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Research Report Outputs 2015

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Tēnei te mihi atu ki a koutou katoa mai i Te Whare Wānanga o Waitaha. E mōhiotia whānuitia ana a UC mō āna rangahau e puta nei i tēnei whare wānanga. Ka kitea te kaha me te hōhonu o ēnei mahi a UC i ngā pūrongo i roto i te pukapuka nei. He kōwhiringa paku noa ēnei o ngā rangahau katoa, hei whakaatu i tēnei āhuatanga o Te Whare Wānanga o Waitaha ki a koutou.

Greetings to you all from UC. UC is widely known for its research reputation. The strength and depth of UC's research can be seen through this small selection of research stories from our activities during the 2015 year with an emphasis on the work done by early and emerging career researchers. These young people are our future!

Andrew Lapthorn

Dr Andrew Lapthorn from UC's Department of Electrical and Computer Engineering at work in the High Voltage Lab, the only facility of its kind in a New Zealand university. It does commercial testing for the electrical industry.

Read Dr Lapthorn's story on page 58.

Research Report 2015
Theme: Building research capability

Research & Innovation

Connecting UC's research with the world

The role of Research & Innovation is to provide services which facilitate and support all stages of research and innovation at the University of Canterbury, from initial funding of the research through to commercialisation of the outcomes, where appropriate. Research & Innovation is the first point of contact for external organisations who are interested in: discussions on how UC resources might help their organisation; assistance in accessing UC expertise and facilities; consulting services and contract research; opportunities to use or commercialise UC's intellectual property; assistance in identifying business or investment opportunities. Please contact us if you are interested in engaging with UC.

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A showcase of UC research

UC SPARK (system for people and research knowledge) is a searchable website which showcases UC's research. You can search SPARK for information about individual researchers, the projects they are working on, the research groups they belong to, the specialist equipment that they use, and their affiliations. SPARK provides a comprehensive view of research at UC.

www.canterbury.ac.nz/spark

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Research 2015

This year's research report brings into focus the research activities of early and emerging career researchers.

The report provides just a "snapshot" of the wide range of research undertaken in 2015 at the University of Canterbury (UC) by academic staff and research postgraduate students in our five Colleges (Arts; Business & Law; Education, Health & Human Development; Engineering; and Science) which make up our comprehensive institution.

UC's early and emerging researchers illustrate our new and innovative future directions and the contribution that research at UC is making, and will continue to make, for both the benefit of New Zealand and to build the world store of fundamental knowledge. The intellectual vigour and enthusiasm of our researchers will be evident from these stories. There are also articles featuring some of our most experienced research staff who, in one way or another, have distinguished themselves in the last year through their research efforts or have been recognised for their long standing records of research excellence.

We have various measures of research activity. In 2015, the total research income received from all external sources was $55m which equates to an average of $76k per full time equivalent staff member (FTE). These are record figures for the University. The total number of quality assured research outputs was 3056 which equates to an average of 4.2 outputs per FTE. The number of research degree completions (doctoral plus research masters) was 423. Doctoral completions and new doctoral enrolments (PhD, EdD, DMus) both reached record figures in 2015. Our head count of doctoral students now exceeds 1,000; given that international students are the majority in our doctoral school, this represents a little "United Nations" dedicated to research and is testimony to UC's reputation as an international research destination.

Each year our governing body, the University Council, recognises excellence both in Innovation and in Research. The 2015 Innovation Medal was awarded to Associate Professor Rick Beatson of the School of Mathematics & Statistics for his work on Radial Basis Functions which has led to applications in medical prosthetics and mining exploration. In 2015, the University Research Medal was awarded to Professor Jennifer Hay of the School of Language, Social & Political Sciences and Director of the New Zealand Institute of Language, Brain & Behaviour. You will find articles describing the work of Rick Beatson and Jen Hay in this report. In fact 2015 was a stellar year for Professor Hay. She was elected a Fellow of the Royal Society of New Zealand, our national academy, and was also one of two UC recipients of the James Cook Fellowship, a highly prestigious national award which permits recipients, (and there were only four in 2015), to pursue their research activities full time. Our other James Cook Fellow for the year was Distinguished Professor Geoff Chase of the Department of Mechanical Engineering for his research on Acute Circulatory Failure. Articles describing his and Professor Hay's research programmes may be found within this report.

The Early and Emerging Career Researcher Award was established by the University Research Committee in 2014. Last year's recipient was Dr Girish Prayag of the Department of Management, Marketing & Entrepreneurship for his work on consumption emotions in the tourism and hospitality industries.

UC researchers are playing leading roles in many of the eleven National Science Challenges and the ten Centres of Research Excellence funded by Government.
Two examples are described in this report, our pivotal role in the 'A Better Start: E Tipu e Rea' challenge led by Co-Director, Professor Gail Gillon, and our hosting of the QuakeCoRE – New Zealand Centre for Earthquake Resilience led by Professors Ken Elwood (Auckland University) and Brendon Bradley (University of Canterbury). There is no doubt that the Challenges and CoREs represent a step change in the New Zealand research landscape to a collaborative, multi-institutional approach, which identifies 'best teams' to drive towards improved outcomes for New Zealand. UC has embraced this collaborative approach.

Finally, I would like to finish with a few words to celebrate the ground breaking work of Emeritus Professor Roy Kerr who was Professor of Mathematics at the University of Canterbury from 1971 – 1983. The University of Canterbury awarded Professor Kerr an Honorary Doctorate of Science in December 2015. At the age of 29, Roy Kerr discovered a solution to Albert Einstein's gravitational field equation which had eluded researchers for 50 years. This in effect represented the prediction of spinning black holes. The recent international report of the detection for the first time of gravitational waves verifies this mathematical predication. Professor Kerr will be presented with the Crafoord Prize by the King and Queen of Sweden in May 2016. Thank you Professor Kerr – what an inspiration to our young researchers and for New Zealand research in general.

Nā reira, anai te Pūrongo Rangahua a Te Whare Wānanga o Waitaha mō te tau 2015 hei whakahihiko i ō koutou hinengaro.

Here is the UC Research Report 2015 to get you thinking.

Tēnā koutou katoa.

Professor Steve Weaver
Deputy Vice-Chancellor, Research

Building a sustainable future for Māori

The partnership will drive research at the frontier of iwi development and Māori and indigenous studies as a discipline and provide an academic view on Māori futures.

This is an area that only a small amount of research has been conducted in says Head of School, Aotahi, Sacha McMeeking (Ngāi Tahu).

"Most importantly, the research will serve our people and deliver benefits that our community and whānau are interested in. It will lift our horizons."

Te Pūtahitanga is a unique whānau ora agency that invests in whānau, entrepreneurs, non-profits and businesses in Te Waipounamu South Island. Aotahi will work with the organisation to discover if it is investing in the right people and ventures to create sustainable futures for Māori.

"By examining fundamental issues for the Māori community, alongside future trends and technologies, we can forecast scenarios and inform the ongoing investment strategy for Te Pūtahitanga."

The year-long research partnership will involve academics and four postgraduate and undergraduate research assistants from Aotahi, including two Summer Research Scholars. Their approach will include analysis, literature reviews and interviews with investors and Māori from the nine iwi across Te Waipounamu South Island.

Ms McMeeking says that including undergraduates in the research group provides a valuable learning opportunity and builds Aotahi's pipeline for postgraduate study and further research.

> "Most importantly, the research will serve our people and deliver benefits that our community and whānau are interested in. It will lift our horizons."

"Our students will experience real problem-solving within the Māori community. They will be able to think about the big challenges in our world and how people might face them".

Disruptive trends and future technology

Examining the macro-disruptive trends that will impact on Te Ao Māori is the starting point for researchers. One of these trends is the development of synthetic foods and how this will impact Māori communities involved in agriculture and horticulture.

Ms McMeeking says that there is currently no other active research considering the impact of these trends on Māori communities and this project will be a key piece of work in the field of Māori and indigenous studies.

Technological disruption is another key factor that will drive change. For example, she says, with so many Māori in the driving industry, what will happen when driverless cars become the norm?

Discovering methods to boost whānau ora

Exploring social capital in light of Māori values and structures will also be a new contribution to the field. Aotahi researchers will draw on tikanga Māori to examine if the current approach to transformation and whānau ora by Te Pūtahitanga is working.

"Organisations need to spend their money well. By collaborating with researchers, the people doing the do at Te Pūtahitanga will be able to validate or adjust their direction."

The organisation also has a variety of capability building initiatives and Aotahi will work to find out which of these have the most impact.

Leadership and start-up support

To support the key studies undertaken, additional teams from Aotahi will develop a leadership programme for 18 to 30 year-old Māori who have the potential to create change in their community. A Kaupapa Māori business accelerator programme will also be created to support new ventures within iwi. Each of these new programmes will be designed to support Te Pūtahitanga to implement the infrastructure needed for whānau to thrive.

Aotahi has already successfully trialled other programmes with Te Pūtahitanga, including one to transition Māori women out of prison. Ms McMeeking says that the opportunity to be involved in a variety of practical projects is a dream opportunity.

Outcomes for Māori

The comprehensive programme of research will enable Te Pūtahitanga to make sound investment decisions in the short and longer-term, leading to positive change across Māori communities in Te Waipounamu South Island.

Ms McMeeking also believes the research will position Aotahi as a leader in academic commentary on the role of whānau ora agencies, as well as shape future policy.

"I believe our research products will be adopted and adapted by a number of iwi and indigenous organisations, which in my view is the greatest possible result for Māori-related research."

By Hannah McKnight

A new research partnership between the University of Canterbury's Aotahi School of Māori and Indigenous Studies and social change agency Te Pūtahitanga o Te Waipounamu aims to predict how future Māori will live and prepare whānau for change.

From projecting future food shortages, to helping children in therapy, to disease control, statistics are helping answer the central questions researchers from a variety of fields are seeking.

Crunching the numbers

Dr Moltchanova, from University of Canterbury's (UC) school of Mathematics and Statistics is passionate about statistics being applied correctly – in fact she applies it to everything.

"It is a well-known fact that statistics are being misapplied and misused and misunderstood all over the place. But when they are applied properly we are able to see useful patterns."

As a result she is working and collaborating on multiple projects that span a number of disciplines at UC.

"Working in statistics is amazing, because you don't have to concentrate on one thing. You can meet a lot of interesting people from all kinds of backgrounds and study what you want to every day."

Emotional responses to LEGO faces

Dr Moltchanova has collaborated with colleagues at the UC's Human Interface Technology (HIT) Lab on a project involving showing emotion on LEGO faces.

Mimicking the Likert scale, which asks for a respondent's opinion on a continuum from 'strongly agree' to 'strongly disagree', this project turns verbal descriptions such as 'feeling happy' into a series of expressions on the faces of LEGO figurines.

> "This is really important for global food security. Because of climate change we need to know where the most vulnerable areas to global warming are. If the world gets one degree warmer we need to know how much food we will be able to grow."

For example, the emotion of happiness starts at the lower end of the scale with a LEGO face slightly smiling, all the way up in five stages to a LEGO face beaming with joy.

Other emotional ranges displayed by the LEGO figurines were anger, fear, surprise, disgust and sadness.

"This project was a lot of fun. In a practical sense these LEGO faces could be used for child therapy, or for people with communication disorders, or in international environments where not all people are speaking the same language."

Global warming, food shortages and citizen scientists

One of Dr Moltchanova's recent projects took place on a sabbatical in Austria. There she collaborated with the International Institute for Applied Systems Analysis, using satellite or aerial observation data combined with crowd-sourced data contributed by volunteers from all over the world to produce global maps of croplands and forests.

These maps give an unprecedented level of accuracy about land use worldwide.

"This is really important for global food security. Because of climate change we need to know where the most vulnerable areas to global warming are. If the world gets one degree warmer we need to know how much food we will be able to grow."

This work is part of a Geo-Wiki project and is a radical departure from the way we traditionally think of research being undertaken. That is because it uses citizen scientists as foot soldiers for the research, taking photos themselves of their local forests or farmlands to add to the database of images, and also in the work of looking at photos and classifying them.

> "You don't know at the beginning whether it is going to become a full-blown epidemic or remain just a small-scale outbreak."

Disease and epidemiology

Dr Moltchanova's work has for many years centred on examining data in the field of health research. She is an acknowledged international expert on epidemiology of chronic diseases, such as diabetes, cardiovascular disease and Parkinsonism.

The practical implications of this research are numerous, with the results of her analysis of the possible effects of water hardness on the risk of heart attacks being incorporated into current European Union guidelines on drinking water composition.

Dr Moltchanova has been working for the past decade on a project relating to finding the optimal time to vaccinate a population when there is an epidemic.

"You don't know at the beginning whether it is going to become a full-blown epidemic or remain just a small-scale outbreak."

"You can wait for longer, but by that time it is too late to vaccinate the population. So we are trying to figure out if there is an algorithm or some kind of method to choose the optimal time to vaccinate. It would be fantastic for public health officials to have an app, which would monitor the number of reported cases and tell them when to start vaccinating."

By Bridget Gourlay

World of possibilities: Lab-on-a-chip

Dr Volker Nock is a Principal Investigator in UC's Biomolecular Interaction Centre, a multi-disciplinary centre dedicated to the study of molecular interactions critical to biological function.

On a chip the length of a thumb, he has developed a platform for studying the mechanics of microorganisms. His most recent research has come about thanks to collaboration with UC biochemist Dr Ashley Garrill, whose fields of research include biochemical and biophysical processes that underlie growth and development and the morphogenesis and pathogenicity of fungi.

The team's work has important implications for understanding how fungi and oomycetes grow as pathogenic species on plants and animals. One of the products of the vegetative growth of fungi and oomycetes are protrusive forces generated by the tip of the growing hyphae. This aids in the invasion of crops or other living organisms.

The lab-on-a-chip platform is able to measure these forces and determine factors that underlie them.

Understanding the invasive capabilities of these organisms is the first step on the path to eventually knowing how to interfere with, or supress their protrusive force.

"Lab-on-a-chip is an area where New Zealand can compete internationally. We have a strong biological sector. We can respond here first in this country, and from there, deliver solutions to the world."

Nematodes, robots and in-vitro fertilisation

Previously, Dr Nock collaborated with Associate Investigator at the MacDiarmid Institute, Dr Wenhui Wang, who is now at the Department of Precision Instruments at Tsinghua University, in Beijing. Dr Nock's research into force patterns in biological microorganisms originated from Dr Wang's work into increasing the rate of success for in-vitro fertilisation, he says.

"In realising that you can measure the force of a cell and consequently automating the in-vitro fertilisation process, you can tell a robot to stop at the right point. Being able to do that with manual in-vitro fertilisation takes years of training."

In collaborating with Dr Wang, Dr Nock had access to nematodes, a neurologically simple, highly adaptable worm species used as a model organism. Being transparent, it is possible to see the internal organs and structure of the worms. As part of the project Dr Nock developed a system where he could measure the force of a nematode when it moved.

"If you can measure the force of a nematode with normal behaviour and then measure the force when you stimulate it such as with light or electricity, you have taken a step in figuring out how one very simple organism will react. Will it for instance modify its system?"

"Lab-on-a-chip is an area where New Zealand can compete internationally. We have a strong biological sector. We can respond here first in this country, and from there, deliver solutions to the world."

Dr Nock was integrally involved in perfecting the experimental environment, where small flexible pillars on a chip provide the tool to measure the force response of an organism.

The problem with working with the nematodes is that existing mutants with interesting behavioural traits were difficult to import into New Zealand. A further problem for the team of engineers was that at UC there were no biologists who were driving this work.

Laying the ground work for the future

The answer came when UC's Dr Ashley Garrill approached him to see if there might be an application for his work with fungi.

Dr Garrill was researching how organisms growing on a plant try to penetrate the host organism. This involves understanding how they generate a force to penetrate the plant cells. The work is highly topical as it may unlock secrets around potato blight or kauri pit-fruit disease.

In turn this ability to measure forces could have applications for human disease, says Dr Nock.

"We are laying the ground work for future potential capability. For example, people have observed that cancer cells are very susceptible to the mechanics of the environment they grow in.

"It is in no way conclusive yet, but hypothetically if you were to expose cancer cells to mechanical forces they might revert back to something that looks like the behaviour of a normal cell. This is very exciting since we have the fabrication techniques at UC for producing labs-on-a-chip, which may offer the possibility of looking at what mechanical forces cells experience in certain tissues and expose them to a whole range of mechanical stimuli."

Dr Ashley Garrill says the collaborative approach has proved productive.

"As an engineer and a biologist we often respectively think of different ways to tackle the same problem and to then interpret the results. This can lead to synergies in the research lab that would be unlikely to happen without collaboration. For example, an important aspect of the lab-on-the-chip that makes it so successful is how the design of micro-pillar arrays are optimally positioned for hyphae to grow into them."

By Fiona Clayton

Dr Volker Nock (left), Ayelen Tayagui (centre) who is a PhD student working on the project, Dr Ashley Garrill.

Saving kauri trees, detecting bacteria in milk, addressing disease and infection and slowing the progress of cancer or multiple sclerosis are all future possibilities thanks to a new technology called laboratory-on-a–chip.

Dr Regina Eisert (centre), and colleagues.

Research on Antarctica's Ross Sea ecosystem can position New Zealand to not only contribute to the international management of Antarctica's future, but to be a leader.

Working together to secure Antarctica's future

Dr Regina Eisert is based at the Gateway Antarctica Centre for Antarctic Studies and Research at the University of Canterbury (UC).

She joined Gateway Antarctica in June 2013 to develop a new research programme on megafauna (seals, whales, penguins, and toothfish) in the Ross Sea. Her expertise is in the physiology and nutritional ecology of Antarctic marine mammals (seals and killer whales). Before coming to UC, she completed a PhD on the energetics of lactation in Antarctic Weddell seals at Lincoln University and worked as a postdoctoral researcher at the Smithsonian Institution in Washington, DC.

The challenge in engaging with other countries with an interest in the Ross Sea, she says, is to ensure that science and evidence forms the basis for policy discussions.

Strength in numbers

Dr Eisert knows there is strength in numbers. She spearheaded the formation of the Top Predator Alliance of New Zealand (TPA) in 2013, which has three primary partners, UC, NIWA, and Landcare Research. The goal of the alliance is to develop and expand research on Antarctica's top predators including penguins, seals, killer whales and toothfish, and increase scientific capacity by creating a network of local and overseas experts working on these species together.

The issues and goals are straightforward but addressing them requires determination and a robust, long-term commitment.

"We know the Ross Sea is under pressure from multiple drivers such as fishing and climate change. What we don't have is the baseline data for the ecosystem. We need this so we can detect and if possible mitigate change. Top predators are key to this, because they function as ecosystem sentinels."

Over time, scientific evidence produced by the TPA can be provided to the New Zealand Government and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), an international organisation of 25 member states that is responsible for the sustainable management of the Southern Ocean.

A very high priority initiative jointly proposed by New Zealand and the USA to CCAMLR is the establishment of a Ross Sea Marine Protected Area (MPA), which would be more than twice the size of the Kermadec Sanctuary and the largest MPA in the world.

"For member countries like China and Russia to support the proposed Ross Sea MPA, which would restrict fishing, the proposal needs to be evidence-based. The common baseline for people with different backgrounds is science and evidence. Science provides a good space for discussion and decision making.

"If you know the state of the environment, this can form an objective basis for policy and that ultimately is about sustainable stewardship of the Ross Sea area. Let's remember, it was New Zealand who started and continue to lead the fishery there. The reputational risk to New Zealand is important. If there is any risk of depletion of fish stocks or of damage to the Ross Sea ecosystem, the New Zealand Government want to know about it.

"We know the Ross Sea is under pressure from multiple drivers such as fishing and climate change. What we don't have is the baseline data for the ecosystem. We need this so we can detect and if possible mitigate change. Top predators are key to this, because they function as ecosystem sentinels."

"New Zealand is deeply invested in building a reputation for leadership through our foreign policy for Antarctica and the Ross Sea – we need to continue to be seen as the leaders in this.

"The strength is how Gateway Antarctica links in with the alliance. If you put us all together we are going places. And a key outcome of the synergy we hope to create is an increase in capacity and opportunity for Antarctic science – it's not about getting a bigger piece of the pie – it's about getting a bigger pie, so everyone benefits."

Collaboration is key

An important aspect of Dr Eisert's work is mātauranga Māori which acknowledges indigenous knowledge and that there is benefit in looking at anything from the perspective of many different sources of knowledge.

"Conservation is more effective when you involve all stakeholders. For example, the Ngāi Tahu traditional approach to the management of marine resources, kaitiakitanga (guardianship or protection), adds a really valuable and uniquely New Zealand perspective to conservation planning that is highly relevant to the sustainable management of the Ross Sea. I am also working with Dr Phil Lyver at Landcare Research and Dr Ingrid Visser at the Orca Research Trust to develop collaborations with iwi on whale research. Our Antarctic killer whales (Orcinus orca) commute to New Zealand waters, and it is a natural next step to study them here."

An ongoing challenge for her research is stable funding.

"If we can obtain stable funding, we can settle into doing the science."

By Fiona Clayton

Research supported by:
- Ministry for Primary Industries.

Discovering more about language patterns is the focus for Professor of Linguistics Jen Hay.

Unique testing ground for linguistics

Linguistics is more than the study of languages. At its heart, it seeks to find out how language influences the way people think, feel and interact.

Professor Jennifer Hay was awarded in 2015 a $767,000 Marsden Funding grant for her research project 'Statistical learning with and without a lexicon', a project which seeks to discover more about language patterns in New Zealand.

Professor Hay's research centres on the fact that native speakers of a language display a vast amount of statistical knowledge about when different sounds tend to occur in their language, and the relative likelihood of particular sounds occurring together in combination.

"However speakers of a language also possess knowledge about the statistical properties of sounds in running speech, which they use to segment the speech stream into words. The relationship between knowledge of lexical statistics (generated from the lexicon) and pre-lexical statistics (generated from running speech) is not understood."

Professor Hay seeks to use New Zealand as a unique testing-ground for finding out how this is affected when you do, or don't have a lexicon.

That is because many New Zealanders have regular exposure to Māori, but do not know many words. This enables researchers to study pre-lexical statistical learning in considerable depth.

Professor Hay's team will document the statistical properties of Māori sound structure. Then, using the established experimental architecture to present experiments in the form of computer games, they will investigate what knowledge of these properties non-Māori-speaking New Zealanders actually have.

Fact file:

- In 2015 Professor Hay was elected a Fellow of the Royal Society of New Zealand and awarded a James Cook Fellowship which you can read more about on the adjacent page.
- She is also a Rutherford Discovery Fellow, won the prestigious UC Research Medal and was a finalist in the 2015 Women of Influence awards in the Innovation category.

By Bridget Gourlay

UC academics awarded James Cook Fellowships

Use your words

Professor Jennifer Hay from the School of Linguistics will be using her James Cook Research Fellowship to increase understanding of accent and social variability in New Zealand.

This project aims to contribute fundamental knowledge about mechanisms through which speakers from different backgrounds understand each other.

She will be investigating and publishing how experience shapes different people's words and grammar.

To do this she will conduct a series of experiments which explore hitherto untested hypotheses about the implications of this detailed episodic word storage for morphology (word structure) and phonology (sound structure).

These areas have arisen from her many years of study in New Zealand English, and will draw on resources developed through the long-running 'Origins of New Zealand English' project. She will then unify her findings from this study, as well as her previous findings in New Zealand English, into a coherent theory, which she plans to publish as a monograph.

Acute Circulatory Failure – new insights

Research into Acute Circulatory Failure may provide insight that can be used to develop new and more effective drugs.

A project investigating Acute Circulatory Failure (ACF) has seen Distinguished Professor Geoff Chase from the University of Canterbury's Department of Mechanical Engineering awarded a prestigious James Cook Research Fellowship.

ACF is when the heart and blood vessels cannot efficiently transport oxygen to the organs. It is a severe syndrome common in critically ill patients and leads to organ failure and high mortality rates.

Professor Chase's research leverages off a discovery his group made that found changes in the elastic properties of blood vessels could significantly restrict blood flows and consequently contribute to ACF.

This study seeks to confirm and validate these initial results through both experimental and modelling work, then to identify the physiological and biochemical signalling pathway leading to ACF.

This will shed new insight into how arterial mechanics contribute to this high mortality condition, provide new and non-invasive model-based markers for tracking and treating the condition and, if successful, provide new mechanistic insight that can be used to develop new and more effective drugs.

By Bridget Gourlay

Two UC researchers, Distinguished Professor Geoff Chase and Professor Jen Hay (far left) were awarded prestigious James Cook Research Fellowships in 2015.

The national fellowships enable academics to concentrate on their chosen research for two years without administrative and teaching duties. They are only awarded to researchers who are recognised leaders in their fields.

Corporate design and cultural identity

The first doctorate degree connected to the Ngāi Tahu Research Centre has been awarded to an academic who is continuing a multi-generational legacy of Māori success.

Dr Eruera Tarena (Ngāi Tahu, Ngāti Porou, Te Whānau-a-Apanui) completed his PhD through the Department of Management, Marketing and Entrepreneurship with his research supported by his Ngāi Tahu Research Centre Doctoral Scholarship and a Fulbright/Ngā Pae o te Māramatanga Indigenous Scholar Award.

His research investigated the corporate design of contemporary indigenous organisations, and included conducting case studies into Kamehameha Schools of Hawai'i, the Sealaska Corporation of Alaska, and the iwi corporation Te Rūnanga o Ngāi Tahu in New Zealand Aotearoa.

Dr Tarena carried out case studies to better understand their design, organisational features and definitions of success, and to determine the extent to which these are influenced by cultural values and aspirations.

At the end of 2015, after completing his thesis, he reported back to all three indigenous communities, at Stanford University as well as at numerous hui.

"These organisations are very different and are operating within different political, legal, economic and cultural contexts, as well as having varying population bases and social agendas. However, despite these differences, each organisation faces the same tensions and complexities in terms of having to balance

> "Indigenous organisations have to 'play the game' and be part of the broader society within which they operate. However, there is a risk of cultural assimilation — the risk of the tribe losing its identity and agenda."

economic development — which involves engaging with a Western economic, legal and political environment — with the goal of building distinct cultural identities."

Dr Tarena says a growing concern for these organisations is that tribal corporate structures have come to resemble Western companies and reflect Western values.

"This is an interesting dynamic. Indigenous organisations have to 'play the game' and be part of the broader society within which they operate. However, there is a risk of cultural assimilation — the risk of the tribe losing its identity and agenda. Indigenous organisations can be empowering and emancipatory but, conversely, there are fears of Western structural models contributing to assimilation.

"All three organisations are grappling with this issue. Their structures have been designed to fit their local contexts and environment but they are walking a tightrope trying to balance conflicting commercial and cultural purposes."

Dr Tarena says the goal is to generate understanding and wisdom, to help other indigenous organisations to think about the challenges they may face in the future.

"The rules of Western corporate culture don't reflect indigenous aspirations so it is essential indigenous organisations are designed to fit indigenous purposes."

Dr Tarena's principal supervisor, Associate Professor Venkataraman Nilakant from the University of Canterbury's College of Business and Law, describes him as an ideal student.

"He did not have any background in management when he started his thesis. I wasn't sure how he would cope with complex ideas in organisation theory without the background. He astounded me by mastering the material in a few weeks. He was probably more knowledgeable about organisation theory than most of our Commerce students.

Director of Ngāi Tahu Research Centre (NTRC) Associate Professor Te Maire Tau (Ngāi Tahu) and Dr Tyron Love (Te Āti Awa), Lecturer in Management and Associate Dean Māori also provided supervision.

Fact file:

- The Ngāi Tahu Research Centre was established in 2011 as a joint initiative between Ngāi Tahu and UC , to lead indigenous scholarship and to provide a centre for the intellectual capital and development of Ngāi Tahu, the principal Māori iwi of the southern region of New Zealand.

Proud legacy

Continuing a family legacy of academic achievement, Dr Tarena, who is named after his renowned great-grandfather Eruera Stirling, tells of another legacy he has inherited.

Two weeks before he graduated, Dr Tarena met award-winning writer and anthropologist Dame Anne Salmond who had a very close relationship with his great-grandparents, Eruera and Amiria Stirling - respected Māori elders who collaborated with Dame Anne on three award-winning books on Māori culture.

"[My great-grandfather] Eruera had received an honorary doctorate and my family had gifted his academic bonnet to Dame Anne at his tangi in Raukōkore. When she heard I was graduating she gave me my great-grandfather's bonnet. I was very proud to wear his bonnet on my graduation day and recognise the legacy he left for his descendants as well as my grandfather, Waha Stirling, who also received an honorary doctorate from Lincoln University. Three of my four grandparents are doctors so I have been fortunate to have that legacy in my whānau.

"With the help of the Ngāi Tahu Research Centre scholarship, I have been able to help build upon that legacy. It's also great to see such an amazing cohort of young Māori scholars coming through the scholarship programme. I know they will also create their own legacy of Māori success for their whānau."

By Margaret Agnew

Research into the corporate design of contemporary indigenous organisations will provide a better understanding of how these institutions can best meet indigenous needs and aspirations.

Dr Tarena's research supported by:
- NTRC Doctoral Scholarship.
- Fulbright/Ngā Pae o te Māramatanga Indigenous Scholar Award.

Professor Simon Kingham, GRI Director, and Dr Malcolm Campbell, Senior Lecturer in Human Geography and Director of UC's GeoHealth Laboratory

UC has launched the Geospatial Research Institute Toi Hangarau (GRI) to deliver world-class geospatial science projects in New Zealand and meet the demand for collaborative research with industry and government.

Collaboration at heart of new Geospatial Research Institute

Geospatial Research Institute Director Professor Simon Kingham says there has been enormous growth in the amount of geospatial data being captured in recent times, in industries spanning health to local government. However, there is a skills-shortage in processing this geospatial information.

"Companies do not necessarily have the research capability required to make use of geospatial information in-house. The Geospatial Research Institute Toi Hangarau (GRI) has been set up to provide support in this area by matching companies with the best researchers to meet their needs and provide practical solutions to industry and government problems," he says.

Professor Kingham says that the establishment of the GRI will increase collaboration by providing an umbrella institute that gives the community better access to the University of Canterbury (UC) researchers from different disciplines.

"The Institute will build on our culture of research excellence. UC is invested in collaborative research, both internally across disciplines, and with industry. By working together we can provide a coordinated response to industry research needs."

Professor Kingham believes that the Institute will not only continue to attract external interest and funding, but also bring in new researchers and students.

> "There are so many unique opportunities to apply geospatial research in our recovering city. We can take geospatial information and use it to improve our world."

"Geospatial science feeds into a huge amount of projects and industries. There is a skills shortage of graduates in this area and the GRI is poised to meet this. Our postgraduate students are already being given opportunities to take part in industry research projects that almost always lead on to jobs."

Creating smart, sensing cities

Some of the first research to come out of the GRI will focus on one of New Zealand's National Science Challenges: Building Better Homes, Towns and Cities - Ko ngā wā kāinga hei whakamāhorahora. Researchers will work with the Christchurch and Wellington city councils to create geospatial tools that will inform urban planning decisions.

An example of this type of work is the testing of an app that cyclists can use to track and share their preferred routes around Christchurch. Professor Kingham says that it could eventually not only help cyclists plan routes, but help the Christchurch City Council to maintain and create new cycleways.

"There are so many unique opportunities to apply geospatial research in our recovering city. We can take geospatial information and use it to improve our world," he says.

Monitoring at-risk patients

Leading research is also being carried out by the Institute in partnership with the Canterbury District Health Board (CDHB). Researchers have created technology to monitor the movements of patients with chronic obstructive pulmonary disease. Professor Kingham says that in the near future doctors could track where a patient is in real time, relate this to their health and provide more targeted advice.

Becoming an international player

Professor Kingham says that in five years' time, the GRI will have established an international presence as a key player in co-innovative geospatial research and education.

"Ultimately, the GRI aims to be deeply involved in connecting research with the outside world through commercialisation, social and educational research, and outreach programmes."

A research hub on campus is being set up, so that companies can visit the GRI to talk about their research needs and create professional development opportunities. The Institute will also provide initiatives for collaborative supervision of PhD students and postdoctoral fellows.

Fact file:

- UC has delivered leading geospatial research for many years. The field is inherently cross-disciplinary.
- All of UC's Colleges have been involved in geospatial projects, collaborating to produce results for a variety of industries and government departments.
- Over time the GRI will build on its strategic partnerships and engage in collaborative outreach activities to build an awareness of geospatial science in the community.
- The new institute ties in with a number of research units at UC and has attracted the support of a variety of organisations, including international research centres, government ministries and iwi.
- The Australasian Cooperative Research Centre for Spatial Information (CRCSI) and Land Information New Zealand (LINZ) have recently funded a new Professor of Spatial Information for the GRI.

By Hannah McKnight

A Better Start: E Tipu e Rea

University of Canterbury's (UC) College of Education, Health and Human Development Pro-Vice-Chancellor, Professor Gail Gillon (Ngāi Tahu), is co-directing the government initiative, a new National Science Challenge – A Better Start: E Tipu e Rea – which was officially launched by Science and Innovation Minister Steven Joyce in early 2016.

Professor Gillon is also a principal researcher in the Challenge, which aims to improve the potential of young New Zealanders to have a healthy and successful life.

The challenge for A Better Start: E Tipu e Rea is to identify critical health, education and mental health issues that, if prevented or resolved, would have a major positive impact on children's lives - particularly for our most vulnerable children, she says.

The Challenge has identified that childhood obesity, early literacy and behavioural problems are critical areas that respond to research-based intervention and can lead to vastly improved outcomes for the individual and society.

A Better Start's research strategy is new for New Zealand because it will target the children most in need, early in life, engage their families and communities, and draw together experts from different disciplines and institutions.

> "We can predict with about 90 percent accuracy which children coming into school are going to struggle with their early reading and writing experiences. So rather than waiting for them to experience failure in any way, we really want to get in right from the start and make sure they experience success."

Together with more than 70 researchers throughout the country, the science leadership team will take a holistic view of obesity, learning and mental health, which are usually studied in isolation.

The learning strand in the challenge will initially focus on children's literacy, particularly in children who may have literacy learning problems. Professor Gillon says it can be predicted which children will struggle with literacy, and early intervention is the best approach. She says children usually did not get extra help with their reading until they had been at school for a year, and the project was investigating a different approach.

"We can predict with about 90 per cent accuracy which children coming into school are going to struggle with their early reading and writing experiences. So rather than waiting for them to experience failure in any way, we really want to get in right from the start and make sure they experience success."

"Children's early childhood language learning experiences, family engagement with children's learning, how well children transition from early childhood centres into the school environment, and children's health and well-being are all important factors to consider in understanding what contributes to successful literacy development in a child's first year at school. Effective classroom literacy instruction is also critical."

Pilot study

Professor Gillon says a pilot study indicated that teaching new entrants about the sound structure of words and how to break words down – known as phonological awareness – could have a dramatic impact on improving reading and writing outcomes.

"At the end of Year 1, those children that received phonological awareness instruction were much more likely to be at, or exceeding, their expected reading level with only six per cent of this group requiring further support in the following year. This compared to 26 per cent of children being at risk at the end of Year 1 and in need of literacy support if they hadn't received phonological awareness instruction."

She says the research will explore how the approach could be scaled up and used with schools in other communities and adapted for children who are emerging bilingual speakers and for children with developmental disabilities. In the first part of the Challenge the focus will be on children who are emerging bilingual in English and Māori or English and Samoan.

Grow and branch forth

Professor Gillon says Māori scientists and communities are integral to the research strategy.

"It's fitting that A Better Start's Māori name, E Tipu e Rea, means 'grow and branch forth'. Our research will be designed in line with kaupapa Māori principles, to braid together indigenous and Western scientific understandings and processes."

Also from UC's College of Education, Health and Human Development, Professor Angus Hikairo Macfarlane (Te Arawa) is the Challenge's Māori Research Leader. He says New Zealand has a significant proportion of tamariki and young people with health, educational and mental health vulnerabilities.

"These vulnerable tamariki are concentrated in low socioeconomic communities with a disproportionate burden falling on Māori and Pasifika," he says.

A Better Start is one of 11 National Science Challenges designed to find solutions to large, complex issues facing New Zealanders. UC academics are involved in all 11 of the National Science Challenges.

The science leadership team includes: Professor Wayne Cutfield, Obesity Leader, Director, Liggins Institute, University of Auckland; Professor Gail Gillon, Co-Director and Learning Leader, UC; Professor Barry Taylor Co-Director and Big Data Leader, University of Otago; Professor Angus Macfarlane, Māori Research Leader, UC; and Professor Sally Merry, Mental Health Leader, University of Auckland.

Other leaders in the College of Education Health and Human Development will contribute to the Challenge's Learning theme, including Distinguished Professor of E-Learning Niki Davis, School of Education Studies and Leadership; Prof Phillip Schluter, School of Health Sciences; Associate Professor Una Cunningham, Dr Brigid McNeill, Prof John Everatt, School of Teacher Education; as well as Adjunct Professor Bill Tunmer and Adjunct Associate Professor Sonia Macfarlane. The College's Kaiārahi Māori, Liz Brown, and Kaiārahi Pasifika, Tufulasi Taleni, are also supporting the Challenge.

By Margaret Agnew

UC academics have leading roles in a $34.7 million National Science Challenge to improve health and education outcomes for New Zealand's children, aiming to reduce obesity and improve learning skills and mental health.

Organisational resilience in the tourism industry, particularly in a post-disaster environment, is at the heart of innovative marketing research.

Resilient Tourism

After joining the University of Canterbury (UC) in June 2013, Senior Lecturer in Marketing Dr Girish Prayag's hard work led to him win the 2015 Early & Emerging Career Researcher Award.

Among his fields of interest, he is studying consumption experiences in the services industry with a focus on the tourism and hospitality industries.

"The main area I research is consumption emotions; how people feel when they consume products and services. I also look at how consumers attach themselves to objects and places. But since joining UC, I've embarked on research related to organisational resilience in a post-quake environment."

"When I arrived at UC, I saw many of my colleagues doing something on the topic of resilience, as it is of importance. When I looked at the tourism field, there wasn't much that had been done, even though Christchurch had gone through such a disaster."

Dr Prayag is co-authoring a book on tourism resilience, with Professor C. Michael Hall and PhD student Alberto Amore, both of whom are also from UC's Department of Management, Marketing and Entrepreneurship. He says the book is not just about post-earthquake Christchurch, but will look at tourism resilience in general.

"What does it mean to be resilient, through the lens of community resilience, personal resilience, and organisational resilience? Basically, organisational resilience in the tourism industry is looking at what are the factors, in a post-disaster environment, that can make an organisation resilient?

"The research on resilience in general will look at what we could learn from these different disasters on how to build destination resilience, personal resilience, and organisational resilience."

"In the case of Christchurch what we've found is that there are differences within the tourism sector – whether you are running accommodation, transport, or visitor attractions — on factors such as staff engagement, collaboration and innovation."

His book on tourism resilience will go broader than Christchurch and look at examples around the world, including the Sichuan earthquakes, the Chile tsunami, and Hurricane Katrina in the United States.

"The research on resilience in general will look at what we could learn from these different disasters on how to build destination resilience, personal resilience, and organisational resilience."

By Margaret Agnew

Finding sustainable solutions for NZ forestry

An innovative team at University of Canterbury's (UC) School of Forestry is working hard to find a solution to a key challenge facing New Zealand's forestry industry.

"Another unique feature of the programme is the assessment of the trees at a young age, drastically reducing the time to deploy improved trees from decades to years."

"Wood is a biodegradable material and therefore central to a sustainable and environmentally friendly economy," Dr Clemens Altaner says.

"However, it does decay, or rot, prematurely. To make it longer lasting, wood can be impregnated with chemicals, but these are toxic and some still used in New Zealand are banned in other countries."

Importing naturally durable wood from tropical countries is also problematic because these forests are often not harvested sustainably.

Dr Altaner says eucalyptus trees are highly durable and therefore provide another option. Crucially for foresters they grow fast and straight, which makes them easier for cutting.

Breeding – a five-year plan

What Dr Altaner and his colleagues are seeking now, through creating a breeding programme, is to find which of the many hundreds of eucalyptus varieties are the best option for New Zealand's climate.

"We want to identify not only the trees which are the fastest growing, most frost-resistant and most insect-resistant but also those which produce the best quality timber."

"Selecting trees for wood quality is rarely done due to the amount of time it takes to make difficult measurements, however we have developed new quick wood quality assessments.

"Another unique feature of the programme is the assessment of the trees at a young age, drastically reducing the time to deploy improved trees from decades to years."

Hopefully within five years superior trees identified from the breeding programme will be identified and mass propagated.

All of this is done with the goal of creating high quality wood which can be used for the production of engineered wood products such as laminated veneer lumber, both here in New Zealand and to open up additional export opportunities for the forestry industry.

Dr Altaner's research was awarded a $500,000 grant last year from the Government's Sustainable Farming Fund, and other funding sources have come from every level of the forestry industry – from seed producers to tree nurseries to forest growers and wood processors.

By Bridget Gourlay

A breeding programme could determine which durable sustainable eucalyptus varieties are best for producing high quality wood.

This research aims to enable the design of resilient buildings that respond in a damage-resistant manner. This will allow rapid re-occupancy and reduce downtime after a severe seismic event. Far fewer buildings will be demolished and can be repaired more cost effectively.

Good vibrations – exploring bolder building solutions

Buildings which bear the brunt of extreme force, such as a one-in-500 year earthquake, could be reoccupied much sooner if new structural engineering solutions are adopted.

Solutions which turn conventional building wisdom on its head and reconsider what we define as a 'strong' building are being researched, modelled and tested by Dr Geoffrey Rodgers. Good vibrations, it turns out, are the key to getting back to business.

For Dr Rodgers, who lectures and researches in the University of Canterbury's (UC) Mechanical Engineering department, success looks like "a suite of energy dissipating solutions that can support a range of building design methodologies".

Ultimately, it includes cost efficient 'smart intervention' which will appeal to investors, developers, the building industry and the insurance sector.

Conventional wisdom, which he says is embedded in building codes worldwide, is that we allow damage to occur in selected areas to prevent collapse, and that after a large earthquake we can expect to find damaged structures.

To date it has been common practice for those parts of buildings which provide structural support, such as beams, to limit force by becoming damaged, restricting the load that is transferred elsewhere, such as to a column.

But as the Canterbury earthquake of 22 February 2011, and subsequent earthquakes and aftershocks proved to many in New Zealand, it is this damage that contributed hugely to one of the most prolonged challenges continuing to face local industry, commerce and service providers – timely reoccupation of buildings, for many, became a distant dream.

Demolition and replacement often proved faster and more cost efficient. The material issue Dr Rodger's research addresses, is 'replace with what?'

> "If you're a boxer, you don't stand up hard against the punch, you roll back in a controlled way."

Damage resistant design

This area of research is not new. Earthquakes elsewhere such as Northridge, California in 1994, Kobe, Japan in 1995, Chile in 2010, had all been catalysts for important work on increasing structural resilience. Dr Rodgers says there continued to be a disconnect between the way engineers design and the public perception of expected performance.

UC has been at the forefront of this area of research for some time. Dr Rodgers completed his PhD in 2009. But as often happens, nature provides the catalyst for increased interest.

The Canterbury earthquakes has resulted in a greater translation of the research into real world practices.

He was part of the team which developed the design solutions for Forté Health in Kilmore Street, Christchurch, introducing lead extrusion dampers at the building's base. Instead of the energy transmitted by an earthquake encountering a structure which absorbed the force by becoming damaged, the dampers are designed to dissipate energy without damage.

His research moved next into a focus on designing systems for controlled rocking connections. The analogy he shares provides a clue as to why he was voted, by students, as the best UCSA lecturer of the year in 2015.

"If you're a boxer, you don't stand up hard against the punch, you roll back in a controlled way.

"It takes a lot of energy to cause damage. But if you take away the ability to absorb energy through damage, then you have to provide something else.

"Regardless of the medium or device which is used – tension only braces, viscous fluid devices, lead extrusion dampers – what remains constant is the need to dissipate energy and do so in a damage-resistant way."

Ultimately the combination of these devices with instrumentation, which monitor how buildings perform in the real world, will add additional insight and provide the confidence to guide reoccupation.

Complacency, building understanding and cost

There are a series of challenges, says Dr Rodgers.

"Complacency builds surprisingly quickly following events like the Canterbury earthquakes. There is a significant increase in uptake of the research. However, the margins around cost quickly tighten.

"It's important to remember, most of the time you are in a car you won't crash, but the one time that you do, you want to be wearing your safety belt.

"Then, if consultants don't fully understand new technology, and they're not comfortable with it we don't get very far. The answer is to provide robust modelling from testing the devices as they are developed and to show building experts how it relates to or impacts on the way the Building Code is written. If an instrumented building produces data, and we have the modelling that matches to it, then we've closed the loop."

By Fiona Clayton

Earthquake engineering capability boosted

During 2015, a major element of the Canterbury Engineering the Future (CETF) project, the $8.75m Structural Engineering Laboratory was constructed.

While similar laboratories are being used overseas, this will be the facility that allows testing of the tallest structures in New Zealand and will drastically increase University of Canterbury's earthquake research capability.

The building includes a 9.2 metre high strong wall cantilevered from a two metre thick floor, both cast in-situ and together comprising 400 tonnes of steel reinforcement, 1500m³ of various concrete mixes and 3607 couplers at 400mm centres laid to an accuracy of 2mm.

Associate Professor Greg MacRae from the Department of Civil and Natural Resources Engineering (CNRE) says that one lesson learned from the Canterbury earthquakes is how much is still not understood about structural performance.

This new laboratory will enable researchers to simulate earthquakes of differing strengths, intensities and speeds on various elements and on whole buildings and structures of concrete, steel and timber.

"We already have a facility which uses similar techniques, but it is much smaller and we can only test parts of a building or a scaled-down model. This becomes a real issue with materials such as concrete because things like aggregate size just cannot be scaled down. The results that you get testing small elements are very different to those you get when you test large elements."

"Since the earthquakes, we have been inundated by people from overseas wanting to do their research here, and this new facility is only likely to increase that demand."

Potential to expand

More than a year's worth of projects were booked to start in the laboratory when it opened and began working in April 2016. It is believed the Structural Engineering Laboratory will attract many more researchers, not only from New Zealand but internationally.

"Since the earthquakes, we have been inundated by people from overseas wanting to do their research here, and this new facility is only likely to increase that demand."

To meet that demand, Dr MacRae says there is potential to expand the lab in the future.

By Jann O'Keefe

Opening of Structural Engineering Laboratory 15 April 2016. Left to right: UC Vice-Chancellor Tumu Whakarae Dr Rod Carr, UC Chancellor Dr John Wood CNZM QSO, Managing Director Dominion Constructors Ltd Mr Brett Russell, Tertiary Education, Skills and Employment Minister Hon Steven Joyce, QuakeCoRE Deputy Director Professor Brendon Bradley (UC), QuakeCoRE Director Professor Ken Elwood (University of Auckland).

The newly built Structural Engineering Laboratory will enable researchers to 'shake' full-sized buildings and structures at different speeds and intensities to test their responses to earthquakes.

QuakeCoRE researchers are producing new knowledge on the seismic response of the built environment. They will develop models to understand vulnerabilities within this environment and New Zealand communities will have more technologies and tools to recover quickly when disaster strikes.

Improving resilience to earthquakes

Five years ago Christchurch was devastated by the February 2011 earthquake. From the chaos and destruction came a desire to learn all the lessons we can as a community, to make New Zealand safer for future generations.

The national importance of earthquake resilience, combined with leading researchers in the field, led to the establishment of QuakeCoRE: The Centre for Earthquake Resilience, which officially opened its doors on 1 January 2016.

More than just creating seismically strong buildings, QuakeCoRE will also be a place for the designing of innovative technologies and decision-support tools, so New Zealand communities can recover quickly when disaster strikes.

University of Canterbury's (UC) Professor Brendon Bradley is the co-creator and deputy director of QuakeCoRE.

"The successful establishment of QuakeCoRE was critical for us to develop disruptive technologies and methodologies that will drastically improve our resilience to earthquakes, to bring fragmented research efforts together, and provide a focal point for end-user engagement and international collaboration."

Professor Bradley is one of those earthquake researchers himself. He received a Rutherford Fellowship in 2013 to investigate the mysteries of unresolved ground motion and geotechnical case-histories from the 2010 and 2011 Canterbury earthquakes.

Fact file:

- QuakeCoRE is one of ten Centres of Research Excellence funded by the Tertiary Education Commission until 2020.
- QuakeCoRE is a national network of leading New Zealand earthquake resilience researchers whose mission is to place New Zealand at the forefront of earthquake resilience globally.
- Earthquake resilience encompasses engineering, social and policy, for both preparation and post-earthquake response. QuakeCoRE researchers will produce new knowledge on the seismic response of the built environment and develop models to understand vulnerabilities within this environment.
- QuakeCoRE leverages strengths across the country and internationally, working collaboratively on integrated multidisciplinary programmes of internationally-leading research.

QuakeCoRE key goals

The key goals are to deliver high impact research to improve earthquake resilience. This will be achieved via collaboration between institutions and disciplines as well as engagement with industry.

Professor Bradley receives prestigious international award.

Professor Brendon Bradley was presented with the prestigious 2015 Shah Family Prize at the international Earthquake Engineering Research Institute (EERI) Annual Meeting in San Francisco in April 2016.

The EERI annually awards the Shah Prize to young professionals and academics for creativity, innovation, and entrepreneurial spirit in the field of earthquake risk mitigation and management.

Professor Bradley says it's an honour to be internationally recognised by EERI for the work that collaborators have undertaken over the past decade.

"It has been extremely rewarding working towards understanding the many lessons from the Canterbury earthquakes with amazing New Zealand and international colleagues, and very satisfying to see many of our research outputs having a measurable impact in the way in which Christchurch is rebuilt, as well as being used for other national and international projects."

In 2014, Dr Bradley was honoured as the youngest individual to receive the Shamsher Prakash Research Award, the most prestigious international award in geotechnical earthquake engineering, and, in 2015, was the youngest recipient of the Young Research Award given by the International Society for Soil Mechanics and Geotechnical Engineering's Technical Committee on Earthquake Geotechnical Engineering and Associated Problems (TC203).

By Bridget Gourlay

Building capabilities with high-end technologies

Associate Professor Renwick Dobson from the School of Biological Sciences and the Biomolecular Interaction Centre enlists the capabilities of an analytical centrifuge to study biological molecules as they interact with each other in environments that closely emulate their natural habitats. He says this is a new approach.

"In an era where we can look at whole genomes, we now need to look at whole systems that contain multiple interactions between the different parts of that system. This is more complicated, and very different from the previous reductionist approach where we would take a single molecule, such as a protein, and study it in isolation.

"In reality, proteins don't function in isolation – they function in complex environments. In our cells, they are packed together extremely tightly, they move around and interact with each other all the time, and this is not so easy to study. The analytical ultracentrifuge helps bridge that gap. It enables us to take different macromolecules we think may interact in a cell and probe those interactions in a solution that mimics a cell."

The centrifuge can help ascertain whether a molecule interacts, how it interacts, whether that interaction can be characterised and if the interaction would actually be happening in a live cell.

It can also help determine if two proteins known to be important for a process might be more efficient if they were to interact with each other during that process, what their affinity is for one another and how that is modulated.

"We also have access to the Australian Synchrotron in Melbourne to apply two techniques to large molecules. The first is small angle x-ray scattering, which looks at the shape of objects in solution. The second is x-ray crystallography, where the molecules are made to aggregate in a defined way, as crystals, so their molecular structure can be determined."

> "We are trying to predict those patients who are susceptible to diabetic complications using specific biomarkers."

Cutting edge technique

Access to both the analytical ultracentrifuge and the synchrotron builds the research capability of University of Canterbury (UC) students who learn cutting edge techniques for investigating molecular interactions that they can then apply to real world applications, often in collaboration with industry.

One of these is with Canterbury Scientific Ltd, a highly successful local biotech company who developed the standard for the HbA1C diagnositic test that indicates the levels of glucose attached to a protein haemoglobin in blood.

"Glucose levels in the blood need to stay within closely defined levels, and diabetic patients have problems regulating this. The diabetic population are also highly susceptible to complications, which could include blindness, loss of limbs, and other macrovascular conditions.

"Many diabetics develop some sort of complication, but some develop them early regardless of how well their glucose levels are managed. We are trying to predict those patients who are susceptible to diabetic complications using specific biomarkers. If a blood test indicates an elevated level of this biomarker we can predict that person is likely to get complications at an early stage of their disease and the clinician is able to make appropriate decisions."

> Cells will commit suicide in certain circumstances, such as virus infection, to prevent the virus replicating in it. The best studied pathway is called apoptosis.

Researchers in Dr Dobson's laboratory have identified a number of potential biomarkers and are working towards a clinical trial to test how well they predict the diabetic complications. Initially funded by MBIE, Canterbury Scientific Ltd are funding the project as part of their commitment to supporting research in Canterbury.

When cells commit suicide

Dr Dobson is also working on necroptosis with Dr James Murphy, a UC alumnus who is a Principal Investigator at the Walter and Eliza Hall Research Centre in Melbourne.

"Necroptosis is another way of telling a cell to die. Cells will commit suicide in certain circumstances, such as virus infection, to prevent the virus replicating in it. The best studied pathway is called apoptosis.

"Necroptosis is an alternative pathway to the same result, although it is thought to be more of a redundant, back up system. We are working on a protein called MLKL. It has an odd name, but it is a key protein in regulating the pathway of necroptosis. We used the analytical ultracentrifuge to show that it changes its oligometric state upon induction and that this was a key step to go to a membrane surface and turn on the pathway."

By Jann O'Keefe

Jennifer Crowther, a UC Doctoral student is working with Associate Professor Renwick Dobson. She is using the analytical ultracentrifuge to examine how proteins interact in milk, which, like a cell, is a complex mixture of proteins, sugars and fats.

Using an analytical ultracentrifuge, UC researchers are able to look at molecules while they interact with one another in complex environments, rather than studying them singly in isolation. This increases potential for diagnostic applications and industry collaboration.

Awesome predictions – theoretical and computational chemistry

Theoretical and computational chemistry is a relatively new field of study. Mathematical and computer modelling are used to predict and explain molecular behaviour, and the practical applications are limitless. Knowing how molecules absorb and store energy from light forms the basis for developing new solar energy technologies. Other applications include designing drugs, catalysts and advanced materials.

While TV crime shows mean most are familiar with matching DNA 'fingerprints', Dr Crittenden's work goes a step further, aiming to predict what the fingerprint will look like.

"You start with maths, and then build up a physical picture in your mind, and you can use both to predict things, although in different levels of detail. For highly detailed predictions, we develop mathematical theory into code, which allows us to compute new information about molecules based on their structures alone."

The challenge is to link experiment with theory – line up the two and you've got a high level of certainty about how a molecule will behave.

"Modelling done well is a smarter not harder thing. We can make a lot more progress than doing the same thing over and over in a lab. The potential for progress is high, but so is the potential for going nowhere. It's like finding a needle in a haystack with a very good magnet. There are good ideas about the ways to go through the haystack and there's a bunch of things we know just do not work.

"If we develop tools that enable people to solve problems, then that's really cool. In five years people could be using my methods and discovering new things and developing new technologies, or we might have tried and got only a mediocre or perhaps small improvement. All of the devil is in the detail. If you miss the detail or do not get the detail quite right, there are no guarantees we'll get any closer."

By Phil Barclay

"Modelling done well is a smarter not harder thing. We can make a lot more progress than doing the same thing over and over in a lab. The potential for progress is high, but so is the potential for going nowhere. It's like finding a needle in a haystack with a very good magnet."

For Dr Deborah Crittenden, building research capability means solving chemical problems that can't be directly seen, for which current tools do not exist, with the aim of informing development of a wide array of new products and technologies.

Left to right: Maddie Shankle, Elisabeth Bertolett, Dr Darren Gravely

US students research New Zealand's unique landscape

In only eight years Frontiers Abroad has gone from strength to strength at the University of Canterbury (UC). When the programme began in 2008, five students from three US universities participated. Now, more than 50 students from more than 30 US universities participate each year.

Frontiers Abroad is a programme which gives undergraduate students from the US the opportunity to come to New Zealand and conduct earth and environmental focused field work and research on our unique landscape.

Senior Lecturer at UC's School of Geological Sciences, Dr Darren Gravley is the Director for the Frontiers Abroad geology programme. He says it offers hands on opportunities to US students who have become more aware of New Zealand as a potential destination for studying since the earthquakes.

He says the success of Frontiers Abroad is also due to the growing network of alumni and the fact that Frontiers Abroad students have had their research published in several journals, including leading earth science journal American Mineralogist.

"This adds to UC's Performance Based Research Fund (PBRF) portfolio and also contributes to developing some important links with top US research scientists."

Real research experience

The US students undertake field modules in locations throughout New Zealand including Kaikōura, the West Coast, Banks Peninsula and Taupō. Students learn about geologic field mapping, interpreting geological data, styles of volcanic eruptions, and volcano monitoring and hazards. In the final field module, students go to Banks Peninsula to collect data for their own research projects.

Frontiers Abroad students have the opportunity to learn and work with experts from leading research organisations. GNS Science is involved in the volcanology module of the geology programme in which students learn about different eruption types and their resulting volcanic deposits, as well as how to monitor volcanoes and volcanic hazards.

Students also have the opportunity to work on projects local organisations are involved in. Frontiers Abroad Academic Director Dr Sam Hampton, in collaboration with local community and conservation groups, is spearheading the establishment of a UNESCO designated geopark for Banks Peninsula – an area with internationally significant geological features. Geologic mapping and baseline field research for the initiative comes from Frontiers Abroad students.

Last year 14 students gave presentations at the Geological Society of America conference on their New Zealand research.

"The reason I'm staying is because I feel like I've already got a really good support system here. The community here and the connections and networks you make are invaluable in academia."

"Students who decide to do Frontiers Abroad expect that they can actually do something with their research because previous Frontiers Abroad students have had their work published or given presentations," says Dr Gravely.

Some students continue to work on their research with their supervisor when they return to the US, some of whom Dr Gravley co-supervises. Others are inspired to work on other research projects and some decide to continue studying at UC, such as Elisabeth Bertolett and Maddie Shankle.

Student case study

Ms Bertolett is the first PhD student at UC from Frontiers Abroad after receiving a UC PhD scholarship. She was studying at Denison University, Ohio, when she came to UC for the Frontiers Abroad geology programme in 2014. She returned to UC in 2015 to take on a research assistant position with Dr Gravley, and was also a teaching assistant on the Frontiers Abroad geology programme.

"The reason I'm staying is because I feel like I've already got a really good support system here. The community here and the connections and networks you make are invaluable in academia."

Maddie Shankle discovered Frontiers Abroad through her advisor at Yale University, Connecticut, where she was doing a double major in geology and engineering. She has a particular interest in environmental engineering, focusing on climate studies and atmospheric science.

"I was attracted to Frontiers Abroad because of the geology and research components, and was exposed to a lot of different things that I may not have otherwise experienced. New Zealand is really good for geology."

Ms Shankle says she will continue working on the research she started on the Frontiers Abroad geology programme.

By Hannah Seeley

Frontiers Abroad's earth and environmental programmes provide real research experiences for US students.

A tectonic experience

Two professors from New York are finding New Zealand's active tectonics make for a dynamic and exciting place to conduct research.

Syracuse University (SU) professors Suzanne Baldwin and Paul Fitzgerald are among the latest recipients of University of Canterbury's (UC) prestigious Erskine Fellowship. They are among 70 distinguished international academics, who are invited to UC on an Erskine Fellowship and are teaching and conducting research in geological sciences at UC for three months.

Professors Fitzgerald and Baldwin study earth processes operative on the timescales of millions, or even billions of years. However, New Zealand offers a refreshing change of pace. Being located on the Australian-Pacific tectonic plate boundary, as marked by the active Alpine Fault in the South Island, there is ongoing mountain building and active deformation through events such as earthquakes.

They explain they are excited by the opportunities the Erskine Fellowship brings. In addition to strengthening research relationships with UC scientists, the fellowship has enabled the two professors to spend time focusing on research.

"The Erskine Fellowship has given us the opportunity to learn from UC faculty experts about hazard and disaster management as it relates to the region's ongoing efforts to rebuild," says Professor Baldwin.

From Alaska to Antarctica

As part of the Erskine Fellowship, professors Baldwin and Fitzgerald have been speaking about research they've conducted across the globe, including work in Alaska, Papua New Guinea and Antarctica.

They are also working with New Zealand scientists on joint projects in Papua New Guinea, and say there are some geological similarities between Alaska and New Zealand, both having large strike-slip fault systems: the Alpine Fault and the Denali Fault.

Frontiers Abroad – connecting with undergraduates

While at UC, the researchers are participating in Frontiers Abroad, which brings undergraduate students from the United States of America to UC for fieldwork and research focused on earth and environmental studies.

2016 is the first year undergraduate students from SU will participate in Frontiers Abroad. Four SU students are travelling to New Zealand for the programme, which includes a five-week component where students gain hands-on experience with fieldwork at different research sites across the country. This is followed by a semester taking classes at UC and working on research projects.

By Hannah Seeley

Genetics: impact on the legal system

"If a defendant is arguably 'not criminally responsible' due to a genetic predisposition to crime or violence, legally they cannot be found guilty of murder for example, but is this how society wants its laws applied?"

This is one of the many thought-provoking questions considered in Senior Lecturer at UC's School of Law Dr Debra Wilson's new book.

Genetics, Crime and Justice examines the legal and ethical issues raised by genetic scientific research and explores how the criminal justice system currently reacts, and ought to react, to the new challenges presented by genetic evidence.

"Genetics and neuroscience are going to change the criminal justice system. The genetics defence has already been used in more than 200 cases in America and in Europe, which raises questions around verdicts, jury decisions and sentencing."

Dr Wilson says her book does not provide the answers, but raises important questions that societies, governments and the legal fraternity around the world need to consider.

"We need to talk about these issues and figure out how to respond to these scientific discoveries. With the growing use of DNA databases, there are also issues around privacy and individual rights that need to be considered – should everyone be genetically tested and how should we respond when the gene is identified?"

"We need to talk about these issues and figure out how to respond to these scientific discoveries. With the growing use of DNA databases, there are also issues around privacy and individual rights that need to be considered – should everyone be genetically tested and how should we respond when the gene is identified?"

Genetics, Crime and Justice was published by Edward Elgar Publishing in the United Kingdom. It includes a layperson description of the science related to the 'criminal gene' because Wilson says "we need to know what the science is telling us in order to consider the legal issues". The content is relevant across a range of international jurisdictions and not focused on one particular legal system.

Since it was published in 2015 *Genetics, Crime and Justice* has received significant media attention and reviews, including forthcoming reviews in journals such as the Medical Law Review and the New Zealand Criminal Law review.

And this is exactly what Dr Wilson wanted.

"I hoped to start a debate in publishing this book. The point is that use of genetic information in court is coming. Judges so far don't know what to do with it when they are faced with it, so this book provides the background so these arguments can be understood."

By Bridget Gourlay

Genetics and neuroscience will change the criminal justice system. A UC academic's book explores the legal and ethical issues raised by genetic scientific research.

Unravelling ecological complexities

Ecological possibilities are endless, says Associate Professor Daniel Stouffer from the University of Canterbury's (UC) School of Biological Sciences, of his discipline.

"In ecology there's so much unknown it can feel like colonising the moon."

Originally a chemical engineer, it was when he was doing his PhD in complex systems that he became drawn to ecology, partly because of how much is left to be discovered.

"In engineering much of what you learn as an undergrad are things that people with names like Archimedes figured out well over centuries ago. Ecology is a much younger field where we're still learning the most fundamental things and this makes it a very exciting area to undertake research."

Plant competition

The desire to find out the fundamentals of ecology is exemplified in a set of projects Dr Stouffer is working on.

"We're trying to measure the effect of competition between plants growing beside each other, to see how the extremely ecologically diverse plant communities in the wild exist.

"We honestly don't understand how that happens. Everything we're taught and everything our intuition tells us suggests that when you put two plants next to each other they are fighting to the death to take all of the available resources, such as water and nutrients.

> "It's not just about plants competing with each other but also their neighbours competing with their neighbours and so on."

"Reality is so much more complex and interesting, however. It's not just about plants competing with each other but also their neighbours competing with their neighbours and so on. The wildest part is that all this 'fighting' can often turn into a net positive for everyone involved."

Food webs

Much of Dr Stouffer's research focuses on ecological complexity.

"When you take two water molecules and you put them together you know exactly what will happen. When you take individuals from two different species and put them together you rarely know what will happen. And in ecological communities where you have many individuals and many species you can get very unpredictable or unexpected results."

Drawing on complex systems theory, Dr Stouffer and his research group are trying to take a computational, statistical or analytical approach to push through that complexity. Then they try to figure out if there are basic rules ecologists can understand about how a community works, and what that tells us about ecology and evolution more generally.

Related to this is his study of predator-prey interaction networks, commonly referred to as food webs.

In this pursuit, Dr Stouffer and his research group have sought to find the answer to two main questions.

Firstly, to find out what the structure of a food web looks like from a statistical or a network theory perspective.

"What we're trying to do is see if there is a common backbone. Food webs could be a hairball, but what we've been able to show is that there are some key structures to food webs, whether they take place in New Zealand or abroad, in water or on land. This means that there may in fact be common mechanisms underpinning why food webs are structured the way they are."

This leads to the second question, which asks that if there is a common structure, what are the implications of it?

"Does a food web's structure look the way it is because it allows many species to co-exist? Does it make it more resilient to disturbance? We have found that may be the case. Food webs minimise the degree to which if a species went extinct, not as many other species might notice. For example, if someone introduced a contaminant it may not spread through the whole community but be contained. They tend to be structured in a way which makes the community very stable."

While Dr Stouffer's research focus is at a fundamental blue-skies level, it could in the future be applied to the case of species introduction or invasion to predict the effect that might have on the species already present.

Value in different perspectives

Working with academics from a range of fields is something Dr Stouffer finds valuable, because he feels that the differences bring valuable perspectives and new insights to any research project. With this in mind, he is proud to boast that his current group of postgrads includes biologists, engineers, physicists, and more.

This crossing of paths is something he does himself.

"My research is inherently multi-disciplinary, and I'm constantly inspired by new tools or approaches from fields such as engineering or physics, even when the end game is tackling ecological or evolutionary questions."

In 2013 Dr Stouffer was awarded a prestigious Rutherford Discovery Fellowship from the Royal Society of New Zealand and in 2014 was named one of the inaugural recipients of UC's Early and Emerging Career Researcher award.

By Bridget Gourlay

Unravelling the complexities of ecology may help understanding around how species co-exist, or why some are more resilient to invasion.

Sound and colour – how synaesthetes perceive their world

Synaesthesia often manifests itself as hearing colours (audition colorée or chromesthesia), tasting sounds, or attributing colours to words and numbers. In 2010 Dr Shepherd launched the first part of a study talking with synaesthetes about their condition.

In the project's second stage he examined the specifically musical manifestations of synaesthesia in the 11 synaesthetes taking part in the study, as well as relating his findings to other interesting manifestations of the phenomenon.

Talking with synaesthetes about their experience rather than testing them was an important aspect of his study. Initial findings were presented at at two conferences in Australia in 2011 and 2013. Both stages of his research won UC Summer Scholarships, the first focusing on interviewing the synaesthetes and gathering data, the second working on a website, Synaesthesia Aotearoa, which is currently being updated.

While the study explores synaesthesia in its broadest sense, participants were specifically asked to comment on any ways in which their own learning might have been enriched by their synaesthesia, says Dr Shepherd. They were asked if they felt it made them more or less creative and any ways in which synaesthesia, as they perceive it, might be used in education, particularly with regard to music and the arts.

> "However, it is possible that synaesthetes might use the condition as a positive tool in the teaching of the arts."

"Analysis of their responses indicate that having synaesthesia does not make you more or less creative, and those who have it will just as equally use their synaesthesia in their work as not – it is not a determining factor as to someone's ability to be creative."

"However, it is possible that synaesthetes might use the condition as a positive tool in the teaching of the arts."

"Synaesthesia affects people in very different and usually very inconsistent ways, colour hearing does not automatically come with taste association; combinations are not universal nor are they similar. Synaesthesia can equally be a help or a hindrance – there is no evidence to suggest that it makes you any more or less creative.

"But knowing somebody with a similar view of the world helps by normalising the condition.

Being aware of synaesthesia is important for educators and non-synaesthetes, as well as using colour analogy as part of a dialogue with the students about the way they perceive their world."

He says the theory of synaesthetics, the artistic application of synaesthesia to make connections within the Arts disciplines, clearly underpins the theory of Integrated Arts, though is only ever implicit. However, recent studies show that synaesthetes, those who are clinically diagnosed as having the condition, may number as high as one in 23.

"So many of our children are synaesthetes but may hide the fact, in worst cases regarding it as an affliction, when in actual fact it could be used as a positive tool in the teaching of the arts. Coincidentally, that number is similar to the incidence of dyslexia and that condition often accompanies synaesthesia."

Dr Shepherd says that the next stage of this study needs to focus on children.

"In talking with colleagues overseas it has been strongly suggested that in my professional position as an educator working with primary age school children, and in my role as a university researcher, my studies should focus on young children as that is where the condition is most prevalent."

Fact file:

- Synaesthesia is a condition whereby people "have anomalous perceptual experiences that are triggered by activity in another sensory modality" (Ward et al, 2008).
- It often manifests itself as hearing colours or tasting sounds, or attributing colours to words and numbers, and is a condition experienced by many famous creative people e.g. painter and art theorist Wassily Kandinsky, composer Olivier Messiaen, composer Alexander Scriabin and artist David Hockney.
- Patrick Shepherd is the coordinator for the two undergraduate and graduate arts-based courses in Primary Education at the College of Education, Health and Human Development, and is an accomplished composer, conductor, performer and teacher. He says he is passionate about new music, music education, technology and creativity. He is also the Music Director of the Christchurch Schools' Music Festival which involves over four thousand primary school children in its performances each year

By Fiona Clayton

An ongoing study by Senior Lecturer Dr Patrick Shepherd in the College of Education, Health and Human Development suggests that synaesthesia does not make you more or less creative. However, a teacher's understanding of synaesthesia could enhance how they teach music, the arts and other subjects.

Digging deeper into genomics

In 2001 scientists did something extraordinary. They managed to decode the human genome, which is no mean feat when you consider it is made up of three billion units.

Since then, researchers have been able to make enormous strides in this field, and one of them is Dr Paul Gardner from the School of Biological Sciences.

"The pace has moved extraordinarily fast. It took ten years and millions of dollars to sequence the first human genome. Now we can do it in a few days for a few thousand dollars.

Dr Gardner studies ribonucleic acid (known as RNA) which is a long, single-stranded chain of molecules that often translate the genetic code from DNA to protein.

RNA research is offering insights into how our bodies work.

"The implications of this are apparent in all areas of biology. In the medical field we are looking at a person's genome, finding if and when they might get cancer or heart disease. In agriculture we could figure out which livestock will genetically be good producers. In biosecurity we could detect pathogens earlier."

Scientists are finding it does more than just play a vital role in translation of DNA. What has come as a surprise to RNA researchers in recent years is the importance of RNA in other areas such as regulating genome organisation and gene expression, suggesting a central role for RNA in human evolution.

Further discoveries have shown that RNA is important for defending genome from invasive elements, for de-activating entire chromosomes, and are essential for DNA replication.

"In the medical field we are looking at a person's genome, finding if and when they might get cancer or heart disease. In agriculture we could figure out which livestock will genetically be good producers."

From decoding the human genome to analysis

In the years following the decoding of the human genome, scientists now have more data than they can manually process. This is due to testing being much easier, costs being lower and the enormous amount of samples collected. The bottleneck is now in the analysis and interpretation – exactly what Dr Gardner is doing.

"Genomics is not predictive. You could sequence a genome but still not know a lot about the organism."

"Our long-term goal is to address this problem. We need more experiments into things like what determines the levels the genes expressed.

People tend to think of genes as either on or off but really they're more subtle than that.

"So for example if lots of genes are expressed, then why do they not stick together in big clumps? We think it is because they have evolved not to.

"If we understand why and how genes are expressed then we can design sequences that have large amounts of protein expressed, for example the protein insulin. Then that insulin could one day be manufactured for diabetics."

Making sequencing a game

With a colleague from McGill University in Canada, Dr Gardner created a game called Ribo. In it, players solve pattern-matching puzzles that represent nucleotide sequences to optimise alignments over a computer algorithm. By aligning together each nucleotide sequence, represented as differently coloured blocks, players attempt to create the highest point value score for each set of sequences by matching as many colours as possible and minimising gaps.

The nucleotide sequences aligned by Ribo are obtained from actual sequence data from the Rfam database. High-scoring player alignments are collected as data and sent back to the McGill Centre for Bioinformatics to be further evaluated with a stronger scoring algorithm. Those player alignments that score higher than the current computer-generated score are then reintroduced into the global alignment as an optimisation.

"I have had some of my third year students playing it and they were dramatically improving the alignments from our database. At an Open Day a few years ago we had it going and some of the parents had to drag their high schoolers away."

Connecting to community

Dr Gardener is involved in improving Wikipedia content on RNAs. As the Assistant Editor-in-Chief of a journal called RNA Biology, whenever an academic's paper is submitted, Dr Gardner asks them to write a Wikipedia entry on the topic too.

"This has benefit for the community because journal articles are often behind a paywall, and the language used is highly academic. Wikipedia is for everyone, and we ask our academics to write for the average high school student."

By Bridget Gourlay

The study of ribonucleic acid could lead to predicting disease in humans as well as providing benefits to agriculture and biosecurity.

Marine ecology – leadership and communication

In 2015 the University promoted Professor David Schiel, one of New Zealand's top science communicators and pre-eminent marine ecologists, to the rank of Distinguished Professor.

Distinguished Professor is a title reserved for professors who demonstrate world-class academic leadership, as well as achievements of the highest international standing over a decade or more.

As a world expert on kelp forests and temperate reefs, Professor Schiel has attracted more than $14.5 million in external research funding to UC, including three Marsden research grants. Professor Schiel also established the Kaikōura Field Station as a marine laboratory of note, and worked with the marine aquaculture industry, in particular the blue pearl industry, pāua/abalone and other marine farming.

Professor Schiel has more than 4100 citations to his name and recently published his magnum opus *The Biology and Ecology of Giant Kelp Forests* (University of California Press, 2015, with co-author Michael Foster), which has been described by reviewers as a book that "will have a lasting impact" is "monumental in scope", "insightful in its syntheses" and "the seminal work on kelp forest ecosystems".

In 2015 Professor Schiel was also named the New Zealand Science Communicator of the Year for his work as one of the main science commentators following the grounding of the MV Rena and subsequent oil spill off Tauranga on 5 October 2011, reporting on the environmental clean-up and long-term consequences.

At the time of being named Distinguished Professor, David Schiel said he was greatly honoured and recognised the support of his colleagues and students.

"Marine ecological research has risen to the forefront of national and international science as we grapple with achieving sustainable use of our ocean resources. It is pleasing that we have been able to play a useful role in that science, train many students to face a changing world, and mentor those who will be tomorrow's leaders. I have no doubts that the University of Canterbury will continue to be a leading institution in those endeavours."

By Bridget Gourlay

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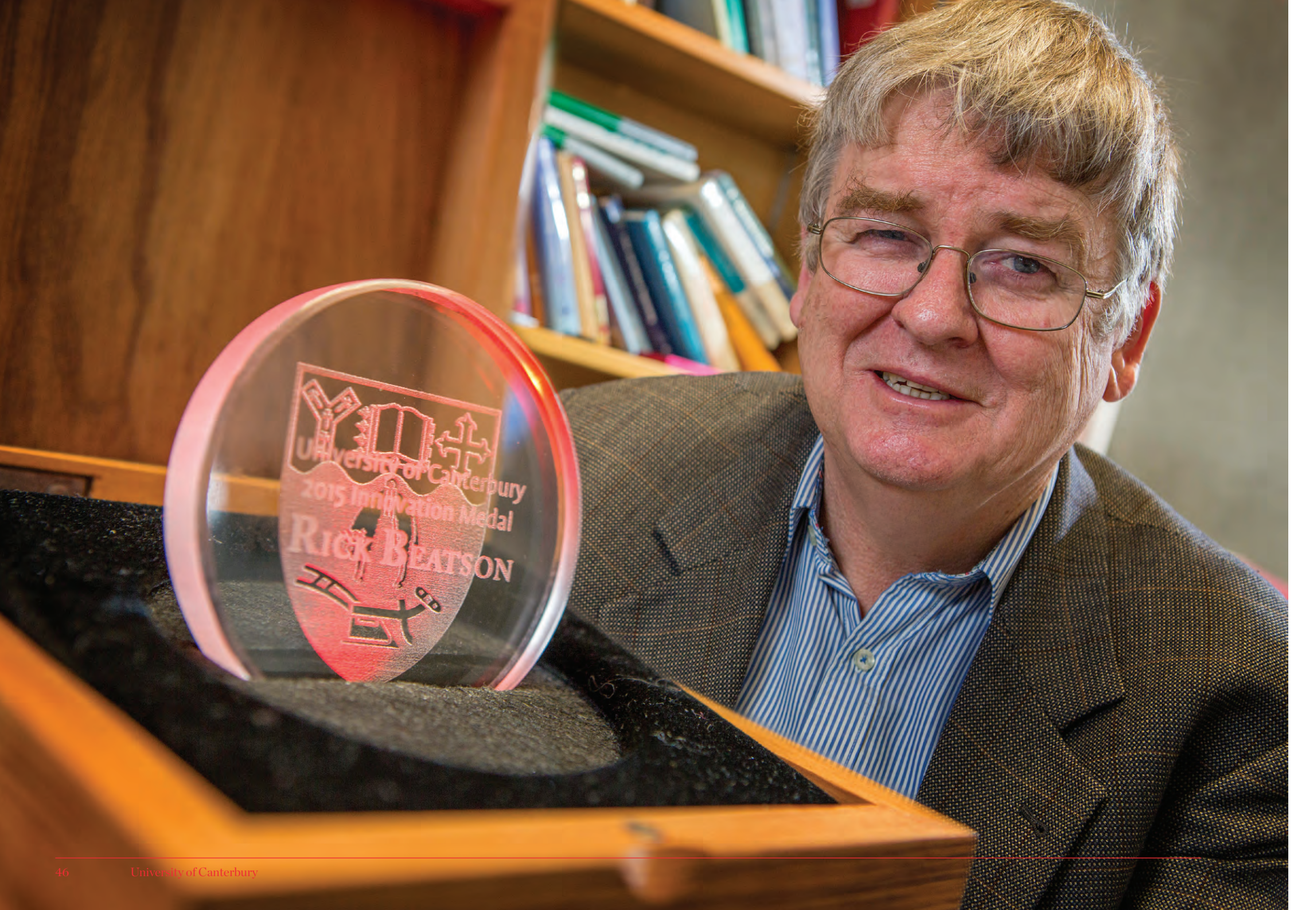
The aquaculture industry, kelp forests, temperate reefs and oil spills reflect the diverse nature of leading science communicator and marine ecologist Distinguished Professor David Schiel's work. Sustainable use of our ocean resources is part of his legacy.



Innovative prosthetics bring new independence

Algorithms developed by Associate Professor Rick Beatson have been used by local company Applied Research Associates New Zealand Limited (ARANZ) in software for its handheld scanner.

The combination of software and scanner means amputees can receive individualised custom manufactured prosthetics, instead of mass produced ones.

Since its development, the orthotics and prosthetics industry has been widely using this new technology.

Dr Beatson says this is deeply satisfying.

"Not many mathematicians have their abstract mathematics applied so directly to helping others".

Literally get back on their feet

ARANZ Medical CEO Dr Bruce Davey says the company's technology developed by Dr Beatson and his team helps bring independence to those with disabilities and physical challenges.

An example is New Zealand alpine skier and Paralympic gold medallist Adam Hall.

"By digitally scanning Adam's leg using FastSCAN, we developed a 3D model which was used to help in the design of new skiing supports for him," says Dr Davey.

"By digitally scanning Adam's leg using FastSCAN, we developed a 3D model which was used to help in the design of new skiing supports for him."

The need for personalised prosthetics is growing. This is due to the rise in chronic diseases such as diabetes, which can lead to amputations for sufferers of debilitating foot ulcers.

Dr Davey says being able to help numerous people is highly rewarding.

"It's exciting to see lives being transformed as people literally get back up on their feet with the help of our systems."

Dr Beatson agrees, adding another reward of creating the technology is the employment opportunities it has brought.

"Overall, perhaps the biggest thrill has been to see my mathematics play its part in creating 109 jobs in Christchurch and 46 overseas."

Willing to take a risk

Dr Beatson says that this long-term project had many aspects to it.

The project began with the enjoyable but intense work of developing new theoretical mathematics concerning Radial Basis Functions in collaboration with various international collaborators and graduate students, he says. Chief among these were Dr Newsam (DSTO Adelaide), professors Powell (from Cambridge), Light and Levesley (both from Leicester), and graduate students, doctors Jon Cherrie and Cameron Mouat.

Following the initial development of the Radial Basis Functions techniques, he collaborated with extremely talented engineers at the Christchurch company ARANZ.

"Due to their skills in both engineering and mathematics and their openness to new ideas, they were willing to take the risk of adopting my new methods. They strengthened them and applied them to problems in scanning for the manufacture of prosthetic devices and to software that makes substantial improvements in the mining exploration industry."

As Dr Beatson collaborated with the ARANZ team, he was able to continue working with UC alumni.

Innovation awarded

Dr Beatson's success was recognised late last year when he was awarded with the Innovation Medal at the annual Chancellor's Dinner.

The Innovation Medal is awarded annually by the University of Canterbury for excellence in transforming knowledge and ideas so they are adopted by the wider community in ways that contribute beneficial value. It is the University's highest recognition of an outstanding innovation and is of similar prestige and standing to the UC Research Medal and UC Teaching Medal.

"I am very grateful to the University for this recognition of the applied side of my work, and to the teams at ARANZ Geo and ARANZ Medical for the opportunity to collaborate on so many fascinating real world problems."

Dr Beatson continues to work on projects which are transforming healthcare.

For example, he is currently working on methods which, given only data, automatically create optimal local approximations and then combine them.

"Such methods would be useful, for example, in minimal dose tomography (X-raying), whereby a good image of a tumour could be obtained at minimal cost to the patient in terms of radiation dosage."

By Bridget Gourlay

Amputees around the world are benefitting from more comfortable prosthetics, thanks to world-leading mathematics from UC.

Armenian genocide - investigating evidence

An emerging academic and archival researcher, Dr Monger is developing a database based on a 1916 book, *The Treatment of Armenians in the Ottoman Empire*, using his expertise in propaganda to test complaints about the book's evidence.

100 years on the genocide remains a controversial topic not officially recognised by the Turkish, British or New Zealand Governments. It was brought to public attention in 2015 when Vladimir Putin and then Kim Kardashian, who is of Armenian heritage, attended commemorative events.

A life-long interest in the First World War led Dr Monger to explore British propaganda and patriotism at PhD level, and then his latest work.

"The military history side of the First World War is pretty much done, and it goes over the same ground again and again – much like the battles themselves.

"There is still a lot that can be learned from how societies behave during war socially and culturally. We think of the terrible effects on soldiers from war, but there were massive knock-on effects on people at home too – those things are just as important.

"Historians should be assisting people to put historical information into context. The events of Gallipoli and the Armenian Genocide are linked. Orders for the deportations of Armenians occurred the same day British warships arrived in the Dardanelles to begin the Gallipoli campaign.

"There's this romantic view in this part of the world of a coming of age in a noble fight against a brave enemy, and you can't take away from that, but the most important consequence of Gallipoli is the impetus it gave to the deportation and murder of between 600,000 and 1.5 million minority Armenians."

Funding has been an issue but progress has also been slow because of the need for great care in designing a database relating to such sensitive material.

"The book has been dismissed as evidence by genocide deniers and others as fabricated British propaganda. I hope this work, informed by my expertise in propaganda, will finally set the record straight."

By Phil Barclay

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UC historian Dr David Monger is working to add to the already large body of knowledge surrounding a pivotal First World War event – the Armenian genocide.

Particles and processes - overcoming limitations

Dr Daniel Holland from the Chemical and Process Engineering department researches particle processes using advanced measurement and modelling techniques. He is working with industry to improve a 'benchtop' instrument with the potential to make magnetic resonance spectrometry a more accessible analytic technique.

"Chemical engineering plants that use particles as a key component often only reach 50 percent of their designed capability. So a plant designed to output 100 tonne a day, may in fact, only produce around 50 tonne."

Dr Holland says that this lost capability is because the way particles move around in the process is not properly understood, making it difficult to run the process in a way that achieves full capability.

"A major difficulty when working with particles is in how differently they behave, depending on their state. A pile of salt on the table doesn't move, so its particles behave like a solid. Pick it up and pour it, they'll behave like a liquid. If particles are highly dispersed they can even behave like a gas. In some processes, particles can exist in all three states at different parts of the process, making the overall process much harder to predict.

"Predictability also changes with the size of the particles. Large particles behave differently from small ones and we need to capture all these things when trying to design or improve processes for purposes as diverse as refining crude oil through to drying of milk."

Collaboration and solutions

Particle processing is further complicated because particles are opaque, meaning it is difficult to see inside the process to understand what is going on. He has overcome this limitation using nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI) – techniques that are familiar in chemistry and medicine, respectively.

> "Large particles behave differently from small ones and we need to capture all these things when trying to design or improve processes for purposes as diverse as refining crude oil through to drying of milk."

"In medicine MRI is used to see inside a person without having to cut them open. We use the same technique to see inside particle processes. Unfortunately it is a lot more difficult to study particulate processes with MRI, than it is people."

In order to apply MRI to particulate processes, Dr Holland has developed new mathematical approaches to extract data from the raw MRI signal. These techniques have led to a new collaboration with New Zealand company Magritek, who designs, manufactures and sells robust and compact NMR and MRI instruments.

"NMR is the most chemically specific analytical technique available. Every chemical has its own unique fingerprint so can be readily identified even in complex mixtures."

This specificity makes it appealing for challenging applications such as forensics and pharmaceuticals, where very specific chemicals need to be identified. However, the cost of traditional NMR instruments is prohibitive for most applications.

"A traditional magnetic resonance spectrometer requires a dedicated laboratory, has super-conducting magnets and costs millions of dollars. A few universities and large companies may have them, but they're not standard analytic techniques because of the expense and difficulty of implementing them. Upkeep for a magnet is between $20,000 to $30,000 per annum for the cryogens alone. Add electricity costs, the special-purpose building, the highly qualified technical support required and you have an extremely expensive piece of infrastructure."

> "In medicine MRI is used to see inside a person without having to cut them open. We use the same technique to see inside particle processes."

Boosting innovation

However, Magritek has designed an NMR instrument that is literally the size of a microwave oven and has none of the complexities or costs associated with the traditional NMR systems. The instrument can be placed directly in industrial environments and operated by regular users.

"The compromise is that the magnetic field within it is weaker than what it would be on a traditional instrument. This means the signal strength is lower, making it take longer to detect small concentrations."

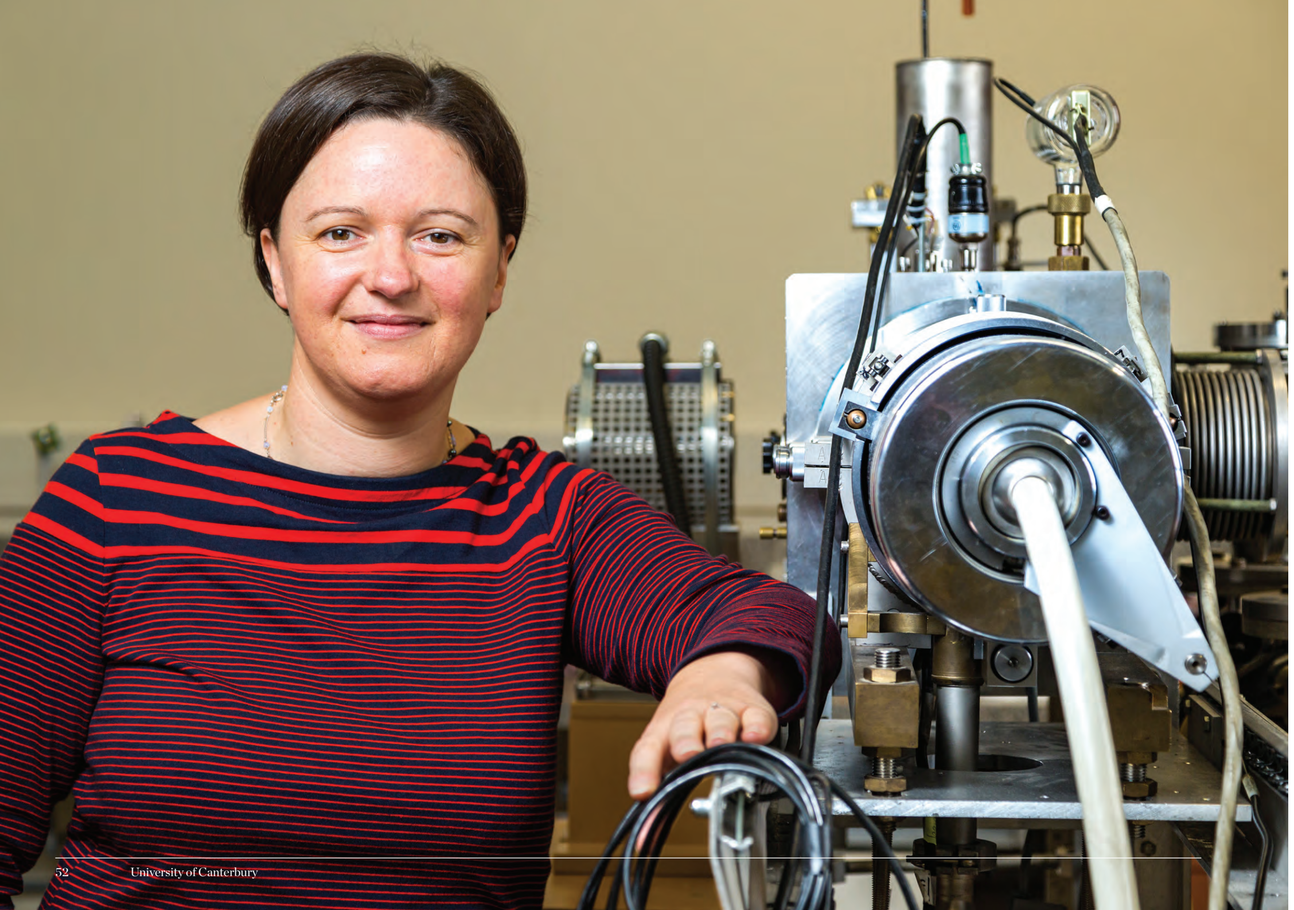
Dr Holland's project is looking at boosting the sensitivity of the instrument by improving the way the signals from it are analysed.

"We build a mathematical model of the signal and by performing some clever analyses on that, we should be able to boost the sensitivity to a level similar to a super-conducting magnet today."

Improving the sensitivity will enable the Magritek instrument to make measurements faster, opening up new markets for magnetic resonance and helping Magritek's novel instrument become a standard analytical tool in the same way as mass spectrometry is today.

By Jann O'Keefe

Research into particle processes using advanced measurement and modelling techniques is used to develop new processes or improve existing ones for industries ranging from fertilisers to petrochemicals and carbon capture.



Shooting molecules with big guns

Dr Sarah Masters from the Chemistry department employs electron guns to determine the structure of molecules that are too small to be seen by the naked eye.

"We do this by photographing them in the gas phase. We generate an electron beam that we fire at the gaseous molecules, with a camera at the other end with photographic film in it. This is easier with smaller molecules, but the larger a molecule is, the more complicated the process becomes."

The technique that Dr Masters uses to look at very large and biologically relevant molecules is called gas electron diffraction. In diffraction, electrons are fired at the molecules, to then scatter off the molecules and hit a detector, forming a pattern. From that pattern, researchers can interpret and work back to what the structure of the molecule was.

"You can infer behaviour of molecules from their structure. The structure of a molecule defines its function, and the way the atoms join together to make the molecule will dictate how it will behave in certain circumstances.

"A lot of structural analysis techniques are actually undertaken on samples in the solid state. Chemically, salt – or sodium chloride – is a large regular array of both sodium and chlorine atoms held together very tightly by electrostatic interactions to form a solid. In the gas phase, you just get two molecules of sodium chloride stuck together, rather than the regular array."

> "If you want to design an effective drug molecule, you need to know both the structure of the drug molecule and the fragment of the protein that the drug molecule is going to sit in."

"Because the environment is different for the molecule, it adopts a different shape. This is why it is important to study things in the gas phase as well. In your body for example, molecules naturally exist with water all around them. Molecules in gaseous and fluid states tend to behave in similar ways because the strong forces that hold molecules together in the solid state are absent."

Dr Masters and her team are researching the structure of small, biologically relevant molecules such as adenosine triphosphate (ATP) with the aim of applying their techniques to proteins, ultimately to provide essential information to the pharmaceutical industry so they can design drugs to fit the receptor sites of those proteins.

"If you want to design an effective drug molecule, you need to know both the structure of the drug molecule and the fragment of the protein that the drug molecule is going to sit in. This is because there are important interactions that hold them together. It is like a lock and a key. We can currently determine what receptor sites on proteins look like, but to get molecular structure on that scale is quite difficult."

Through collaboration with a team at the Deutsches Elektronen–Synchrotron (DESY) in Germany, Dr Masters has access to a more powerful ultra-bright electron gun that can also pulse the electrons, enabling the team to time when the molecules go into the machine, and when the electrons will hit them.

"This means we can look at things in different stages of solvation as well. We aim to keep the molecules in their natural environment as much as possible. By using molecules in solution (called solvated molecules), ablating them into a vacuum using a laser, then timing when the electrons come in, the water molecules will come off and we can capture images of the molecules at different stages of being desolvated."

The internuclear distance information given by gas electron diffraction is one dimensional. Dr Masters says that, in contrast, crystallography techniques generate two dimensional information from molecules that are stationary and are hit from different angles to build up a picture, or a series of spots from which molecular structure is determined.

"In the gas phase molecules are not stationary. They are at random orientations relative to the electron beam. Our one dimensional data is in the form of a series of concentric rings. We analyse the data from the centre of the pattern to the outside, and obtain a series of intensities. We can then use Fourier Transform methods to produce a vibrationally averaged structure from which we generate three dimensional pictures of the molecules."

It is this information that is so valuable to the pharmaceutical industry, who would find it much harder to conduct their own research and development without such detailed knowledge of key target proteins.

By Jann O'Keefe

Research into particle processes using advanced measurement and modelling techniques is used to develop new processes or improve existing ones for industries ranging from fertilisers to petrochemicals and carbon capture.

Masters of knowledge – one slide, three minutes

Each year the University of Canterbury (UC) runs the 'Thesis in Three' competition for postgraduate students. PhD and Masters students give a three-minute presentation to describe their thesis research with only a single presentation slide permitted. The top three students from each college round go on to compete in the UC final.

Professor Adrian Sawyer, Chair of the School of Business and Economics Research Committee, is a past judge of the College of Business and Law's competition, and maintains a strong interest in the development of postgraduates' research communication skills. He says Thesis in Three participants will find the skills they develop invaluable throughout their lives.

"At conferences, researchers often have the luxury of talking for a long time to like-minded people. But if you are looking for funding from outside of your field or trying to express what your work means with a particular part of the community, it's the oral, and visual skills, and the ability to be concise that really matter – you will be able to engage, connect and communicate.

"Building oral skills brings confidence to talk in front of people and to accomplish this within a tight timeframe. The ability to communicate information in one slide which is linked and valuable is a huge challenge. The best presenters often have a hook, can describe how their work will improve society, and may use humour effectively."

"The best presenters often have a hook, can describe how their work will improve society, and may use humour effectively."

Fact file:

- Students have three minutes only to describe what they are doing, why they are doing it – the importance/impact of the research and how they are doing it.
- Only a single slide, no additional electronic media (e.g. sound and video files) and no additional props.
- In addition to financial prizes awarded to the winners of the UC Final, there is a national Three Minute Thesis (3MT) for Master's students.
- The Thesis in Three format was first introduced by the University of Queensland.

Will Kerr
UC Thesis in Three winner 2015
(Chemistry)

What was it about Thesis in Three that encouraged you to enter?

I entered the Thesis in Three competition on a bit of a whim. Only doing research and avoiding anything extracurricular had left me feeling isolated. I saw Thesis in Three as a way of reconnecting with the department. It turned out to be a great way of learning what motivates people to do their research.

I have definitely become a more confident public speaker through this process which has put me in good stead for my end of PhD seminar presentation in the (hopefully) not too distant future.

What would you say to an everyday person if they asked you why your research was important in the 'real world'?

Thesis in Three has led to more people asking about why my research is important in the 'real world' and I've enjoyed answering questions about it. In science, we can be guilty of not looking outwards often enough. Thesis in Three has been a good opportunity for me to regain some perspective. Although it's difficult to say whether my research will ever directly impact the real world, it definitely has improved our collective understanding of chemical reactions. My results will likely be important and influential to the work of others which will, in turn influence further researchers and through this flow-on effect, impact the real world. This is why all research is important in its own right.

Nazlia Alinaghi
Second Prize
College Round 2015
(Economics and Finance)

What was it about Thesis in Three that encouraged you to enter?

To be honest, I thought if I can explain my thesis in three minutes to the people who are not expert in the area and do not know anything about the topic, I would have achieved great objectives such as understanding the topic so well I am able to explain it in a way that everybody can understand, from my grandmother to potential employers. It also makes the topic attractive for other scholars who do not know anything about it, or they have a vague idea about it.

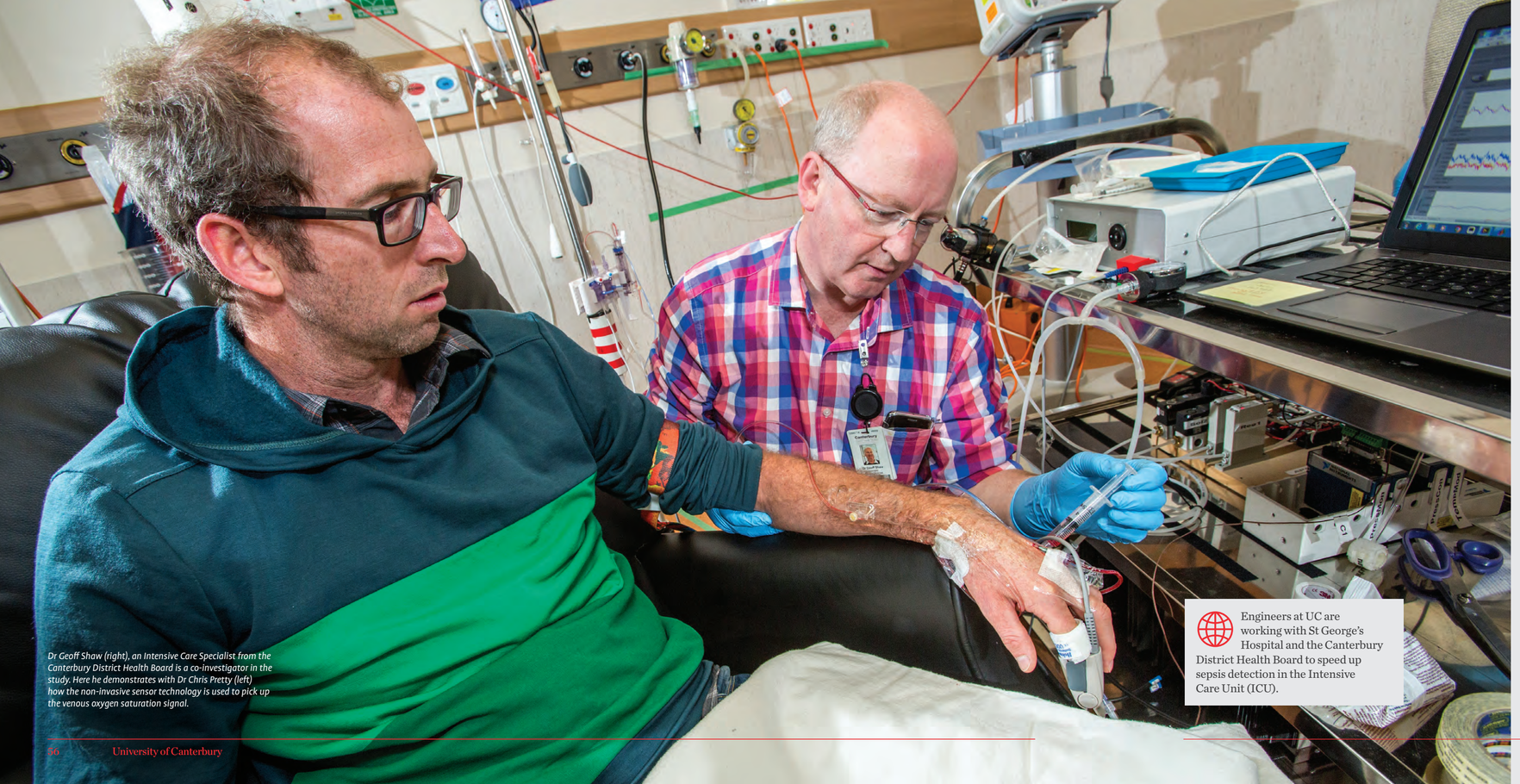
What has happened as a result of your winning Thesis in Three?

There are a lot of people in the University who know what topic I am working on after the competition, so sometimes they ask about the results. I am also comfortable enough to give a speech. I hope gaining these valuable skills helps me to find a great job.

By Fiona Clayton

Will Kerr – UC Thesis in Three winner 2015 (Chemistry)

The Thesis in Three format provides thesis students – doctoral and masters – with the opportunity to present their research to a general, non-specialist audience in a concise manner.



Dr Geoff Shaw (right), an Intensive Care Specialist from the Canterbury District Health Board is a co-investigator in the study. Here he demonstrates with Dr Chris Pretty (left) how the non-invasive sensor technology is used to pick up the venous oxygen saturation signal.

Engineers at UC are working with St George's Hospital and the Canterbury District Health Board to speed up sepsis detection in the Intensive Care Unit (ICU).

Engineering earlier sepsis detection

By modifying existing technology and using it in a new way, the University of Canterbury's (UC) bioengineers have been able to pick up an additional oxygen saturation reading that could provide an early indication of sepsis.

Mechanical Engineer Dr Chris Pretty, from UC's College of Engineering, says existing non-invasive sensor technology has been repurposed to pick up the venous oxygen saturation signal.

"This is normally obtained via invasive blood sampling. This real-time measurement could solve a problem for clinicians, enabling them to identify and treat conditions, such as sepsis, earlier."

Sepsis results in poor oxygen extraction from the blood. Standard pulse oximeters, which attach to a patient's finger, only offer arterial oxygen saturation readings. By attaching a low pressure cuff around the top of a patient's finger and employing sophisticated signal processing and control, Dr Pretty and co-researchers can also obtain venous oxygen saturation readings.

"Knowing both the arterial and venous saturations, and how they change, will enable earlier diagnosis and lead to better patient outcomes."

Dr Pretty and his colleagues have a longstanding relationship with Dr Geoff Shaw from Canterbury District Health Board. This has led to an increasing amount of work at St George's Hospital, which has a strong interest in advancing ICU research.

> "It is a rare and valuable opportunity to conduct applied research in a real clinical setting. St George's has provided significant research support to see this project to this point. This has been critical and highly welcomed."

Dr Pretty says that having access to hospital facilities enables researchers to solve problems more quickly, assisting developments to make a difference in the ICU sooner.

"It is a rare and valuable opportunity to conduct applied research in a real clinical setting. St George's has provided significant research support to see this project to this point. This has been critical and highly welcomed."

The project is progressing well and the next stage will involve trialling the device on real patients at both Christchurch and St George's Hospitals.

The relationship with Christchurch and St George's Hospitals has also inspired other joint applied-research projects to improve outcomes for patients, says Dr Pretty.

By Hannah McKnight

Transforming transformers

Transformers have been around for more than 100 years, ever since the industrial revolution brought us electricity en masse.

They're the device which sit in the power system to change the voltage, and they exist in all frameworks, from small ones in our houses to big ones in transmission lines.

The design of them is being thoroughly modernised by Dr Andrew Lapthorn from the Department of Electrical and Computer Engineering.

He has been designing and constructing Partial Core Transformers which will do the same job as the old ones, but are cheaper to make, use fewer materials and have good noise filtering.

Dr Lapthorn says they are also better for testing procedures.

"When a new generator is built there have to be several tests done on it to make sure it is ready to go. One test involves lots of equipment, literally a truck full of equipment. Our Partial Core idea has developed a system which can perform the same testing with a fraction of the equipment needed. This makes the testing cheaper for the customer."

Working closely with industry is something Dr Lapthorn does often. He is the academic responsible for the High Voltage Lab, the only facility of its kind in a New Zealand University. The High Voltage Lab does commercial testing for the electrical industry.

For example, insulating paint used on transmission towers can be tested to see if it will work and is safe.

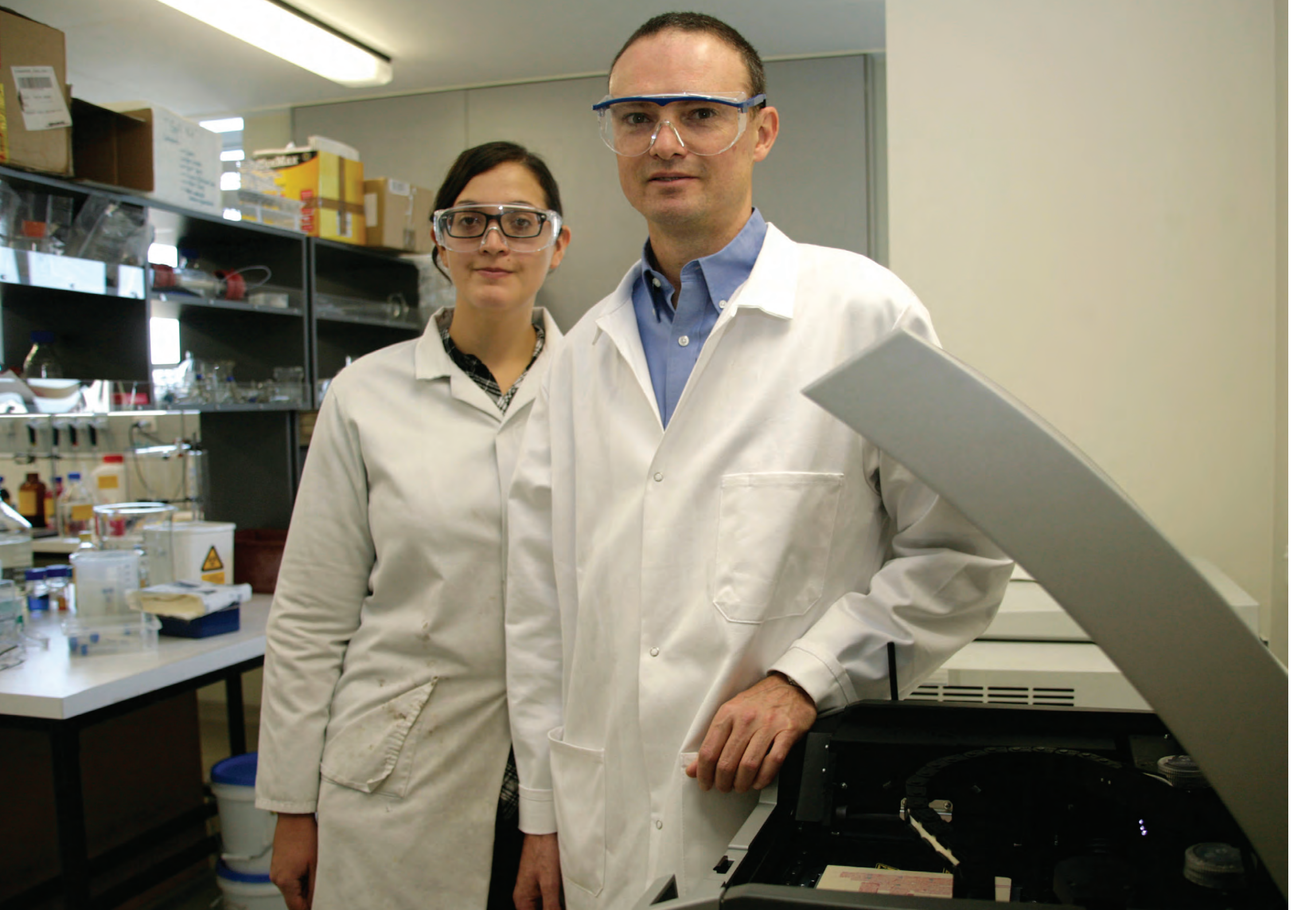
"Our Partial Core idea has developed a system which can perform the same testing with a fraction of the equipment needed. This makes the testing cheaper for the customer."

Fact file:

- Dr Lapthorn is also developing a real time computer algorithm for monitoring information on transformers, so power companies can constantly keep an eye on the health of them. That's because if a transformer stops working, it can cause blackouts and disruptions to customers.
- In the future this could find trends, and give future predictions on the health of a transformer.

By Bridget Gourlay

Improved transformer design will help the electricity industry make cheaper and higher quality products.



Links with industry strengthen capabilities

Through the University of Canterbury's (UC) strong connection with Methanex, Associate Professor Matthew Watson from the Department of Chemical and Process Engineering (CAPE) has helped to strengthen links between CAPE students and industry, while enhancing research capabilities for both parties.

This relationship has opened the way for UC students to gain real world industrial experience, while it gives Methanex a low risk, no obligation method for getting students into their facility for evaluation.

"Methanex is the world's largest producer and supplier of methanol, head-quartered in Vancouver with operations in many countries. Most of their R&D is based in New Zealand and they've been very supportive of student research at UC."

The connection with CAPE was made because Methanex wanted to leverage Dr Watson's industrial experience with steam methane reformers – massive reactors that takes steam and methane, and produce hydrogen and carbon dioxide – the raw ingredients for methanol.

"I tell all the students that have industrial work or research assignments to treat their placement as a job interview and to do the very best they can. We currently have a German student working with them, which adds international connections to other universities as well."

"I tell all the students that have industrial work or research assignments to treat their placement as a job interview and to do the very best they can."

Michelle Kramer, who graduated from Northwestern University in the United States of America and spent three years gaining valuable field experience at Dow Chemical before starting her PhD with Dr Watson, is looking at the design and manufacture of structured catalyst substrates for steam methane reforming.

A catalyst is something that helps a reaction to move along Dr Watson says.

"A substrate is the platform that holds the catalyst, and by structured, we mean something that is built as opposed to say, a random collection of beads or spheres that is packed into a reactor."

In collaboration with Professor Conan Fee (also from the department of Chemical and Process Engineering) and his 3D printing group, mathematical models are being used to design an idealised structure for this purpose, and to produce the structure using 3D printing.

Dr Watson says with a 3D printer, structures can be created with all kinds of unconventional geometry that were previously not possible to manufacture.

"The idealised structure will guide designs of new catalyst structures which can lead to process intensification – where you get the same amount of material out of a given process, you just make it a lot smaller.

"But our 3D printing capabilities at UC are restricted to using plastics as a medium, and to build some of the structures we're interested in, we will inevitably need to move towards metal or ceramic materials. This is where links with industry can prove invaluable."

Dr Watson is using his connections with Callaghan Innovation to help create these linkages and give students access to metal 3D printers, essential equipment, and a wealth of knowledge. Meanwhile our students are constructing a powder 3D printer for exploring non-plastic materials.

Extracting a high value metal

Dr Watson's links with industry through his previous employers have also made possible a proof of principle study with collaborators Drs Aaron Marshall and Catherine Bishop into extracting titanium metals from New Zealand Steel's waste material at Glenbrook.

"Titanium is a high value metal, reaching anywhere from $20,000 to $300,000 a tonne, depending on purity. Currently no one in New Zealand produces it, but when New Zealand Steel make iron from iron sands as a precursor to steel manufacture, a glassy slag containing 31% titanium dioxide is a by-product of the process.

"The slag comes off at an extremely high temperature, around 1750 Kelvin, and we propose to electrolytically separate the titanium components out at those temperatures. Not only will the thermodynamics be more favourable for separation to occur, but we think the ionic mobility will be high enough at these temperatures that the slag will conduct enough electricity to negate the need to add an electrolyte, an essential ingredient of an electrolytic cell."

The furnaces required to take materials up to extremely high temperatures to undertake such research are specialised and Air Products, Watson's previous employer, has donated the necessary high-temperature furnaces, gas handling and monitoring equipment that will bring ultra-high-temperature electrolysis capability into UC laboratories.

By Jann O'Keefe

In a win-win relationship, students receive invaluable first-hand experience working in real world environments, while industries get unique opportunities to test drive potential employees.

College of Arts
Te Rāngai Toi Tangata

Professor Jonathan Le Cocq
Pro-Vice-Chancellor, College of Arts

The research of academics within the College of Arts, Te Rāngai Toi Tangata, is diverse, ranging from documentary, visual and other forms of interview research in areas like history, to various forms of social and cultural research, to practice-led research in the creative arts, and hard to classify fields like human services.

The breadth of research produced is evident from some book titles published in 2015: *John of Paris: Beyond Royal and Papal Power* (Chris Jones); 推銷中共：中共中央宣傳部的運作 *Marketing the CCP: the Role of the Central Propaganda Department* (Anne-Marie Brady); *Political Animals: Representing Dogs in Modern Russian Culture* (Henrietta Mondry); *Film on the Faultline* (Alan Wright); and *Importing EU Norms? Conceptual Framework and Empirical Findings* (Natalia Chaban).

Much research in the Arts is individualistic, but collaborative work is a growing trend reflected in the success of our research centres. The Macmillan Brown Centre for Pacific Studies, for example, has been involved in a number of collaborative projects with various institutions in order to further enhance its national, regional and international reputation. Professor Jen Hay and Associate Professor Jeanette King of the New Zealand Institute for Language, Brain and Behaviour received Marsden Funding for their project entitled 'Statistical learning with and without a lexicon'. The Centre's Director, Professor Hay, was also awarded a prestigious James Cook Fellowship. In 2015 the NCRE completed a €1m 10-country study for the EU's foreign policy service that examined perceptions held towards Europe and the effectiveness of the EU's public diplomacy. 2015 also saw the establishment of the Canterbury School of Continental Philosophy, and the DASSH (Digital Arts, Social Sciences and Humanities) Lab, supporting digitally-based research across the College.

Academics presented at national and international conferences, and high profile research symposia hosted by the College included the New Zealand Historical Association Biennial Conference; the International Conference on Pacific Regional Security; the 21st Biennial New Zealand Asian Studies Society (NZASIA) Conference; and the Aotearoa New Zealand Human-Animal Studies Conference.

College of Business and Law
Te Rāngai Umanga me te Ture

Professor Sonia Mazey
Pro-Vice-Chancellor, College of Business and Law

Staff continue to produce high quality research outputs in the form of books (and book chapters), peer-reviewed articles in leading national and international journals, reports, and conference presentations.

A significant number of masters and PhD theses were completed during 2015, including the first doctorate degree connected to the Ngāi Tahu Research Centre (Eruera Tarena, Department of Management, Marketing & Entrepreneurship (Ngāi Tahu, Ngāti Porou, Te Whānau-a-Apanui)). The College was delighted that Dr Girish Prayag (MME) was awarded the 2015 UC Early and Emerging Career Researcher Award, and Professor Adrian Sawyer (Accounting and Information Systems) the ATTA-Hill Medal in 2015 for his contributions to tax policy and teaching. A further highlight of the year was the award of the Brocher Foundation Fellowship for Medical Law Research to Dr Debra Wilson (Law).

Within the School of Business and Economics, a focus has continued to be on the post-earthquake environment in Canterbury, including impacts on tourism, recovery of business, resilient organisations, and leadership. Two external research grants were received during 2015: one to examine valuers' assessment techniques and the second building employee resilience through wellbeing.

Law school staff enjoyed another productive year of research, which saw the publication of four new books written, co-authored or co-edited by law staff, as well as four new editions of earlier books. Other publications included a research report commissioned by AKO Aotearoa, *The Making of Lawyers: Expectations and Experiences of First Year New Zealand Law Students*, thirty-two book chapters written or co-authored (other than those in the books listed earlier);14 refereed journal articles and seven conference papers published in refereed proceedings. Staff also presented 29 papers at a wide range of conferences in nine countries.

2015 also saw success in obtaining external research funding for various projects, including a further stage of the AKO Aotearoa project; an investigation of possible revised legal frameworks for ownership and use of multi-unit dwellings on a single land title, the Feminist Judgment Project Aotearoa, a project looking at ombudsmen and perceptions of justice and a multidisciplinary, collaborative project investigating surrogacy law.

College of Education, Health and Human Development
Te Rāngai Ako me te Hauora

Professor Gail Gillon
Pro-Vice-Chancellor, College of Education, Health and Human Development

The diverse range of high quality research outputs listed in our 2015 research report highlight the research strengths of our College of Education, Health and Human Development, Te Rāngai Ako me te Hauora, in areas related to teacher education, health sciences, educational studies, education leadership, sport coaching and physical education.

Amongst the numerous important research outputs during 2015 are five books authored by professors within our College that offer scholarly discussions, analyses and thought provoking insights that will be influential both nationally and internationally. Topics addressed include ethics, education and existence (Prof Roberts and colleagues), advances in rugby coaching (Prof Light), teaching as inquiry with a focus on priority learners (Prof Conner), assessment for children with learning disabilities (Prof Everatt and colleagues), socio cultural realities (Profs Macfarlane and colleagues).

Our researchers are contributing to important debates and challenges we face within our New Zealand Education and Health sectors. Their research findings provide valuable evidence to help inform policies and practices within our communities. Examples include research outputs related to effective assessment practices for children with special education needs (Dr Guerin and Prof Morton), leading change with digital technologies in education (Dr Mackey, Distinguished Prof. Davis and colleagues), the experience of Māori students during middle school years (Prof Macfarlane), effective practices for technology education (Dr Fox-Turnbull), health promotion workforce development (Dr Lovell and colleagues), teaching sexuality education (Prof Cushman, Tracey Clelland and colleagues), understanding why patients choose acupuncture (Prof Kirk and colleagues), alternative communication systems for children with autism (Dr McLay and colleagues), and physical activity and health care (Prof Culpan).

Developing collaborative and multidisciplinary research teams is a strong focus in our current research environment. A highlight for our College in 2015 has been our successful collaboration with other leading universities in the National Science Challenges and, in particular, our researchers' involvement in the $34M "A Better Start- E Tipu e Rea" National Science Challenge focused on addressing obesity, literacy learning, and mental health issues in children and adolescents in New Zealand.

College of Engineering
Te Rāngai Pūkaha

Professor Jan Evans-Freeman
Pro-Vice-Chancellor, College of Engineering

Research in the College of Engineering, Te Rāngai Pukaha, covers a vast range of practical topics and dimensions, from items as large as forests and buildings, to items as small as nanotechnology and devices, plus many theoretical studies of engineering problems.

In 2015, notable research events included the following: the announcement of $21.5 million of government funding over five years to run the QuakeCoRE, a Centre of Research Excellence for earthquake resilience, to be hosted in our Civil Engineering department; our UAV research and work in the new "Drone Lab" saw us collaborating with CAA to define flight rules for UAVs and secured a restricted airspace for us to fly them beyond visual line of sight; the development of a unique methodology for building intelligent tutoring systems; the award of a large MBIE grant to the HIT Lab NZ in partnership with Victoria University to collaborate with Korean universities in developing 4D home entertainment technology; funding was awarded to the School of Forestry for the NZ Dryland Forests Initiative that is developing genetically improved planting stock and management systems for ground-durable eucalypt species suited to New Zealand's dryland regions; funding was awarded to apply Bayesian analysis to Nuclear Magnetic Resonance (NMR), which would make cheap, portable NMR instruments as sensitive as today's very large instruments; a James Cook Fellowship was awarded to Distinguished Professor Geoff Chase, and Mathematician Rick Beatson was awarded the University's 2015 Innovation Medal for his pioneering research on fast surface fitting that has transformed the medical prosthetics industry.

The College has seen a steady increase in the number of PhD students in 2015 across many disciplines, in line with our strategy. We have significantly increased our industrial linkages for final year research projects and expect some of these to flow into postgraduate research projects in the future.

College of Science
Te Rāngai Pūtaiao

Professor Wendy Lawson
Pro-Vice-Chancellor, College of Science

2015 was a bumper year for research in the College of Science. A particular feature of our success is the vote of confidence from our external stakeholders in our excellence, and ability to deliver on contracts, expressed by the unprecedented 22% increase in annual external research income, to its highest level in our history.

Our research has a diverse range of outcomes. Some of these outcomes relate to our contribution to the global development of fundamental knowledge, for example through our research on black holes and expanding universes. Some outcomes result from access for our diverse stakeholders to the internationally-renowned expertise of our staff, for example through our work with the community in the CAREX project on stream restoration. Some of these outcomes relate to the development of next generation research capability, expressed in record numbers of PhD research students. That process of capability development occurs in a range of ways, from the integration of our research into the undergraduate curriculum, and culminating in the intensive shoulder-to-shoulder working-as-colleagues experience that we offer our Masters and PhD thesis students.

A key focus has been in continuing to plan for our move in mid-2017 into the new purpose-built research and teaching laboratories in the Rutherford Science and Innovation Centre. Our excitement about the incredible opportunity offered by this new facility is growing day by day as we see the building take shape. One of the goals of this facility is to enable and underpin a greater degree of outward-focus and stakeholder partnership for our research, and we look forward to working with you as our stakeholders as we head towards that goal.

University Statistics

Academic staff[1]		486.65
Adjuncts and research fellows[2]		106.98
Post-doctoral fellows[3]		43.93
Outputs		3000
Postgraduate degrees completed	PhD	163
	LLM	2
	MA	45
	MAntaStud	1
	MAud	11
	MCom	23
	MCouns	2
	ME	20
	MEd	10
	MEFE	1
	MEM	18
	MET	8
	MFA	7
	MForSc	2
	MGIS	1
	MHealSc	5
	MHIT	6
	MMus	3
	MSc	104
	MTchLn	1
	MWaterRM	7
Research Income		$27,433,671

1 FTE; includes continuing and fixed-term staff members employed throughout the year
2 FTE; includes adjuncts and research fellows employed for greater than one year during the year
3 FTE; includes fellows employed for greater than one year during the year

UC HPC

University of Canterbury Super Computer

New Zealand's supercomputing and services facility for research and development.

UC HPC aims to help improve New Zealand's advanced IT skills and research capability, and provide infrastructure that contributes to scientific and industrial development.

UC HPC, as part of the National eScience Infrastructure (NeSI), seeks collaboration among all research organisations. We invite you to explore the experiences and opportunities outlined on our website and to contact us to see how we can help.

UC HPC was established by scientists and engineers to make it easy and convenient for researchers to use world-class supercomputers. UC HPC features the first IBM Blue Gene to be installed in the Southern Hemisphere and an IBM p755 super cluster. The systems are made available via the REANNZ network.

Email: hpc@canterbury.ac.nz

www.canterbury.ac.nz/spark/UC HPC

www.hpc.canterbury.ac.nz

www.nesi.org.nz

Research supporters

** Please note: These are some of the organisations that supported the research featured in Research Report 2015.*

Research Institutes and Centres

Biomolecular Interaction Centre (BIC)

The Biomolecular Interaction Centre (BIC) is a multi-disciplinary centre dedicated to the study of molecular interactions critical to biological function. Understanding biomolecular interactions is central to a range of fundamental sciences, new treatments for disease and a wide range of highly functional products.

The centre was founded in 2007 at the University of Canterbury and includes researchers from the Colleges of Science and Engineering and partners with several New Zealand Crown Research Institutes, universities and Callaghan Innovation.

In 2010, BIC received a multi-million dollar investment from the University of Canterbury to become one of two new premier research institutes on campus. BIC has nine principal investigators and more than 35 associate investigators. These investigators are supported by experienced postdoctoral fellows and more than 30 postgraduate students researching biomolecular interactions. The biomolecular flagship projects include engineering biotechnology, evolving and engineering biomolecules and exploring the commercial applications of protein science. BIC supports a dynamic research environment for both staff and students.

www.canterbury.ac.nz/spark/bic

Electric Power Engineering Centre (EPECentre)

The EPECentre is New Zealand's Centre of Research Excellence for electric power engineering. It works closely with the Power Engineering Excellence Trust (PEET) whose membership is representative of the various sectors of the industry, including generation, transmission, distribution, contracting, consulting and manufacturing. Its core areas of operation are education, research and industry interaction.

The EPECentre is focused on bringing fresh minds and perspectives to New Zealand power engineering through student-industry interaction and enabling awareness of and planning for future industry challenges.

The EPECentre's mission is a research centre of excellence in electric power engineering that meets industry's research needs, as well as fulfilling PEET's purpose to promote and support the education of power engineers and the study of power engineering as a field of excellence in New Zealand.

www.canterbury.ac.nz/spark/epec

Gateway Antarctica

Gateway Antarctica is a centre for Antarctic studies and research at UC.

The purpose of Gateway Antarctica is to contribute to increased understanding and more effective management of the Antarctic and the Southern Ocean. It does this by being a focal point and a catalyst for Antarctic scholarship, attracting national and international participation in collaborative research, analysis, learning and networking

www.canterbury.ac.nz/spark/anta

Geospatial Research Institute (GRI)

The Geospatial Research Institute (GRI) *Toi Hangarau* is a multi-disciplinary research centre dedicated to outward-facing, collaborative geospatial research and innovation.

The GRI Toi Hangarau aims to substantially increase geospatial research output and be deeply involved in connecting this research to the outside world through commercialisation, social and educational research, as well as outreach programmes.

www.canterbury.ac.nz/spark/anta

Human Interface Technology Laboratory (HIT Lab NZ)

The Human Interface Technology Laboratory New Zealand (HIT Lab NZ) is a dynamic human-computer interface research centre hosted at the University of Canterbury. We focus on supporting people in performing real-word tasks by applying advanced interface technology.

The HIT Lab NZ is revolutionising the way people interact with computers by creating cutting edge interfaces to:

- enhance human capabilities
- compensate for human limitations
- assist people to better perform tasks for work and in their daily lives.

The HIT Lab's multi-disciplinary approach to research and education facilitates an entrepreneurial climate, which fosters a wealth of innovative ideas, leading to an improved economic climate in New Zealand. Currently, the HIT Lab NZ is working on a range of projects in collaboration with industry, academia and government partners from around the world.

www.canterbury.ac.nz/spark/hitlab

Macmillan Brown Centre for Pacific Studies

The Macmillan Brown Centre for Pacific Studies was founded through a bequest by Professor John Macmillan Brown (1846-1935), a founding professor of the University of Canterbury and a former Vice-Chancellor of the University of New Zealand, who spent considerable time travelling and studying the countries of the Pacific. Under the terms of Professor Macmillan Brown's will, the centre was established in 1988 at the University of Canterbury to facilitate the "investigation and research of the history, traditions, customs, laws, and ideas of the peoples of the Pacific generally".

www.canterbury.ac.nz/spark/pacs

National Centre for Research on Europe (NCRE)

In 2000, the forerunner to the National Centre for Research on Europe (NCRE) — the Centre for Research on Europe — was founded at UC. In 2002, a grant from the European Commission was awarded and, at this time, the centre became the National Centre for Research on Europe.

NCRE is New Zealand's premier EU tertiary level centre and undertakes both academic and outreach activities, involving a variety of roles and mechanisms.

Since 2006 NCRE has managed the EU Centres Network of New Zealand, incorporating all eight New Zealand universities, and has formal links with similar EU centres in the Asia-Pacific, including RMIT and the ANU in Australia, Waseda and Tokyo, Korea University in Seoul, and Tsinghua University in Beijing.

The NCRE has been awarded several EU-funded Jean Monnet grants, including two Chairs and a number of teaching modules. It is a designated Jean Monnet Centre of Excellence involving Fudan University in Shanghai, Chulalongkorn University in Bangkok and the University of Kent in the UK.

The main focus of NCRE concerns the European Union's impact on the Asia-Pacific region, with special emphasis on media perceptions, development policy, trade and regional integration.

www.canterbury.ac.nz/spark/ncre

New Zealand Institute of Language, Brain and Behaviour (NZILBB)

The New Zealand Institute of Language, Brain and Behaviour (NZILBB) is a multi-disciplinary centre dedicated to the study of human language.

The researchers come from a wide range of disciplines, forging connections across linguistics, speech production and perception, language acquisition, language disorders, social cognition, memory, brain imaging, cognitive science, bilingual education and interface technologies. This highly interdisciplinary team is working together toward a truly unified understanding of how language is acquired, produced and understood in its social and physical contexts.

www.canterbury.ac.nz/spark/nzilbb

Ngāi Tahu Research Centre (NTRC)

The Ngāi Tahu Research Centre (NTRC) was established in August 2011 as a joint initiative between Ngāi Tahu and the University of Canterbury. NTRC was founded for the purpose of being a leader in indigenous scholarship and to provide a centre for the intellectual capital and development of Ngāi Tahu, the principal iwi of Te Waipounamu.

www.canterbury.ac.nz/spark/ntrc

QuakeCoRE: New Zealand Centre for Earthquake Resilience

QuakeCoRE is a national Centre of Research Excellence (CoRE) of earthquake resilience researchers. QuakeCoRE leverages strengths across the country and internationally, working collaboratively on integrated multidisciplinary programmes of world class research. Its aim is to support the development of an earthquake-resilient New Zealand where thriving communities have the capacity to recover rapidly after major earthquakes through mitigation and pre-disaster preparation.

www.canterbury.ac.nz/spark/quakecore

Spatial Engineering Research Centre (SERC)

The Spatial Engineering Research Centre (SERC) addresses the engineering problems of modern day navigation and remote sensing geo-referenced data collection. Investigations into the linkages between positioning and data collection is the fundamental baseline for many geospatial sciences, and new ways to navigate in Global Navigation Satellite System (GNSS) starved environments is essential for complete geographic data coverage.

The SERC team consists of a multi-disciplinary force of engineers who specialise in wireless systems, global navigation satellite systems, computer machine vision and inertial navigation. In its College of Engineering laboratories, SERC supports geospatial science research in conjunction with industry, other universities and UC students, as well as providing commercial remote sensing services to large and small companies.

The centre was founded in 2009 from the Geospatial Research Centre NZ Ltd and has been the mainstay of geospatial engineering research for UC since 2006. Amongst its many areas of work, SERC specialises in photogrammetry and aerial photography, with aerial thermal imaging being a special interest for the group. Its navigation engineering skills enable indoor navigation research and the design and control of Unmanned Aerial Vehicles (UAV). Further UAV activities include the running of a national UAV forum, and the administration of a 100sqkm UAV flight test site.

SERC contributes towards teaching the Master of Geographic Information Science programme, supervises final year, international interns, masters and PhD students as well as participating in a high school outreach programme to encourage students to take up a career in geospatial engineering.

www.canterbury.ac.nz/spark/serc

UC Quake Centre (UCQC)

The UC Quake Centre (UCQC) is a dynamic partnership between the engineering industry and the University of Canterbury. It has developed strong collaborations with the University of Auckland and other partners, including the learned societies, architects, local government, consultancies, large asset owners, the construction sector and overseas institutions, to provide world-class knowledge, research and solutions to seismic issues.

The UC Quake Centre focuses on training and fostering expertise, supporting and encouraging the best professional practices, keeping individuals and groups informed about ongoing work and research within the sector, identifying the levels of risk facing communities, and looking at ways to provide innovative and commercially viable solutions in response to those risks.

The Quake Centre is committed to using the unique events in Christchurch's recent history to inform their research and recommendations for the future and, ultimately, providing proven solutions which help make individuals, businesses, governments and communities more resilient to future earthquakes.

www.canterbury.ac.nz/spark/ucqc

Waterways Centre for Freshwater Management

A joint venture between the University of Canterbury and Lincoln University, the Waterways Centre for Freshwater Management is a focal point for improving knowledge-driven water resource management in New Zealand.

The centre offers undergraduate courses and postgraduate degrees in water resource management, to serve the ever increasing demand for graduates in this field.

A strong connection is maintained with private sector and water research organisations to ensure the skills, knowledge and awareness conveyed in the classroom is relevant to the whole water sector. The centre also acts as first point of contact for external groups seeking research expertise and community or professional development education in the field.

It is an example of strong co-operation between the two universities, leading to better education outcomes for the country.

www.canterbury.ac.nz/spark/waterways

Wireless Research Centre (WRC)

The Wireless Research Centre (WRC) is responsible for driving research and innovation within the field of wireless communication at the University of Canterbury.

WRC's purpose is to secure the continuing presence of a strong and successful industry knowledge base in wireless communications in New Zealand. The key goals of the centre are to assist New Zealand industry by de-risking the early stages of product development in the wireless space and by providing innovative wireless solutions for niche applications tailored to the specific needs of industry partners.

The centre plays a key role in maintaining New Zealand expertise at the forefront of international telecommunications research and development, measured by the graduation of high calibre students, economic impact, publications and patents. The centre has extensive knowledge and experience working with emerging wireless standards, including the 4G and 5G cellular (mobile phone) family of standards, low power wide area (LPWA) standards, local area and personal-area networks.

Specific technologies of expertise include multiantenna systems (MIMO), error control coding, diversity systems, relaying, scheduling and the application of combinations of wireless and geospatial technologies such as indoor logistics and intelligent transport systems.

www.wrc.canterbury.ac.nz/spark/wrc

UC 7

University of Canterbury is a truly holistic place of learning, made up of 7 outstanding dimensions that will prepare you to change the world.

1 UC Academic

Did you know UC is ranked in the top 3% of universities worldwide? Founded over 140 years ago, our legacy of celebrated graduates has shaped the world we live in today. Here, you'll learn from passionate lecturers in over 100 programmes of study. You'll have a chance to be part of groundbreaking research at our research centres and field stations. Best of all, you'll graduate with an excellent academic qualification under your belt.

Jordan: A+ student choosing his own path

'At UC it's easy to be your own person, seek out opportunities and really make a name for yourself.'

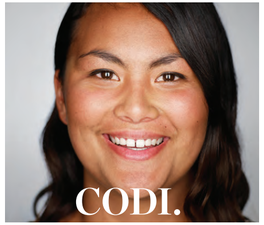
2 UC Community

The city of Christchurch is a growing hotbed of opportunity. Developments and initiatives are popping up at a rapid pace and our graduates are perfectly poised to access these opportunities. Over the last few years our students have earned an international reputation for their community involvement. Get involved by joining the Student Volunteer Army or connect with a range of local organisations — Christchurch is a great place to be!

Kian: Helping 1000+ student volunteers

'I helped manage the flow of thousands of students coming in every morning, getting them out to where they were needed.'

3 UC Bicultural



At UC we are committed to biculturalism. That's a good thing for Aotearoa New Zealand, and a good thing for you too. As part of this commitment we work with Ngāi Tahu, the tangata whenua in our region. At UC you'll gain bicultural perspectives and experience in your courses of study through engaging with course content, ideas and activities in your chosen subjects. You can also take specific courses on Māori language, culture, art, and Te Tiriti o Waitangi.

Codi: New found independence & whānau

'I have a really good relationship with the Māori Development Team and I know a lot of the staff. I was elected onto the exec last year.'

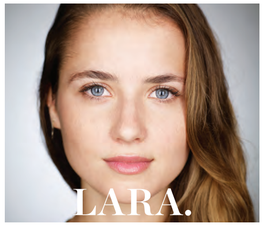
4 UC Active

From the sea to the mountains and everything in between, UC is on the doorstep of a massive outdoor 'playground'. Grab your snowboard/surfboard/mountain bike/trail shoes and give it a go. On campus you'll have your choice of high-end accommodation and all the amenities of a fully equipped student village. At its heart, UC features a thriving student association plus over 130 student-led clubs covering every interest under the sun!

James: Morning lectures. Afternoon skiing.

'I'm really into my surfing, my mountain biking and my skiing, and those three things are so close to UC.'

5 UC Global



Come to UC and get ready to see the world. We have exchange agreements with over 50 universities worldwide in North America, Europe, Asia and Australia. We also bring the world to UC. Our unique Erskine Fellowship programme brings 75 international academics each year to teach at UC. We don't just promise a global perspective, we deliver a global experience.

Lara: Biochem & Husky tours in Sweden

'I've been on a six-month exchange to Lund, which is one of the best universities in Sweden. The choice of partner universities at UC is really exciting.'

6 UC Enterprise

Get switched on, get hands on. Over 35% of our courses will get you out into the workplace or the community. The result? When it comes to interview time, you'll have the kind of real experience employers are looking for. Budding entrepreneurs will have the chance to shine with entré, UC Innovators and the UC Hatchery, which are dedicated to supporting innovation and student start-up ventures. At UC you'll create connections that count.

Isabelle: 12 weeks @ Google in Sydney

'The Google opportunity came about through a UC event called Women in Tech. I attended two interviews and then I was called back and told I had an internship.'

7 UC Support

What are your strengths? Your interests? Your learning style? At UC you'll have a dedicated support system to help you find your way and make the most of uni life. From your first week you can pair up with a second or third year "student buddy" who will show you the ropes and make sure all your questions are covered. Approaching graduation your Co-Curricular Record — an electronic record of verified extra-curricular activities — will add that real-world edge to your CV.

John: Student mentor. Future leader.

'I'm a mentor for the Pacific Development Team. At the moment, our main objective is to look after first year students — to help them out and be a face for them to talk to.'

We have a vision of people prepared to make a difference – tangata tū, tangata ora.

Our mission is to contribute to society through knowledge in chosen areas of endeavour by promoting a world-class learning environment known for attracting people with the greatest potential to make a difference.

We seek to be known as a University where knowledge is created, critiqued, disseminated and protected and where research, teaching and learning take place in ways that are inspirational and innovative.

Looking towards 2023, the 150th anniversary of our founding, the primary components of our strategy are to Challenge, Concentrate and Connect.

University of Canterbury Statement of Strategic Intent