Zealand. This project will establish how individual and household characteristics determine observed movements in people's incomes, and their position in the income hierarchy, over time – leading to both upward and downward mobility. It will also address how poverty persists over time for some individuals while others move into or out of shorter spells of poverty. Understanding these dimensions will have substantial impacts on the way New Zealanders' wellbeing is evaluated. The project results will therefore contribute evidence for the formulation and evaluation of government policy. It will provide more comprehensive input than is currently available into major government programmes such as those targeted at poverty, education, regional development and health care. Future incomes across the New Zealand population will be better understood, and the policies designed to improve them will be better conceived, including policies targeting regional, ethnic or occupational mobility.
	Next-generation technologies for pest control: gene silencing for invasive wasp control	3	$999,999	Pest control is essential for environmental, health and economic wellbeing. However, the global attitude towards pest control is changing. There are increasing concerns over non-target effects of pesticides and their effects on human health. Pesticide resistance is also a substantial issue for the vast majority of pests where chemicals are used. This research programme will develop a next-generation pest management approach that is highly targeted and environmentally safe. Our aim is to develop a bait that is only effective on our target species, the European paper wasp, and leaves other species, including bees, unaffected. We propose to use a technique called gene silencing. This uses custom designed double-stranded RNA (dsRNA) for pest control. This is not genetic modification but instead represents a whole new type of pesticide. The European paper wasp (Polistes dominula) is a newly arrived invasive species that has already become a major problem in the Nelson area. The study will involve the selection of target genes, the development of a highly-attractive bait matrix, and the registration of the dsRNA and bait matrix product with the Environmental Protection Authority (Te Mana Rauhi Taiao). While there is a critical need for control methods for this invader, gene silencing holds promise for a wide range of pests and pest-management programmes. Our work with Maori communities suggests gene silencing is a preferred next-generation pest control technique. Discussion and consultation with end-users will continue within this programme. Given that the design and implementation of gene silencing is a knowledge-intensive process, our work involves collaboration between NZ's leading applied entomologists, geneticists and ecologists. Our work will pave the way for a world-leading industry in New Zealand providing highly providing this next-generation technology.
	Non-toxic hybrid nanomaterials for luminescent solar concentrators	3	$999,999	To fully realise the government's commitment to a low carbon economy, we need to develop game-changing renewable energy technologies that can be produced here in NZ. Our goal is to create inexpensive-high efficiency, non-toxic luminescent solar concentrators coupled to commercial solar cells. Luminescent solar concentrators (LSCs) offer a simple method of decreasing the cost while increasing the efficiency of solar energy generation. LSCs consist of a cheap transparent material incorporating highly luminescent chromophores (light-absorbing molecules). Sunlight falling on the LSC is absorbed by the chromophores and then transported to photovoltaic cells. This means you can effectively replace expensive solar panels with cheaper, potentially structural, materials while maintaining the overall power output. However, problems with toxicity and the reabsorption of concentrated light, which leads to a drop in luminescence intensity and thus efficiency, severely limit the realisation of commercial LSCs. Reabsorption has previously been addressed through synthetically complicated organic molecules or toxic inorganic nanocrystals. But their synthetic complexity and toxicity mean they are not suitable for commercialisation. While non-toxic nanocrystals and simple organic molecules emitters do exist, their luminescent efficiencies limit the use. We aim to combine two previously separate fields of research to create hybrid organic/inorganic chromophores. These will not require the complex surface treatments needed by current state-of-the-art non-toxic emitters, and they will also alleviate the reabsorption problem through energy transfer to a low concentration emitter. The materials we will produce will be superior to any other luminescent materials for use in LSCs and easier and cheaper to manufacture. We will work with industry partners Resene Paints and Callaghan Innovation to rapidly develop LSC prototypes. We envision having a next-generation solar device on the market in 10 years' time.
Weather Radar New Zealand Limited	A New Approach to Weather Radar Observations for Real-time Natural Hazard Warnings	3	$999,999	Climate change projections signal an increase in the intensity of extreme rainfall in coming decades. Heavy, localised rainfall is responsible for many natural hazards, from poor water quality to the diabolical effects of flooding, erosion and landslides. Although, significant effort has been made to develop models aimed at mitigating these hazards and providing advance warnings, these efforts have been hampered by the availability of suitable rainfall observations. Rain gauge accumulations are often the only viable option, though are particularly ill-suited for detecting high-intensity rainfall events due to the poor spatial coverage of the observations. In contrast, weather radar measures both the instantaneous rainfall intensity and its spatial coverage; this information can be disseminated in real time. However, national weather radar observations are still too coarse for many hazard modelling applications. This Smart Idea will create world-first, hybrid radar systems for rainfall observation. Uniquely, profiling the vertical structure of rain and drop size distributions. Incorporating this information in scanning radar observations, allows rainfall to be mapped with exceptional spatial and temporal resolution, and unprecedented accuracy. Systems will be deployed directly in regions of interest, observing intense and rapidly-evolving rainfall with unprecedented detail, so the project partners (GNS, NIWA, Auckland Council and Scion) can improve their hazard models. This will revolutionise the ability of decision makers to understand, predict and respond to the threats of rainfall-induced landslides, forestry catchment erosion, flooding and water quality in urban, semi-urban, rural and natural environments. For the first time, rain drop size distribution profiles will be used to quantify rainfall processes in mountainous, coastal regions, resulting in dramatically improved weather forecasts in regions prone to extreme rainfall.

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 RESEARCH PROGRAMMES

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
AgResearch Limited	Rapidly evolving climate-smart dairy cattle	5	$10,000,000	Climate change is reality and dairy cattle are both contributing to it (through greenhouse gas emissions) and negatively affected by it (through rising temperatures). Traditional cattle breeding strategies are unable to lessen this mutually detrimental environmental impact that threatens the sustainability of dairy production in NZ. Confronting these challenges, we will develop novel ways of genetic improvement to rapidly evolve climate-smart dairy cattle. Short-cutting decades of conventional breeding efforts, we use naturally occurring DNA variants to unlock the vast genetic resources held within the national dairy herd. Combinations of favourable DNA sequences will be bred into top NZ dairy genetics in a single generation, accelerating genetic gain without integrating foreign DNA. This innovative technology addresses the three pillars of climate-smart agriculture: 1) enhanced resilience (adaptation), 2) sustainable intensification (productivity), and 3) reduced greenhouse gas emissions (mitigation). We first demonstrate the advantages of this novel breeding program with known variants that improve milk production, health and animal welfare under heat stress to produce heat-resilient animals. Next, natural variants for reduced greenhouse gas emissions, increased fertility and disease-resistance will be stacked on top of heat-tolerance traits. In parallel, we will evaluate the social acceptance of new biotechnology-based agricultural practices that reduce environmental impact and secure sustainable dairy-based food production. The proposed innovative animal breeding practices add genetic flexibility, which is vital for rapidly adapting livestock in NZ's temperate dairy regions to a changing environment. This opens new domestic and global markets to valuable NZ dairy germplasm and associated industries, providing benefits to NZ through faster genetic gain and increased export revenue. Enabling sustainable intensification of dairy production will reduce our society's vulnerabilities to diminishing natural resources and global warming.
	Beyond the genome: Exploiting methylomes to accelerate adaptation to a changing environment	5	$5,412,915	Organisms evolve over long time-frames through natural selection of advantageous mutations in DNA sequence. However, environmental challenges, such as drought stress or disease, require immediate biological responses which are conditioned through changes in gene expression. Epigenetic modifications to DNA, including altered methylation, can affect gene activity without changing the underlying DNA sequence. This is an important mechanism by which gene expression is stably altered for rapid adaptation to environmental stress. Genomic methylation patterns therefore reflect past 'experience', including cumulative stress exposure, and can be utilised as an indicator of successful adaptation to environmental change. This research programme will: Develop and validate cost-effective methods for profiling DNA methylation that will enable it to be used as a predictor of resilience to toxin exposure, drought and other environmental stresses Produce new knowledge on the contribution of methylation patterns to adaptation, including the timescale in which they are induced, the longevity of these changes and whether methylation patterns are transferred between generations Elucidate epigenetic 'clocks' that predict the cumulative stresses experienced by an animal or plant Design ways to incorporate methylation profiles into breeding decisions to select for healthier and more persistent individuals in species across the agricultural continuum Generate industry-applicable tools, through close collaboration with end-users Development, validation and implementation of methylome profiling will increase our understanding of the genetic mechanisms that make individuals better suited to varied environmental conditions and will ultimately be employed as a selection tool for improved breeding for environmental change. While this programme centres on pastoral-based systems (livestock, forage plants and fungal endophyte), it will serve as an exemplar for application of this technology in other species for production and conservation outcomes.
Auckland University of Technology	The expression, experience and transcendence of low-skill in Aotearoa New Zealand	5	$4,350,807	Over 1.3 million adult New Zealanders live with low literacy and/or numeracy (L/N) skills, with a strong over-representation of Maori and Pacific peoples. This poses a substantial social threat to the economy, with impacts including increased risk of unemployment and poverty, detrimental effects on physical and mental well-being, and decreased social and political attachment. Effects are felt at individual- and family/whanau-levels, as well as community- and national-levels. Importantly, this complex policy problem occurs against a backdrop of extensive structural change in the labour market, including future of work megatrends such as accelerated technological, which further marginalises low-skilled adults and limits economic growth and prosperity. Utilizing novel methods, such as the application of small area estimation techniques to PIAAC (Programme for the International Assessment of Adult Competencies) data, in conjunction with administrative data in the IDI (Integrated Data Infrastructure), this research programme will build a detailed and multidimensional, population-wide picture of those with low L/N skills. Different life-course pathways and interventions will be analysed with respect to a range of economic and social outcomes, and future changes in population skill level will be forecast. Combined with the qualitative work this will build an understanding of the barriers and enablers that build resilience to this risk and pathways to transcend low skills. The exploration of the life-course trajectories and evaluation of intervention effectiveness will facilitate improved public service delivery aimed at improving the economic and social outcomes of those living with low L/N skills in NZ. Specific Maori and Pacific people opportunities, knowledge, and resources will be identified (through hui via noho marae, and our stakeholder advisory group) to provide a strong, rich, and culturally-sensitive benchmark evidence-base to inform policy and practice.
	Advanced, novel biopotential sensor platform for New Zealand health-tech companies	5	$7,946,676	Measuring high-quality electrical signals from the brain, muscles, heart and elsewhere is crucial in healthcare, and valuable in fitness and increasingly, consumer entertainment. However, traditional electrodes are difficult and time-consuming to apply, irritate skin and fail over time, or are highly affected by factors such as movement. Ideally, sensors could be applied without fuss and used for many months, but sensors with these capabilities are not available. Our research programme will deliver multiple, highly novel technologies to make possible easy-to-use, long-term, wearable sensors . Our team from Auckland University of Technology, University of Auckland, Callaghan Innovation, New Zealand Brain Research Institute, and our industry partners has extensive experience in advanced biopotential sensor research, advanced manufacturing and includes clinical experts and a Maori researcher. Our team includes people with experience in the international commercialisation of healthcare technology. This research is supported by many New Zealand health technology companies and New Zealand manufacturing partners. The results of our research will benefit these companies by helping them develop new capabilities and business opportunities to address global markets.

*Transform proposals

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 RESEARCH PROGRAMMES

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
Cawthron Institute	A toolbox to underpin and enable tomorrow's marine biosecurity system	5	$10,433,370	As a maritime nation, our coasts and oceans are central to our identity as New Zealanders. These values are increasingly threatened by the impacts of marine non-indigenous species, which can result in irreversible impacts to our ecosystems and be a costly nuisance for the general public, industries, councils and government agencies to manage. Although efforts at the border have increased over the past decade, and councils and industry are involved more than ever in managing the spread of pests between regions, a lack of tools and technologies to prevent marine pests invading our ports and harbours, finding them before it is too late, and managing them once found currently undermines all efforts. The goal of our 5-year research programme is to develop a new toolbox for tomorrow's biosecurity system, effectively transforming how marine pests are managed here in New Zealand and, ultimately, overseas. Under this programme we will develop: New and environmentally-friendly tools that prevent marine pests getting a foothold in our marinas, ports and harbours; High-tech molecular tools that can detect marine pests at low densities - before the 'horse has bolted'; Simulation models and software to assist managers to better allocate effort and resources to prevent impacts from marine pests and diseases. The project team involves collaborators and partners from over 20 organisations, including stakeholders from government, Maori, industry, and education providers. This inclusive, multidisciplinary approach will ensure that the toolbox developed will be ready for immediate use and fit-for-purpose.
GNS Science	*Geothermal: The next generation	5	$10,689,200	New thinking in geothermal energy will help New Zealand reach its ambitious renewable targets. The government wants 100% renewables by 2035 and a 'Net-Zero Emissions Economy' by 2050. Solar, wind and conventional geothermal alone cannot reach this goal. The solution is deeper, supercritical geothermal. Supercritical fluids have abundant energetic potential, because they can carry three times more heat and are lower density. In the next two decades, exploration must move towards hotter and deeper supercritical resources. Utilising New Zealand's deep (gt;4 km) supercritical resources requires an innovative approach to identify suitable locations and their geochemical conditions. This research programme will look at the next generation of geothermal resources. Building on more than a decade of research, this project will minimise exploration and technological risks by locating targeted areas and detailing heat transfer at significant depth. It will research interactions between New Zealand rocks and fluids at supercritical conditions, modelling system viability and delineating the potential of these resources. We aim to identify the best New Zealand targets by understanding the source, location and behaviour of supercritical resources. We will re-create at-depth interactions between supercritical fluid host rocks and re-injection brine and non-condensable gases. A multi-disciplinary team of exceptional New Zealand and overseas geophysicists, geologists, experimental geochemists and modellers will work on the project, as well as economic and Maori strategic investment advisors. Stakeholder engagement is integral to this programme and it will opens doors to new investment opportunities far beyond the conventional geothermal industry. We will share these results with stakeholders so they can assess short- and long-term opportunities.
Landcare Research New Zealand Limited	Eradication Science: eliminating the last survivors to achieve predator freedom	5	$7,500,000	Pest control targeting possums, rats and stoats with traps and poison is able to remove ~95% of pest animals but always leaves some survivors (~5%). Eradicating these last survivors is extremely expensive because these animals are sparsely distributed and often wary of traps or poison baits. While 95% kills routinely cost $20–$30 per hectare, eradicating the last 5% costs over $400 per hectare. This prohibitive cost means pest eradication (100% kill) is only feasible for relatively small islands (e.g. Rangitoto Is.), but nationwide pest eradication – our Predator Free NZ 2050 goal – is impossible using traps and poison. We need new methods for pest control capable of eliminating the 'last surviving 5%' of pest animals. We know survivors have some distinctive behaviours (e.g. bait shyness) and our research will use recent advances in animal behaviour science to assess how animal 'personality' traits, like sociability, boldness or tendency to explore, affect the likelihood of an animal being trapped or consuming poison. Understanding these behaviours then enables us to identify new lures to attract these animals, such as recorded animal calls, animal scents, or visual lures like artificial bird nests or LED lights. To deliver these lures in the wild, we will create novel devices that use image recognition and artificial intelligence to recognise the approaching animal and automatically present the appropriate lure for that species and behaviour type, and then deliver the appropriate kill mechanism. We will work with iwi/imi and hapu to co-develop methods that are culturally acceptable to tangata whenua, drawing on traditional and current knowledge of pest control strategies.
Lincoln Agritech Limited	Subsurface processes in braided rivers – hyporheic exchange and leakage to groundwater	5	$7,970,670	This programme will provide the first accurate quantification of how much water is lost from braided rivers into groundwater. Braided rivers are unusual worldwide, but very important in NZ for their provision of natural habitat, sources of agricultural and drinking water, and recreational use. At present, regional councils set water limits and identify management plans for braided rivers without knowing how much water is lost as rivers traverse their alluvial plains. The impact of river management practices (e.g. gravel extraction, flood protection engineering) on groundwater recharge and river flow during dry periods is also unknown. This programme will deliver new knowledge regarding the Selwyn/Waikirikiri (Canterbury), Wairau (Marlborough) and Ngaruroro Rivers (Hawkes Bay), together with models so that councils can estimate water loss from any part of any braided river, and quantification of the environmental and economic benefits accruing from different river management strategies. These outputs will be an important step towards Regional Councils enacting policy with defensible limits to meet the Government's NPS-FM 5 requirements by 2025, and ensuring that society's competing needs for water can be met in the best way possible. Our multidisciplinary team from Lincoln Agritech Ltd, NIWA, Technische Universität Dresden (Germany), Aarhus (Denmark), Lincoln and Flinders (Australia) Universities has the required range of skills in field data collection, hydrological modelling and cost benefit analysis to make this major step forward in understanding NZ's braided rivers.
National Institute of Water and Atmospheric Research Limited	*Halving rural and Māori community wastewater treatment costs: Mainstreaming novel ecocultural technologies	5	$10,000,000	New Zealand's rural wastewater treatment systems are often overloaded and fail to meet existing discharge conditions, and will require substantial investment and innovation over the next 10–20 years to future proof for population growth and climate change. Both Maori and the wider New Zealand public aspire to move beyond current practise, and to improve the cultural acceptability and environmental performance of wastewater treatment systems. Currently available upgrades are costly to implement, however, and do little to address concerns around acceptability of wastewater treatment/disposal options (i.e., direct discharge into waterways), and provide few opportunities to offset costs through wastewater resource recovery. With our hapu/iwi and rural council partners, we will co-develop transformative eco-cultural wastewater treatment technologies, by combining Matauranga Maori with cutting-edge wetland and pond science. These technologies will provide culturally acceptable, effective, resilient and affordable future options to upgrade and recover resources from rural New Zealand wastewater treatment infrastructure (marae, papakainga, camp grounds and towns), while coping with variable flows. Cost savings for rural communities will be over $1 billion. Our new technologies will support Maori communities through co-developed Intensified Multi-Layered Wetland Filters for marae and papakainga septic tank effluent treatment; small rural towns through co-developed High Rate Filamentous Algae Pond wastewater treatment to upgrade oxidation ponds; and all communities through co-developed Final Effluent Wetlands. For all technologies, we will identify culturally appropriate options for beneficial resource recovery (e.g., energy and fertiliser) to enhance ecotechnology sustainability and affordability. Implementation and uptake will be greatly facilitated by our co-development approach and through our long-standing partnerships with iwi and rural councils.

*Transform proposals

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 RESEARCH PROGRAMMES

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
Scion	Forest flows – creating water-resilient landscapes	5	$13,736,775	Clean, fresh water is essential for life and forests can help provide this precious resource. As land-use intensification and climate change place growing pressure on water resources, we need to understand the role that planted forests can play in managing water use sustainably. However, forest-hydrology science cannot currently provide the information needed to manage planted forests for optimal water supply and nutrient attenuation. We will use new remote-sensing and sensor-network technology to create a model that will revolutionise the way forest hydrology is approached, both in NZ and internationally. It will allow us to quickly and cost-effectively collect data from planted forests, which can then be translated into accurate predictions of hydrological fluxes. The benefits of this research will be: • an understanding of water storage and release by planted forests • quantified impacts that may result from intensification of planted-forest productivity • knowledge of whether some tree species and forest types are better at flood mitigation than others • identified potential 'water-reservoir' forests that could reduce the need for irrigation schemes By the end of the program, we will have generated several practical tools: look-up tables for tree species water use, a regional map of key water ecosystem services for major planted forests, and the framework for an assessment tool enabling decision makers to evaluate different tree species and forest types to maximise planted forest water resources.
The New Zealand Institute for Plant and Food Research Limited	*Re-imagining aquaculture: inventing low-impact, offshore mobile technology that transforms finfish production	5	$18,750,000	Re-imagining Aquaculture will deliver new technologies for offshore finfish aquaculture, providing New Zealand with opportunities to significantly increase high-value finfish production with a minimal environmental footprint. Conventional inshore finfish aquaculture will be complimented by the development of a Mobile Autonomous Production System (MAPS) that uses New Zealand's abundance of clean, open waters to produce resilient, optimally growing fish within a sustainable and scalable production system. By taking the lead in technology development we will also ensure that enabling technology for off-shore aquaculture is well suited to New Zealand conditions and at the same time create opportunities for high-value support industries based in New Zealand, with potential for significant global exports. Scientific knowledge critical to the design and operation of our systems (e.g. materials science, hydrodynamics, species specific requirements) will be generated from engineering and oceanographic evaluations of our designs, as well as eco-physiological and behavioural assessments of fish performance and welfare. We will use King salmon and tamure/snapper as exemplar species for MAPS technology development, placing fish biology at the heart of the design process and aligning with principles of kaitiakitanga. New knowledge of optimal conditions for fish, and new methods to remotely monitor fish, will be developed. We will evaluate the economic, operational and environmental feasibility of our systems, whilst developing implementation pathways for downstream technological development. Our vision is to develop a scalable production system which will make offshore finfish aquaculture accessible to a wide range of New Zealand investors and produce significant benefits to the broader New Zealand economy.
Unitec Institute of Technology	*Marae Ora, Kāinga Ora: Marae-led housing interventions that develop kāinga.	3	$3,527,403	Traditionally, marae were the heart of the kainga (village) – the ways the whanau lived as a collective community. The process of urbanisation has alienated many marae from their kainga. Whereas kainga had previously resourced the marae, today marae are now left to service whanau, often within high-need communities. Studies have addressed how Maori in South Auckland are often defined by what they lack rather than what they have. South Auckland has a high Maori and Pasifika population, and therefore is also relatively culturally and linguistically rich. Marae are part of the cultural landscape and vitally important hubs in the South Auckland context for Maori and the wider community alike. This research, entitled Marae Ora, Kainga Ora (MOKO), investigates the ways in marae-led developments of kainga can facilitate community cohesion and wellbeing. While marae have been recognised as an important part of our national cultural heritage, there is a noticeable gap in what we know about how contemporary urban marae operate and the benefits they can bring to whanau and others in the community. Purposefully located in South Auckland, and working with marae, community and key stakeholders (that include government agencies and service providers), this research aims to make meaningful change for some of the most marginalised and impoverished whanau in our urban communities in Aotearoa. MOKO is a kaupapa Maori research project aiming to make a transformative impact on marae development and community wellbeing, strengthening marae connectedness to kainga and whanau wellbeing and resilience. Marae are complex entities, as are kainga, so a diverse, multi-discipline team of experienced kaupapa Maori researchers has been drawn together to meet the challenge of researching with, and in marae.
University of Auckland	Our generation, our voices, all our futures	5	$5,216,585	New Zealand is purported to be a great place to raise children, offering opportunities for all to succeed. It should be - but currently statistics paint a different picture - one where many, but not all, children thrive. Important groups of individuals fall behind from childhood and are consistently over-represented in measures of poor economic and societal wellbeing. Too often our Maori and Pasifika youth are counted in these poor statistics. To improve overall societal wellbeing, every child needs to thrive across their life course and the most vulnerable cannot be left behind. The voices of these most vulnerable are also under-represented in administrative datasets, so their life stories and lived experiences have limited ability to inform development of appropriate cross-sectoral strategies to address the inequities they experience. Even when counted in administrative datasets these data largely capture deficit measures so the opportunity to develop strengths-based solutions is limited. If we do not address the widening inequities directly then the future prosperity of all New Zealanders will be limited. This proposal will leverage established connections, and create new digital connections, with youth and technological experts to collect unique real-time information from a diverse group of 6000 children whose early lives have been well characterised in an established longitudinal study. Enhanced and new connections will create a rich multidisciplinary and multidimensional future evidence platform regarding what works, for whom, when and how, and additionally create digital platforms to continue to connect with the cohort as they emerge into adulthood. Short term impact metrics will be seen in improved measurement and overall wellbeing of all youth, leading to greater societal and economic wellbeing for all our futures within a generation.

*Transform proposals

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 RESEARCH PROGRAMMES

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
	Transitioning Taranaki to a Volcanic Future	5	$13,676,785	Mt. Taranaki is the most likely New Zealand volcano to cause national-scale impacts over our lifetimes. Positioned upwind from our most populous regions of Auckland, Waikato and Bay of Plenty, all Taranaki eruptions will disrupt air and surface transport, tourism, farming, power and water supplies. This volcano has a 50% probability of erupting over the next 50 years. Yet the dormancy since Mt. Taranaki's last eruption (~AD1790) is one of its longest. Thus, we have no modern experience of its typically very long eruptions. Past research shows that once Mt. Taranaki starts erupting, it continues for years, decades, or even centuries. A recent estimate of the net losses in economic activity from a brief Mt. Taranaki eruption (considering only a subset of potential impacts) is crudely estimated at ~NZ$1.7-4.0 billion of GDP per year, or ~NZ$13-26billion, for a decade of volcanism. Our research will build and test the geological, engineering and socio-economic knowledge essential for the New Zealand economy to transition through such an unprecedented level of on-going disruption. Using a novel integration of volcanic scientific knowledge, experimentation and advanced mathematical and economic simulation, we aim to radically cut down the uncertainty that hinders decisive hazard and mitigation planning for transitioning to a new state of ongoing hazard. We will demonstrate how robust decisions can be made across space and through time, for multiple stakeholders. In this way we will also discover how to transform New Zealand in the face of continuous change. This requires developing an integrated quantitative understanding of volcanism in order to confidently forecast the volcanic impacts over timeframes suited to socio-economic decision-making.
University of Canterbury	*3-D printed porous media for process engineering	5	$9,812,550	We are poised to disrupt over 130 years of chemical engineering science by creating 3D-printed (additive manufactured) structures comprising complex solid and fluid channel geometric designs, that promise step-changes in heat and mass exchange efficiency over current technologies, enabling unprecedented levels of performance. Almost every item we touch comes from industrial processes involving heat-exchangers, various separators and catalytic-reactors, and these critically depend upon heat and mass transfer between gases or liquids and solids. However, industrial equipment fabrication is currently driven by manufacturing methods developed in the 19th and 20th centuries using tubes, plates and randomly-packed particles - technical designs have advanced only incrementally since then. We will leverage our world-leading 3D-printing capabilities to enable optimal geometrically-complex flow channel structures to be designed and fabricated. Our work to date has shown that 3D-printed triply periodic minimal surfaces (3D-TPMS) offer significant advantages over existing heat exchanger and porous bed designs, but the lack of engineering science and computational tools required for the systematic design of 3D-printed structures prevents their implementation in real-world applications. Our research will address this knowledge gap, creating computer-aided design tools to provide a versatile process engineering platform for wide-ranging applications. We will determine quantitative relationships between geometry, printed-material properties, physical strength, fluid flow, dispersion, pressure-drop, heat and mass transfer, adsorption and reaction using computational fluid dynamics and magnetic resonance imaging. This new knowledge will be used to develop the required novel methods for 3D-TPMS engineering design and optimization. This research will create the materials, tools and technologies required to design, optimize and build industrial equipment with vastly improved efficiency over existing processes and generate world-leading expert design consultancy and manufacturing opportunities and transformational business potential for NZ.
University of Otago	*New Frontiers in Antiviral Development	5	$13,525,451	Viruses affect human and animal health, cause large economic losses, and burden healthcare facilities. For many viruses there are limited or no treatments. One effective means of controlling viruses is the use of antivirals, small chemical compounds that prevent or block viral infection to provide rapid control during disease outbreaks or where there are no vaccine options. The recent development of Hepatitis C antivirals is an example of how effective antivirals can be. The development of antivirals requires a broad multidiscipline team that includes virologists, chemists, structural biologists, cell and molecular biologists and manufacturing capability. We have this capability in New Zealand. We will develop antiviral agents discovered in New Zealand that are already in human trials, we will engage with our international collegues on the development of a new class of naturally occurring antivirals. We have discovered lead compounds that target new aspects of viruses that have not been targeted previously. Our goal is to have a broad platform of antiviral development that is focussed upon outstanding core science applicable to a range of viruses. This platform will span the antiviral development spectrum from fundamental development of new parts of viruses to develop antivirals against through to enhancing antiviral agents that are approaching clinical use. We will ultimately have a broad New Zealand based team with the expertise and skills to tackle serious virus problems, find agents against those viruses and bring those antiviral agents to market.
	*Precision Antimicrobials: Targeted Therapeutics for Food and Companion Animal Infections	5	$8,709,022	To preserve human and animal health in the face of antimicrobial resistance (AMR), the discovery of new antibiotics with novel mechanisms of action is paramount. Despite the urgency for new antibiotics, the progression of novel agents through the discovery pipeline is extremely slow and few are successful. Increasingly antibiotics have been used to prevent and treat disease in food animals and antimicrobial usage in animal food production is predicted to rise by 67% by 2030. Unfortunately, the shared use of the same classes of antimicrobials in humans and animals has created a global pandemic of AMR. To help solve this problem we are developing transformational animal-specific therapeutics and the aim of our proposal is to optimise the biological and chemical properties of a new class of narrow-spectrum antimicrobial agents called Precision Antimicrobials . These Precision Antimicrobials will be used to treat and prevent microbial-mediated disease in food, and companion animals. Our Precision Antimicrobials will be new (novel), eco-friendly (narrow spectrum) with no ecological impact on commensal microbial populations or consumer products. The internationally-leading science team is key to the success of this programme. Importantly, the team includes young researchers, allowing for capability succession in this critical area of research. Recognising the key role of Maori in animal production (major farming businesses), we are co-developing our research with Maori through Advisory Groups, where together, we will continue to co-develop aspects of special importance, including more holistic insights guided by kaitiakitanga.
	Whakapapakainga: Low Carbon and High Cultural Connectedness Futures for Community Cross-generational Benefit	5	$7,248,016	There is an urgent need to move our planet toward a low-carbon future. A suite of solutions is required beyond science as usual. The New Zealand context uniquely provides opportunity to explore new ways of engaging indigenous knowledge and western science from a community-driven, kaupapa Maori nexus. This research pioneers the development of marae-based and marae-led platforms and processes. The research will be grounded by resilient kin communities already seeking to create positive environmental change. Indeed, critical concerns – but opportunities – facing Maori communities are finding ways to best respond to climate change, create new sources of value, and enhance the cultural fabric of their communities, cross-generationally. Yet many Maori are dissociated from their whenua (soils and waterways), kainga (marae communities) and taonga (ancestral belongings and resources). This doubly affects overall wellbeing of Maori, leaving both urban/dislocated whanau and their depopulating home communities struggling to survive, let alone prosper. Meaningfully reconnecting kin members with their lands, waters, home marae and resources to build interconnected community and environmental resilience is essential. This programme of research, therefore, explores and develops novel programmes of innovation, testing and wider feasibility of application, aiming to reduce GHG emissions and strengthen socio-cultural capital. In so doing, this programme charts low-carbon pathways of transformation so that key outcomes can be adapted and applied by any small community, nationally and internationally; and provides much needed policy guidance for charting new futures.

*Transform proposals

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

2019 Endeavour Round Successful Projects

SUCCESSFUL 2019 RESEARCH PROGRAMMES

Organisation	Title	Duration *(years)*	Contract Value *(GST excl)*	Applicant's Public Statement
University of Waikato	Turning the tide on prison violence	5	$3,916,045	Interpersonal violence is a global concern and a significant cause of death around the world. In prison contexts, where the state holds responsibility for the care and well-being of incarcerated men and women, the human, financial, and health burden of violence becomes a critical social and economic issue. The growing prominence of gang-affiliated prisoners in New Zealand is also a complicating factor that has been shown to contribute to increasing levels of violence. Yet, the realities of incarcerated gang members and how gang membership influences the culture and interactions in prison and therefore violence in New Zealand remains largely unknown. The aims of this research programme are to reduce interpersonal violence and increase safety in New Zealand prisons. This will be achieved by developing innovative approaches to indigenous knowledge, gang culture, and data visualisation. This will be achieved by developing: (1) a violence prediction tool (2) a measure of threat perception to capture prisoners and prison staff perspectives (3) new knowledge of gangs, especially their role and culture within New Zealand prisons and the relationship with violence, and (4) localised, place-based knowledge of violence in specific contexts to inform interventions to reduce violence. The new knowledge generated by this Research Programme will inform practice to create the next generation of aggression assessment, intervention, and prevention strategies. The outcomes of this research inform approaches and provide technical resources that can be easily used by relevant organisations such as the Department of Corrections and New Zealand Police.
Victoria University of Wellington	Informatics for Social Services and Wellbeing Data New Zealand	3	$2,658,600	The Informatics for Social Services and Wellbeing Programme is a data science research project. The aim is to develop our national linked data including the Integrated Data Infrastructure (IDI). Our programme will address New Zealand's critical need for better linking of data and access to datasets. We will leverage New Zealand's exceptional administrative and other data resources to advance excellence in the use of social data. Our programme will enhance current data platforms that provides nationwide access to a range of large, in-depth datasets containing information on social services; create an enhanced inventory and description of the different data sources available in NZ and associated metadata; develop solutions that encourage data privacy and ethics, data standards and Maori data sovereignty, as well as clarifying legal issues and develop and apply novel data science and analysis approaches. This programe will help to produce better policy and to enhance delivery of social services in a range of areas. Itwill also increase the number and types of research projects using New Zealand's rich social data infrastructure and add value over and above current activities. We will not only increase the profile and highlight the importance and research impact of social data, but also ensure the highest standards and the best chance of buy-in from a range of academic and governmental stakeholders.
	Extreme events and the emergence of climate change	5	$10,273,285	EWEs are and will continue to be the primary manifestation of climate change in the near future. Recent preliminary work by our team implies that the current costs of climate change-attributable EWEs is in excess of several hundred million dollars per decade. To date, we have only studied a small number of events. This proposal will allow us to greatly expand the historical coverage of our understanding of EWEs and their impacts, help quantify a far greater and more representative range of EWEs, understand how that pattern of EWEs is likely to change under a range of plausible future scenarios, and quantify their future costs to our society. New Zealand has made significant progress in filling many of the information gaps assessed in the IPCC's AR5 report (2013), but our understanding of the links between climate change and EWEs lags behind their emerging importance. In undertaking this work we will deliver value to national agencies such as RBNZ and Treasury, as well as directly addressing the impact of EWEs on Maori: on Maori cultural and financial assets, and on Maori society. The benefits to society will include quantification of the relationship between extreme events and anthropogenic climate change, an improved understanding of New Zealand's exposure and vulnerability to extreme events, a more sophisticated appreciation of the likely evolution in EWEs and their associated costs, and how these are likely to affect New Zealand's interests, here and abroad.
	*Zero-CO2 production of essential technological metals	5	$6,494,327	Steel and vanadium are essential to modern life. Structural steel is used everywhere: high-rise buildings, bridges, water mains, pylons, railways, power plants, vehicles, ships – the list goes on. Large quantitites of steel is required to build new wind turbines, and solar cell arrays, and this will drive increasing future demand. NZ has a particular requirement for high quality steel to build earthquake-resilient bridges and buildings, and this needs to be produced in a rigorously-certified process. Vanadium-steel alloys are very strong. This means that lightweight high-strength structures can be built. By 2025, fuel efficiency targets will mean that 85% of all new cars will incorporate vanadium alloy chassis. Vanadium is also required for next-generation batteries that can provide the very large energy storage capacities required to integrate wind and solar power into national electricity grids. But there is a problem. Current manufacturing processes for both these metals produce large volumes of CO 2 . NZ wants to become a zero-carbon economy by 2050, and to achieve this we need to fix the emissions from our metals-manufacturing industries. The good news is that New Zealand has some big competitive advantages when it comes to producing 'zero-CO2' metals. Our electricity supply will be 100% renewable by 2035, and we have bucket-loads of geothermal heat to spare. This research project targets the development of entirely new process technologies that can leverage these advantages to eliminate CO 2 from the production of iron and vanadium in NZ. If we are successful NZ can lead the world, selling premium zero-CO 2 metals to an avid global market.

*Transform proposals