# Discover *More*

## Research Report 2014

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

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Cover image: University of Canterbury Early and Emerging Career Researcher Award recipients
Dr Daniel Stouffer (left) and Associate Professor Brendon Bradley.


Through research one is able to venture beyond the horizons into uncharted waters, unidentified fields, unseen domains, and unexplored knowledges to piece together the unfamiliar in the creation of new patterns, new ways of knowing, as is suggested in the Māori word for research, rangahau. It is through research that we can tap into our potentials and ascend to new heights, like "te piki kōtuku", the ascending heron.

**The bird that partakes of the miro berry reigns in the forest.**
The bird that partakes of the power of knowledge has access to the world.

Artwork and text: ***Nōna te Ao***. Mixed media (ink, watercolour) by Dr Mere Skerrett, Waitaha, Kāti Mamoe, Ngāi Tahu, Ngāti Pikiao and Ngāti Mahuta (Senior Lecturer, School of Teacher Education).


(From left) Dr Daniel Stouffer and Associate Professor Brendon Bradley

University of Canterbury biological scientist Dr Daniel Stouffer is pictured with earthquake engineer Associate Professor Brendon Bradley. Both have been awarded the inaugural UC Early and Emerging Career Researcher Award. Bradley is an earthquake engineer whose research focus is on the prediction of earthquake-induced ground motions and seismically-induced losses to infrastructure; whereas Stouffer is a theoretical ecologist whose primary research focus is the study of complex species-species interaction networks. See their story on page 14.

## Research Report 2014
## Theme: Health and Well-Being

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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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UC

# Research 2014

## The University of Canterbury is a research-led institution. With very few exceptions, the academic staff who teach undergraduate and postgraduate courses are research active within their disciplines.

Staff produce research outputs across a very wide range of subjects within the five Colleges — Arts; Business and Law; Education, Health and Human Development; Engineering; and Science — which make up our comprehensive university. What is not generally known or appreciated are the activities of University of Canterbury researchers in the broad area of health and well-being.

It is generally assumed that in New Zealand this area is the prerogative of the two universities which have medical schools. The theme, therefore, of the University of Canterbury's 2014 Research Report is "health and well-being", chosen to illustrate our research contributions which are of benefit to the New Zealand community and internationally. We have assembled in our report health-related stories to illustrate research work in such wide-ranging topics as hip replacement implants, stuttering and speech therapy, audiology, stroke rehabilitation, cardiovascular disease, learning disabilities, drug delivery agents, breast cancer detection, post-traumatic stress disorder in children, and many other topics. Taken together, this research and more not reported here demonstrate the significant contribution that the University of Canterbury is making in the health sector.

We have various measures of research activity. In 2014, the total research income received from

all external sources was $52.4m, which equates to an average of $72k per full time equivalent staff (FTE) and an increase on previous years. The total number of quality assured research outputs was 3090 which equates to an average of 6.2 outputs per full time equivalent academic employed throughout 2014. In 2014, the number of research degree completions (doctoral plus research masters) was 414. Doctoral completions and new doctoral enrolments both reached record figures in 2014. Given that international students are in the majority in our doctoral school, this is testimony to the University of Canterbury's reputation as an international research university.

Each year, the University Council recognises excellence in research by the award of the Research Medal[1]. In 2014, there were two recipients from very contrasting research areas — Distinguished Professor Mike Steel of the Department of Mathematics and Statistics for his work in phylogenetics and the mathematics of evolution, and Professor C. Michael Hall of the Department of Management, Marketing and Entrepreneurship for his work in tourism management, environmental change and planning. Both recipients are truly world leaders in their respective research fields.

In 2014, the University Research Committee established the Early and Emerging Career Researcher Awards[2] and the inaugural recipients were Associate Professor Brendon Bradley of the Department of Civil and Natural Resources Engineering for his work in earthquake engineering, and Dr Daniel Stouffer of the School of Biological Sciences for his work in ecological and evolutionary mechanisms.

The University also recognises excellence in innovation — the 2014 Innovation Medal[3] was awarded by the University Council to Associate Professor Maggie-Lee Huckabee from the Department of Communication Disorders for her pioneering and transformative work on the rehabilitation of patients, often stroke victims, who suffer from dysphagia or swallowing impairment. You will find in-depth articles on the work of our medal and award winners in this Research Report.

The achievements of our leading researchers continue to be recognised nationally and internationally. Last year, Fellowship of the Royal Society of New Zealand, our National Academy, was conferred on Professor Alison Downard of the Department of Chemistry and Professor David Schiel of the School of Biological Sciences in recognition of their world-class research. In 2014, Associate Professor Brendon Bradley became the youngest ever recipient of the Shamsher Prakash Foundation Research Award for Geotechnical Engineering.

I congratulate our researchers, both staff and postgraduate students, for their endeavours and achievements in 2014. For most individual researchers and for the University as a whole, the hiatus in research activity generated by the 2010-2011 Canterbury earthquakes has been successfully navigated as evidenced by the accounts of research activities that you read in this Research Report. The University of Canterbury is contributing to the benefit of New Zealand and its people — this is one of our key objectives.

Nā reira, anei te Pūrongo Rangahau a Te Whare Wānanga o Waitaha mō te tau 2014 hei whakahihiko i ō koutou hinengaro. Here is the UC Research Report 2014 to get you thinking.

Tēnā koutou katoa.

**Professor Steve Weaver**
*Deputy Vice-Chancellor, Research*

1. *See www.research.canterbury.ac.nz/research_medal.shtml*
2. *See www.research.canterbury.ac.nz/earlyresearch_award.shtml*
3. *See www.research.canterbury.ac.nz/innovation_medal.shtml*

*Associate Professor Maggie-Lee Huckabee*

# Quite an award to swallow

**A leading New Zealand communication disorders researcher has been recognised by the University of Canterbury for her work aimed at improving the health of stroke patients and making financial savings for the health care sector.**

UC's Associate Professor Maggie-Lee Huckabee (Communication Disorders) is a world leader in cough-reflex research and, in recognition of her ground-breaking work, has been awarded UC's Innovation Medal for 2014.

The Innovation Medal is awarded by the University Council for excellence in transforming knowledge or ideas so they are adopted by the wider community in ways that contribute beneficial value.

"It is an honour to receive this award but I see it not so much as an award for me, but for me and all the clinicians and hospitals who I have worked with, including postgraduate students. The research programme was a group effort," says Huckabee.

The aim of Huckabee's research is to help prevent pneumonia in post-stroke and post-surgical patients caused by dysphagia, or swallowing impairment. Her work has led to clinicians across New Zealand changing care protocols.

"If you or I have food that goes down the wrong way — towards the lungs — we produce a strong reflexive cough to protect our airways. This is what keeps us from getting pneumonia. In some patients with swallowing impairment, sensation in the throat is reduced so food can go into the lungs but not produce a protective cough. In this case, the food in the lungs is not cleared and causes an infection, called aspiration pneumonia.

"We used a test known as the 'cough reflex test', which very directly irritates the chemo receptors that sit on the vocal folds and produces a very unpleasant, profound cough response. It is a very short test but allows us to directly test the sensory nerve that controls cough and the response to cough.

"We decided to apply this test to our clinical population. We recruited the district health boards across New Zealand and started a clinical trial," she says.

The original clinical trial began in 2010. It ran for one-and-a-half years and involved a sample of 312 acute stroke patients. The trial found that there were high rates of pneumonia among these patients, and although responses to the cough test predicted risk of pneumonia well, patients continued to get sick. Subsequently, the Dysphagia in Stroke Protocol was developed in response to the outcomes of the first clinical trial as a joint effort between the Canterbury District Health Board (CDHB) and Huckabee's research team. It gives clinicians clear guidance on how to interpret the cough reflex test and what decisions to make for clinical management. Early research after implementation of the protocol has revealed a significant reduction rate in pneumonia.

In the CDHB catchment alone, the rate of pneumonia for patients who struggled with swallowing following a stoke dropped from 26 percent to 11 percent in a three year period following the implementation of Huckabee's research results.

Another clinical trial is currently being conducted with the help of the CDHB to further evaluate this clinical protocol.

The research also resulted in potential cost savings to the national health system of about $1.4 million. The trial has not only improved patient outcomes and reduced health costs, but has facilitated a culture of research and innovation for frontline clinicians, which is a key priority for the New Zealand Health Research Council.

Huckabee has been at the forefront of setting up the University of Canterbury Rose Centre for Stroke Recovery and Research at St George's Medical Centre*. The centre is a new state-of-the-art facility, made possible by the generosity of Shirley Rose, who spent many of her final years tending to the needs of her husband who was affected by a stroke. The centre builds on the successes of the current Swallowing Rehabilitation Research Laboratory.

The recovery of swallowing in patients is complex, but Huckabee says that several approaches can be taken to rehabilitate patients.

"Many of the traditional approaches focus on muscle strengthening. Just as you would strengthen limb muscles in physiotherapy, we target the muscles of swallowing in swallowing therapy. We use various types of biofeedback instruments to help patients monitor, online, how they are swallowing so they can adapt movement patterns for more efficient and safe swallowing. It is all about improving skill and efficiency.

"Neuromodulatory techniques, involving direct manipulation of neural structures, are emerging into research and clinical practice and we are very interested in the development of biomedical technologies that can be used as biofeedback modalities for retraining swallowing. A key component of biomedical technology research in our lab is the development of biofeedback modalities that allow patients in some way to visualise and therefore adapt swallowing in a physiologically meaningful way for recovery."

Before taking up a position at UC, Huckabee worked as a clinician in acute care and rehabilitation, addressing swallowing disorders.

"I love my academic career, but my biggest achievement isn't the research I do — it is those individuals that either directly or indirectly benefit from the research. My biggest priority is the patient who isn't even in the academic institution. We are making improvements for them.

"Behind the patients are the students that work with me and go on to do wonderful things. I am very proud of them too."

UC Innovation Medal

***By Charlene Smart***

* *See page 40 for an article on the Rose Centre for Stroke Recovery and Research.*

# Plans to boost centre's research

**Expanding the reach of the Macmillan Brown Centre for Pacific Studies to boost its place as a world-class centre for Pacific research is the aim of its new director, Professor Steven Ratuva.**

Ratuva, who is also a Professor in the Department of Sociology and Anthropology, joined the University of Canterbury in January 2015 from the University of Auckland and is already making progress towards his goal to make the centre a world leader in Pacific research.

"I want to expand the centre horizontally, meaning engaging with various universities and research institutes around the world, in the region and nationally as well. I also want to grow the centre vertically, in terms of its research capacity, its expertise, its prestige and status within the University, in the region and nationally and internationally," he says.

"I have put together a strategic plan where we are moving in relation to research. I have identified four key strengths of research — empirical field study, qualitative research, policy research, art/creative research — and also identified various activities and strategies in terms of consolidating our student numbers, our research capacity and community outreach," Ratuva says.

Ratuva is a political sociologist, although his trans-disciplinary research interests span sociology, politics, international relations, development studies, anthropology and philosophy. He believes that modern academic research should be more trans-disciplinary as the world becomes more globalised and issues become more complex.

This approach is reflected in his latest book, *Politics of Preferential Development: Trans-global study of affirmative action and conflict in Fiji, Malaysia and South Africa*, published by ANU Press (2013).

Ratuva's areas of research interest and publications relate to affirmative action, ethnic conflict, social protection, civil-military relations, electoral engineering, indigenous intellectual property, security and Pacific regional politics.

In recent years, Ratuva has been part of a number of international research groups including the British Academy, the Oxford and Cambridge project on affirmative action and labour market; a Duke University-based project on neoliberalism; a global varieties of democracy project based at the University of Notre Dame; and a John Harper Publishers project on political parties of the world.

He also put together a research database on elections and electoral challenges in 17 countries in the Pacific (including New Zealand and Australia) for the International Institute for Democracy and Electoral Assistance, and designed and put together a database on perception index of governance in Fiji for the United Nations Development Programme (UNDP), along with other major research projects he has carried out internationally.

Ratuva says he is interested in using his own research skills and interests to enhance and expand the centre, and plans to do that through fostering key regional and international relationships and partnerships with major regional players.

"I was interested in the way in which the research centre can move into areas of policy thinking and policy research," he says.

"I am trying to explore new areas in the academic market, and one of them is policy research in the Pacific. We are trying to boost the status of the centre to become involved in that relationship with governments, industry and civil society, and the community at large in a professional way."

Ratuva received $600,000 in Marsden funding in 2013 to carry out research on regional security.

"I am looking at the interface of state-based security approaches and community-based security approaches, and how they interrelate with each other. This is especially important given the emerging issue of conflict, not only globally, but in the region and how we address some of these conflicts," he says.

"There are different ways in which we frame conflict and security as well as the way we address them, so that's a key part of my focus right now.

"I am also looking at regional geopolitics and conflicts between China and the United States and the new regional geopolitics with New Zealand, Australia and Fiji, and the tensions associated with it. A lot of things are happening at the regional level and they impact on the national and local level of politics as well."

Ratuva says part of his project includes hosting a major conference on regional security in the Pacific in November 2015 at UC, through the Macmillan Brown Centre for Pacific Studies. It will be held in partnership with Australia National University, the UNDP and the International Political Science Association.

Ratuva is also involved in organising further symposiums in Fiji, Tonga, the Solomon Islands and New Caledonia in 2015.

"I have tried to bring in some major players to get involved in the conferences because that is part of the horizontal and vertical growth of the centre, which makes us more visible on a global scale," he says.

"There have been security symposiums in the past but they have become very routine. I would like to make these unique, cutting-edge, innovative and policy-focused.

"What we want to do is begin to reanalyse security in a much deeper and alternative way than it is normally defined. Security is being redefined all the time and we want to reframe it in a way that looks to the future."

Ratuva hopes the symposiums will provide enough material to produce a policy document that will essentially be a security manual on the Pacific, which he hopes will have a real impact on security in the region.

"The manual will be for Pacific leaders, regional and international organisations, in terms of how

they can best deal with issues of security in the Pacific, so it's much more applied and much more focused in terms of policy orientation," he says.

Apart from the security manual, there will also be an academic volume of the papers presented.

Ratuva is currently writing three books to support his research. The first, *Revisioning Regional Security*, focuses on four countries with unique approaches and experiences with security and conflict: Fiji, which has had multiple coups; Tonga, which had riots in 2006; New Caledonia, which has independence-related tension; and the Solomon Islands which had a civil war in 1999.

He has just completed another book, *The People Have Spoken*, now being published by ANU Press, on last year's Fiji election, and is writing another book on the 2006 Tongan riots, *Thy Kingdom Burn*.

"I am trying to link some of the partnerships and relationships we form into the Macmillan Brown Centre for Pacific Studies. Hopefully all this work can help generate interest in the centre, as well as UC and the subject area in general."

Research supported by:
• Marsden Fund

***By Renee Jones***

*Professor Steven Ratuva*

*(From left) Associate Professor Steven Gieseg, Professor Justin Roake from Christchurch Hospital, and masters student Edward Marks*

# Going to the heart of the problem

Finding out how white blood cells full of cholesterol cause heart disease and stroke is a key research focus for UC biochemist Associate Professor Steven Gieseg.

Gieseg (Biological Sciences) is leading a research team investigating heart and vascular disease in a project funded by the New Zealand Heart Foundation and supported by the Christchurch Hospital Department of Surgery.

Cardiovascular disease is the leading cause of death in New Zealand, accounting for 30 percent of deaths annually. Every 90 minutes, a New Zealander dies from coronary heart disease.

Gieseg says the collection of cholesterol packed white blood cells can create growths in artery walls. These growths sometimes have to be removed by surgery as they block the supply of blood to organs, causing cardiac arrest or stroke.

Gieseg and his team are examining growths, called plaques, removed from patients at Christchurch Hospital. After surgeons remove these growths, the live tissue blocking the patient's arteries is rushed from the hospital to the School of Biological Sciences to be analysed.

"We get the call and within an hour of the tissue being taken out of the patient, they will be little slices in petri dishes in our incubator," says Gieseg.

"By examining live samples of the tissue causing artery blockages, we will be able to identify some of the key mechanisms of cell death.

"White blood cells are relatively tough as they have to survive in the hostile environment of infected tissue. Yet, when white blood cells encounter damaged cholesterol particles in the wall of arteries, they die.

"A lot of our work focuses on the white blood cell not dying and looking at how the cell is killed by damaged cholesterol particles," he says.

"We now have a pretty robust system of testing these cells and can start to look at more difficult questions.

"We want to target the tissue so we can start looking at the effectiveness of various drugs and how they affect the tissue, which has never been done before."

Gieseg says the tissue is analysed at "an interesting stage" of its development, when it is just starting to cause trouble for the patient, opposed to when it could be fatal.

While the work on cell death in heart disease is the primary focus of the research, Gieseg says there have been a number of spin-offs into other areas.

"We have had a PhD student looking at inflammation within rugby players. What we have been looking at is how white blood cells get activated in rugby from exercise stress and from the physical impacts of the game.

"We have developed a set of non-invasive and stress-free chemical tests to measure the level of damage occurring in rugby players using only urine and saliva."

Gieseg says technology is now available to help people determine how hard sports players have been pushed and whether they have injuries and need to be rested.

"It gives coaches and players the ability to check out their recovery procedures."

Gieseg says the research is also spurring the development of new technology that will be of benefit to patients and medical practitioners.

"We are developing entirely new x-ray technology that will allow us to be able to look inside people's arteries without having to use any nasty compounds. It will have a much higher resolution than current CT scanners. What we should be able to get with this new technology is 10 to 20 times more information for the same radiation dose and find out what is happening in someone's artery.

"We should be able to both see heart disease and the type of vascular disease that causes strokes years before it actually happens and, most importantly, the technology will allow surgeons to see if the drugs are working or if a patient will need to go to surgery."

Gieseg says this could potentially help speed up the testing of new drugs and make the use of current drugs far more efficient.

"Our research with plaques gives us the opportunity to ask questions about real disease tissue from humans. We are able to interrogate the body's system in real time, and start looking at behaviours to see exactly what we are dealing with.

"By being able to non-destructively interrogate the tissue and look at it with x-ray, we are able to find out if some of the current models of heart disease are correct. This will provide a test for new drugs and some of the old drugs to see if they work the way that we think they do."

Gieseg says his team's research has opened up new and unexpected avenues of investigation.

"The research of why white blood cells die in heart disease has ended up having a lot of spin-offs that we weren't expecting, and has led to a series of techniques that you wouldn't normally have developed, which suddenly become an answer to somebody else's problem."

Research supported by:
- New Zealand Heart Foundation
- Christchurch Hospital Department of Surgery

***By Charlene Smart***

# In a legal bind

The law does not adequately address surrogacy issues that are developing faster than legislation can deal with it, according to University of Canterbury researcher Dr Debra Wilson.

Wilson (Law) has launched a three-year study, with the initial phase receiving funding from the New Zealand Law Foundation, to assess the shortfall in both New Zealand and international laws regarding surrogacy — when a woman bears a child for another person.

"It is widely acknowledged that our surrogacy laws do not work. The judges in the courts are clear that the law as it stands doesn't work, the New Zealand Law Commission says the legislation is out of date and the European Parliament has also said that surrogacy laws worldwide need to be urgently addressed," she says.

"This is a global problem. In New Zealand, we don't have specific surrogacy laws. There are a few provisions under a 2004 piece of legislation about artificial reproduction and a 1955 law on adoption, but these brief provisions cannot understand the complexities of the issues involved in surrogacy.

"It used to be that a child came about through two people, a man and a woman. But now we are in a situation where there are potentially multiple parents to a child. There are multiple people who have some sort of legal claim to being involved in bringing this child into the world and that's a scary concept, and one that our law can't possibly deal with as it is."

The study — a collaborative project between UC's College of Business and Law, School of Health Sciences, Philosophy department, and the Office of the Assistant Vice-Chancellor (Māori) — aims to make recommendations on domestic law, research what an international law might look like and provide a practical guide as to how surrogacy works in New Zealand.

"The internet gives conflicting information on surrogacy in New Zealand. There is no practical information. This is an issue because, in the courts, judges are finding that parents did not take the correct steps. Even though they did their best to research surrogacy they couldn't get accurate information before they went ahead so they didn't know what legal complications could arise.

"Lawyers and government departments are also struggling with the issues in relation to surrogacy. We are dealing with a couple of very experienced lawyers in this field but there are many lawyers out there who aren't as experienced. Surrogacy matters are hitting their desks in increasing numbers and they have only a limited idea of where to start."

Wilson, who is collaborating with researchers in Israel, the United Kingdom and Australia, says there are multiple issues relating to surrogacy laws including child welfare, reproductive freedom, exploitation of the surrogate, commodification of the child, immigration and citizenship, parenthood and custody.

In most countries, including New Zealand, it is illegal to pay someone to be a surrogate and such an arrangement carries a penalty of up to one year in jail. This has resulted in a lot of people going overseas to hire surrogates particularly in Thailand, India, Mexico and the Ukraine where it is legal to pay for the service.

"If people cannot find a surrogate in their own country then many will go offshore to pay someone to bear a child. There are many issues resulting from this, including how the surrogate is treated and even who the legal parent of the child is, because there are different laws in different countries."

Wilson says child welfare is an issue with children sometimes admitting they feel they have been purchased.

"There have been some cases in which children born by surrogacy feel pressure when they are older to do well at school and succeed in other areas because their parents have spent, in some cases, hundreds of thousands of dollars to have them. In other cases, the legal battle to bring the child home can take two or three years so the child is often placed in a foreign orphanage during this time, preventing bonding with the parents. Such an environment is not in the child's best interests, particularly when there are parents who desperately want the child to live with them," she says.

Wilson says reports have emerged of exploitation of some surrogates overseas who are forced to live in controlled environments.

"There are some horrible stories of women confined to a small room with about 10 other surrogates so the surrogacy clinics can make sure the women are being properly treated and fed. There are documentaries where you see rows and rows of beds. The surrogates often can't go home and are forced to take fertility drugs. Some of these women are entering these contracts because they are so poor that they are desperate to provide some money for their families."

A major issue is also that of parenthood. In New Zealand, the law states that the woman who gives birth is the mother.

"That is incredibly outdated but, before artificial reproduction came about, it made sense to define a mother in this way. In other countries where commercial surrogacy is legal, the law states that the woman that intends to raise the child is the mother, not the woman who gave birth," she says. As citizenship generally follows parentage, this can leave children with no country recognising them as their citizens.

"There was a case in Australia last year where a couple hired a surrogate from Thailand who had twin babies. The parents took the female baby but left the male baby, who was disabled. Australian law would say those children are Thai citizens but Thailand would say they are Australian, so there is no citizenship for the children. When they turn 18 the children therefore have to leave the country — but where do

they go? They have no passport, no right to driver's licenses, are unable to get a job. It's incredibly complicated."

Although most people, including the surrogate, would agree that the intended parents should be considered the parents of the child, the intended parents will still need to go through the courts to legally adopt the child, which leads to the usual processes of adoption such as police background checks and dealing with social welfare departments. This requires the child to be in New Zealand, which is problematic when the child has no citizenship, and the intended parents have no legal link to the child to permit them to travel with the child.

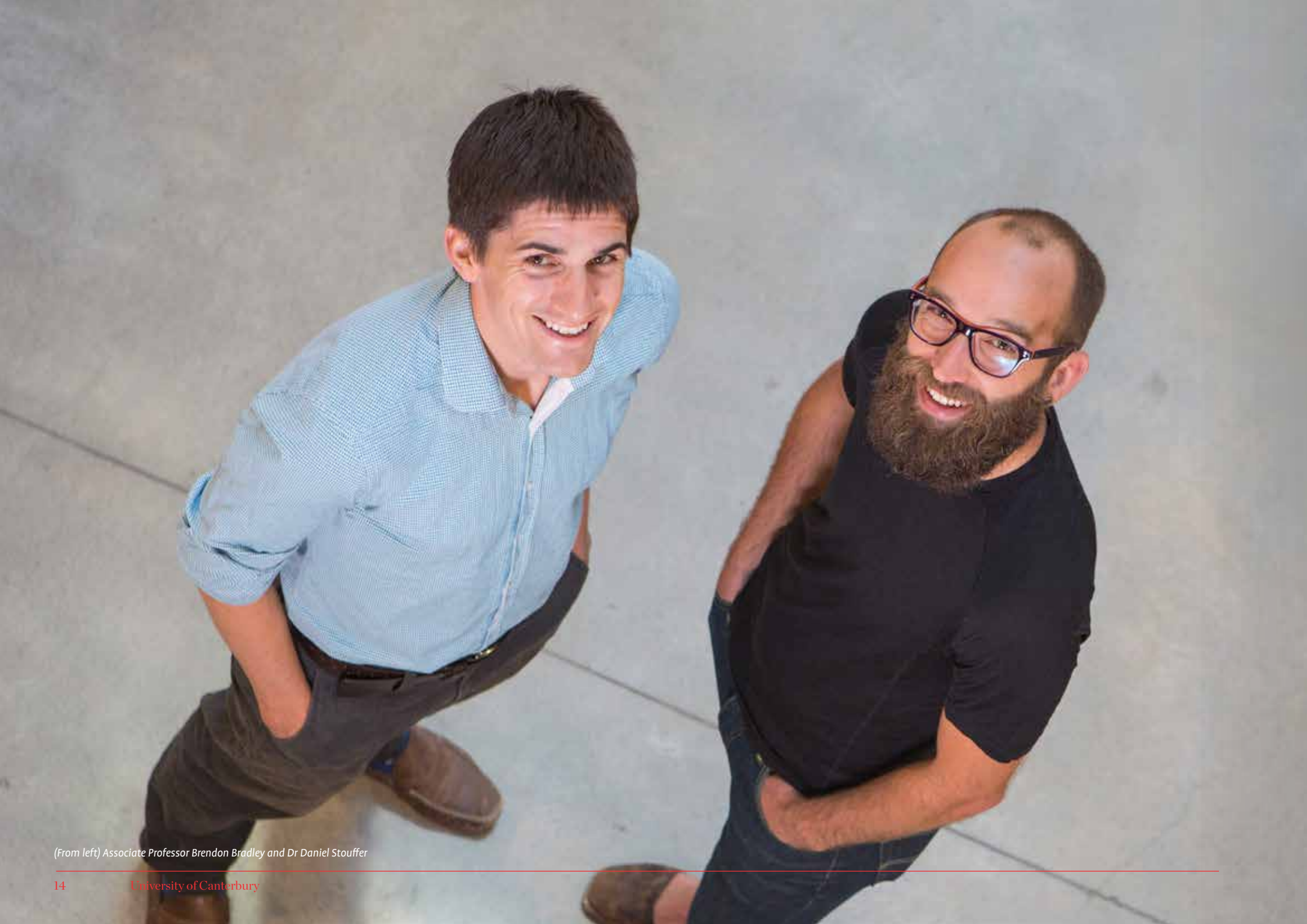
"The law in relation to artificial reproduction is a massive legal mess and it's only going to become more complicated. Medical technologies are developing constantly. There is artificial sperm being developed, and artificial wombs that are ready to go but are being held up by ethical arguments," she says.

"If our legal definition of motherhood is who is carrying the child, then what happens when the child is being carried by a machine? If we don't start thinking about these issues now, when at least there is a mother, then we are going to be in real trouble in the future."

Research supported by:
• New Zealand Law Foundation

***By Renee Jones***

*Dr Debra Wilson*



*(From left) Associate Professor Brendon Bradley and Dr Daniel Stouffer*

# Awards recognise research achievements

**Two University of Canterbury academics have been named the inaugural recipients of UC's Early and Emerging Career Researcher Awards.**

Associate Professor Brendon Bradley (Civil and Natural Resources Engineering) and Dr Daniel Stouffer (Biological Sciences) received the award for their outstanding contribution to research at UC so early in their careers.

The Early and Emerging Career Researcher Award will be awarded annually by the University Research Committee.

Deputy Vice-Chancellor (Research) Professor Steve Weaver says Bradley and Stouffer have shown exceptional talent in their respective fields, producing ground-breaking research that has real-world applications and significance.

"Brendon and Daniel are both inspiring future research leaders and this award recognises their contributions to their respective fields both nationally and internationally," says Weaver.

Bradley is an earthquake engineer whose research focus is on the prediction of earthquake-induced ground motions and seismically induced losses to infrastructure, whereas Stouffer is a theoretical ecologist whose primary research focus is the study of complex species-species interaction networks.

"It feels fantastic to be recognised as one of the emerging career researchers at UC and I am very much looking forward to what is to come in the following years with my research," says Stouffer.

Bradley says the last few years of performing extensive research into the Canterbury earthquakes has been "fruitful but chaotic".

"So it's nice to see the efforts rewarded both 'at home' and also elsewhere."

Both Bradley and Stouffer were awarded prestigious Rutherford Discovery Fellowships in 2013, each receiving $800,000 over five years to help them further their research. The fellowships, administered by the Royal Society of New Zealand and funded by the Ministry of Business, Innovation and Employment, aim to develop and foster future leaders in the New Zealand science sector.

Stouffer is investigating the ecological and evolutionary implications of species' interactions for the persistence and viability of species populations.

He says his research will provide an understanding of structure, function and future of ecological communities.

"It will also help develop strategies to preserve the diverse and complex ecological communities that form a key part of New Zealand's national identity and biological heritage."

Bradley says his research will have a national and international impact in the assessment and mitigation of earthquake hazards in major cities. Specifically, he will analyse data from the 2010 and 2011 Canterbury region earthquakes and apply world-leading research and expertise to understand severe ground motions in the Christchurch urban area.

Bradley has helped produce more than 60 high-impact journal articles and 101 conference papers in his five years at UC. He was also named Young Engineer of the Year at the New Zealand Engineering Excellence awards. He is also the youngest ever recipient of the US-based Shamsher Prakash Foundation Research award for internationally recognised research in geotechnical earthquake engineering.

Stouffer has produced 28 peer-reviewed articles since 2005, including two each in *Science* and *Nature*, and these articles have received more than 1300 citations to date.

"Both researchers are highly regarded within New Zealand and internationally. They both have very bright careers ahead of them, and would be recognised as exceptional in any company of their peers," says Weaver.

Early and Emerging Career Researcher Awards

***By Charlene Smart***

# The grit of young adults studied

The impact school camps have on the resilience of children is being investigated by a University of Canterbury education researcher.

Deputy Head of the School of Educational Studies and Leadership in the College of Education, Health and Human Development, Associate Professor Billy O'Steen, is using the GRIT factor to test the resilience of school-aged children.

The GRIT factor, developed by Associate Professor Angela Duckworth at the University of Pennsylvania's Positive Psychology Centre, measures a person's capacity to succeed or be resilient and involves a short survey of 12 questions. The survey is being used by the United States Army to help train soldiers to become more resilient.

O'Steen, who is also Director of the UC Community Engagement Hub, says that while researching the GRIT survey he came across a case study that was very intriguing.

"Two schools in New York City were using the GRIT survey and character education as part of their curriculum. One was a prestigious, elite private school and the other was a charter school with most of its students coming from very low socio-economic backgrounds.

"They were using the GRIT survey for the same reasons in that they were both increasingly convinced that their students' later successes or failures in life were more attributable to their character traits than other predictors such as IQ, test scores or grades. Further, leaders of the low socio-economic school wanted to show its students that they had developed the character traits for success by being resilient and tough in their everyday life circumstances."

With a background and interest in experiential education, O'Steen wondered if the survey could be applied to New Zealand schools to find out what lessons New Zealand children were learning from school camps.

O'Steen has been working on the project with Paul Nicholson, the Director of a company called Full On, which provides school camps and experiences around leadership and perseverance.

"We took the survey questions and broke them into sections relating to perseverance, planning and passion, with four questions for each category.

"We ran a trial with one school on a five-day camp. We gave the survey to all the students at the beginning and at the end of the camp and then I went on the camp so I could observe and match up students with their scores and see if the survey was accurately capturing students' behaviours relating to perseverance and resilience."

O'Steen says since the trial, the research team has surveyed more than 3000 secondary school students in New Zealand.

"The two interesting things about the results are that they are incredibly consistent, so it doesn't matter if it is boys or girls, private or public, the results are consistent.

"What we have seen is a 10 percent gain in overall GRIT from the beginning of camp to the end. We also have a bigger gain with passion and perseverance than we do with planning. Passion and perseverance rose about 12 to 15 percent from when the students took the survey at the start of the camp to when they redid it at the end.

"The other consistency is that the length of the programme — one day in schools or five days in the wilderness — appears to not have a related impact on the gains. In other words, we're not seeing a five-fold increase in the gain on a five-day camp versus a one-day camp. It is essentially the same gain."

Nicholson says being able to measure the impact of the programme has been beneficial for the Full On company.

"Being able to quantify the impact of our programmes has led to increased confidence and a sense of credibility when marketing and selling our services. Additionally, it has been a proven point of difference and sent a strong message to our clients about the value of our programmes and the measurement of them," says Nicholson.

O'Steen says, in the long term, the research team hopes that the information will provide parents, teachers and schools with a resource to assist in further developing students' drive and resilience.

"Typically, students go to school camps and they aren't insignificant in terms of cost, time and resources but there is often no feedback. Schools are devoting five days out of the classroom and there is no real attempt to ask, 'What did we get out of this and how should we measure it?'

"With this research, however, we can illustrate the real benefits for students going on camps in terms of developing their resilience."

The next step in the research is to provide students, parents and teachers with post-camp recommendations in order to see how the results can be transferred into other areas of life.

"We would really like to look at getting the GRIT profiles of Kiwis that high school aged students would look to as being successful, such as John Key, Helen Clark, Lorde, Richie McCaw and Gareth Morgan. It would be great to find out their GRIT scores and say to students, 'here is what it looks like to be like this person and to be this successful and this is what you need to work toward to have skills like them'.

"This is the reason that I do academic research — it should be applicable in an environment beyond a journal and academic conference," says O'Steen.

Research supported by:
- Full On

***By Charlene Smart***


*Associate Professor Billy O'Steen*

*(From left) Distinguished Professors Jack Copeland, Niki Davis and Mike Steel*

# Three honoured with Distinguished Professorships

The University of Canterbury has promoted three Professors to the rank of Distinguished Professor in recognition of their outstanding research and teaching work.

The status of Distinguished Professor is reserved for Professors who have clearly demonstrated world-class academic leadership and achievements of the highest international standing over a decade or more.

In 2014, the prestigious title was awarded to Professor Niki Davis (Educational Studies and Leadership), Professor Jack Copeland (Humanities and Creative Arts) and Professor Mike Steel* (Mathematics and Statistics).

Davis is a professor of e-learning and Director of the College of Education, Health and Human Development's e-Learning Research Lab. She is recognised internationally as a leading expert in information and communication technologies in teacher education.

Davis says she is delighted by the honour but says her appointment is not just for her but also for those she works and collaborates with.

"I love being a professor and, as a professor of e-learning, I have had the privilege of collaborating with people all over the world."

Davis is currently looking at organisational change in digital technologies and hopes to write a book on the subject during her sabbatical later this year.

"I am still learning something new all the time. "For me and the people that I collaborate with, it is still learning, it is still creative, and we are still exploring," she says.

Copeland is Professor of Philosophy and Director of the Turing Archive for the History of Computing. He is a world leader in the philosophy and history of computing. He is also Honorary Research Professor of Philosophy at the University of Queensland, Australia, and in 2012 was Royden B. Davis Visiting Chair of Interdisciplinary Studies in the Department of Psychology at Georgetown University, Washington DC. In 2014, he was Guest Professor in Philosophy and Computer Science at the Swiss Federal Institute of Technology, Zurich (ETH Zurich), and has just returned from a visiting professorship in information science at Copenhagen University.

Copeland says being promoted to Distinguished Professor "means nothing and means everything — university life hasn't changed at all, but it's a strong message that UC values me and values my work".

"I love teaching — it gives me a real buzz. UC is just great and I love New Zealand and all the things you can do in Canterbury — the mountains, the harbours and the rivers. I have had offers of permanent professorships elsewhere, but have never really felt tempted. This is home and I have no desire to leave UC."

Copeland will be on sabbatical in the second half of 2015 and will spend two months at ETH Zurich before taking up a fellowship at the Institute of Advanced Studies in Jerusalem, where he will work on two books about computability.

Steel is a mathematics expert who uses mathematics to help biologists discover more about the evolution of life. He is a world leader in phylogenetics, which is the science of reconstructing evolutionary trees and networks from genetic data.

Steel, who is also one of the two academics to receive the University's 2014 Research Medal*, says he is thrilled with the appointment.

"I am really honoured to be awarded this promotion position. It's just great for the University and for students also, as we look to an exciting future on a redeveloped campus.

"I am pleased that the University has made several appointments and that there will be a group of people at that level," says Steel.

Davis, Copeland and Steel join Distinguished Professor Geoff Chase, who was promoted in 2013.

***By Charlene Smart***

*See story on page 32

# Studying the design of indigenous organisations

*UC doctoral candidate Eruera Prendergast-Tarena*

An investigation into the corporate design of contemporary indigenous organisations could help provide a better understanding of how these institutions can best meet indigenous needs and aspirations.

UC doctoral candidate Eruera Prendergast-Tarena (Ngāi Tahu, Ngāti Porou, Te Whānau-a-Apanui), who is completing his PhD through the Department of Management, Marketing and Entrepreneurship, has carried out case studies of three indigenous organisations 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.

His research has been supported by a Doctoral Scholarship awarded by the Ngāi Tahu Research Centre (NTRC) and a Fulbright/Ngā Pae o te Māramatanga Indigenous Scholar Award, which allowed him to spend four months in the United States collecting data.

The three organisations Prendergast-Tarena studied were Kamehameha Schools of Hawai'i, the Sealaska Corporation of Alaska and the iwi corporation Te Rūnanga o Ngāi Tahu in New Zealand.

"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," says Prendergast-Tarena, who currently works for Te Tapuae o Rehua.

"Each organisation exists in very different realities and cultural contexts. However, despite these differences each organisation faces the same tensions and complexities in terms of having to balance economic development — which involves engaging with a Western economic, legal and political environment — with the goal of building distinct cultural identities."

Prendergast-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."

The organisations Prendergast-Tarena studied are now all economically secure and politically established but he says there is a need for them to "openly discuss and address the organisational tensions they face through mediation and negotiation".

"This will enable them to better balance the complexities they face and address any conflicting priorities — for example, the commercial needs of the organisation versus regional tribal needs for jobs and food.

"Equal weighting needs to be given to economic, cultural, environmental and social agendas, and the measure of success these organisations adopt is critical. For indigenous organisations, success is measured in terms of opportunities created for their people and by having a distinct indigenous identity, while also operating successfully within the broader economic environment. The challenge is how to devise new indigenous models of organisation and wealth creation grounded in cultural values.

"The need for organisational learning is really high — the greater the complexity of an organisation the more tension is created and the greater need there is for more thinking, more discussion and better balancing."

Prendergast-Tarena says he hopes his research will help build knowledge of the complexities of indigenous organisations.

"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 the Western corporate game don't reflect indigenous aspirations so it is essential indigenous organisations are designed to fit indigenous purposes."

Research supported by:
- NTRC Doctoral Scholarship
- Fulbright/Ngā Pae o te Māramatanga Indigenous Scholar Award

***By Stacey Doornenbal***

# Getting the inside running on enzymes

A UC biomolecular scientist is looking at how enzymes work and the chemical reactions that sustain human existence.

Professor Emily Parker (Chemistry) has received Marsden funding of $860,000 over three years to study enzymes — how they work and how they can be regulated.

Parker says her team is working on understanding how communication networks in proteins support the transmission of signals between different sites on an enzyme molecule.

"The key focus of the research is about fundamentally understanding the network and how it evolved. Can we design a protein to be regulated in a similar way because we understand fundamentally the mechanisms in which this enzyme activity is controlled by the regulator?

"The particular enzyme that we are looking at is a bacterial enzyme, which is part of a pathway that makes an amino acid called leucine. Amino acids are required by cells to make new proteins and humans don't actually have that enzyme — we get leucine from the proteins that we eat. It is an essential part of our diet.

"Plants and micro-organisms make leucine themselves, so the enzyme I am looking at is found in plants and micro-organisms," says Parker.

Parker says all living systems rely on biological chemical reactions and the rate at which the chemical reaction takes place needs to be regulated and controlled.

"You don't want an enzyme working to make a product that a cell doesn't need. You need to regulate enzyme activity. There is a vast complex process to the mechanisms that are available for enzymes to work.

"The enzymes I primarily work with are found in pathogenic bacteria so there are some overlaps where we can target these enzymes for the treatment of bacterial diseases. If we understand them in more detail we have a better chance at producing inhibitors."

"There is a possibility of using advanced protein engineering techniques for sensing applications or understanding the way in which we can turn molecules or biochemical pathways on and off. These findings may also inform the design of new antibiotic therapies."

Parker says the focus of the research is on the part of the enzyme that controls its regulation and appears to act like a molecular pendulum. The motion of this pendulum is thought to control the enzyme activity.

"We think that the pendulum arm can rock back and forth, and that rocking changes in frequency or amplitude in response to the binding of the regulator molecule.

"So what we are going to do is prove that there is a pendulum action and see how this changes the activity of the enzyme. This molecular level understanding is difficult to probe and we are using different techniques to probe the way it works."

Parker says a knowledge of enzyme and protein communication networks and the importance of the mechanisms of regulation is vital for understanding how biological molecules may be used as sensors.

She says there are many benefits in the work.

"There is a possibility of using advanced protein engineering techniques for sensing applications or understanding the way in which we can turn molecules or biochemical pathways on and off. These findings may also inform the design of new antibiotic therapies."

Research supported by:
- Marsden Fund

***By Charlene Smart***

*Professor Emily Parker*

# Pair honoured with fellowships

*Professor Alison Downard and Professor David Schiel*

**An internationally recognised chemist and a world-renowned marine scientist have received national recognition for their research excellence and their contribution to the advancement of knowledge.**

University of Canterbury academics Professor Alison Downard (Chemistry) and Professor David Schiel (Biological Sciences) were among 12 of New Zealand's top scholars to be elected Fellows of the Royal Society of New Zealand in 2014.

The society awards fellowships in recognition of distinction in research or the advancement of science, or technology or the humanities. Fellows are involved in providing expert advice, promoting best and innovative research practice, and disseminating information on the sciences and humanities.

Downard, who works in the fields of electrochemistry and surface science, says she is "absolutely thrilled" to receive the fellowship.

"It is very strong recognition of my scientific achievements by my peers in New Zealand. For me, it felt really nice to be recognised in New Zealand for my work," she says.

"As a fellow I will have opportunities to contribute to the advancement of knowledge, including through outreach activities, which really appeals to me as I already work with primary school teachers as part of my role with the MacDiarmid Institute."

Downard has made pioneering discoveries involving the chemical modification of surfaces with layers only a few nanometres thick. Because the coatings are bonded to the surface, they cannot chip off. Diverse applications are possible, ranging from preparation of materials with long-lasting biocompatibility, to smart materials that can sense and identify molecules in their environment.

"In one of our projects we're using the coatings to stabilise materials for improved long-term performance of energy storage technologies. In another new project we're working with physicists and engineers to produce surface coatings on advanced semiconductor materials that show promise for various device applications."

Downard is also Deputy Director, Stakeholder Engagement, of the MacDiarmid Institute for Advanced Materials and Nanotechnology and has had more than 100 papers published on a range of aspects of electrochemistry.

Schiel, one of New Zealand's top marine scientists, says he is "really chuffed" by his fellowship.

"I was initially surprised but it's nice to be recognised for the work I've already done.

"The real question now is what am I going to do next and how can I turn that into something advantageous in terms of inspiring students or continuing on the path of high-quality science."

Schiel says being a fellow provides more "scientific credibility" to his work and opportunities for higher level interactions, "which is increasingly important in popularising science and in promoting scientific endeavour in a cohesive fashion".

Schiel is currently involved in five major research programmes: a study of near-shore oceanography, looking at how processes and species are connected; the aquatic rehabilitation of whitebait; the dynamics and recovery of estuarine habitats; the role of key marine species in facilitating diversity; and looking at how best to manage New Zealand's coasts and oceans sustainably. He is also involved in the Sustainable Seas National Science Challenge.

"We need to start thinking about marine systems holistically because much of the impact on coastal marine life comes from land use and growing populations. If we can educate children and their parents about this then we are not only highlighting the work we're doing at the University but also interacting with society in a meaningful way."

Fellowship of the Royal Society of New Zealand

***By Stacey Doornenbal***

# Spotlight on neural causes of stuttering

For the more than 33,000 adult New Zealanders who stutter, the act of speaking can be a daily struggle.

Stuttering is involuntary and disrupts the fluency of speech either through repetitions of sounds or syllables, stretching of sounds or blocking of sounds. The level of stuttering varies from person to person, and can also vary depending on the situation the person finds themselves in.

No cure or permanent treatment currently exists for this speech disorder, yet a University of Canterbury-led research team is hoping its work will help pave the way towards the development of new treatments.

The team, led by UC academic Dr Catherine Theys, is looking into the neural causes of stuttering. The work is being supported by a $345,000 grant awarded by the Marsden Fund in its 2014 funding round.

Theys, who is based in UC's Department of Communication Disorders and the New Zealand Institute of Language, Brain and Behaviour, says stuttering affects one in 20 children and, for a significant proportion, the disorder persists into adulthood. Known as developmental stuttering, this speech disorder can lead to well-known vocational and social challenges, such as fear of speaking in public, and can also cause anxiety, stress, anger and embarrassment.

"The ability to communicate effectively is vital to a person's health and well-being," says Theys.

"After centuries of research, the cause of stuttering remains unknown. While popular theories have related the origin of stuttering to psychological problems, recent studies have shown differences in brain structure and function between those who stutter and those who speak fluently, indicating a neural cause.

"However, we do not know if these differences in brain function are the key components of the long-searched-for cause of stuttering or if they represent neural changes due to many years of compensating for stuttering."

Theys says the research team hopes to unravel these questions and, for the first time, determine in which areas of the brain, and in which sequence, differences in neural processing occur between people who stutter and those who speak fluently.

The team will work with adults with persistent developmental stuttering, as well as with adults who speak fluently. The participants will be asked to perform speech production tasks, allowing the research team to detect location and timing differences in brain activation. To collect this information, a combination of electroencephalograpy (EEG) and functional magnetic resonance imaging (fMRI) will be used.

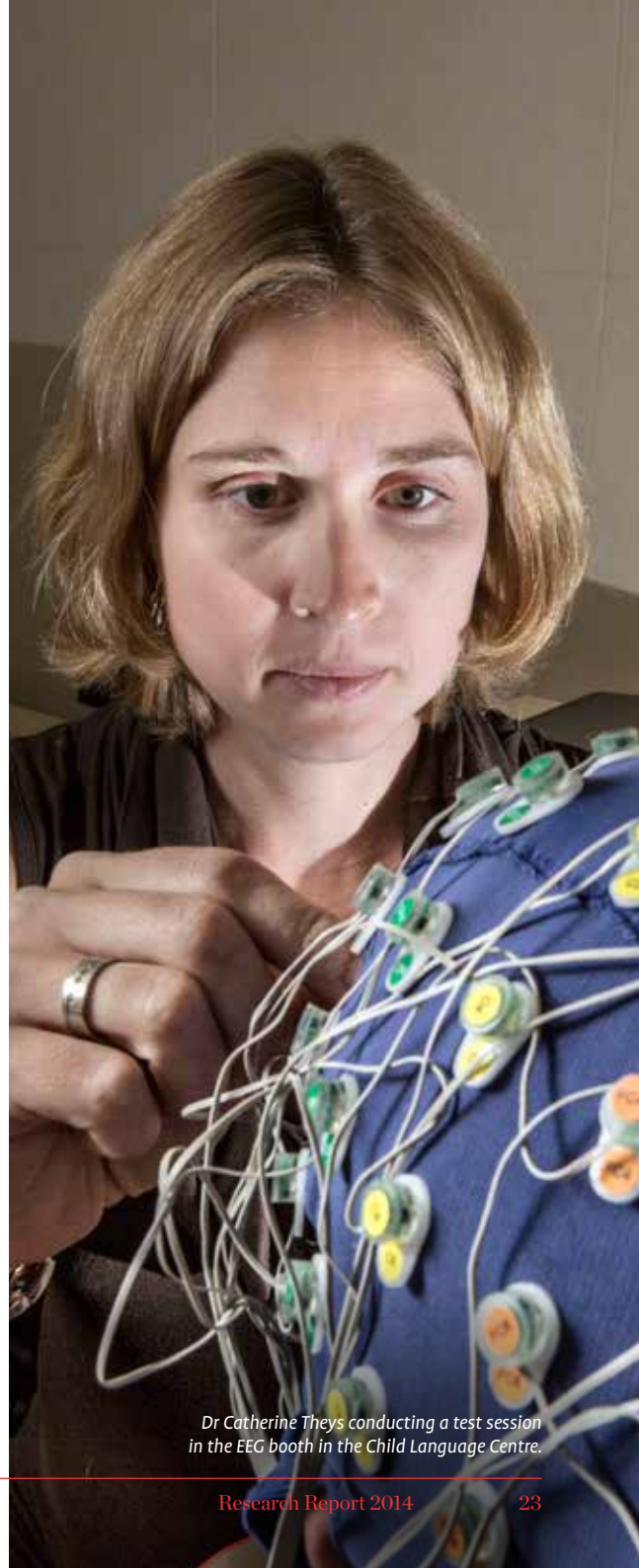
"From the collected data, we aim to develop a neuro-computational model capable of simulating the neural and behavioural characteristics of stuttering," says Theys.

"Having a neural model of fluent and dysfluent speech production will improve diagnostic possibilities and may lead to the development of innovative treatments for stuttering based on direct links between neural and behavioural characteristics."

The research team includes University of Canterbury academic Associate Professor Megan McAuliffe (Communication Disorders), Professor Frank Guenther from Boston University in the United States, Professor Maarten De Vos from Oxford University in the United Kingdom, and Dr Tracy Melzer from the Christchurch-based New Zealand Brain Research Institute.

Research supported by:
- Marsden Fund
- Lottery Health Research

***By Kip Brook***



*Dr Catherine Theys conducting a test session in the EEG booth in the Child Language Centre.*

# Studying the impact of physical forces on cancer cells

Determining how cancer cells respond to physical forces in their cellular environment could improve cancer treatment, according to two UC researchers.

Professor Maan Alkaisi and Dr Volker Nock (Electrical and Computer Engineering) have been investigating how physical forces in the micro-nano environment of the body influence how cells develop, spread and interact, in order to understand ways cancer treatment could be enhanced.

"Cancers are more susceptible to metastasise and spread depending on the stiffness of tissue. It becomes almost an engineering problem if you can determine what forces cancer cells experience in the body," Nock says.

"We are trying to determine if there are ways of treating cancer from a different perspective, not from a mutation-based perspective. There seems to be a connection between mechanical stiffness and cancer development and, if we can determine that and how that affects the biochemistry of the cells, then there's potential to develop drugs that will help."

Alkaisi and Nock, who have collaborated with Christchurch Hospital and researchers at Toulouse University in France, have developed cutting-edge "bioimprint" technology to find out how physical forces in the micro-nano environment influence cell behaviour.

"Physical forces range from nano to micro-Newtons, so they are extremely small forces that we are talking about," Alkaisi says.

He says bioimprint technology enables researchers to mimic how cells react by recreating imitation cells in polymeric material with features of a similar size and shape to that of a cell's morphology.

"We can essentially replicate the micro-nano environment of the cell by replicating the cell itself in some polymer, which we use as a platform to culture cells and see how cells react to an environment that mimics the shape, topography and dimensions of an actual cell. We can do this in a variety of environments, both positive and negative, for the cell to grow and interact," Alkaisi says.

"We have results that show that forces do influence the morphology, including the shape or even genetic expression. What the cell secretes is also different on different topographies, which means the cell membrane can interact within an environment and produce different types of protein to deal with different situations."

Nock previously worked with a microscopic worm, *C. elegans*, to see how the environment the worm moves in influences forces exerted by it during locomotion.

"We used a worm which is an excellent model for all sorts of diseases. We designed devices with arrays of miniature sensor pillars in which we could track its movement and every time it touches a pillar we can measure the force it exerts by recording the deflection of the pillar.

"We can apply this to cancer cells. We have the system and we know it works; it is just a matter of making it smaller for individual cells. There are some interesting engineering challenges around the system but, in principle, we know it works," Nock says.

Alkaisi says bioimprint technology allows researchers to determine the difference in the role of the micro-nano environment and that of surface chemistry.

"This is probably one of the best technologies to isolate these two factors. We have a topography that exactly mimics the environment so we can isolate the chemical from the physical influences," he says.

Alkaisi and Nock, whose research has been supported by the Marsden Fund, want to apply their discoveries to measure the forces cancer cells exert on the micro-nano environment, what size the forces are, how cancer cells grow and interact with their environment where tissue is both soft and hard.

"First, we will measure the forces that cancer cells exert on the environment and what the size of those forces are," Alkaisi says.

"We will look at 3D clusters of cancer cells — spheroids — growing and see how they push the surrounding environment under different conditions. We are going to use the set of pillars developed by Volker and measure the deflection of these pillars. From these deflections we can extract the mechanical and physical forces the cancer is applying."

Alkaisi says the ultimate goal will then be to discover how to apply external forces on the cancer cells and look at any changes in genetic expression and changes in growth rate, spread or behaviour.

"There is an argument in the scientific community that triggered this research which proposes that by applying certain forces, cancer cells can be reverted back to normal cells, which, if that could be achieved, would be pretty amazing," Alkaisi says.

"What we want to do is to build a model whereby we characterise, exactly, the magnitude and nature of the forces required to induce changes and possibly reverse cancer growth."

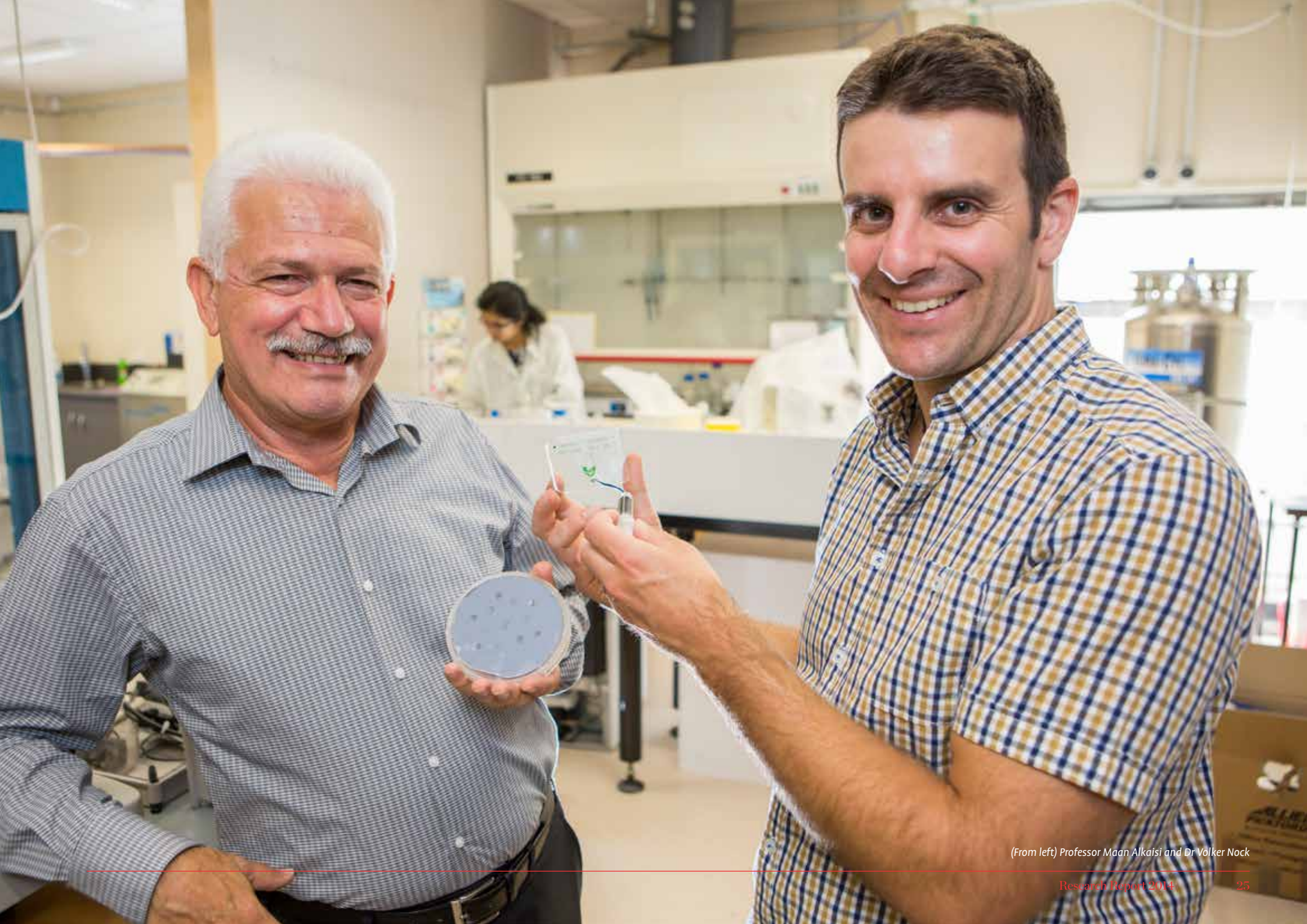
Alkaisi says they hope to focus on ovarian cancer, ultimately using live cancer cells from patients, because it prefers soft tissue whereas breast cancer prefers stiffer tissue.

"There is certainly a response to the environment; this might explain why certain parts of the body are more vulnerable to cancer than others. I want to discover what is missing in cancer treatment. Once we know what impact mechanical forces could have on cancer cells then that might give us an idea for developing better, more effective treatment," Alkaisi says.

"Medical doctors cannot create devices on such a small scale to measure forces and detect these changes so we are hoping this is an area we can help in."

Research supported by:
- Marsden Fund

***By Renee Jones***



*(From left) Professor Maan Alkaisi and Dr Volker Nock*

*Dr John Pirker and Dr Sharyn Goldstien*

A community engagement initiative by two University of Canterbury scientists has led to a partnership with local mana whenua and the wider community that is not only providing unique learning opportunities for students but is also benefitting the local marine environment.

Marine ecologists Dr Sharyn Goldstien and Dr John Pirker (Ngāi Tahu), who are based in the University's School of Biological Sciences, have been working in partnership with Te Rūnanga o Kaikōura and local community groups on a range of marine conservation projects around the Kaikōura Peninsula.

The projects have largely been initiated by the local community and all research has been co-developed with Te Rūnanga o Kaikōura to ensure the projects meet rūnanga conservation objectives, and mātauranga Māori, or traditional knowledge, is integrated into the research programmes.

"The rūnanga is very proactive and is keen to be involved in any projects that are about protecting the environment and managing resources sustainably," says Pirker.

# Community-driven research growing in Kaikōura

"Our goal is to strengthen the work we have already done to underpin the marine management strategy developed by Te Korowai o te Tai-o-Marokura to sustainably manage local resources, and which will be delivered in partnership with the local rūnanga."

Goldstien says Kaikōura is dynamic in terms of its marine environment as it has a high level of biodiversity.

"It is an area that lends itself to having the whole community engaged in research that is led by the community and Te Rūnanga o Kaikōura, and is supported by an understanding of shared conservation objectives and underpinned by a strong working relationship."

Goldstien and Pirker say the key to developing a working partnership with Te Rūnanga o Kaikōura and the community has been building trust — by being present in the community, taking part in community activities, and taking the time to listen and develop shared goals.

"Partnership means the strengthening of familial relationships, sharing aspirations, bringing knowledge systems together, moving shared questions and interests forward together," says Pirker.

"It means the recognition of the rights and status of iwi, hapū and whānau as Treaty partners and the recognition and value of mātauranga Māori. Importantly, engagement and partnership need to be in place at the conceptual stage of the project."

Pirker says the partnership with Te Rūnanga o Kaikōura stems from a first-year science paper, "Māori and Indigenous Knowledge", which is offered to UC students by the School of Biological Sciences and Aotahi: School of Māori and Indigenous Studies. The course provides students with a basic understanding of Māori and indigenous peoples' knowledge in fields such as astronomy, physics, health sciences, conservation biology, aquaculture and resource management, and includes a field trip to Kaikōura where students stay at the local Takahanga Marae and work with rūnanga on an ongoing pāua reseeding project.

"Through this course, we developed a relationship with the rūnanga in terms of becoming aware of their aspirations and conservation objectives, and students have been able to get involved in the marae environment and learn about other knowledge systems and mātauranga Māori," says Pirker.

"Having this relationship has added a huge amount of value to the field trip, and it is a relationship that is valued on both sides. Since then, we have looked at how we can extend this relationship in terms of undergraduate and postgraduate research opportunities that give students a chance to engage with the wider community on projects that have been initiated by the community."

Goldstien says research links with the Kaikōura community have expanded and now include a working relationship with the Hutton's Shearwater Charitable Trust and Te Korowai o te Tai-o-Marokura, a group that represents Kaikōura-based organisations with an interest in marine conservation. Goldstien has become a member of Te Korowai o te Tai-o-Marokura and the relationship with the charitable trust has led to a number of student projects on the Hutton's shearwater, an endangered seabird found only in Kaikōura. One such project saw an undergraduate student investigate the flight path of young shearwaters.

"Shearwaters nest in the mountains in the Kaikōura ranges and, when they're young birds, they leave the nest, at night, to fly to Australia. To get out to sea, they have to fly over the township but some of the locals were finding young birds that hadn't made it to sea, and they wanted to find out why. One of our undergraduate students took on the project and worked with the community to record where the birds were found and when. It seemed the birds were being distracted by the lights of the township, causing them to crash. The township now knows how to mitigate the issue and the student is now doing a masters degree on the topic," says Goldstien.

"It's a nice example of interaction with the community and helping build on their conservation goals. We also now have a masters student working with the trust on a project looking at the changing foraging behaviour of the shearwater."

Goldstien and Pirker say other projects in development, based on the local community's interests, include a study of the seal colony to monitor its expansion and what it means for the sanctuary and the community; and a project in partnership with local charter fishermen to monitor the number of fish taken from the sea to ensure the fishery is being managed sustainably.

The relationship with the community and rūnanga has also led to the development of a joint project to establish a national centre of marine conservation in Kaikōura. Goldstien and Pirker say the aim is to create a centre for research excellence and an education hub for the community.

"Our goal is to deliver education programmes in partnership with Te Rūnanga o Kaikōura and community conservation groups, and provide a base for postgraduate research projects developed with Te Rūnanga o Kaikōura that underpin key conservation objectives," says Goldstien.

While funding for the centre has yet to be secured, Pirker and Goldstien say the project would not have been developed as far as it has without the support of the rūnanga and the community groups.

"Kaikōura has so many engaged citizens who are curious about their environment — they are the ones asking the questions and we are helping them fill in the gaps," says Goldstien.

"The relationship is enriching from both sides and that's exciting. It has taken a bit of time to build trust but it has been very much worth it."

Pirker and Goldstien were, in 2015, the recipients of a Vision Mātauranga Capability Fund grant from the Ministry of Business, Innovation and Employment.

Research supported by:
- Ministry of Business, Innovation and Employment

***By Stacey Doornenbal***

# Sport research hitting the right targets

**Analysing the physiological and psychological stress of elite athletes to improve recovery and performance, using 3D imaging systems to improve and track croquet players' techniques, and designing a cricket app that predicts where a player is likely to hit the ball are all part of cutting-edge sport research being undertaken at UC.**

Biological sciences PhD student Angus Lindsay is studying the science behind elite athletes' psychophysiological stress, including that of amateur and professional rugby players, competitive mixed martial arts proponents, and body builders.

"My research is focused on quantifying the physiological stress of those athletes and how it can be best used to manage their recovery and improve performance," says Lindsay.

"I have investigated the acute and chronic physiological and psychological stress response at an individual level while simultaneously assessing recovery intervention strategies following games and competitions.

"There is an abundance of research identifying the contributing factors of psychophysiological stress in exercise, however the applications of this knowledge have yet to be completely elucidated and applied."

Lindsay, whose research is being supervised by Associate Professor Steven Gieseg (Biological Sciences), says this exploratory and observational research can help increase the longevity of an athlete's career.

"The purpose is to minimise the qualitative and often subjective measures of current methodologies like questionnaires, GPS units and video-analysis which do not necessarily correlate with changes in specific biomarkers, and instead utilise quantitative factual measures of stress through biochemical analysis."

Lindsay has written 11 papers supporting different aspects of his PhD research.

"I love sport. I am so passionate about the industry that I wanted to accommodate my science background to develop original and innovative research that can hopefully provide a new means for athlete stress management and recovery analysis," says Lindsay.

Current world croquet champion, Dr Jenny Clarke (Sport and Physical Education), has been analysing the problems with crooked croquet swings and how swing accuracy can be corrected.

Clarke is a member of the New Zealand team which won the 2014 world championships. She is also a croquet coach. She says it was her own crooked swing, which resulted in intermittent wrist pain, that inspired her research.

"With a crooked swing you have to be really good with timing to hit the ball accurately. Basically, you have to strike the ball when your mallet is pointing exactly straight ahead, which for some players isn't very often," she says.

"It is really hard to coach players with a 'bad' swing and to help them to improve their shooting accuracy. My own investigations of my swing suggested that the twisting seemed to occur largely as a result of bending the wrist at the top of the backswing. Generally, this isn't desirable because a good swing should come from the shoulder and should use larger muscles, as smaller muscles tend to get fatigued more easily, are weaker and can also lead to unwanted fine movements."

Clarke's study looked at the correlation between how much a player's wrist bends at the top of the backswing and how much twist there is in the mallet head.

"Our study involved 40 participants and we used a 3D imaging system which included placing markers on joints and the croquet mallet, and tracking those markers with infrared cameras to precision of better than 0.5mm," she says.

Clarke says the aim of the study was to determine whether supporting a player to change their technique and use less wrist movement could lead to a straighter swing and benefit the player by reducing the likelihood of wrist pain.

"By analysing the tracked markers we found a clear correlation between wrist bending and mallet twisting, which supported our original hypothesis," she says.

Clarke says this research has been so successful that she is now looking at how this theory can be used in golf.

"We want to look at the rotational velocity of different body parts — wrists, shoulders and hips, mainly in a golf swing. We want to not only measure the speed of rotation, but also the angular acceleration of those body parts and the time of when these rotations begin and end relative to each other in a swing.

"It is an exciting time for research and we hope our research will have a positive impact on the sport and help to reduce injury on players," she says.

UC lecturer in sports science and cricket researcher, Dr Carl Petersen (Sport and Physical Education), has developed an app that shows where batsmen are more likely to hit a certain type of delivery.

"Until now, players and captains have had to rely on experience and gut feeling with regards to where a batsman is likely to hit a ball," he says.

Petersen has been studying where batsmen hit balls based on the ball's location, and the work has resulted in the development of an app that allows a more detailed collection of data.

"The app has been utilised in our sport science lab classes allowing students to have hands-on experience of collecting cricket performance data in real-time and, more importantly, introducing students to performance analysis.

"This tool will help with field placements and deciding on appropriate bowling tactics. Bowlers are forced to develop skills to bowl tightly on batting-friendly pitches. This also offers spin bowlers the chance to play an important part in the game."

Petersen says sports science involves incorporating new technology with the aim of improving results.

Head of the School of Sport and Physical Education, Professor Richard Light, says sport and sport research are important, due to the impact such research can have on athletes and coaches at all sporting levels.

“Sport is in the DNA of Canterbury and we value sport. The University of Canterbury offers the only sport coaching programme in New Zealand and we have the potential to be a big hitter nationally. One of my aims is to make sport an important part of the student experience while they are at UC,” says Light.

Light says the sport research produced at UC informs teaching and helps produce high quality coaches.

“Quality coaches make sport enjoyable and positive for participants. We are working at the community level and at the elite level as well.

“We are putting our research out there and it keeps the community informed about what we are doing. We are working with local coaches and coaching organisations and this is where we want to make an impact,” says Light.

***By Charlene Smart***

*PhD student Angus Lindsay (left) and Associate Professor Steven Gieseg*


*Dr Anne van Bysterveldt*

# Making meaningful connections

**Being able to tell personal narratives about your experiences is a key social skill that most people develop at an early age.**

However, for children with learning disabilities, being able to develop and convey a personal voice can be a lot more difficult, says University of Canterbury researcher Dr Anne van Bysterveldt (Health Sciences).

Van Bysterveldt, who is based in the College of Education, Health and Human Development, is studying the personal narrative skills of school-aged children with Down syndrome. Her research focuses on facilitating speech, language and literacy development in young children with developmental disabilities.

She says the goal of the research is to develop interventions that will give teachers and teacher aides techniques to support children with Down syndrome to develop the necessary language skills to communicate their stories effectively.

The research is being supported by the New Zealand Institute of Language, Brain and Behaviour at the University of Canterbury.

"Competence in producing personal narratives is very important for socio-emotional well-being and for academic performance," says van Bysterveldt, who is also an associate staff member at the Champion Centre, a Christchurch-based early intervention service provider for children with disabilities.

"Sharing your experiences is an important part of developing friendships and making connections with others. However, if you have nothing to share, or you can't share, you miss the chance to be part of a peer group. If the listener is also made to work hard to follow your story, your ability to connect with them is limited. This is a huge disadvantage and can be isolating.

"For children with learning disabilities, the difficulties can be in giving order to the content of their stories, linking their ideas and not being able to give their narratives a punchline. There are always bits missing, which can be limiting both for the listener and the child."

Working with Dr Marleen Westerveld from Griffith University in Queensland, who is also an adjunct at UC in the School of Teacher Education, van Bysterveldt collected information on the personal narrative skills of 10 children with Down syndrome in mainstream primary schools in the Canterbury region.

The children's parents and teacher aides helped with data collection, which involved obtaining narrative samples from each child using a standard protocol used by New Zealand speech-language therapists. This involved showing the children a series of pictures to prompt them into talking about an event that happened in their past. The children's own photos were also used as prompts. This was done in three different contexts — with their parent, their teacher aide and with an unfamiliar speech and language therapist.

"This will show us what helps the children most when telling their stories — does their familiarity with the listener or their familiarity with the story help them? How does their relationship with their teacher aide affect their narrative ability and does the complexity of the listener's language or the questions about their story affect their narratives?

"What we want to know is what helps and what doesn't. For example, is it a question of people simplifying their language or waiting longer before they repeat their questions so the children aren't overloaded with information? Maybe it is a matter of developing an intervention that will help children with Down syndrome learn how stories work, such as learning about story grammar, because it appears that just being immersed in stories as part of their school environment isn't enough."

Van Bysterveldt and Westerveld are still analysing the data, but van Bysterveldt says it is hoped the information they have collected will allow them to develop guidelines and suggest support mechanisms that could be used by educators anywhere in the country and be incorporated into education training programmes.

"We can't leave these children behind. We have to be able to make tasks easier and harder to cater for all abilities in the classroom and include children with learning disabilities in the same learner group. We can find ways to vary the demands and supports so children with Down syndrome still feel part of their learner group, and not separate from it," she says.

"There is a belief that teachers working with children with learning disabilities need different training or that it involves extra work, but my philosophy is that teachers should be able to teach and support the learning of all children — and they can if they know how to make learning easier and harder for the range of abilities in their classrooms."

Van Bysterveldt's latest research stems from an earlier investigation she carried out into the phonological awareness and literacy development of children with Down syndrome. In the earlier study, van Bysterveldt and Professor Gail Gillon, Pro-Vice-Chancellor of the College of Education, Health and Human Development, investigated the reading skills of a group of 77 New Zealand children with Down syndrome with the aim of finding out how to better support their educational success. The study included information from the children's parents and teachers about the literacy environments at home and school, as well as assessments of the children's letter knowledge, phonological awareness and their reading accuracy and comprehension.

"We found that children with Down syndrome are learning to read in different classroom settings around the country, and they can learn to read very well. However, many children still lacked those early skills of understanding letters and sounds and how these combine to make words that carry meaning. Reading comprehension is a bit more of a challenge due to verbal memory and cognitive processes associated with learning, but this is enhanced when the tasks are broken down into small steps and explicitly taught, with lots of successful repetition.

"It's a reaffirmation that children with learning disabilities don't just pick things up by being immersed in them. They still need someone to work with them through the learning process and make sure those early skills are in place for the child to build on."

Van Bysterveldt says, historically, expectations for children with learning disabilities have been low.

"But there is now a growing understanding internationally that we need to have high expectations of children with learning disabilities as well as the need to put strategies in place to support them. And, if you have high expectations, then it's our responsibility to do our utmost to find the best ways to help and support them within our New Zealand cultural context."

Research supported by:
- New Zealand Institute of Language, Brain and Behaviour

***By Stacey Doornenbal***

# Research excellence recognised

**A UC academic who is using mathematics to help biologists discover more about the evolution of life and a leading international sustainability and tourism researcher have each been awarded University of Canterbury Research Medals for 2014.**

The medals were awarded to Distinguished Professor Mike Steel (Mathematics and Statistics) and Professor C. Michael Hall (Management, Marketing and Entrepreneurship).

The Research Medal is awarded annually by the University Council for excellence in research or in recognition of research of outstanding merit produced over a limited time frame. It is the University's highest recognition of an outstanding contribution to research.

Steel, who was awarded his medal for leading work in phylogenetics and in autocatalytic networks, says he was surprised but delighted to be awarded the medal.

"The last three years have gone so well, which has been a big plus for me. Having such good students and colleagues and good projects that turn to gold is great."

Steel's main research focus is phylogenetics, which uses mathematics to come up with better ways of reconstructing evolutionary relationships between species based on genetic data.

"It is something I have been involved in for quite some time and, of course, an area that has grown enormously because of the explosion of genomic technology."

Steel's research on autocatalytic networks, a key step in the "origin of life", is based on looking at how life might have begun from a mathematical point of view.

"There is an unanswered question as to how life started. Various people have an opinion on how it started. It is an area where there are lots of opinions and theory but not a lot of data.

"But it is, curiously, an area where mathematics can play a useful role and handle the possible scenarios on how life might have started. We have a systematic way of taking any reaction system and very quickly identifying the substructures that would be feasible for early life. I find this a lot of fun.

"Mathematics is really essential since it gives a way of systematically exploring the huge space of possible evolutionary scenarios. Since evolution is a random process, probability models also play an important role."

Steel says a highlight of the past year was delivering free public talks called "Darwin's regret", which refers to Charles Darwin's wish that he had learned more about maths. The talks, organised through the Allan Wilson Centre for Molecular Ecology and Evolution where Steel has been deputy director for the past six years and is a founding member, discussed ideas from maths and statistics that have become central to the study and visualising of evolution.

Steel was recently named as one of four principal investigators to be awarded a $695,000 grant for a three-year research project, called "Terraces, Large Trees and Trait Evolution", from the United States-based National Science Foundation. The project is a collaboration between leading systematic biologist Professor Mike Sanderson from the University of Arizona in the United States, his colleagues and Steel. The team will look at patchy taxon coverage and why these methods are giving biologists misleading results when building evolutionary trees from modern data.

Steel is Director of the Biomathematics Research Centre hosted within UC's Department of Mathematics and Statistics and is a Fellow of the Royal Society of New Zealand. One of his next projects is a book for the Society for Industrial and Applied Mathematics, called *Mathematical Phylogeny*, and will be based on a series of invited lectures Steel gave in the United States on the mathematics of inferring and analysing evolutionary trees.

Hall, Professor of Marketing at UC, received his Research Medal for his ground-breaking work in spatially integrated tourism management, environmental change and planning.

He is highly regarded and admired by key figures in his area of study.

"The significance of his research is attested by the fact that he is the most frequently cited tourism scholar in the world," says Deputy Vice-Chancellor (Research) Professor Steve Weaver.

"At the end of 2014, he had been cited more than 25,000 times. He has published 35 authored and 35 edited books and completed more than 180 refereed journal articles and 320 book chapters.

"He has made a significant impact on the thinking around tourism policy, regional development, event marketing and management, food and wine tourism, biosecurity and issues surrounding environmental change."

Hall says his research examines the environmental, economic and political aspects of temporary human movement.

"This is something called tourism — but it is actually much wider than how people usually conceive of tourism as going for a holiday. It covers all aspects of the voluntary temporary mobility of people.

"This focuses on issues such as sustainable cities and sustainable mobility, public transport, walkability, wine and local foods, biosecurity, climate change, entrepreneurship, innovation, rebound effect, as well as prospects of behavioural change given the design of economic, educational and technical systems."

Hall has an honorary doctorate in science from the University of Oulu, Finland, and in the arts from Umea University, Sweden. In 2009, he was the recipient of leading international publisher Elsevier ScienceDirect's For Great Thinking Award for the arts, humanities and social sciences, which was judged from researchers throughout the world. He also holds senior visiting positions at the University of Johannesburg, South Africa, Linneaus University, Sweden, and the University of Mauritius.

However, Hall says the most important aspect of his work is not the awards but having his research read and applied.

"Having work cited by organisations such as the OECD, UNEP and the IPCC is reward in itself. Importantly, sometimes in order to make a difference you have to be different," he says.

Hall is currently working on a number of projects, including research into local food markets and how they affect local and regional development, low carbon tourism, sustainable cities, and holiday homes and their impact on the housing market and the environment.

UC Research Medal

***By Charlene Smart***

*Distinguished Professor Mike Steel*

Dr Tyron Love

# Creating future leaders

Supporting young Māori students to achieve their goals is a top priority for the School of Business and Economics' Associate Dean of Māori, Dr Tyron Love.

Love (Te Atiawa), a lecturer in management and managing corporate responsibility as well as a trained primary school teacher, says in supporting Māori and Pasifika students in the School of Business and Economics he is helping develop the next generation of leaders.

"I was supported as I did my studies and I guess that it is reciprocation. Being able to support other Māori students and see them grow is what I enjoy doing."

Love, who started teaching at UC in 2013, says while doing his PhD at Massey University he was surrounded by a great group of academics and got a sense of the collaborative spirit amongst Māori researchers from diverse backgrounds.

"I was really interested in being part of a team and working with Māori academics, and this is really where my interest in collaborative research came from."

Love's research interests involve corporate responsibility and corporate philanthropy. He teaches the fundamentals of management and is interested in challenging commerce students to think critically about how organisations are created, maintained and disrupted by actor-agents.

Love's research projects are largely centred on theorising corporate philanthropy, exploring how indigenous ways of knowing can enhance organisation-public engagement and using narrative methods for understanding people's experience of organisational phenomena.

"I am interested in the reasons why corporations make and give contributions and, out of my PhD studies, I have developed an interest in narrative methods and how time orientates corporate philanthropy," he says.

Love has also been working on a number of collaborations with colleagues in Australia and New Zealand.

"We have been looking at public relations and, more specifically, looking at the engagement with Māori and Māori communities and media representation," he says.

"Some of the work I have been collaborating on is within the broad field of public relations and, more specifically, organisation and Māori community engagement. In the mainstream organisation-based research, we have a lot to learn from Māori ways of knowing and engaging.

"I am also part of a research group with UC Māori researcher Professor Angus Macfarlane. We are working on projects with UC researchers Dr Joana Kuntz, Associate Professor Katharina Näswall and Te Hurinui Clarke examining Māori values in the workplace and how they are being used by organisations to build organisational well-being and resilience.

"I think it is about building good collaborative research teams and following various interests. I also think it is about building teams and learning from others."

Love says he originally became involved in this type of management research after reading a *Harvard Business Review* article.

"The article was arguing for the strategic relevance of corporate philanthropy which seemed very oxymoronic to me, the idea that corporations could create some strategic advantage," he says.

"It was that conflict that really got me interested and I was fortunate enough to have a couple of supervisors that were interested in corporate social responsibility. I had great support from them."

Love is currently supervising seven masters and PhD students with another coming on board in the middle of 2015.

"As of June, I will be supervising four PhDs and four masters students. All of them are Māori or Pasifika, as well as one Malaysian student, and that is something that is really important. They are also included in some other research projects," he says.

***By Charlene Smart***

# Leprosy's Pacific legacy

The role played by a contagious and debilitating bacterial disease in forging new and ongoing relationships between New Zealand and the Pacific Islands is being studied by a University of Canterbury historian.

Dr Jane Buckingham (Humanities and Creative Arts) has been looking at the history of leprosy in the Pacific with a particular focus on the Central Leprosy Hospital on Makogai Island, which is located just off the coast of Ovalau in Fiji.

Her research, which has been supported by a Global Project on the History of Leprosy grant for oral history research and a Marsden Fund grant, examines the experiences of patients during and after leaving Makogai. The project is based on a collection of oral testimonies of 35 former patients of the Makogai facility and the archive of the Pacific Leprosy Foundation, both of which are held in the University's Macmillan Brown Library.

Buckingham says Makogai Island became a quarantine and treatment facility for leprosy sufferers in 1911, only closing in 1969 when the development of new drug therapies made outpatient treatment possible. The hospital became the main isolation facility for leprosy-affected people for the entire British dominated South Pacific region and, from 1925, included a number from New Zealand who had been quarantined on Quail Island in Lyttelton Harbour.

"What is significant about Makogai is that while it was an isolation island it was also designed to have state-of-the-art treatment facilities," says Buckingham.

"It was very different from other isolation islands, like Molokai in Hawai'i, where people with leprosy were basically 'dumped'. At such places, there was little medical care as the key function was to separate those with leprosy and contain the disease.

"However, Makogai was purpose-built for leprosy care and treatment. This is significant because it created a kind of pan-Pacific community. All the patients were living in different villages but on the same island. They had schools and workshops, and the medical staff lived in the same community. Those living on Makogai were all different and came from different countries but they came together and were connected by a disease. They saw each other as 'brothers' and Makogai became a model institution that was visited by dignitaries from around the Pacific."

Leprosy, or Hansen's disease, is an endemic disease caused by a myco-bacterial infection. It can take up to seven years for symptoms to appear after the disease is contracted and, if left untreated, can damage peripheral nerves and cartilage, and cause skin lesions. Those affected by the disease can be left disabled and disfigured, and socially isolated.

*Dr Jane Buckingham*

Buckingham says the connection between New Zealand and those affected by leprosy in the Pacific began through the voluntary work of Benjamin Pratt and Patrick Twomey who, in the 1920s, worked to bring friendship and support to those affected by leprosy — first to those on Quail Island and then to those on Makogai Island.

"The funding for many of the facilities and the kinds of things that make life pleasant — like books, movies and luxury goods — came from a New Zealand philanthropic initiative by Pratt and Twomey, who asked New Zealanders to make donations to support the leprosy affected of the Pacific. This initiative gained momentum and eventually led to the creation of the Makogai Lepers' Trust Board, which is now the Pacific Leprosy Foundation.

"New Zealanders provided the primary funding for the Makogai facility and, even now, New Zealanders are having an impact by supporting leprosy care in the Pacific. These early volunteers forged new social, cultural, political and medical links between New Zealand and the wider Pacific that continue to this day."

Research supported by:
- Marsden Fund
- Global Project on the History of Leprosy

***By Stacey Doornenbal***

# Student helping Tonga combat mosquitoes

Photo supplied.

*UC masters student Tom Swan in Tonga.*

Research which could help in the fight against mosquito-borne diseases in Tonga has been undertaken by UC biological sciences masters student Tom Swan.

Swan, who is being supervised by Professor Jon Harding (Biological Sciences), investigated mosquito larvae in Tonga last summer, collecting samples from 88 sites throughout the main island of Tongatapu and offshore 'Eua Island.

Swan says an important part of his research involved not only collecting mosquito larvae to re-assess the diversity and distribution of species in Tonga, but also working with local schools and the Tongan Ministry of Health to increase public awareness about the mosquitoes in Tonga.

"Mosquitoes are a significant pest and carrier of malaria and dengue fever diseases around the world. Although malaria is not currently present in Tonga, dengue fever is, and there have been serious outbreaks of this nasty disease in the past," he says.

Swan says he found the virulent Asian tiger mosquito, which is only the second recorded occurrence of this mosquito species in Tonga.

"The Asian tiger mosquito has spread swiftly through the tropics and is a significant vector for dengue fever and chikungunya virus, for which there is no cure. It is a voracious feeder and notorious for outcompeting other native mosquito species. This may be primarily due to its ability to feed during the day, while most established mosquitoes feed primarily at dawn and dusk," Swan says.

"Dengue fever and the chikungunya virus cause fevers, muscle pain and severe joint inflammation. These diseases are particularly fatal for the elderly and young. A recent outbreak of chikungunya virus in April 2014 infected 10,000 Tongan residents, resulting in numerous fatalities.

"Initial assessment has shown that the Asian tiger mosquito appears to now be widespread across Tongatapu. This is of growing concern for the people of Tonga and may increase the frequency of mosquito-borne diseases in Tonga in the future."

Swan says reducing the number of larval habitats could have beneficial health outcomes.

"If we can reduce the number of mosquito habitats through education then we could make a significant impact on disease reduction in Tonga," he says.

Swan found that the larvae were frequently breeding in artificial habitats created by humans such as car tyres and fuel drums where water can pool and the larvae can develop.

"Mosquito habitats form in warm, stagnant water. Artificial habitats such as car tyres and water containers, and natural habitats like pools and ponds are the most common. Car tyres were the most common habitat from which mosquito larvae were collected," he says.

"Educating the Tongan people about these diseases and the prevention of habitat — mainly the removal of car tyres — was a key component of my research with involvement from Tonga High School, the Atenisi Institute and the Tongan Ministry of Health."

Swan plans to create the first pictorial identification key for Tonga to help with the identification of the nine mosquito larvae species found in the island state.

"There are keys to identify mosquito larvae around the Pacific and globally, but this will be the first pictorial key for Tonga to aid in identifying mosquito larvae through a high-powered microscope. It will have pictures of the key distinguishable features — combscales, pectin hairs — between the species. This will provide a resource to help entomologists and the Tongan Ministry of Health."

***By Renee Jones***

# UC spin-off developing improved breast cancer detection device

Technology that will improve breast cancer screening, and devices that detect anthrax and contaminated food at meat processing companies, have been the focus of two UC spin-off companies — Tiro LifeSciences and Veritide.

Distinguished Professor Geoff Chase, the lead UC researcher who founded Tiro LifeSciences, says the company is creating technology that could save lives by providing effective, low-cost and non-invasive early breast cancer detection.

Chase, along with Dr Matt Signal and CEO Marcus Haggers, have helped design the Digital Imaging-Based Elasto-Tomography Technology (DIET) which identifies cancerous tissue.

"The research mixes traditional engineering methods and analysis into an all-new approach to medical diagnosis of breast cancer. DIET measures the propagation of shear waves in the breast tissue that is induced by a simple mechanical actuator. This propagation is interrupted by sudden changes in tissue stiffness. Since cancerous tissue is four to 100 times stiffer than regular breast tissue, it acts something like a rock in the water as the motion propagates past it. We can thus detect it easily using digital image processing methods," Chase says.

"It should, over time, significantly improve diagnosis, while reducing overall screening costs, and do so in concert with traditional mammography and other methods. In addition, as it works on small vibration inputs, it is not painful, whereas mammograms must flatten the breast to ensure they get a good image, which is very painful and reduces compliance as women would prefer to avoid it if possible."

Chase says the aim is to create a low cost, zero radiation, zero pain device that has equal or better detection than a mammogram. As it doesn't involve x-rays it will be effective in women of all ages, not just those over the age of 45.

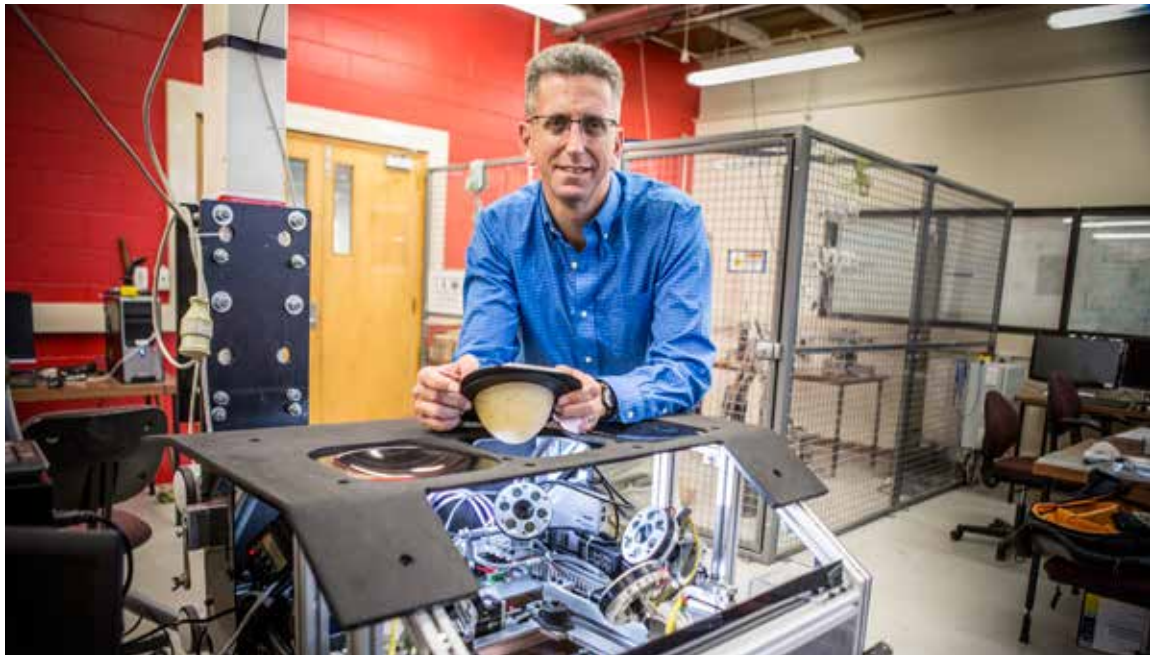
"We have already demonstrated this in limited pilot trials and we are now entering much larger clinical trials this year of up to 400 subjects," he says.

Chase says their overall goal is to save lives and reduce the cost of care for the approximately 2800 New Zealand women who are diagnosed with breast cancer every year.

"Early detection is everything. This will provide early detection as it is non-invasive, and can be done regularly in your GP's office at very low cost. Equally, it can serve as a pre-screener before subjecting someone to a mammogram if they have discovered a lump at home," Chase says.

Meanwhile, UC graduate and CEO of Veritide, Craig Tuffnell, says the company initially commercialised anthrax detection technology to assist first responders in terrorist attacks but is now also developing cutting-edge food quality technology.

"Over the past two years we have been working on technology for detecting faecal contamination and bacteria on meat to help meat processing companies improve food quality and lower food spoilage rates," he says.



*Distinguished Professor Geoff Chase*

"Our detector has been developed initially as a portable device, but we will eventually have a full carcass scanning system. It's a very sensitive optical fluorescence detector with some interesting analysis algorithms.

"We are also porting the technology to camera-based systems that will be less sensitive, but much faster. We have been doing trials on our portable device at a local meat processing plant and the results are exciting. They have been using it as an auditing tool and have shown how they can rapidly improve their processes with it."

Tuffnell says new research includes developing a system for rapid detection of bacteria on swabs used to capture bacteria from surfaces, food products and for medical diagnosis.

"Bacteria can be detected in minutes, whereas other practical techniques typically take a couple of days. We are also increasing our analysis capability for applications in food quality such as analysis of near-infrared spectrometer data to look for food contaminants."

***By Renee Jones***

# Harnessing microscopic agents

**Researchers at the University of Canterbury are investigating ways to improve drug delivery methods and assist medical diagnoses by using magnetically switchable microscopic agents.**

Professor Paul Kruger (Chemistry), who is also a Principal Investigator at the MacDiarmid Institute, heads a UC research group that recently received $750,000 in funding from the Marsden Fund for its work to see if molecules can be altered to become better drug delivery agents or more effective contrast agents for magnetic resonance imaging (MRI) to aid medical diagnoses.

Kruger, whose research focus is on inorganic supramolecular chemistry, says the group is looking at how metal-organic molecular cages, created in the lab, can be used to trap molecules then release them under an external influence such as heat or light.

Molecular cages are 3D constructs that consist of organic components (ligands) held together by metal ions so that an internal cavity of a predetermined size is formed. They are typically synthesised through self-assembly, whereby the ligand components and the metal ions are simply mixed in solution and they "self-assemble". The structural outcome of the assembly process is controlled by careful ligand design and by using appropriate metal ions to direct the order of assembly.

"Synthetic chemists have the ability to make molecular cages of any size and can adapt them to capture molecules of many shapes and sizes," says Kruger.

"We will develop functional, responsive and adaptable molecular cages able to reversibly switch their properties and behaviour through light irradiation or by a change in temperature. "Light and heat are then the keys that open and shut the cages.

"These Trojan horse complexes would be capable of controllably releasing their contents via an external stimulus and would represent a great advance towards the development of novel drug delivery agents. Such novel agents could reduce the harmful side effects that result from the indiscriminate delivery of drug molecules to sites within the body not associated with disease."

Kruger is also making molecular cages which exploit the spin state of metal ions within them, but instead of using just one metal ion, he's using two, or four, or more, to increase the number of switching points.

"We're interested to see how they interact with each other — how the switching in one of the metal sensors influences each neighbour," he says.

"We're trying to design systems where the metal ions know what their nearest neighbours are doing, and then they can potentially co-operate with each other."

Kruger is trying to build molecular cages which change properties due to a spin state change of metals when they capture other molecules.

"So the binding event happens and we can pick that up through a noticeable change in one of the properties like colour, magnetism or size."

Similar molecular cages could be used to lock molecules inside. With changes in temperature, light or pressure, the spin state of the metal ions change, and a guest molecule could be trapped or released from a molecular "cage".

"So, let's says at 10°C the molecule is trapped within that cage. We can have it so we heat that solution and then at a differing temperature, say 50°C, the molecule obtains its open state and the cage releases its guest. That's pretty cool."

Kruger says an advantage of using magnetic metal ions in the synthesis of these cage molecules is that the research group could also develop MRI contrast agents that can be switched on when they are needed and off when their task is complete.

Current state-of-the-art MRI contrast agents use expensive and toxic metal ions that cannot be switched off. Kruger says the development of a new type of contrast agent will not only reduce costs in the health sector, but also be of benefit to patients by replacing these toxic metal ions. Switching MRI "on and off" should allow clinicians to access much better contrast images whereby the contrast can be variably tuned.

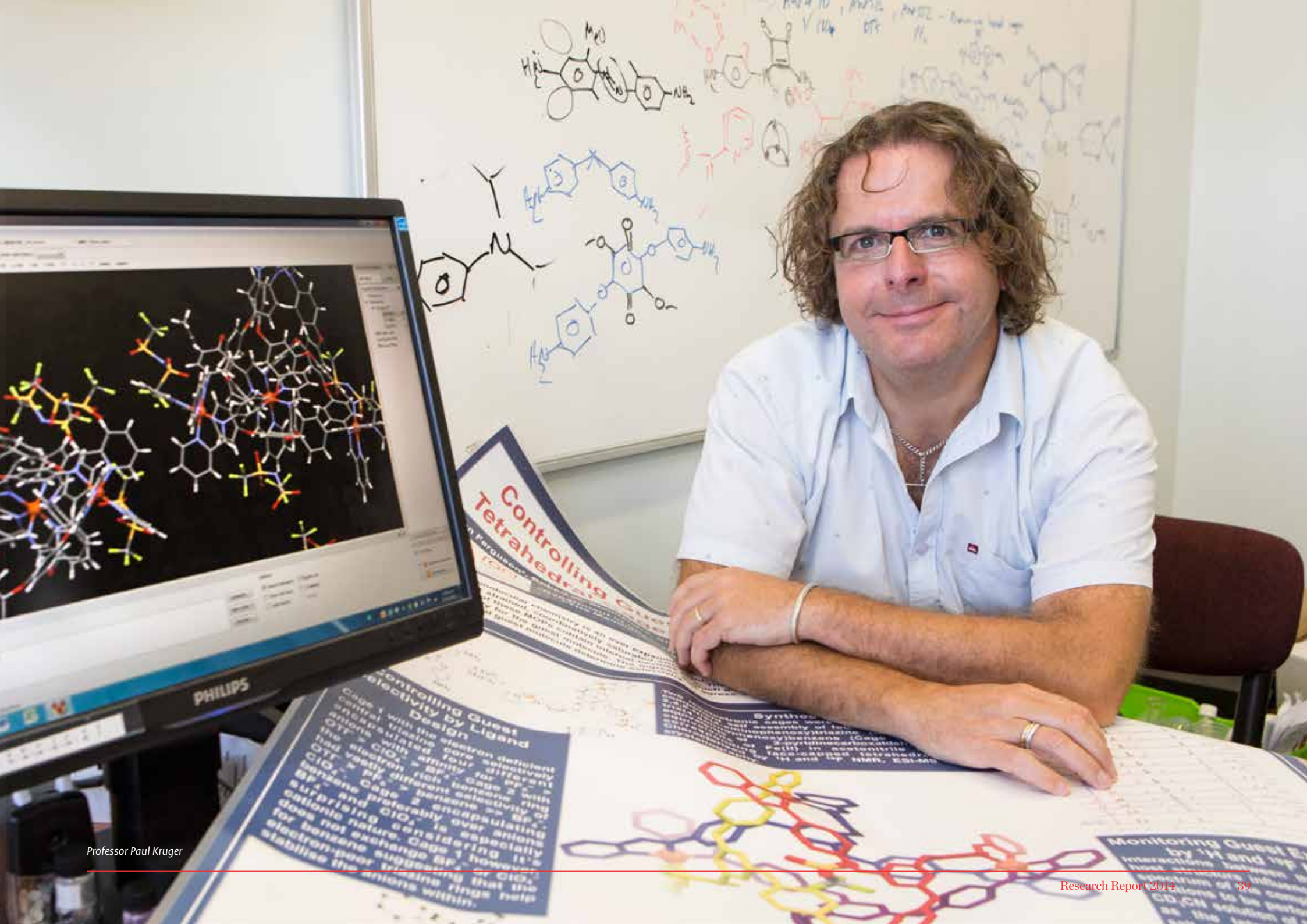
Kruger says molecular cages could have other uses outside the medical industry. There is also the potential for these cages to be modified to behave like sensors to detect the presence of harmful environmental pollutants, such as anions, when they are trapped inside the cage.

"Anions, such as phosphate and nitrate, are found in fertilisers and are detrimental to waterways when present in an overabundance, and can cause damage to river and lake quality as a result of run-off from dairy farms," says Kruger.

"Access to molecules capable of selectively and specifically sensing these ions may lead to the development of test kits for on-site real-time analysis."

Research supported by:
• Marsden Fund

***By Stacey Doornenbal***




*Professor Paul Kruger*

# Easier swallowing aim of new centre

A new UC-led research centre dedicated to improving rehabilitation practices for impairment following strokes has opened at St George's Medical Centre in Christchurch.

The University of Canterbury Rose Centre for Stroke Recovery and Research was established in 2014 in a state-of-the-art facility and is headed by UC's 2014 Innovation Medal winner, Associate Professor Maggie-Lee Huckabee*.

The centre is a clinically based stroke research and rehabilitation facility and its aim is to develop new standards of best practice for stroke patients across all ages.

The centre was made possible by a donation from the Rose family through the Canterbury Medical Research Foundation and has been set up in recognition of Huckabee's stroke research programme run through her Swallowing Rehabilitation Research Laboratory.

The Rose Family Trust bequest of $450,000 has been supported by a donation of $250,000 from an anonymous benefactor to employ a clinical fellow in the centre, and another $100,000 from the research foundation's annual art and wine auction.

"These donations have allowed us to move into our current facilities and will accommodate short-term future growth. In the next 18 months we will focus on neuropathology and neuro-rehabilitation of swallowing impairment or dysphagia, with particular emphasis on development of bioengineering applications for rehabilitation. Ultimately, we will include therapies such as physical and occupational therapy," says Huckabee.

"The centre is equipped with the latest biomedical and neural technologies for understanding and visualising swallowing processes. These technologies, when applied to rehabilitation, enable great capacity for change in swallowing function."

The UC Rose Centre houses the Evaluation and Treatment of Swallowing (EATS) Clinic. Clinical Director Sara Moore says the centre is the driving force in New Zealand for dysphagia or swallowing disorder research in stroke patients.

"We specialise in intensive rehabilitation programmes that maximise recovery of function in both the sub-acute and chronic patient.

"In a typical day we would see patients from across New Zealand and further afield who have been referred to our clinic for either assessment or treatment sessions. It is not uncommon to receive international referrals."

Stroke is the second most common cause of death worldwide and a common cause of disability in adults in developed countries. The incidence of stroke in New Zealand is high compared to other developed countries with more than 6000 new stroke events each year, and more than 2000 deaths attributable to this condition.

At any point in time, there will be more than 32,000 New Zealanders who have survived a stroke but are living with the disabilities arising from it.

Moore says the clinic offers specific, effective and innovative diagnostic and rehabilitative procedures that are driven by the latest research.

"We offer specialist diagnostic assessments, such as radiographic video imaging of swallowing, as well as high-resolution assessment of sequencing and pressures in the throat."

Moore says that these two assessments demonstrate the philosophy that the most efficient way to rehabilitate a patient's swallowing function is to be guided by robust and specific diagnostics.

"Stroke recovery research is critical, and the area of swallowing rehabilitation research is still in its infancy compared to other disciplines. The research wing of the Rose Centre is set to make waves in the stroke research world with its strong relationship with international and national hospitals that assist with data collection.

"We are the only clinic in New Zealand offering such in-depth assessment of swallowing pathophysiology and our patients really stand to benefit from the Evaluation and Treatment of Swallowing Clinic, which is an arm of the Rose Centre," she says.

UC PhD student Kristin Lamvik says that the collaboration between clinicians, postgraduate students and researchers is what makes researching at the Rose Centre so rewarding.

"My supervisor, Associate Professor Huckabee, is truly world renowned. Her passion for her work and her desire to help patients is contagious. In addition to the tremendous academic support, the Rose Centre is arguably the most sophisticated of its kind in the southern hemisphere," she says.

Lamvik's research focus is on studying how the brain controls swallowing and involves working with patients with swallowing problems as well as with healthy participants.

She is also looking at the differences in how the brain controls swallowing in different conditions — such as when you are asleep versus being awake.

"Swallowing is much like breathing — your body controls it reflexively, or without thinking about it. You can also swallow or breathe on command, or when you think about it.

"This gives us very interesting and important information about how the brain controls swallowing, which can make all the difference when problem solving how a patient's ability to swallow becomes impaired after brain injury and how we can rehabilitate that if there is damage," she says.

"Swallowing is an essential task for survival, but also for enjoyment and quality of life. Clinical experience has identified a patient group with a previously unrecognised cause of swallowing impairment following certain brain disorders. These patients mis-sequence their swallowing, causing food or liquid to be misdirected either

out the nose or into the airway, instead of directly to the stomach.

"We are evaluating the aetiology of this important phenomenon in a broad group of patients with brain disorders, including stroke, Parkinson's disease, and brain surgery."

Lamvik's research is being conducted in collaboration with local clinicians working for the Canterbury District Health Board, and also with clinical researchers at Singapore General Hospital.

"It has been an incredible experience in terms of international research collaboration," she says.

Moore says the centre has plans to broaden and develop further in the coming years.

"We are a brand new centre and, as such, we are beginning with one specialty — swallowing disorders. But we have plans to broaden our scope to include language and motor speech therapy services.

"We also plan to expand into a multidisciplinary rehabilitation research centre, broadening our clinical treatment that is guided by the most current evidence and research," she says.

Research supported by:
- Rose Family Trust
- Canterbury Medical Foundation

***By Charlene Smart***

*The team at the UC Rose Centre for Stroke Recovery and Research. Pictured are (back row, from left) Professor Richard Jones, Karen Ng, Kerstin Erfmann, Sarah Davies and Kristin Lamvik; (front row, from left) Dr Phoebe Macrae, Associate Professor Maggie-Lee Huckabee, Sara Moore and Esther Guiu Hernandez.*

*See story on page 6


*Associate Professor Kathleen Liberty*

# Quakes' impact on new entrants subject of study

The impact the Canterbury earthquakes have had on the psychological well-being of new entrant school children is being investigated by UC academic Associate Professor Kathleen Liberty.

Liberty (Health Sciences) is looking at the long-term effects of post-traumatic stress disorder on children who were aged between 17 months and three years at the time of the earthquakes and who have now started school.

The project was launched when, following the earthquakes of 2010 and 2011, Liberty became aware of learning and behavioural problems being observed by teachers in some primary school entrants.

The earthquake-related project came soon after Liberty and colleagues completed a study on children's health and learning, concentrating on children who were starting school.

"After hearing from teachers that they had observed those behaviours, I wondered if there was a big increase in behavioural problems in new entrants. I knew we should be able to compare it to our pre-earthquake study because we measured these things in the initial study."

The earlier study involved eight schools, six of which were in areas later severely damaged by the earthquakes.

Liberty says five schools are involved in the current study, with more than 260 children taking part. The team started data collection in 2013 and are measuring children's behaviour at the start and end of each school year.

"The teachers report on the children's positive behaviour development, any concerning behaviour, how they are learning in relation to their peers in a number of areas, how they are learning in relationship to the national standards set by the Ministry of Education, and their attendance. Our analysis of the teachers' reports produces information on symptoms of post-traumatic stress, coping, and the development of self-regulation.

"We are following students for the first three years of school because when children reach seven or eight years of age they have the mental capacity to engage in meaningful types of therapy and are able to understand more easily what has happened to them."

Liberty says young children would not have had the chance to develop coping mechanisms to deal with the impact of the earthquakes. When the earthquakes occurred, these children would have been aged between 17 months and three years.

Liberty says one of the symptoms of post-traumatic stress is having intrusive thoughts, where you may have an emotional flashback or images appear to you, which may trigger a "fight" or "freeze" response. When this happens, the child may suddenly become upset, or even appear to be daydreaming or suddenly "not there".

"Young children can't explain what is happening in their brain [the intrusive thought] and can't separate what they are thinking from what they are feeling and they don't have the language to explain it. This is one way post-disaster stress can affect their behaviour and learning.

"We don't define the earthquake as a single event in February 2011. It is an extended period of time and there have been other post-disaster events, such as people having to move out of their homes," she says.

Liberty says children learn a lot from observing others in the classroom and, with fewer children able to settle down and learn at the start of school, it presents problems for teachers.

"One of the things that the schools are trying to help children with is their communication skills, particularly around their emotions. What is happening is that these children are having these fearful intrusive thoughts that deregulate them and they aren't able to cope.

"On the other hand, we are looking at children who are good at self-regulating, but are finding that much fewer children have those skills when they start school as compared to our pre-earthquake study. So, not only do more children have mental health problems, exhibited in behaviour like being very irritable or not following directions, you also don't have as many children who can model good learning and good behaviours as you did before.

"It is concerning. However, the good news is that we are finding that children who are starting school do have more varied coping skills than those in our pre-earthquake study. They have learned different ways of coping and, from our initial research results, we have observed that after children have been in school for a year, about a third of them did improve and settle down, and are doing a lot better," she says.

"We are following students for the first three years of school because when children reach seven or eight years of age they have the mental capacity to engage in meaningful types of therapy and are able to understand more easily what has happened to them."

Liberty says post-traumatic stress in children of such a young age presents a new set of challenges for teachers and parents.

"It is very reassuring for parents to find out that they are not alone. We should have enough information this year to provide parents with coping suggestions to help their children develop more mature coping skills.

"I want to be able to make a difference and I feel that this is the contribution I can make for the rebuild of Christchurch," she says.

***By Charlene Smart***

# Safety of sex workers investigated

An examination of the safety of sex workers in New Zealand following the decriminalisation of the industry 12 years ago has been undertaken by UC researchers.

The project, led by Dr Laura Meriluoto (Economics and Finance), used data from a survey conducted by researchers at the University of Otago, Christchurch, in 2006 of 724 female, male and transgender sex workers to determine the level of violence, threat and thefts experienced in Christchurch, Auckland and Wellington.

"The aim of the study is to gain further understanding about the industry risk environment, including the effect of the sector and the city of employment on the risks faced by sex workers, as well as to understand the individual risk factors to inform further action," Meriluoto says.

"We want to improve safety and I think the awareness of who is at risk is really important for policy makers if they are trying to understand what can be done to improve safety. There are a lot of misconceptions out there about who is at risk and why."

Dr Meriluoto — who also collaborated with UC's Dr Rachel Webb, Associate Professor Annick Masselot and Associate Professor Sussie Morrish as well as Associate Professor Gillian Abel from the University of Otago, Christchurch, who conducted the 2006 survey with Lisa Fitzgerald and Cheryl Brunton — says the results showed that, compared to other countries, violence within the New Zealand industry is relatively low but does occur.

"While this is encouraging news for the sex industry in New Zealand, and gives some support for the merits of decriminalisation, more work needs to be done to further reduce the risks of violence and other adverse experiences among sex workers," Meriluoto says.

"We found that 38 percent of all sex workers surveyed in Christchurch, Auckland and Wellington had an adverse experience relating to sex work during the 12-month period preceding the survey. About 23 percent of all those surveyed had had money stolen or a client refused to pay, 20 percent had been threatened with violence or received an abusive text message and 16 percent had been subject to physical violence, rape or been held somewhere against their will."

Meriluoto analysed three main sectors in the study: the street sector where people work on the street and usually work for themselves; the indoor sector where people place private ads and entertain clients at home or a private space and work for themselves; and the managed sector, which includes brothels and escort service agencies where sex workers are employed by a business.

"Decriminalisation appears to have had little effect on the number and proportion of street-based workers, although it has moved a significant number of sex workers from the managed sector to the private sector."

Meriluoto says the study revealed that the street sector, despite overwhelming global evidence that it is more dangerous than others sectors in the industry, may not be more risky than other sectors in New Zealand when it came to physical and sexual violence.

"The apparent discrepancy between our finding that the street is no more dangerous than the other sectors stems from the fact that our prohibit analysis controls for multiple sex-worker-specific factors simultaneously, which is not possible when using simple statistical analysis.

"We found that alcohol and/or drug use is the most significant individual risk factor contributing to the incidence of violence in the sex industry, particularly in the street sector."

Meriluoto says a programme targeting alcohol and drug abuse among sex workers could help reduce the risk of physical violence.

"Alcohol plays a large role in the overall risk of violence especially in the street sector where 39 percent of the respondents were classified as drug or alcohol users. Alcohol and/or drug use also increases the probability of theft and threats, especially in the managed sector although these effects are not as strong as those for violence," she says.

"These results suggest that a programme to target drinking and drug problems amongst sex workers could have a significant impact on reducing physical violence, particularly in the street sector."

Furthermore, once Meriluoto controlled for alcohol and drug use, they found that there were no differences between sectors in terms of violence.

"That tells us that the street violence record is worse simply because there are more people with drug and alcohol problems in the street sector. They may not be able to find work elsewhere or they just want the quick cash," she says.

"To contrast this result, however, the probability of theft and threats remain higher on the street than the other sectors after controlling for alcohol or drug dependency."

The street sector in Christchurch was also found to be significantly safer in terms of violence and theft than in Auckland. Christchurch also had 20 percent of sex industry workers on the street whereas in Auckland and Wellington it constituted 10 percent of the industry. However, the managed sector in Christchurch is significantly less safe in terms of violence than Auckland.

"The relatively safer street environment in Christchurch may have pulled sex workers from other sectors, explaining why Christchurch has twice as many street workers than other cities. In Wellington, street workers face less theft, private workers face more theft and managed workers face more threats than sex workers in Auckland."

Education was found to have a large impact on the levels of violence. Primary school educated sex workers experienced 50 percent more violence than those who were educated to high school level, while tertiary educated sex workers also received a higher portion of violence.

***By Renee Jones***


*Dr Laura Meriluoto*


*Dr Donald Derrick*

# Technology puts the puff where the words are

Ground-breaking research under way at the University of Canterbury's New Zealand Institute of Language, Brain and Behaviour could soon be helping New Zealanders who are deaf or have hearing problems.

Dr Donald Derrick has been working on cutting-edge technology that will measure the air flow that occurs when people speak, making it easier for people with hearing difficulties to understand speech better.

His research, which received a $1 million funding boost from the Ministry of Business, Innovation and Employment in 2014, involves looking at ways to improve the usefulness of audio communication devices by harnessing air flow as a carrier of speech information.

"The demand for improved hearing aids is largely unmet and noisy conditions seriously interfere with headphones, emergency radios and smartphones," says Derrick.

He says that by taking air flow information from the audio environment, audio communication devices can use it to enhance speech perception of individual words.

"When people speak, air leaves their mouths and if someone is close enough to you, the air flow can be felt. When mimicked artificially, speech air flow has the potential to help people better understand speech.

"If you blow a puff of air at someone's hand at the same time as they hear a 'pa' or 'ba' they are more likely to receive it as a 'pa'. If you put your hand in front of your face and say the word 'ba' you will not feel an air puff. But if you put your hand in front of your face and say 'pa' you will," he says.

A puff is characterised as a short burst of air flow with a relatively higher initial pressure.

Derrick says investigations with the sounds 'pa', 'ba', 'ta' and 'da' showed that the air flow takes place anywhere from 50 milliseconds at the correct time of speech, to up to 200 milliseconds after the correct time of speech.

"We even demonstrated that if the air puff happens on a person's ankle and there is no other air flow around, even that will help people understand the 'pas' and 'tas' more accurately," he says.

"Listeners incorporate this inaudible air flow information automatically without any effort and without distracting the listener from the message or taking away from visual tasks.

"We developed an automated system that runs in real time and uses existing technology. The entire system could easily be miniaturised to about the size of the tip of a thumb. We are currently optimising this system to enhance speech perception for continuous speech, a requirement for many real-world tasks," he says.

"The basic idea is that we can take an audio signal and extract the air flow information from that and then reapply the air flow information using an artificial system. This will give the listener audio from headphones as well as air flow from the artificial system to help them understand speech better."

Derrick says improving audio clarity enhances user experience and the device also allows users to lower volume to protect their hearing.

"The intention at the moment is to enhance any audio device. The underlying principle for this is that you don't have to be trained to understand what is happening for this to work, similarly for the enhancement of speech," he says.

"If you hold up a cellphone or radio to your ear, the system would give you airflow to the head.

"We also believe that if you have hearing loss at the lower end of the spectrum this will help to restore some of your speech comprehension. These devices will give you a secondary source of sound and also produce sounds at high frequencies."

Derrick says the research team is keen to demonstrate that the air flow device will also work with a wide range of languages.

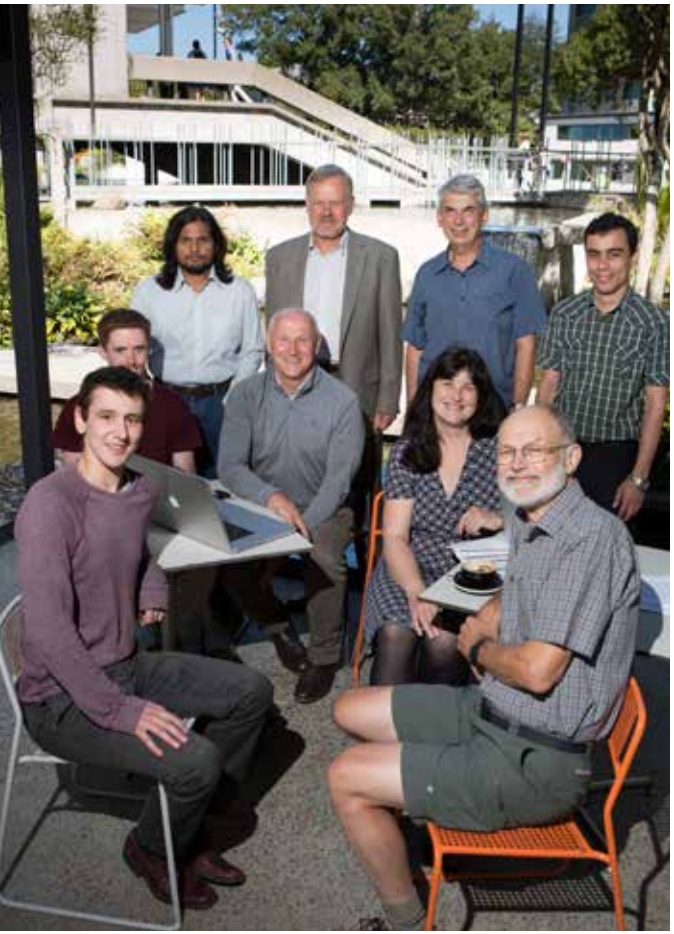
"We are about to look at Hindi, Thai and Mandarin to demonstrate that this works linguistically across the board, and it will help listeners to understand any language."

Derrick says it is hoped the device will provide social and economic benefit to New Zealand in that people who may have been limited in their hearing will be able to communicate more effectively.

Research supported by:
- Ministry of Business, Innovation and Employment

***By Charlene Smart***

# Taking aim at a sleeping target



*Pictured standing (from left) are PhD student Sudhanshu Ayyagari, Adjunct Professor Richard Jones, Dr Steve Weddell and PhD student Reza Shoorangiz. Seated are (from left) PhD students Alex Palmer, Simon Knopp and Russ Buckley, Adjunct Fellow Dr Carrie Innes, and Professor Phil Bones.*

World-leading research into developing technology that can detect and even predict lapses in responsiveness has the potential to save lives in transport sectors worldwide.

The research is a close collaboration between the Christchurch Neurotechnology Research Programme in the New Zealand Brain Research Institute and the Neural Engineering Research Group in the Department of Electrical and Computer Engineering at the University of Canterbury.

The research is led by UC Adjunct Professor Richard Jones, Professor Phil Bones, Dr Steve Weddell (Electrical and Computer Engineering) and Adjunct Fellow Dr Carrie Innes. It also involves a large number of postgraduate research projects and students.

Jones says there are three types of lapses that can occur and, in some situations, can be dangerous.

"Microsleeps are instances of falling asleep but regaining consciousness after a few seconds. Then there are sustained attention lapses in which the person is awake but has a brief but complete loss of attention. Finally, there are diverted attention lapses where the person's attention is not lost but has been directed onto something other than the task they are doing, such as driving, which they are meant to be focusing on.

"All three types of lapses disrupt performance and, in certain situations can and do, lead to injury and multiple fatality accidents.

"Microsleeps are our big research focus. Most of us have them to varying degrees. During a microsleep our performance stops and we become unresponsive for anywhere up to 15 seconds.

"It is a colossal problem worldwide, particularly in the transport sectors. A lot of accidents on the road are from microsleeps, although they are very difficult to prove. They are considered to be a bigger problem in terms of fatal accidents on the road than alcohol and drugs combined."

Jones says the research programme is also looking at understanding the mechanisms in the brain that cause microsleeps.

"We wish to characterise microsleeps, determine how often we have them, how many we have and under what situations. There is also a primary focus on developing technology to detect microsleeps and the other two lapses. We are aiming to use EEG and eye-video to detect lapses close to their onset and, ideally, before so that they can be given a 'wake-up call' before a potential accident."

Jones says his research team has carried out several laboratory-based studies to characterise microsleeps.

"In one study, we put 20 people in an MRI scanner and recorded their brain activity for an hour while they were doing a relatively monotonous visual-motor task. The participants weren't sleep deprived but we were hoping that some would have microsleeps and we could catch these in the scanner and see what was happening in the brain, as they happened."

Jones says 16 of the 20 people had microsleeps and at an average rate of 79 microsleeps per hour.

"We were blown away to see this in young, healthy, non-sleep-deprived men and women."

Jones says microsleeps are of particular importance for those who work in transport sectors, such as pilots and long-haul drivers.

"When we are driving and feeling a bit tired, rather than taking a break or nap, we tend to struggle on and, in some cases, end up having microsleeps. We have all heard of accidents in which someone has gone off a straight bit of road or crossed the centre line and killed themselves and often others. In nearly all of these accidents, the driver would have had a microsleep."

Jones says his research group is working to develop technology that will provide early detection and the prediction of microsleeps.

"If we can predict microsleeps from pre-microsleep changes in the brain, we can truly save lives in high-risk occupations."

***By Charlene Smart***

# A degree of teaching excellence

**The research-teaching nexus is a hallmark of teaching and learning at the University of Canterbury, and a new, intensive professional programme to prepare primary and secondary school teachers in the College of Education, Health and Human Development is an example of this important relationship between research and teaching.**

The new Master of Teaching and Learning degree, offered through the School of Teacher Education, has been developed from latest national and international research findings related to the characteristics of effective teacher education.

As the programme is being delivered, independent evaluators are investigating the effectiveness of the teaching and learning in producing graduate teachers who have advanced research-based knowledge of New Zealand school curriculum delivery, an understanding of contemporary educational theory and high competency in practical teaching skills.

Pro-Vice-Chancellor of the College of Education, Health and Human Development, Professor Gail Gillon (Ngāi Tahu), says the programme will promote effective teacher education, enabling teachers to meet priority learner needs. Graduates will be professionals who are culturally competent, responsive to their students and will have strong curriculum knowledge and practical teaching skills necessary to work in varied school communities.

"This initiative is part of the Ministry of Education's focus around effective teaching practices, appreciating that quality teaching does make a difference in children's learning and that the nature of the relationships that teachers build with children also makes a difference in their learning," says Gillon.

"Funding for the programme includes a research element that gives us an opportunity to examine and evaluate the effectiveness of different elements of the new qualification both in terms of the resulting competencies of our graduating teachers and the difference they will make to the primary or secondary school pupils they teach."

In partnership with the school community, the programme will provide practice-based experiences for pre-service teachers in local schools and allow them to gain experience of working in different school contexts, including modern learning environments.

Another aim of the programme is to mitigate the inequities of health and well-being outcomes for Māori and Pasifika students, those students who experience special educational needs, and raising knowledge of key curricular subjects such as science, mathematics and technology.

Head of the School of Teacher Education, Professor Letitia Fickel, says there are a lot of opportunities to prepare new teachers for more dynamic learning contexts.

"I think we have seen schools change more radically in the last few years, and there are a lot of new learning environments emerging as a result. Our pre-service teachers have the benefit of learning in these spaces and through the different ways these might challenge them as they become new teachers," Fickel says.

*(From left) Professor Letitia Fickel, Professor Gail Gillon and Professor Angus Hikairo Macfarlane*

"One of the benefits in designing the programme completely from the ground up is that we were able to draw on current research in a more comprehensive way than we might have been able to do in the past."

Professor of Māori Research, Professor Angus Hikairo Macfarlane (Te Arawa), says the course emphasises cultural responsibility.

"With the diversity that teachers and educators are challenged with on a daily and weekly basis, the need for graduates to be culturally proficient has never been more important than it is now," says Macfarlane.

Macfarlane says the programme is world leading in terms of focusing on cultural responsiveness, on preparing teachers for diverse learners, children who experience special educational needs and working with children living in poverty.

***By Charlene Smart***


*Dr Malcolm Campbell*

# Smart device to help those with respiratory condition

**UC researcher Dr Malcolm Campbell (Geography) is helping to develop a "smarter and more resilient city" through a health pilot project that will help people with a severe respiratory disease called Chronic Obstructive Pulmonary Disease (COPD).**

COPD is a significant healthcare issue in New Zealand, which has among the highest hospitalisation rates in the developed world, adding significant cost and burden on the healthcare system. With the help of the Canterbury District Health Board, the project is working with patients who have this disease.

"What we have done is give patients a device called a smartinhaler™. This device wraps around their normal inhaler and monitors the usage of medication."

Campbell says the aim is to also be able to look at where patients are geographically in the city when they are taking their medication and ultimately link this to real-time environmental conditions.

"We want to know where the person is when they use their inhaler — is it at home, or is it when they are outside and encounter something that makes their condition worse?

"The other part of this is that we want to see if this is linked to air pollution. Does a high pollution night correlate to lots of inhaler use in these people and does this mean that they end up in hospital?

"The reason that this is important is that every time someone ends up in hospital from an attack, it roughly costs $7500," he says.

Campbell's project is being developed alongside the Sensing City initiative, which was created to take advantage of the unique opportunities presented by the rebuild of Christchurch.

Campbell says that because a large portion of the city is being redesigned and rebuilt, sensors can be included in new structures, such as street lights and buildings, and be able to collect real-time data about a range of factors, including pollution, noise and dust.

"Ultimately, the key thing is that it will make a difference to the patients. Information obtained will ensure that they are better managed so they take their medication when they are meant to," he says.

Campbell says the goal is to be able to intervene in real time and help prevent a COPD patient ending up in hospital.

"I think that this is one of the main driving factors in producing smart solutions. Instead of using technology for technology sake, you can actually do something that makes a real difference and use cool gadgets at the same time.

"Ultimately, the key thing is that it will make a difference to the patients. Information obtained will ensure that they are better managed so they take their medication when they are meant to."

"There is room to intervene and make real differences to the quality of life of patients, but also bring significant savings to the healthcare system by thinking smarter about how to treat this condition," he says.

The project is being undertaken in collaboration with the Sensing City project and the Canterbury District Health Board. Campbell says while the project is in its infancy, he hopes that the results will be really positive for those who suffer from COPD.

Research supported by:
- Canterbury District Health Board
- Sensing City
- Callaghan Innovation
- Nexus6 Limited

***By Charlene Smart***

# Improving the memory of stroke survivors

University of Canterbury researchers have designed a cutting-edge computer-based treatment that improves the memory of stroke survivors.

Professor Tanja Mitrovic and Dr Moffat Mathews (Computer Science and Software Engineering) have led a project which has enhanced the prospective memory — the ability to remember to do actions in the future — of stroke survivors.

Stroke is a leading cause of death and a major contributor to disability in New Zealand, and Mitrovic says current rehabilitation research and practice predominantly focus on managing disabilities rather than improving cognitive outcomes. Deficits in prospective memory also reduce independence and adversely affect quality of life.

"Research developing effective computer-based cognitive rehabilitation is of high importance. The extent of impairment following a stroke directly affects aspects of daily functioning and often necessitates constant care," she says.

"Customised rehabilitation, performed by trained medical staff, is required but is labour-intensive and expensive. Neuropsychological research suggests that appropriate cognitive training could improve functioning, remediate core deficits, and positively affect quality of life, which is what we set out to do and successfully achieved."

The research, funded by the Marsden Fund, involved developing a treatment based on visual imagery and a virtual reality environment which was tested on 15 stroke survivors aged between 45 and 82 years in a 10 session study.

"Our visual imagery training teaches participants to remember a list of tasks with their associated cues using visual imagery as a mnemonic strategy," Mitrovic says.

"The training is presented in audio, images, video and written text. During training, participants gradually progress from remembering individual pairs of words to remembering complex, real-world tasks.

"We made several videos that we used in the study of driving around Christchurch on different routes. So, before they started, we would give them a set of tasks to remember by using this technique. Then they would start watching the videos and when they saw a place or something important they would stop the video and record whatever they were supposed to do."

The virtual reality environment was designed to help participants remember to do key everyday actions, from remembering to call the doctor for an appointment at 4pm, to remembering to bring in the washing if it starts raining, or collecting a parcel from the door that was delivered by a courier.

"We designed typical household scenes in a home with all the household items they may need. At the beginning of each session we would give them a set of problems to remember and they were supposed to move around the virtual environment and perform the tasks using a joystick.

"The results of our treatment, which were assessed using the CAMPROMT test, an internationally recognised, independent, reliable and valid psychological test of prospective memory functioning, showed a significant improvement in prospective memory functioning.

"Our lab study revealed that the prospective memory skills of participants improved significantly after the treatment and virtual reality practice," Mitrovic says.

"Even more impressively a delayed test conducted four weeks after the virtual reality practice show that the improvement is stable.

"Analysis of the data collected from the visual imagery training, as well as the data from the video and virtual reality practice, show the participants have improved their performance during the study."

Mathews says the team, which also included Research Fellow Jay Holland, Professor Stellan Ohlsson from the University of Illinois, Chicago, psychologist Dr Audrey McKinlay from the University of Melbourne, and UC students Anthony Bracegirdle, Scott Ogden, Jon Rutherford, Tegan Harisson, Matt Lang and Sam Dopping-Hepenstal, conducted multiple projects to inform the best way to undertake the study with stroke survivors.

"We have had a number of studies leading into this. We have evaluated our approach with three groups of people: healthy young people, healthy older people, and stroke survivors. Having different studies has provided us with a cross-dimensional view on how prospective memory works in these age ranges," Mathews says.

He says that extensive research was undertaken with healthy people to determine the best input device for post-stroke survivors, some of whom would be physically disabled, to successfully participate in the study.

These included investigating brain-computer interfaces that use electroencephalography (EEG) to access neural activity that could enable participants to control software by using facial expressions and thoughts in the virtual reality environment.

"Some participants in the study reported discomfort after about half an hour of wearing the EEG device. The conclusion was that it required too much training time and therefore it would not be a good solution for a stroke survivor," Mathews says.

Further studies were conducted into different input devices such as a joystick, keyboard and Razer Hydra, which are two hand-held controllers that sense motion and can be used to navigate around the environment and interact with it; as well as an Oculus Rift, which is a virtual reality headset that gives the user a sense of actually being in the environment with a stereoscopic view, providing full 3D immersion in the environment.

"Each participant trialled the system six times: three different devices for interaction using the keyboard, joystick, and Razer Hydra, without the Oculus Rift, and the same devices were also trialled with the Oculus Rift.

"The participants completed several tasks in a specific order, such as taking items from the

pantry or turning on the radio. The participants then completed a short survey and rated their experiences with the devices. It was found that users preferred the joystick for interaction and also that the Oculus Rift induced motion sickness in an alarming number of participants with 18 experiencing motion sickness, five of those so much so they had to stop and finish the experiment early."

Another device, the Tobii eye tracker, was also investigated to determine if it would allow users to control the computer using eye movements.

"Tobii gives sufficiently precise information about the user's eye-gaze, which is robust to head movements. The version of virtual reality controlled solely by the eye gaze was developed, which allowed the user to move around the environment by looking to the left or right of the viewport. In order to select objects or interact with them, the user could blink," Mathews says.

"In the end we determined the easiest and most efficient way for the stroke survivors to conduct the study was to use a joystick."

Mitrovic says she is delighted so much hard work has resulted in a positive result with post-stroke patients being assisted in regaining their cognitive skills by improving prospective memory.

"We are now hoping to work with clinicians and investigate brain injury to see whether the system we have developed could also assist others recovering their cognitive skills and improve their prospective memory," she says.

Research supported by:
• Marsden Fund

***By Renee Jones***


*Dr Moffat Mathews and Professor Tanja Mitrovic*

*Dr Brigid McNeill*

# Study focus on rare speech disorder

The largest study ever done internationally to improve the understanding and treatment of a rare speech development disorder in young children is being conducted by UC researchers.

Dr Brigid McNeill (Teacher Education) has led the two-year national study following the speech, literacy and language development of 54 infants aged between four and six years of age who displayed one of the symptoms commonly associated with apraxia.

"It is the largest study of its kind given the rarity of apraxia, which impacts only a small portion of the children who have developmental speech difficulties, and the first longitudinal study ever conducted. We are aiming to look at the connection between types of speech errors, language ability and the trajectory of literacy development in this group," she says.

Childhood apraxia of speech (CAS) results in significant difficulties with speech development and oro-motor movements. McNeill says many of the children in the study could use only five or six consonant sounds and were entirely unintelligible in connected speech.

"Traditionally, the disorder has been thought of as a purely motor impairment, with children's difficulty pronouncing sounds thought to be due to difficulty planning movements for speech. We hypothesise that the array of representational, literacy and language comprehension difficulties experienced by the group mean that the underlying difficulty is more than just motoric in nature and this holds key information for designing interventions for the group," she says.

"The majority of research on this group of children has focused on these speech features, but emerging evidence has also shown that these children are more likely to experience difficulty with understanding language and in their literacy development. Struggles with language and literacy are generally evident even when the speech production difficulty has minimised somewhat in late childhood."

McNeill says results from the study show that participants are generally affected in multiple areas, not just speech production.

"More than 75 percent of children in the study needed support in at least one area such as mouth movement, language and literacy, in addition to speech production. In particular, children in the group who used inconsistent speech errors, including where they used different errors on repeated productions of the same word, appear to have particular difficulty with spelling development," she says.

"Children in the cohort who used such errors have poorer spelling than both an age-matched comparison group without speech errors and a reading level comparison group such as children who are younger but who exhibit the same reading level."

McNeill hopes the research will help inform treatment for children affected by the condition and ultimately improve their outcomes.

"It is likely that the difficulties with speech production and early literacy development are linked in some way to the same underlying phonological/linguistic representation difficulty," McNeill says.

"If this is the case, then therapy should not just be focused on speech output for this group — it should embed speech practice with building strong representations of words in the brain that can be used to drive both speech production and reading and spelling."

NcNeill believes intervention at an early age could help children affected by apraxia.

"Once we understand the representational difficulties, if any, and the literacy difficulties experienced by these children then we can start to integrate speech production, sound awareness and emergent literacy intervention within speech therapy sessions right from the early childhood years," McNeill says.

"Because of the severe nature of the spoken difficulties experienced by this group, they typically first access therapy at three years of age. There's a lot that could be happening in the preschool years that not only supports speech development, but prepares the children with the foundational skills needed to take advantage of formal literacy instruction at age five in New Zealand."

McNeill says she wanted to research the condition because children with apraxia need assistance to meet their potential for language and educational development.

"Speech-language therapists list children with childhood apraxia of speech as making much lesser gains in traditional speech therapy than children with other types of speech-language impairment," she says.

"We have very little intervention data on which to base clinical decisions upon for this group. Further, the growing number of studies reporting that these children experience severe and ongoing literacy difficulties is concerning. I believe that if we intervene early with more than the surface speech error then a lot of these outcomes can be improved.

"More work is needed to enhance the educational achievement of children with CAS and the best chance children have to meet their potential is to integrate speech therapy and educational support."

McNeill hopes the study will have a positive impact on children suffering from the disorder.

"The study could lead to a better understanding. I am hopeful that clinicians and teachers will work together to provide therapy that not only supports speech development but also facilitates reading and writing development for those affected," she says.

***By Renee Jones***

# Project examines law students' well-being

The first national longitudinal study assessing the university and employment experience of New Zealand law students, including their well-being, is being conducted by researchers at the University of Canterbury.

The five-year study, led by UC's Professor Ursula Cheer and Associate Professor Lynne Taylor (Law), will follow law students in each year of their studies from their first year at university right through to their first year in the workforce.

Cheer says the aim of the project is to give those involved in the teaching and learning of law students a comprehensive pool of data to inform both their individual teaching practices and the potential enhancement of the general law school experience in New Zealand.

"It is intended that, over time, a complete law student profile will be developed which will detail the expectations, views and experiences of law students during each year of their law studies and in their first years in the workforce after completing their law degrees," she says.

"There has been a lot done overseas on this but nothing specifically on law students and following them right through their studies in New Zealand, so this is unique. We are well aware of overseas studies that have found law school to be extremely competitive and levels of well-being can be up and down, and quite low at times, so it will be interesting to track that here. Ultimately, we want to make the study of law better and make our teaching better."

Taylor says the results of the study, which analyses students' experiences and expectations from law schools at Canterbury, Auckland and Waikato universities, will be shared within the law community to help improve practices.

"At the moment we do not have this sort of information. We are not just doing this to inform our own teaching practices because the results will be published and be available to other law teachers and also the New Zealand Council of Legal Education, which sets a lot of the regulatory rules around the teaching of law in New Zealand."

The study began last year and included a survey at the start of the year of about 700 first-year students, who will form the main cohort that will be followed throughout the duration of their studies. In 2014, the cohort was surveyed twice, at the beginning and then later in the study year.

"We included well-being questions in both surveys and found that the students' perceived levels of well-being didn't drop over the course of the year. There didn't appear to be a significant difference from the general population in terms of well-being levels. They were relatively positive and more positive than results from studies that have been done in American and Australian law schools," Taylor says.

"It is interesting that our results didn't fit with findings elsewhere and, of course, that could change in the future, but that's what's exciting about this study. We can see the pits and falls and what might be causing that."

The survey analysed the experiences and expectations of different gender and ethnic groups, to see if specific groups had different results within the cohort.

"There have been findings in America and Australia that law school is a gendered experience and women experience it more negatively. We asked questions, in particular about confidence and well-being, and found that at the extremes women were more likely to be nervous about their studies, less confident about their ability to get into second-year law and just less confident generally," Taylor says.

"However, despite evidence of greater feelings of overall negativity, there was no difference in questions relating to the overall experience at law school and overall satisfaction with the teaching experience. So men and women were equally satisfied in those areas."

The survey also assessed the experience of different ethnic groups including New Zealand European, Māori, Pasifika, Indian, Chinese and Korean law students.

"There was a surprisingly low number of Māori students that chose to participate in the study but those that did were overall really positive about their prospects and about their law school experience. In fact, they were more positive than the New Zealand Pākehā students," Taylor says.

"I think we can tentatively conclude that the support those students are getting in that first year is really working for them.

"It was a different story with our Pasifika students who were less confident and satisfied, which was a concern, and Chinese students also felt similar, but the rest of the groups were in line with the overall results."

Cheer says other areas of well-being were assessed including what sort of things affected students' studies with the main finding being home and family issues, study and work, and employment issues.

Meanwhile, stress levels were in line with the general population, but the proportion that indicated they were very stressed was relatively low across the whole cohort. However, students at UC and Auckland University had higher stress levels recorded than Waikato University, which does not limit numbers entering second year law.

Cheer says the study will also include working with employers and law firms as much as possible to determine industry needs from students and how that affects them.

"We want to produce students who are work ready. Anecdotally, there seems to be a flight from practice at 18-months and if that is happening then we hope to determine why," Cheer says.

"Our results show that well-being in law students in the first-year seems to be okay. We hope to determine at what point, and why, stress comes in and is there something we can do to address it? There will be incredibly rich data generated by this study which could give us real insights and we intend to use it to have a positive impact."

***By Renee Jones***

*(From left) Professor Ursula Cheer and Associate Professor Lynne Taylor*

*Professor Julia Rucklidge*

# Investigating the health benefits of micronutrients

**A University of Canterbury clinical psychologist is investigating the impact micronutrients can have on a range of illnesses, including mental illness.**

Professor Julia Rucklidge (Psychology) became aware of the idea of using micronutrients when she was a PhD student and began looking at it more closely when she came to UC. She says that while she is "studying something that is a little bit outside her field", she has followed an idea that has produced results.

Rucklidge, along with her team of PhD students, has been conducting a number of trials using nutrients to treat various illnesses.

"We have been looking at using nutrients to treat insomnia, to help people quit smoking, and to treat ADHD, or attention deficit hyperactivity disorder, in adults. Overall, our results are confirming that the nutrients are beneficial for ADHD and we have now extended that trial into children with ADHD," she says.

Rucklidge says her micronutrient research is also addressing fundamental problems in how mental illness is treated.

"In many cases, current medical treatment is only partially successful in treating people with mental illness. People are ending up on disability benefits which, for me, suggests that we are just not doing a good enough job for people who suffer from mental illness.

"Many people believe we have mental illness under control and that if you have an illness it is okay, we have drugs for that, rather than really looking at it as a whole," she says.

Despite the advent of medications and other therapies over the last 50 years, the rates of mental illness have been on the rise rather than in decline, says Rucklidge.

"We have to look at our approach again. What we are doing right now is good enough for some people but certainly not good for others and, in the long term, we are not solving the problem of mental illness."

Rucklidge says her idea to treat mental illness with nutrients is a unique approach, but the trials her team has conducted have shown they can have a positive impact.

"If you are well nourished and you have all the nutrients you need then your brain should function much better than it did before taking adequate levels of nutrients.

"What we have been doing is approaching it a number of different ways. The idea of using nutrients to treat mental illness could be approached by looking at what people are eating or giving people pills that have got a much greater amount of vitamins and minerals than you would get out of your diet typically."

Rucklidge says the recommended daily allowance (RDA) of nutrients flags what is required in order to prevent nutritional deficiency only and is not at a high enough level to target complex problems, such as mental illness.

"We think you need to give people a higher dose than RDA to correct possible in-born variations in metabolism that may lead some people to need more nutrients than what is available in their diet. However, for some cases this approach doesn't work. It is important to note that we might not help everyone but we sure are helping a substantial amount."

Rucklidge says evidence from her trials has shown the dosage levels are important.

"We are giving patients a much larger dose than the RDA. What is also important is another factor which is called the upper limit. This is important in terms of micronutrient safety. RDA is to prevent nutritional deficiency, it is not a limit and it is not a level that identifies optimal functioning.

"We have a huge range of opportunity to give nutrients at a higher dose than the RDA but lower than the upper limit. This is the area that we are working in."

Rucklidge says some people are sceptical that nutrition can be a viable way to treat mental illness.

"It goes against all of our beliefs about psychiatric conditions, that there is no way that you could just solve it with a simple solution of nutrition. It takes a long time for people to change their understanding of mental illness, and for some people, it could be an expression of nutritional deficiency."

Rucklidge and her team are about to start a trial that assesses the effects of micronutrients on pre-menstrual syndrome (PMS).

"Vitamin B6 has been shown to be effective for the treatment of PMS. This trial will be looking at a comparison of B6 to the broad spectrum micro-nutrient formula that we have been using. We suspect that a broad spectrum is going to be even better than just one nutrient.

"As a general approach to treatment of any condition, we manipulate one variable at a time. We grasp onto one nutrient as being the answer when it actually makes no sense physiologically to grasp onto just one nutrient because if you look at the complex chemical reactions that occur in the body, it needs a broad array of nutrients."

Rucklidge started looking at nutrients after her PhD supervisor also took an interest in the subject.

"At the end of the day, my goal and research is directed at trying to help people with mental illness and if that means that I have ended up studying something that is a little bit outside of the field, to me that doesn't matter. I have ended up following an idea that makes a lot of sense to me and has proven results."

Rucklidge's research has been largely funded by a private donation alongside support from a small group, The Vic Davis Memorial Trust, devoted to supporting this approach to treating mental illness.

"With more funding, we have the potential to determine to what extent nutrients may be helpful in treating mental disorders, which disorders are most likely to benefit and why. We are also interested in determining whether the effect of nutrients can be sustained long term."

Research supported by:
- The Vic Davis Memorial Trust

***By Charlene Smart***

# Colour x-ray imaging has huge potential

University of Canterbury researchers are creating the world's first human colour x-ray scanner, which could revolutionise medical imaging.

Professor Anthony Butler (Physics and Astronomy) says the scanner would make New Zealand a world leader in the field and provide biomedical research tools to enable health researchers to better understand many health problems, ranging from heart or vascular disease and cancer, to joint implants.

The project, which has received $12 million of Government funding, is being developed by UC in collaboration with the University of Otago, Christchurch, and Auckland University.

"This is a revolution in medical imaging that enables medical researchers to see inside the body in colour, and be able to measure components of human tissues and some drugs to improve medical diagnosis and disease management," Butler says.

"This technology will give colour x-rays of the internal structure of the body. It will give new information about what tissues contain and how much fat and water content there is, which is important because normal lumps are very fatty and abnormal or cancerous lumps don't have any fat. You could also see where the inflammatory cells are located."

The team has already worked with local industry to design small pre-clinical scanners which have been sold to medical researchers around the world through the UC spin-off company, MARS-Bioimaging.

Butler says the challenge now is to enhance the device so it can be used in clinical trials.

"This will be the world's first full spectral CT colour x-ray scanner. Our MARS spectral scanners measure eight x-ray energies simultaneously to give compositional — molecular — information about tissues.

"We are focusing on heart disease and bone implants such as hip replacements, but also looking at helping cancer researchers and drug developers."

Butler says that 30 percent of people die from heart, stroke or vascular disease in New Zealand and the colour x-ray scanner could help reduce that number.

"We are looking inside the blood vessel walls to see which blood vessels are likely to kill the person and which ones will cause a stroke or a heart attack. We are measuring that by looking inside the plaque in the arteries and the bio-markers," he says.

"Doctors will get to make more informed decisions than they do now. Seeing inside the body, inside the blood vessel wall, at the tissue level is critical. A vital part of research with the scanner is to understand what disease looks like. If you can understand what it looks like then you can put it into the decision points of patient management, and that becomes really critical."

Butler says the team is working with experts in lung cancer, gynaecological tumours, endometrial carcinoma and breast cancer.

"At the moment, it is really hard to tell the difference between normal tissue and cancerous tissue. Most imaging in medicine with x-rays only gives you the morphology and anatomy. To determine if any lumps are cancerous they need to take a sample of that tissue and test it. But if we could put a contrast agent into the body that went to one particular tumour type then you could see the tumours better, in colour, and identify what sort of tumour it is so you have much better information to plan treatment.

"Cancerous tissue leaks blood really quickly and one of the questions people have about cancer is did the drug get to the tumour? If someone has chemotherapy it would be really nice to know how much of it went to the tumour and how much of it went to the liver."

The colour x-ray scanner could also improve bio-metal interfaces for people with implants such as dental and knee devices.

"Bone and metal interfaces are normally really hard to image on an MRI or normal CT scanner so with the colour x-ray scanner we will be able to see how the bone and metal fuse. This will allow us to make better implants for people, help doctors make better decisions about whether a patient needs an operation, how the implants are performing, if small cracks are forming, and cartilage health."

Butler says the project has involved collaboration on a level that has made New Zealand world leaders in this technology.

"The reason we have got so far and are world leaders is because you have to collaborate. You need detector physicists, engineers, mathematicians, radiologists, pathologists, surgeons, biochemists all working together and that's really rare all around the world. But in New Zealand, collaboration is what we are good at."

The project also has links with dozens of international universities, many of whom now visit New Zealand to test their pharmaceuticals on the MARS pre-clinical scanners, including Yale University, the Mayo Clinic and CERN, the European Organisation for Nuclear Research.

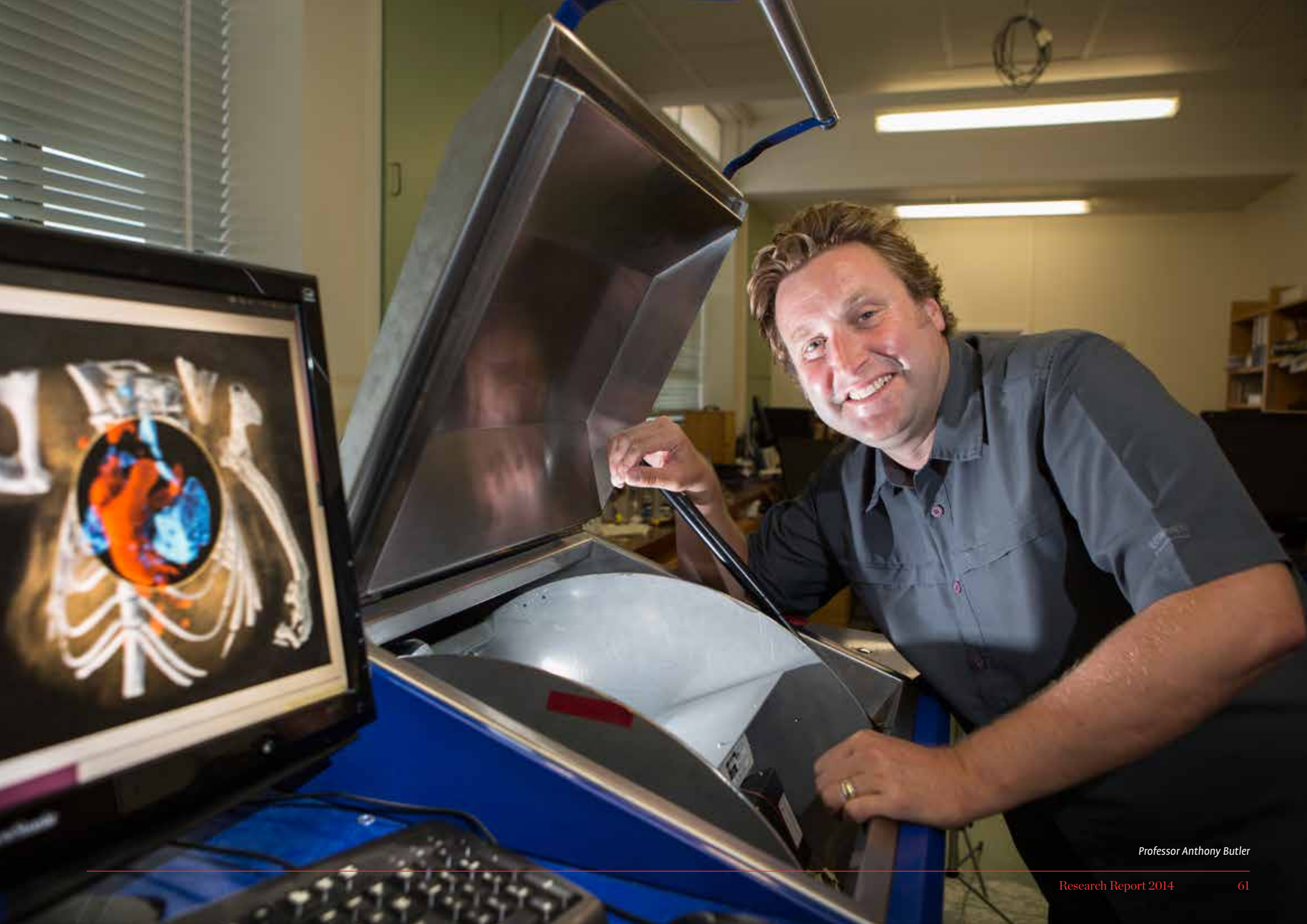
"We will also forge business links with international companies including healthcare organisations and many local industries such as high precision mechanical companies and electronic manufacturers. We will be training a high-tech workforce and we expect more than 30 PhD students to be involved during the programme," he says.

"Five years ago there were only a small number of people in the world doing this research. There are now special editions of journals covering the topic and conferences. The human medical imaging market is currently worth $US27.4 billion and growing at 4.4 percent a year."

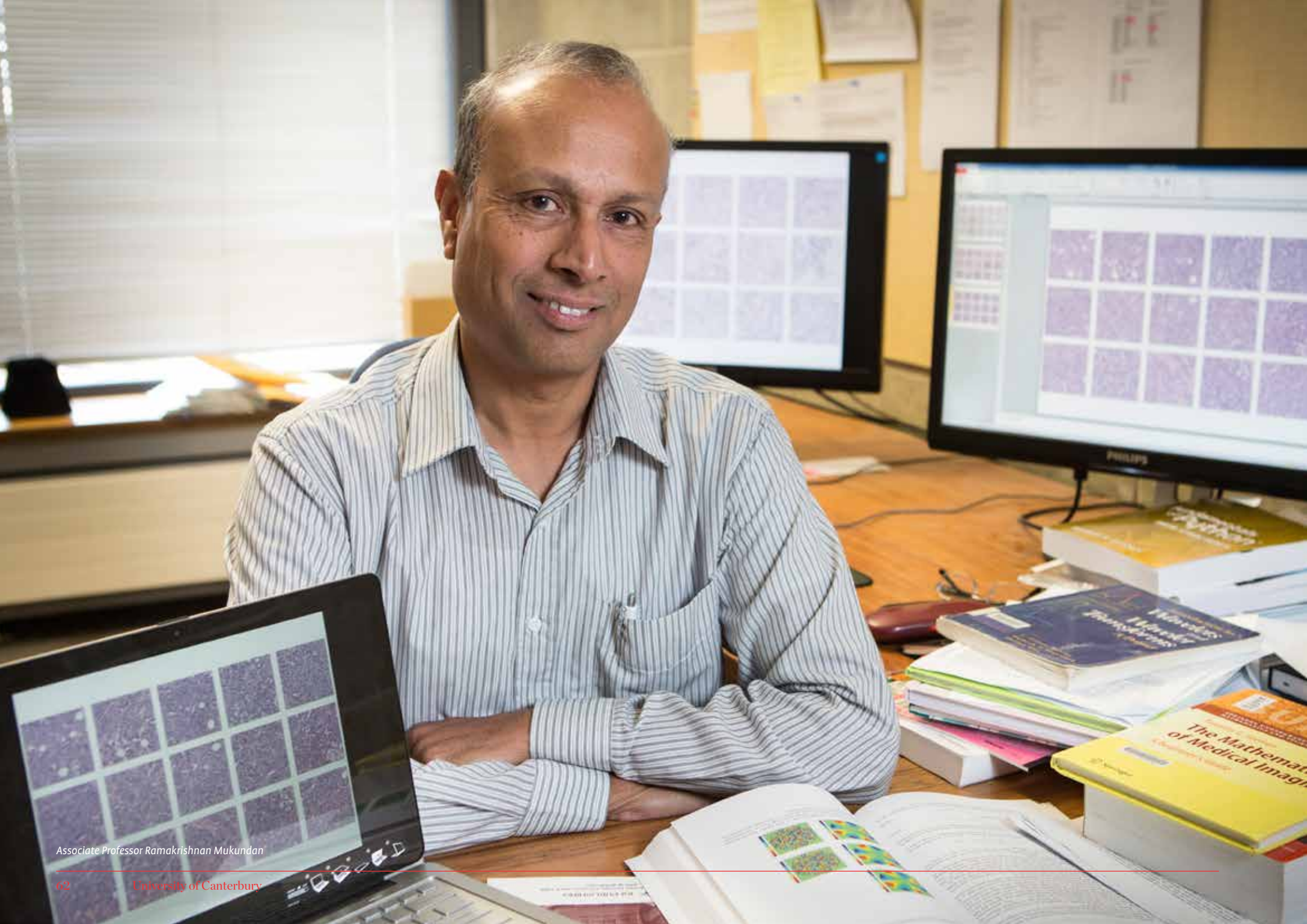
MARS-Bioimaging last year won the Canterbury Regional Deloitte Fast 50 Rising Star Award and was a finalist in the two categories in the 2014 New Zealand High-Tech Awards. The University of Canterbury has a share in the company.

Research supported by:
- Ministry of Business, Innovation and Employment

***By Renee Jones***



*Professor Anthony Butler*



*Associate Professor Ramakrishnan Mukundan*

# Imaging put to work in breast cancer detection

A University of Canterbury researcher is looking at more efficient ways to use image processing technology for automatic cancer grading of breast tissue samples.

Associate Professor Ramakrishnan Mukundan (Computer Science and Software Engineering) is working on a joint project with the Image Pervasive Access Lab (IPAL) in Singapore on the processing of high-resolution digital microscopy images for identifying and characterising cytological features present in biopsy slides.

"The research group at IPAL has been working in collaboration with the Centre National de la Recherche Scientifique and the National University of Singapore on various aspects of biomedical image analysis," says Mukundan.

"IPAL has excellent facilities for acquiring and processing digital microscopic images of tissue samples, which greatly help in fostering strategically important areas of research in medical imaging."

Breast cancer grading is usually performed by pathologists via visual inspection of the biopsy specimens under a microscope. The grades are assigned based on the deviation of cell structures from normal tissue.

"In a digital microscope facility, the images can be further enhanced and, using a stylus interface, a clinician will be able to mark out or annotate areas that have some relevant pathological significance."

There are different scoring systems available for determining the grade, or aggressive potential, of breast cancer. The Nottingham Histologic scoring system is one of the standard grading procedures used in breast cancer assessment. The grade of cancer helps determine the treatment options for the patient.

Mukundan says grading breast cancer biopsies is generally a time-consuming process and there could be several grading cases each day.

"We would like to perform an in-depth analysis of different ways in which we could automate this process, where the digital image is fed directly to software that identifies the essential image features and also estimates the level of breast cancer."

Mukundan says that there are several aspects to this research problem.

"The assigned Nottingham grade represents the aggressiveness of the tumour and will depend on several features, such as the amount of gland formation and the number of mitotic cells, or cell divisions in a given region.

"The research problem here is to accurately characterise these image features using statistical models in order to obtain the grades that the pathologist would have assigned to the image."

Mukundan says it is important to first analyse how the intensity values vary in image regions and then use proper statistical measures to model various shape features and parameters.

"This type of analysis is also called texture analysis in the field of image processing. Our research uses a novel method, called multifractal analysis, to classify various types of texture features present in the image."

Multifractality broadly refers to different levels of statistical self-similarity present in an image. The output of multifractal analysis is a graph that shows the fractal dimension of image structures with similar intensity variations in pixel neighbourhoods. This graph, known as the multifractal spectrum, is used as the primary descriptor in the classification of images.

Mukundan says that multifractual analysis is slowly gaining popularity in the field of biomedical image processing and that his research group is working on tissue image classification using multifractual decomposition of images.

"The other problem we are looking at is how we are going to process these large, high-resolution and high-magnification images.

"Performing computationally intensive tasks on such images takes large amounts of processing time, and we need to find ways to parallelise the algorithm so that the tasks could be subdivided and assigned to multiple processors.

"We have implemented an initial version of the multifractal algorithm using the Open Computing Language, and tested it on high-performance graphics processing units and also on the BlueFern Visualisation Cluster at UC. Further optimisations are currently being tried."

Mukundan says this process is all about providing second opinions and reducing pathologist workloads.

"Obviously, the pathologist will have a lot of experience. We will not be able to replicate that experience in a computer program, so there will be many cases where pathologists will still need to look into them more closely," he says.

Mukundan started working with the IPAL group during his sabbatical leave in 2009.

"At that time, I had presented some work I was doing in biomedical analysis at the National University of Singapore, and the IPAL group showed keen interest in starting a collaborative project on tissue image analysis."

Mukundan will be on sabbatical leave again from July 2015, and will spend a month working with IPAL in Singapore.

"We need to do more and move forward in this research. I hope that I will be able to get some significant research done by the end of the year.

"Working with IPAL provided a great opportunity to know more about current research in the vast field of medical image analysis and also to gain an in-depth understanding of the processes and data used in some key areas," he says.

Research supported by:
- Image Pervasive Access Lab (Singapore)

***By Charlene Smart***

# Spotlight on issues behind high birth weight

**A recent University of Canterbury PhD graduate is studying the impact of different socio-economic brackets, obesity, and nutritional supplements on babies that are born with dangerously high birth weights.**

Economics and finance graduate Dr Rachel Webb says unlike low birth weights, high birth weights, or macrosomia — babies born over 4500 grams — is an area that has received little attention by health researchers, in particular health economists.

"People know about low birth weight and the dangers associated with it but fewer people are aware about the issues with macrosomia," she says.

"Macrosomia is problematic during the birth for both the mother and baby. It has a significant increase in injuries and death for the mother and baby often due to the body and shoulders getting caught in the birth canal.

"Some research reveals macrosomic babies also don't perform as well at school. It isn't as significant as low birth weight babies but there does seem to be a connection and I think it deserves a bit more attention."

Webb used data from the New Zealand Ministry of Health, the Pharmaceutical Management Agency, and Statistics New Zealand, as well as data from the National Center for Health Statistics, Center for Disease Control and Prevention in the United States to undertake her research.

Webb says she analysed the relationship between socio-economic status and high birth weights to explore whether high socio-economic status has a unique effect on high birth weight compared to other health disorders in which it generally helps alleviate the incidence.

"My preliminary analyses show that high socio-economic status women tend to have a higher incidence of high birth weight babies. However, when controlling for inherent characteristics of the mother and the child, the results didn't show that socio-economic status is unambiguously positively related to high birth weight risk," she says.

"Instead, my results tend to lend support to the theory that socio-economic status improves health outcomes by reducing both low birth weight and high birth weight risk. In fact, with controls in place for characteristics like ethnicity, age and marital status, it becomes apparent that lower socio-economic groups are at a higher risk of macrosomia."

Webb used a technique called multivariate regression analysis to isolate the effect of single variables in the data while still holding everything else constant, creating a more accurate reading of the data she used.

"There is a lot of health economics research into socio-economic status and education appears to be a big factor. Higher educated people seem to have the ability to know about health and what to do to get the best health outcomes. They most likely have a better knowledge of how to keep healthy during pregnancy."

Webb says maternal obesity has frequently been identified as a risk factor for high birth weight; however, no study has specifically addressed the causality of this relationship.

"There is a reasonable amount of research looking at obesity and macrosomia and there is a very strong relationship with obesity increasing the rate of high birth weight. A lot of research seemed to imply that this was a causal relationship so, if someone was obese and they lost weight, then they might achieve a lower risk of macrosomia. But to me that seemed an odd finding because we know obesity has a strong genetic component and losing weight may have no effect on reducing the risk."

Webb used an instrumental variables technique to determine if the relationship between obesity and macrosomia is causal or just a correlation.

"My results suggest that although being overweight, obese, or morbidly obese is highly correlated with high birth weight risk, there is only a significant causal effect once a woman reaches the level of morbid obesity.

"Controlling for endogeneity also substantially reduces the size of the estimated effect. Therefore, studies on the effect of obesity on high birth weight risk which ignore the endogeneity of obesity run the risk of greatly overestimating its role.

"This has important implications for public health decisions on advice given to pregnant women and for funding decisions which may depend on body mass. If the danger of obesity during pregnancy with regard to high birth weight risk has been previously overstated then advising women to try to lose weight before conception may be of less importance than previously believed."

Webb also demonstrated other links between macrosomia and obesity, including ethnicity and gender.

"My results consistently show that Pacific women have the highest propensity to have high birth weight babies followed by European/Pākehā, Māori, Middle Eastern/Latin American/African, and Asian women," she says.

"Male infants have a higher risk of high birth weight, as expected. In particular, a male infant has a 1.5 percentage points higher risk of high birth weight than a female infant. Also, as expected, increasing maternal age and parity increases the likelihood of high birth weight but at a diminishing rate."

Webb also examined a range of vitamin supplements and whether they had an impact on macrosomia. While a number of studies have found connections between iron supplements and low birth weights, there are none that have assessed whether foetal growth that is aided by supplements leads to an increased likelihood of high birth weights.

"Iron supplementation is recommended for foetal growth and a number of studies have shown a positive correlation between iron supplementation and birth weight. However, some studies have also found no association between iron supplementation and birth weight. If iron supplements have a positive relationship with birth weight then they may be

beneficial for infants at risk of low birth weight but detrimental for infants at risk of high birth weight," she says.

"I had data from New Zealand from 2003 to 2010 that listed any vitamins and supplements that women used during pregnancy. I found a strong correlation with iron. Most of the other supplements had no effect on high birth weights but iron supplements showed a strong connection," she says.

"I wanted to check the causality behind this so I got the price of the iron supplements and used the instrumental variables technique to try and tease out the causal relationship. When I did this I found the relationship with iron supplements and macrosomia disappeared."

Webb's research was supervised by UC's Dr Andrea Menclova (Economics and Finance).

***By Renee Jones***

*(From left) Dr Rachel Webb and Dr Andrea Menclova*

# Impacts of methadone during pregnancy focus of study

**For the last 40 years, methadone has been the most commonly used method of treating pregnant women with an opiate addiction.**

However, despite its widespread and increasing use, there is limited evidence of the effects of prenatal methadone exposure on infants, and even less evidence of the impact on later child health and brain development, says University of Canterbury researcher Dr Jacki Henderson.

"Methadone is an opiate substitute treatment, and is the only approved treatment for opiate-dependent pregnant women in New Zealand. In Canterbury, 25 to 30 women enrolled in the methadone maintenance treatment programme give birth each year. Yet, despite its widespread and increasing use, there is limited evidence of the effects of prenatal methadone exposure on infants, and even less evidence of the impact on later child psychosocial, cognitive and health development."

Henderson, based in UC's Department of Psychology, is leading a unique study to assess the neurodevelopmental outcomes of children at age nine whose mothers were on a methadone maintenance treatment programme (MMT) during pregnancy. This study is being supported by a 2014 Health Research Council Emerging Researcher First Grant of $146,243 over three years.

Lead investigator Henderson and her research team are conducting a nine year follow-up assessment of children and their families who have been participating in a long-term methadone in pregnancy project. The methadone in pregnancy project is a longitudinal study which is being carried out by the University's Canterbury Child Development Research Group, which was first launched in 2002 by principal investigator Professor Lianne Woodward, a former UC academic who is now at Harvard University. Each follow-up assessment takes around six years to complete and the children have been assessed at regular intervals at birth, 18 months, two years, and four-and-a-half years.

Henderson says earlier findings from the Canterbury Child Development Research Group project suggest prenatal exposure to methadone increases risks of neurological disturbances during infancy and poorer neuro-behavioural outcomes.

"At age two years, there is evidence of more cognitive delay, and poor psychomotor function and communication skills. Prior to beginning primary school, at four-and-a-half years, methadone-exposed children show evidence of poorer school readiness, higher rates of attentional, behavioural and emotional problems, and longer language delay than comparison children."

Henderson says one of the goals of the follow-up is to assess and characterise the children's educational, behavioural and developmental outcomes, as studies of these high-risk children at nine years are virtually non-existent. Study findings will inform the development of targeted early intervention and school-based programmes to support physical and mental health, and educational needs.

"This is important as children born to substance-dependent parents represent a very high-risk group for a range of adverse outcomes, such as child abuse and neglect, educational underachievement, antisocial behaviour problems, criminal offending, and the development of alcohol and other drug problems.


*The Canterbury Child Development Research Group: (from left) researcher Matt Ward, MA student Beth Milne, MSc student Jamie Stringer, Dr Jacki Henderson, Karelia Levin, Dr Alison Gray, PhD candidate Melissa Liard, Associate Professor Nicola Austin, PhD candidate Sam Lee and Marie Goulden.*

"Educational achievement and emotional self-regulation are competencies during this developmental period that are essential for later optimal functioning and, as such, these domains are being assessed by two PhD candidates."

This study will examine data of 91 babies born to mothers maintained on methadone during their pregnancy alongside a randomly identified community sample of 97 non-exposed methadone children.

Three UC postgraduate students are also conducting research as part of this assessment wave. In 2014, one of these students, PhD candidate Samantha Lee, received a three-year $120,000 Lotteries Health Research Doctoral Scholarship to work on the project.

Research supported by:
- Health Research Council
- Lotteries Health Research

***By Kip Brook***

# App helps report health and safety incidents

The construction industry in New Zealand could be safer following the development of an innovative web application designed by University of Canterbury students.

SiteSorted is an app created by engineering graduates Matt Cobham and Ashok Fernandez, and industry partner Worthington Contracting. It allows workers in the construction industry to report health and safety incidents to the office from a construction site in real time.

The application can be accessed from almost any device that can browse the internet, which means it can be used by site workers on their existing mobile devices.

Cobham says the support and interest from industry has been overwhelming.

SiteSorted ran a trial with Worthington Contracting, which had been searching for a software solution for some time, to see what improvements the application would have on a real construction site.

"During the trial, site workers spent no more than a minute filling out the SmartForm, and all events reported were actioned within the hour and closed within a day," says Cobham.

"The average time for completing a paper-based health and a safety form on site was around 10 to 20 minutes, and after the paper work was done it took a further one to three days to complete an investigation and close the event."

James Worthington, owner of Worthington Contracting, says the trial was well received on site.

"Getting our staff to use any health and safety system is always a challenge. SiteSorted made it easy. I like the clean, simple and easy-to-use solution SiteSorted has brought to the issue of complex health and safety management in construction. It's a true innovation."

Cobham says the aim of the app is to make it as easy as possible for construction companies across New Zealand to meet compliance standards.

"We want to reduce the amount of effort it takes to ensure sites are compliant with safety standards and, most importantly, make the sites managed by SiteSorted as safe as possible.

"We are looking to standardise it for the industry, which is something we have been alluding to for some time. We know that we have the backing and industry ties and the encouragement of contractors around New Zealand."

From the trial at Worthington Contracting, Cobham and Fernandez have identified new features to add to their application which will look at the hazard analysis side of health and safety on the worksite.

"We looked at how people used what we had built, and also at the things that they couldn't do with what we had given them and had to still use paper. Some of the processes they are expected to complete on paper are complex and it is not surprising that contractors spend so much time trying to get everything compliant," says Fernandez.

"We want to reduce the amount of effort it takes to ensure sites are compliant with safety standards and, most importantly, make the sites managed by SiteSorted as safe as possible."

"The goal of the software is to allow the guys on the ground to act in a safer way by removing their focus from paperwork and back onto the job, while still maintaining a tight channel of communication between the workplace and office."

Cobham says their vision is to improve health and safety in workplaces around New Zealand.

"We want to make New Zealand workplaces the safest workplaces in the world and we think that what we are building will produce some fantastic results within the industry. We have the opportunity to really revolutionise the system and make a big difference."

Research supported by:
- Worthington Contracting

***By Charlene Smart***

*(From left) Matt Cobham and Ashok Fernandez*

# Breaking the cycle of violence

**Uncovering an individual's strength and resilience, along with factors that prompt women to move away from violent relationships, is a key research focus for UC academic Yvonne Crichton-Hill.**

Head of the Department of Human Services and Social Work and Senior Lecturer, Crichton-Hill has investigated how women can be empowered to leave violent relationships and move forward with their lives.

The research was a collaboration between the Te Awatea Violence Research Centre at the University of Canterbury, Aviva (formerly Christchurch Women's Refuge) and The Family Help Trust.

Crichton-Hill says the aim of the research was to assess the skills and abilities women use to leave violent relationships.

"It was an opportunity to look at the strengths women bring to the situation and how they actually move on, what happens if they have children, what skills and strategies they have and use."

Crichton-Hill interviewed 11 women about their experiences. The women had to meet certain criteria, such as being out of a violent relationship for more than two years, and having been supported through the process of moving away from violence by Aviva and the Family Help Trust.

"I decided to take a narrative approach, which meant that I was really interested in their stories and where their experiences took them.

"What I noticed was that in really chaotic, difficult relationships, women suffered a range of violence, most of it severe. Of all the women I interviewed, all of them except one had faced physical, as well as emotional and verbal, abuse."

She says more than 80 percent of women had been stalked after they left the relationship, with one being stalked for seven years by her ex-partner. For some of the women, it was not until their ex-partners were arrested that they were able to move on.

Crichton-Hill's study involved women from a range of ethnic backgrounds, and each had faced a range of challenging situations.

"There were a number of European, Māori and Pacific women — one experienced violence from a same sex partner. The women experienced similar violence, regardless of ethnicity or social circumstances, but how they interpreted their experience and dealt with the violence differed," she says.

"Many of the women had children and they wanted to leave their relationship because they wanted to protect their children but they also knew that it was going to be really dangerous to leave.

"One of the things that I learnt was that the women understood their partners really well. They knew what a simple look would mean, they knew their partner's mood swings, they knew when it was building up to something dangerous like a violent incident and they also knew when he or she was calm."

Crichton-Hill says the women would use this knowledge to their advantage when planning their escape.

"While other people look in and think that she was being compliant and see that as a negative, they were being compliant because it was a way of keeping themselves and their children safe. They knew what might happen and they appeared compliant to keep their violent partner unaware that they were planning to leave," she says.

"It was a coping, planning and strategy mechanism. Many of the women used that compliant strategy while they were slowly planning to get away, over a period of time."

Crichton-Hill says the women involved in the study did not want to be seen as victims and were concerned about their futures.

"The women talked about the importance of education and employment in the process of moving away from violence. Another thing that became apparent is that the women wanted practical assistance such as where to live, how to earn money, how they could afford to buy groceries — all those basic necessities that we all need."

Crichton-Hill says all those involved in the study have managed to move forward with their lives.

"These are amazing women. Some of them have gone on to get degrees, some have obtained employment — I think they are incredible. It didn't happen quickly but over time their ability to sustain this desire to move on and do the best for their children is fantastic," she says.

Crichton-Hill is a member of the Pacific Advisory Group to the Taskforce for Action on Violence within Familes, and the Ministry of Social Development, and says there is limited knowledge about violence in Pacific families.

"The data is really mixed in New Zealand. We haven't collected good data so we have no idea of the rate of family violence in our communities. It is all anecdotal. When people say that more family violence happens in Pacific families, they are not saying that because that is what the data shows — the data doesn't show that. It is a generalisation and I think that is a real shame," she says.

"We really need more research that tells us what is happening to help us understand how and why women move away from violent relationships and how this violence is experienced by different ethnic groups. Understanding what they went through and the battles they faced and how they might have interpreted those experiences because of their backgrounds gives us an indication of how we can better respond to their needs."

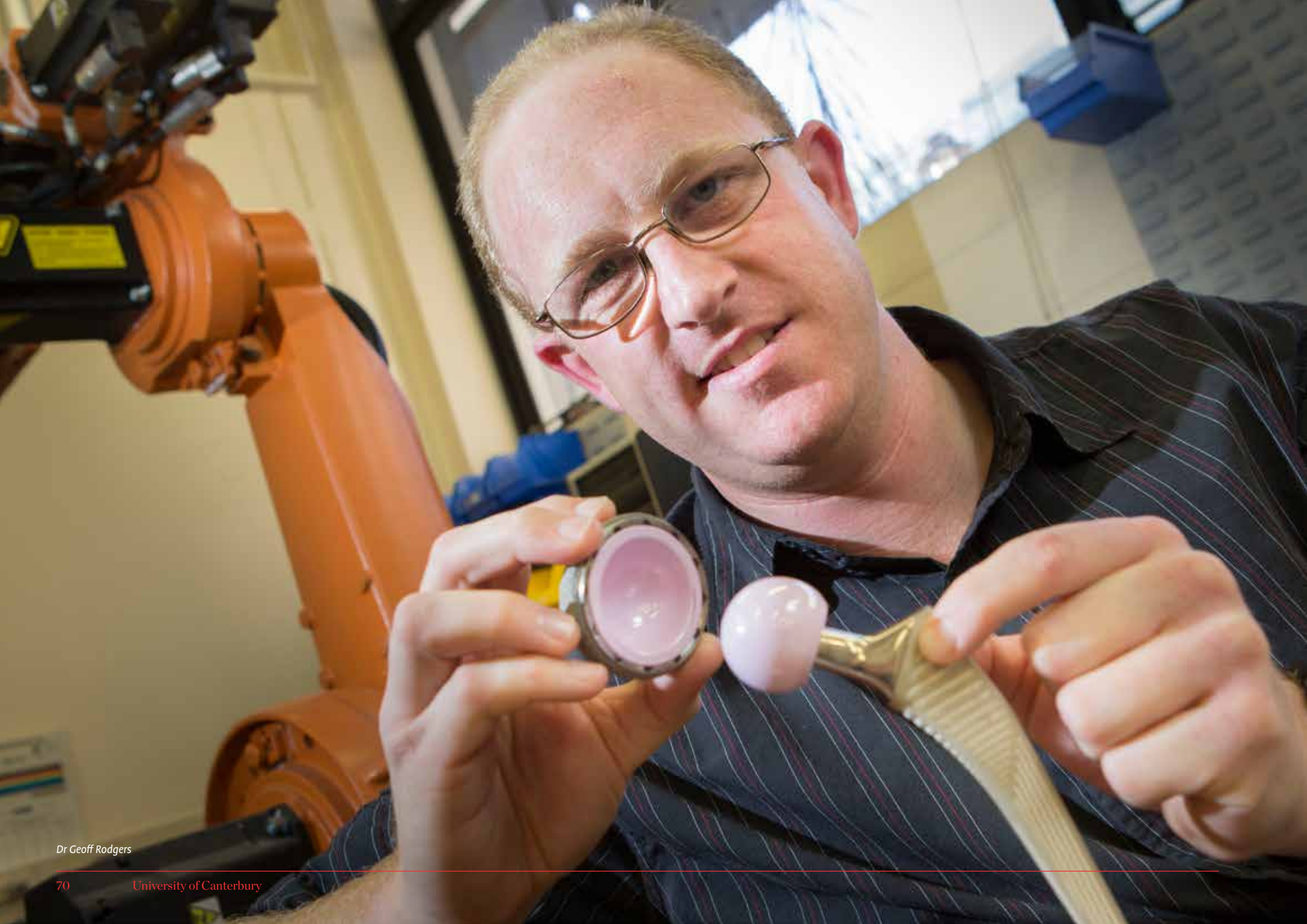
Crichton-Hill, who is currently working towards her PhD, says this research was a "great opportunity to focus on people's strengths and perhaps change the perception of women".

"I thought this was a great opportunity to challenge those perceptions and I am really thankful that I have been given the opportunity and support from the agencies involved to put this project together."

Research supported by:
- Te Awatea Violence Research Centre
- Aviva
- The Family Help Trust

***By Charlene Smart***

*Senior Lecturer Yvonne Crichton-Hill*



*Dr Geoff Rodgers*

# Sound technology helps monitor hip implants

A University of Canterbury mechanical engineer has developed a cutting-edge device that analyses the performance of hip joint replacement implants.

Dr Geoff Rodgers (Mechanical Engineering) has worked with Christchurch Hospital's orthopaedic department, including Dr Tim Woodfield and Professor Gary Hooper from the University of Otago, Christchurch, to create an acoustic emission monitoring system that monitors the sound vibrations transmitted from a patient's hip replacement implants.

Total joint replacement surgery is typically the last resort for people with osteoarthritis, which is also known as degenerative joint disease. Joint replacements are on the rise, largely due to demographic ageing. Replacement surgery is extremely successful but artificial joints need to be replaced due to wear or premature loosening of the implant after 10 to 15 years.

Rodgers says the device is designed to help surgeons improve their diagnosis of any implant problems and manage patient treatment and revision surgery.

"Patients often come to surgeons complaining of pain or discomfort from their replacement hips, or in some cases experience audible squeaking from the hip joint. It can be very difficult for orthopaedic surgeons to diagnose what is happening within the joint and why the patients are having trouble," he says.

"With an ageing population it's very important to enable surgeons to gain insight into the implant condition and decide on a correct course of action, without operating unnecessarily.

"The monitoring technique measures vibrations that are created by the implant and make it through tissue to the skin surface. By listening to the ultra-sonic vibrations of the implant, we have the ability to record sounds and relate them to implant condition. It is entirely non-invasive and can detect issues when a patient is moving and the implant is loaded."

Rodgers began working on the project in 2010 and has developed the prototype and tested the device on 80 patients at Burwood Hospital's Canterbury Orthopaedic and Bone Research Association Unit to gain insight into the condition of the implants and help improve the surgeon's diagnosis.

"We developed a range of motions for the patients to perform while wearing the device. This monitoring system can obtain information about how the implant responds to patient motion that cannot be obtained from a static image, such as from an x-ray or traditional ultrasound," he says.

"The vibrations are related to observed implant failures and clinical outcomes to help detect implant loosening or any deterioration. The monitoring technique could also be used to assess the performance of different implant designs."

The system uses four passive ultra-sonic receivers to record vibrations as a patient performs everyday motions. They are placed directly on the skin near the hip, from near the pelvis to the mid-thigh.

During testing, wires from sensors on the patient are connected to the recording system. Rodgers hopes one day the device will be wireless and be so small that it could be worn in clothing and obtain data over multiple days outside the clinic.

"Results to date have shown some significant promise, with the movement between different implant components displaying clearly different sound signals. We can also detect loosening of the implant within the bone and sounds such as squeaking, grinding or clicking from the implant.

"We not only monitor outcomes but we also test the implants that are removed from patients and analyse the vibrations they make so we know how they have been moving. We have also done microscopic analysis of the retrieved implant surfaces to see if there is deterioration on the surface and to categorise the wear mechanism.

"Ultimately, we want to provide surgeons with a non-invasive diagnostic tool that means they can reduce the number of the more costly MRIs and CAT scans. It could potentially help prevent unnecessary revision surgery, help provide earlier interventions and ultimately achieve better outcomes for patients."

***By Renee Jones***

# College of Arts
# *Te Rāngai Toi Tangata*

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

**Research in the College of Arts, Te Rāngai Toi Tangata, is highly diverse, ranging from experimental and lab-based investigation in areas like linguistics, to various forms of social and cultural research, to practice-based research in the creative arts, and to classification-resistant fields like philosophy.**

The variety of research produced can be gleaned from some book titles published in 2014: *Mendel's Ark: Biotechnology and the Future of Extinction*, Springer (Amy Fletcher); *Social Work Practice for Promoting Health and Wellbeing: Critical Issues*, Routledge (Jane Maidment and Liz Beddoe (University of Auckland) eds); *Endurance in the First World War: Experiences and Legacies in New Zealand and Australia*, Cambridge Scholars Publishing (David Monger, Sarah Murray and Katie Pickles eds.); *Sovereignty and Responsibility: Power, Norms and Intervention in International Relations*, Palgrave Macmillan (Jeremy Moses); *The Counter-Narratives of Radical Theology and Popular Music: Songs of Fear and Trembling*, Palgrave Macmillan (Mike Grimshaw ed.); and *Visions of Peace: The H.W. Youren Collection and the Art of Chinese Soft Diplomacy*, MTG Hawkes Bay Tai Ahuriri and Confucius Institute Canterbury (James Beattie and Richard Bullen).

It is intrinsic to much research in the Arts that it is individualistic, but collaborative work is a growing trend reflected in the success of our research centres. Our two largest centres, the New Zealand Institute for Language, Brain and Behaviour and the National Centre for Research on Europe have been joined by the Macmillan Brown Centre for Pacific Studies, undergoing a significant re-visioning and expansion under new Director, Professor Steven Ratuva.

Academics presented at national and international conferences, and high profile research symposia hosted by the College included the annual conference of the Sociological Association of Aotearoa New Zealand and the New Zealand Association of Philosophers Conference, preceded by the Australasian Association of Logic conference.

Dr Ruth McManus became the first President of the Society for Death Studies (NZ) at its inaugural meeting; and Head of Music, Associate Professor Glenda Keam, became the only non-European Executive Committee member of the prestigious International Society of Contemporary Music.

# 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, peer-reviewed articles, reports and conference presentations. Much research involves national and international collaboration including, in the case of research into employment practices and on the preparedness of New Zealand's legislative framework to handle natural disasters, collaboration between the School of Law and the School of Business and Economics. Colleagues have successfully secured funding from the Ministry of Business, Innovation and Employment and the New Zealand Law Foundation in respect of earthquake-related research.**

The College was delighted that Professor C. Michael Hall was awarded the 2014 UC Research Medal for his outstanding contribution to research, especially in the area of tourism.

Within the School of Business and Economics, there has been a focus on earthquake tourism, the impacts of the Canterbury earthquakes on business, exploring resilient organisations and business recovery, and examining NGO leadership. More broadly, the School has retained its wider research strengths, including entrepreneurship, experimental economics, financial risk management, information systems, management, marketing, social and environmental accounting, and taxation. In 2014, the School supported the First Australasian Interpretive and Consumer Culture Research Symposium and a conference on Human Rights in the Pacific: Priorities, Practice and Sustainability.

The School of Law's research has focused on issues such as genetics and criminal law, international and comparative surrogacy arrangements, competition law and the World Trade Organisation, disaster management and the law, media and privacy law, human rights in the Pacific and oceans governance. Staff have successfully obtained funding from the New Zealand Law Foundation for collaborative research on international and comparative surrogacy arrangements and several projects involve collaborative partners in Australia and Europe. They continue to maintain their long-standing reputation for excellence in rigorous black-letter law research and their publication of textbooks in areas such as public law, contract, torts and land 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 College of Education, Health and Human Development, Te Rāngai Ako me te Hauora, is committed to research excellence in teacher education, health sciences, educational studies, leadership, sport coaching and physical education. This commitment is recognised in our subject ranking consistently being in the top 100 in the world (QS World Rankings by Subject, 2014).**

The impact of our research outputs is wide-reaching, informing policies and practices worldwide. The book *Mental health services for vulnerable children and young people: Supporting children who are, or have been, in foster care,* Routledge, 2014 (Michael Tarren-Sweeney and Arlene Vetere, eds.) was launched in the House of Lords by an all-party parliamentary group and the British Association for Adoption and Fostering. Researchers from Te Rū Rangahau: The Māori Education Research Laboratory continue to make important contributions nationally, informing policies and practices in advancing Māori educational success and well-being, and the role of the Treaty of Waitangi in education.

Our researchers are investigating in a wide range of areas. Associate Professor Kathleen Liberty is studying post-traumatic stress in Christchurch children affected by the 2010 and 2011 earthquakes; Dr Julie Mackey, Dr Chris Jansen and Distinguished Professor Niki Davis are leading work in the emerging area of "modern learning environments", looking at classroom design and changes in teaching pedagogy in the Christchurch rebuild; and Associate Professor Billy O'Steen is leading research on community well-being and the role of youth in post-disaster environments. Supported by the US Embassy, he helped host the first New Zealand/US Youth Leadership Symposium on Disaster Response and Preparedness, and the second New Zealand Tertiary Community Engagement Summit.

Australian researcher Professor Richard Light was appointed Head of the School of Sport and Physical Education. His research complements other studies in the School in physical education and sport in schools, sport coaching, Olympic studies, and outdoor and health education.

# 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 activities, including areas as diverse as rockets, quantum dots, pure mathematics, useful robots, working with the dairy industry, bioengineering, virtual reality to improve memory of stroke survivors, financial and industrial mathematics.**

In 2014, we defined the areas into which our research falls and came up with seven key themes: sustainability, security and safety, energy, environment, society and community, innovative design for economic growth, and pure mathematics.

Our staff attracted considerable external research funding in 2014 and many internationally renowned researchers arrived to work with us in collaborative projects. In the past year, amongst other innovations, we have commenced work on swarm testing of UAVs, appointed an architect-in-residence into the Department of Civil and Natural Resources Engineering, and seen the opening of the first multi-storey post-earthquake timber building in the city, which uses low-damage post-tensioned timber technology designed by staff in our College.

A priority for the College is to increase our postgraduate numbers, in order to boost our research outputs and continue to develop our research in all areas. An increase in postgraduate numbers also enables us to work collaboratively with industry and respond to their needs, thus deepening our existing industrial relationships and creating new ones.

# College of Science *Te Rāngai Pūtaiao*

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

**2014 was another highly successful year for research in the College of Science, Te Rāngai Pūtaiao.**

Our health-related research — selected highlights of which are profiled in the stories in this report — is a key part of the spectrum of our research activity. As you will see from these stories, our staff and postgraduate students conduct a wide range of research using a variety of laboratory, field and clinical methodologies and this research is conducted in partnership with a range of national and international collaborators.

This work includes our world-leading medical technologies research on colour x-rays in the MARS project. It includes work addressing heart disease in various ways, from understanding patterns of inhaler use by COPD sufferers, to more biomedical approaches to understanding the disease from our biochemists. It includes a range of work that explores various links between the brain and health — for example through the analysis of speech pathologies like stuttering and the neuroscience of dementia. Most of our health research is done in close partnership with stakeholders and end-users — from clinicians to health technology companies to innovation investors — both nationally and internationally, and some is supported by philanthropic donations from donors whose lives have been improved as a result of our work. We are humbled by the support for our work, and proud of its outcomes and impacts.

If you would like to discuss our research or ways in which we may be able to work with you and your group or organisation to solve a research problem in health — or in any other of our areas of research — please do not hesitate to get in touch with me at wendy.lawson@canterbury.ac.nz.

# University Statistics

| | | |
|---|---|---|
| Academic staff[1] | | 501.2 |
| Adjuncts and research fellows[2] | | 119.8 |
| Post-doctoral fellows[3] | | 44.8 |
| Outputs | | 3090 |
| Postgraduate degrees completed | PhD | 178 |
| | DMA | 1 |
| | LLM | 2 |
| | MA | 49 |
| | MAud | 10 |
| | MCom | 13 |
| | MCouns | 3 |
| | ME | 21 |
| | MEd | 7 |
| | MEFE | 1 |
| | MEM | 22 |
| | MET | 6 |
| | MFA | 1 |
| | MFA(Creative Writing) | 1 |
| | MForSc | 4 |
| | MGIS | 1 |
| | MHealSc | 7 |
| | MHIT | 2 |
| | MSc | 99 |
| | MTchLn | 2 |
| | MWaterRM | 1 |
| Research Income | | $26,666,481 |

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

# Bluefern

## University of Canterbury Super Computer

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

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

BlueFern, 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.

BlueFern was established by scientists and engineers to make it easy and convenient for researchers to use world-class supercomputers. BlueFern 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 KAREN advanced research network.

**Email: bluefern@canterbury.ac.nz**

**www.canterbury.ac.nz/spark/bluefern**

**www.bluefern.canterbury.ac.nz**

**www.nesi.org.nz**

# 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 eight 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, probing enzyme design and evolution, 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 Electric Power Engineering Centre (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 and fulfils 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 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**

## Human Interface Technology Laboratory (HIT Lab NZ)

The Human Interface Technology Laboratory New Zealand (HIT Lab NZ) is a human-computer interface research centre hosted at the University of Canterbury. The lab is a partner of the world leading HIT Lab US based at the University of Washington in Seattle.

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

- enhance human capabilities
- vanquish human limitations
- increase the flexibility and utility of industry's existing products

HIT Lab's multi-disciplinary approach to research and education facilitates an entrepreneurial climate, which fosters a wealth of innovative ideas. Currently, the lab is working on a range of projects in collaboration with industry and academia.

One of HIT Lab's key goals is to expedite economic development within New Zealand by transitioning breakthrough interface technologies to industry.

**www.canterbury.ac.nz/spark/hitlab**

## Macmillan Brown Centre for Pacific Studies

The Macmillan Brown Centre for Pacific Studies was founded through a bequest from the late 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". The main areas of research of the centre are the societies and cultures, past and present, of the indigenous peoples of Oceania (including New Zealand). In developing its research programme, the centre is responsive to concerns expressed by these people.

**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 remains the only EU dedicated tertiary level centre in New Zealand. Since then, NCRE has developed significantly in 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 Monash, RMIT and the ANU in Australia, Waseda and Keio universities in Japan, NUS in Singapore, and Fudan and Tsinghua in China.

The main focus of NCRE is on research into how the European Union impacts 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.

**www.canterbury.ac.nz/spark/ntrc**

## 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.

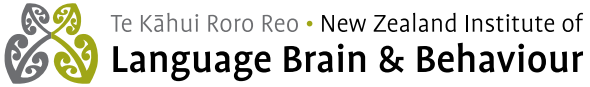
The centre plays a key role in maintaining New Zealand expertise at the forefront of international telecommunications research and development through impactful research measured by graduation of high calibre students, economic impact, publications and patents. The centre has extensive knowledge and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

Specific technologies of expertise include multi-antenna systems (MIMO), error control coding, diversity systems, relaying, scheduling and the application of combinations of wireless and geospatial technologies.

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

# Research supporters*

















** Please note: These are some of the organisations that supported the research featured in Research Report 2014.*

# 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**

An electronic copy of this publication and a list of 2014 research outputs are available from the Research & Innovation Research Report website www.research.canterbury.ac.nz/researchreport

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