2016 SFTI Challenge Seed Projects

Organisation	Name	Description
University of Auckland	A giant leap for small displacements	This proposal is to accelerate development of a new, patent-pending platform machine vision technology to more reliably, accurately and efficiently determine shape, motion, surface and volume deformation data. Novel digital image correlation techniques will be further enhanced to detect deformations of 1/10,000th pixel using intrinsic or applied small-scale features in the images. This unprecedented accuracy will enable industrial partners in a variety of sectors to add value to their products and services. Initial research will focus on applications in industrial monitoring and maintenance (e.g. wind turbine blade inspection), healthcare (new cardiovascular diagnostics), and agriculture (improved fruit sorting). **Challenge Theme**: Materials, Manufacturing and Design. (Secondary alignment with Information Technology, Data Analytics and Modelling.)
Victoria University	Magnetic silver clusters - a disruptive technology in bio imaging	The World Health Organisation recently stated the number of new cancer cases will increase by 70% in the next 20 years. It is clear that the need for improved diagnosis is in high demand and will increase. This project will develop new, highly efficient magnetic resonance imaging (MRI) contrast agents for early disease detection. Currently, the market for MRI contrast agents is driven by gadolinium but is plagued by toxic effects, low sensitivity, short imaging time and large injection volumes. This project will address these problems by generating silver nanoclusters, a non-toxic, <10 nm size nanomaterial with magnetic and fluorescent properties. The synthesis and fluorescent properties have been well investigated but their magnetic properties have not. The researchers will provide first time characterisation of the magnetic properties and in turn develop capacity in the area of materials synthesis, bio-imaging and drug delivery – potentially resulting in a positive impact on New Zealand's future economy. **Challenge Theme:** Materials, Manufacturing and Design. Mātauranga alignment.

University of Canterbury	Enabling sustainable economic development with advanced additive manufacturing of wood	There is huge economic potential in harnessing the enabling three-dimensional (3D) printing technology in product manufacturing. Although challenging, there is potential to use live cells as an advanced manufacturing material in a yet-to-be invented, new industry. The principle of 3D printing live plant cells (bio-printing) has recently been demonstrated with live green algal cells. It is possible that other types of plant cells, such as the wood-forming cells of eucalyptus trees, could be used as bio-printing materials. Hence, it is a potential, socially acceptable opportunity for sustainable economic development derived from native forests. The objective of this project is to manufacture a wood product (a non-living 3D structure) without the need for the destructive harvesting of trees. Live eucalyptus tree cells will be prepared specifically for bio-printing. They will be physiologically primed in a 3D structure in the biotech lab at the University of Canterbury (without any genetic modification) to be capable of responding to the appropriate triggers for transformation into a principal wood cell called a tracheid elements cell. The changes in the cells will be studied in relation to the characteristic morphological features and chemical properties of tracheid elements cells using various microscopic, histochemical staining and fluorescence techniques. If successful this research would be among the most significant scientific advances towards the realisation of the full potential of 3D printing. The manufacturing sector would have a new, sustainable and advanced biomaterial for developing niche products in a New Zealand context. **Challenge Theme:** Materials, Manufacturing and Design.

University of Otago	Mechanically induced drug release	The aim of this project is to develop a new technology for controlled drug release based on mechanically-sensitive soft materials. These novel materials will contain nanoscale drug reservoirs that can be triggered to release their contents through stretching, compression or ultrasound irradiation. They will initially be aimed at implantable drug depots and bandages. The key idea is that drug release can be triggered when needed, and that this could be repeated many times. By using ultrasound for the depots, the drug release can be done non-invasively, potentially over a period of many weeks. The bandages could be used to hold unstable molecules such as proteins that can be used to promote healing - upon stretching the proteins are released to be active. While pressure sensitive plastics and rubbers have been developed, this project will be the first time that the method has been applied to soft gels. The key is in producing gels with the required mechanical strength. The researchers have found generic ways of toughening gels and now want to integrate these gels with microscopic drug capsules that can be broken open inside the gel. If long term repeated release could be demonstrated this could be used widely in many clinical situations where pulsed delivery is desirable including epilepsy, cancer, pain relief and heart arrhythmias. **Challenge Theme:** Materials, Manufacturing and Design.
Lincoln Agritech	Controlling spray droplets in flight: new science enhancing innovative capacity	The project researchers will develop the science required to create a “perfect sprayer” – one that can sense the crop canopy location and apply agrichemicals to achieve optimal leaf coverage, while minimising chemical wastage and loss to the environment. The vision of the project is a Dynamic Electrostatic Spraying (DES) system that automatically adapts to varying target shapes, delivering droplets with high accuracy. It will generate fundamental new knowledge to manipulate trajectories of charged droplets through varying electromagnetic, electrostatic and fluid forces. The concept that droplets from a sprayer can be directed to variable trajectories in real time, matching the morphology of target surfaces, is new. The projects will develop a control system that solves the inverse problem of how to change the initial conditions of the drops generated in an electrostatic spray to provide complete target surface coverage. The research has an initial focus on horticultural and agricultural spraying, but has broad application in spraying paints and coatings, as well as active coatings in a wide range of industrial applications. This research will focus on

		sprayers for high-value row crops (e.g. potatoes, grapes, apples and kiwifruit) in New Zealand and overseas. Researchers will work closely with Kono, a Wakatu Incorporation company, recognising its interest in delivering high quality food while minimising impact on taonga species and valued ecosystems. New Zealand will benefit from a) new export revenues derived from sales of DES technology, b) increased exports of high-value crops due to improved crop protection and c) savings for growers through reduced chemical costs, concurrent with fewer crop losses due to pests. Environmental benefits come through pesticide application reduction of at least 50% and a reduction in associated off-target pesticide losses to soil, water and air. **Challenge Theme**: Sensors, Robotics and Automation. Vision Mātauranga alignment.
Landcare Research	Algae-derived food supplement	Eicosapentaenoic acid (EPA) is a high-value omega-3 polyunsaturated fatty acid with clinically supported health benefits. EPA from fish oil, the current primary source, can in some cases have quality problems (heavy metals, degradation over time), and cannot be consumed by vegetarians. This project meets market demand for more acceptable, high-EPA materials for food supplements. Algae are prime candidates for developing fish oil alternatives, but commercialisation struggles due to low productivity of EPA. This project seeks to build on earlier work to create a commercially viable method to boost EPA levels in algae. The researchers propose that manipulating the spectral composition of light is key to this and will work with an ideal algal species from Awarua Wetland (a mahinga kai site for Ngai Tahu) called Trachydiscus Awa9/2. Because Trachydiscus Awa9/2 is new to science, and its ecology is poorly understood, the science begins with a field study to understand its environment and how this affects EPA potential/production. This will guide bench scale bioreactor experiments to optimise light quality and other conditions for commercial production. The project will test current assumptions about the biology of this type of algae to resolve barriers to commercialisation. The global EPA industry is worth $450M p.a. and is predicted to grow at 13% p.a. It is a high-value product, with retail prices for fish-sourced EPA upward of $200/kg. Development of new EPA sources will gain New Zealand a greater share of global EPA markets, and access the vegetarian market. It will diversify New Zealand's economy, enhance its reputation for safe, high-quality natural food products, and complement wider investment in this country's bioactives sector.

		A commercially-viable algal EPA will contribute to key partner Ngai Tahu’s economic development aspirations. Based on realistic assumptions, the research team calculates a potential of c. $6.44 M annually per manufacturing plant. Existing local companies are well placed to manufacture algal EPA. Leveraging the Aotearoa/NZ Story and cultural provenance opportunities would contribute to major export potential. **Challenge Theme**: Materials, Manufacturing and Design. Vision Mātauranga alignment.
University of Auckland	A self-healing silicon electrode for lithium battery applications	In the search for even-higher performance lithium batteries, particularly for electric vehicles and energy storage applications, the current choice of graphite anode material must be replaced by a much-higher capacity anode. Silicon is promising as it could boost batteries' charge capacity by, in principle, a factor of 10. However in each charge-discharge cycle, silicon swells and shrinks substantially, fracturing the anode and quickly ending the battery's life. This project will use a stretchable binder coating that will maintain the mechanical and electrical integrity of the silicon anode during charge-discharge cycles. The researchers further hypothesise that this stretchable binder can be self-healing and able to repair the mechanical damage and cracks in the anode spontaneously during charging. Such a smart binder ensures the realisation of a high-capacity silicon anode in lithium batteries. They will use supramolecular chemistry to develop a self-healing binder, which is then coated on the silicon anode to provide an excellent cycling lifetime while maintaining high capacity. With the theoretically ten-fold higher capacity, lithium batteries with silicon anode are expected to store much more energy and power electric vehicles for much longer distances. The developed self-healing binder technology can also be employed in other high-performance electrodes that suffer from similar volumetric expansion issues, such as sulphur electrodes in lithium-sulphur and magnesium-sulphur batteries. The realisation of high-capacity batteries based on this can pave the way for further development of energy storage devices that can be used to store and transport other renewable energies such as hydrogen, wind and solar cells. **Challenge Theme**: Materials, Manufacturing and Design.

University of Auckland	Golden Polymer for Enriching Biogas to Biomethane	Biogas is a combustible gas produced by the breakdown of organic waste such as manure and landfill in the absence of oxygen. Biogas is recognised as a carbon neutral renewable energy, like solar and wind energy. According to the Bioenergy Association, the current estimate of total biogas capacity in New Zealand is around 57 MW from 31 key biogas generation sites. Globally, organic biogas market size was worth over USD $19.5 billion in 2015 and is forecast to exceed USD $32 billion by 2023. Biogas naturally contains little energy due to its high carbon dioxide (CO2) content. Carbon dioxide dilutes biogas energy density, as well as letting it pass into the environment. Biomethane (i.e. enriched biogas) is the answer to increasing the value of biogas through enrichment of its methane content, as well as bringing multiple economic gains. Biomethane could be injected into the existing natural gas grid and transported to homes, or compressed and used as a transportation fuel. This proposal focuses on developing “golden” polymers that can efficiently filter CO2 from biogas, leaving biomethane with >98% purity. These polymers act as molecular sieves with pores tailor-made for CO2 separation. The researchers aim to transform biogas into a gold standard biomethane for the New Zealand domestic and export market. Their recent breakthrough allowed them to more than double the permeability of these membranes for CO2 by making specialised adjustments to the interpolymer chain distance and rigidity of the molecule so that CO2 would preferably pass through. Their newly discovered “golden” polymer (it is yellowish in appearance) currently holds the record for the most permeable gas separation polymer for this gas pair (CO2/CH4). Their end goal is to have a polymer membrane ready for biogas enrichment proof-of-concept demonstration. **Challenge Theme:** Materials, Manufacturing and Design.
Digital Sensing Limited	Nitrate Sensor Arrays	Toku awa koiora me ngona pikonga he kura tangihia o te matamuri’ > The river of life, each curve more beautiful than the last - Kingi Tawhiao The lamentation of Kingi Tawhiao retells his adoration of the Waikato River and the significance of the river as a taonga for all generations. The Waikato-Tainui environmental plan aspires to ‘have waters that are drinkable, swimmable, and fishable with the water quality at least at the level it was when Kingi Tawhiao composed his maimai aroha’. To achieve the objectives of the plan, Waikato-Tainui aim to ‘establish the current health of the Waikato River using Matauranga Māori and the latest available scientific methods’. The need for monitoring and restoration of New Zealand’s waterways is well recognised and requires immediate attention.

		This bid presents a collaboration between Horahora Marae (mana whenua and kaitiaki of the Waikato River at Rangiriri), The University of Auckland and Digital Sensing Ltd, to support the development of a low-cost fit-for-purpose sensor network that provides continuous real-time monitoring of the quality of freshwater supply, with an initial emphasis on nitrate levels in the Waikato River. This project will feature on-going interaction between researchers and Māori, drawing knowledge from western science and Te Ao Māori, in the development and deployment of devices that will not only benefit Waikato-Tainui, but also have the potential for implementation in waterways across wider New Zealand and abroad. **Challenge Themes:** Vision Mātauranga, Sensors, Robotics and Automation.
University of Waikato	Te Tāhū o te Pātaka Whakairinga Kōrero: Next Generation Indigenous Knowledge	This proposal addresses the pressing need to formulate a framework for Next Generation Indigenous Data and Knowledge Management (IKM) in eResearch. Informed by a needs analysis and a multi-method approach, incorporating kaupapa Māori protocols, iterative design processes and participatory design, the researchers will develop, in consultation with Vision Mātauranga (VM) teams, a platform for digitally managing and distributing Indigenous Knowledge (IK) within and across each of the National Science Challenges (NSC). The novelty of the approach stems from the utilisation of spatial hypermedia to provide fine-grained representation of, and access to, IK in a digital domain. Requirements for the IK management software will be driven by hui with VM teams to build a conceptual framework. The aims of this project are: (i) The development of a framework for digital IKM; (ii) The realisation of software that supports the digital IKM framework; and (iii) The application of that framework to a range of IK domains. Three key research questions are: (i) What are the concerns of VM leaders/teams regarding the permissions, rights, and interests of Māori researchers, Iwi, and other stakeholders involved in the collation and distribution of IK derived from the NSC? (ii) How do VM NSC teams manage, collate and consider permissions, rights, and interests of Māori researchers, Iwi, and other stakeholders involved in the collation of IK derived from the NSC? and (iii) How can a spatial hypermedia platform provide a fine-

		grained representation of, and access to, IK in a digital domain? **Challenge Themes:** Vision Mātauranga, Information Technology, Data Analytics and Modelling.