research.swinburne.edu.au

SWINBURNE UNIVERSITY OF TECHNOLOGY

RESEARCH IMPACT

MARCH 2018

HACKING THE HACKERS
Detecting the fingerprint of cybercrime

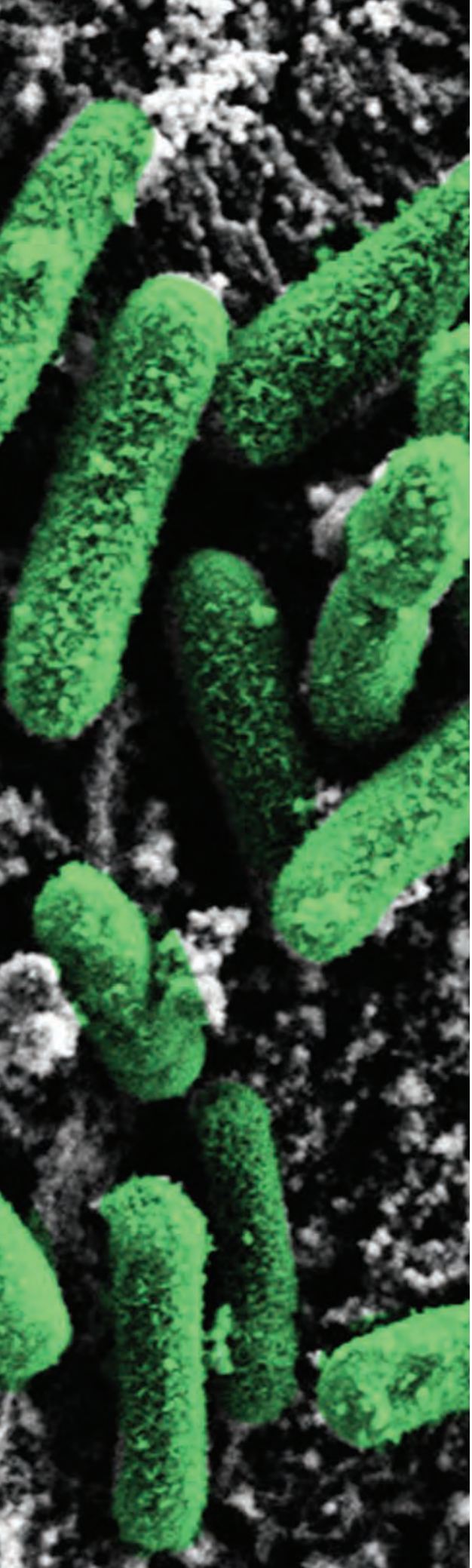
MAGIC BEANS
Meet the fresh fixers in the fight against climate change

BEST BUDS
3D-printed personalised hearing aids

MAPPING CONNECTION
Bringing the disadvantaged in from the fringes

ROBOTS REACH OUT

Android demonstrators lead social and physical therapy



RESEARCH IMPACT

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ABOUT THIS MAGAZINE

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ABOUT SWINBURNE RESEARCH

Swinburne University of Technology is an internationally recognised research-intensive university that is focused on delivering research that creates economic and social impact. Our researchers are producing innovative research solutions to real-world problems across a range of disciplines and sectors. In 2017, Swinburne was listed within the top 2% of higher education institutions by the prestigious Academic Ranking of World Universities (ARWU) and we were also listed within the top 2.1% and top 2.2% by the Times Higher Education University World Rankings and QS World University Rankings. We are committed to delivering world-leading research outcomes and innovations in select areas of science, engineering and technology. In 2017 Swinburne launched a number of exciting initiatives that will drive our future research achievements. Our new 'Innovation Precinct' in Hawthorn, Melbourne, is a hub of world-class research-led innovation activity, and our recently launched Research Institutes focus on big challenges facing our industries and society. Swinburne's research future is bright.
>>> research.swinburne.edu.au

SWINBURNE PRODUCTION TEAM

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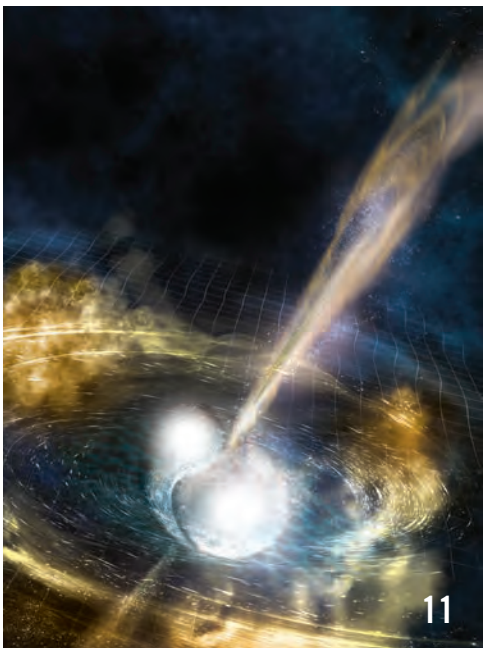
Annie Jones



Contents

World-class research at Swinburne

SWINBURNE UNIVERSITY OF TECHNOLOGY

Swinburne University of Technology is an internationally recognised research-intensive university that is focused on delivering research that creates economic and social impact.

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We are committed to delivering world leading research outcomes and innovations in select areas of science, engineering and technology.

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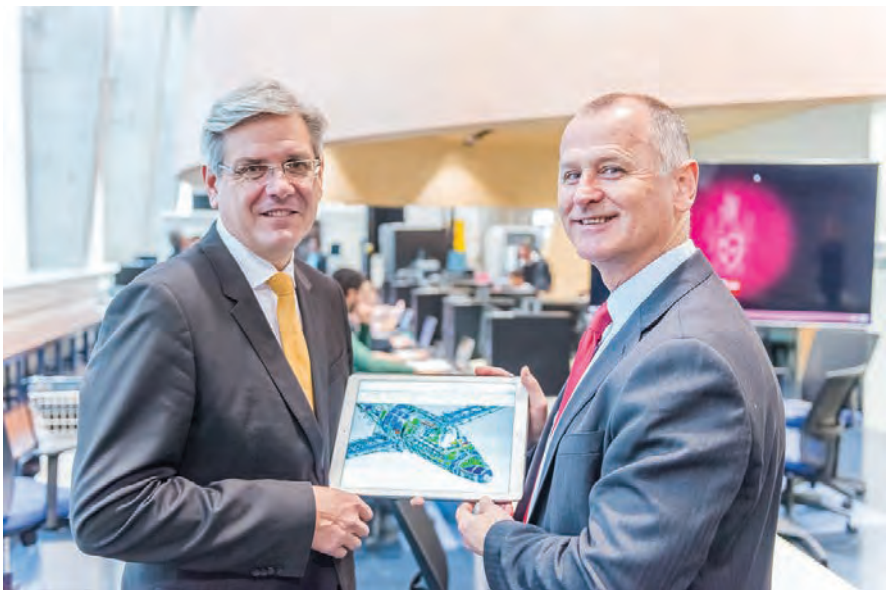
Technology for the good of humanity

Technology is driving change at breakneck speed, and the pace is accelerating. Artificial intelligence and machine learning, big data and analytics, the Internet of Things, sophisticated sensors, cloud computing, robots and drones, 3D printing, augmented and virtual reality, are many of the digital technologies integrating our physical and virtual worlds. This is the fourth industrial revolution in action.

In coming years, countless new products and services will be invented based on new technological solutions. With so many potential and promising applications of technology, what is the best investment of our resources, effort and ideas? The challenge is to put technology to good use, to serve individuals and society.

At Swinburne University of Technology, this is the deeply ingrained principle driving our research: technology must aim to achieve positive economic and social impact by improving people's lives and the state of our planet through better and smarter applications. Put another way, new technologies that help people will be the ones that succeed.

Our applied research at Swinburne is placed at the interface between technology and humanity. Big data analytics are helping us develop guidelines to assist in designing future social enterprises. Personalised robots are being used in aged-care settings to help individuals living with dementia. Our touchscreen technology is assisting the cognition of primary school children. We are using 3D printing technology to create personalised earphone buds and hearing aids, and other implantable technologies. Cyber-physical technologies drive our Industry 4.0 Testlab in advanced manufacturing.



Siemens awards a $135 million industrial digitalisation grant to Swinburne. Jeff Connolly CEO at Siemens Australia New Zealand and Professor Aleksandar Subic, Deputy Vice-Chancellor (Research and Development) are both members of the Prime Minister's Industry 4.0 Taskforce.

As a science and technology university, Swinburne's fundamental research often leads to new discoveries and breakthrough technological solutions. Our OzGrav Research Centre of Excellence helps answer some of the most complex and fundamental questions of human existence using the most sophisticated instruments available today. The centre communicates these amazing insights to the broader public and future generations of science, technology, engineering, and mathematics students using state-of-the-art augmented reality and visualisation technologies.

At Swinburne, we are proud to pursue research with impact. By driving innovation built on excellence in science and technology, we are transforming industries, and shaping lives and communities for the better.

Professor Aleksandar Subic
Deputy Vice-Chancellor
(Research and Development)

On the cover

Associate Professor Sonja Pedell poses with NAO, a commercially available robot that she has been using to facilitate social integration with elderly dementia patients.

Cover image: Eamon Gallagher

Swinburne in Numbers

GLOBAL RANKINGS FOR 2017

TIMES HIGHER EDUCATION

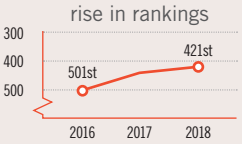
TOP 2.1% of 20,000+ higher education institutions (#420)

TOP 300 in physical sciences

RANKED 61 of universities under the age of 50

QS WORLD UNIVERSITY RANKINGS

TOP 2.2% of 20,000+ higher education institutions (#421)



TOP 50 in art and design

ACADEMIC RANKING OF WORLD UNIVERSITIES

TOP 2% of higher education institutions (#337)

65 RANKED in **SPACE SCIENCE** by *US News*' annual published rankings

EXCELLENCE IN RESEARCH FOR AUSTRALIA FEDERAL REPORT*

5 OUT OF 5

WELL ABOVE WORLD STANDARD

- Physical sciences
- Astronomical and space sciences
- Atomic, molecular, nuclear, particle and plasma physics
- Optical physics
- Physical chemistry (including structural)
- Materials engineering
- Nanotechnology
- Neurosciences

4 OUT OF 5

ABOVE WORLD STANDARD

- Quantum physics
- Chemical sciences
- Computer software
- Engineering
- Civil engineering
- Electrical and electronic engineering
- Mechanical engineering
- Technology
- Communications technology
- Psychology
- Language, communication and culture
- Communication and media studies
- Neurosciences

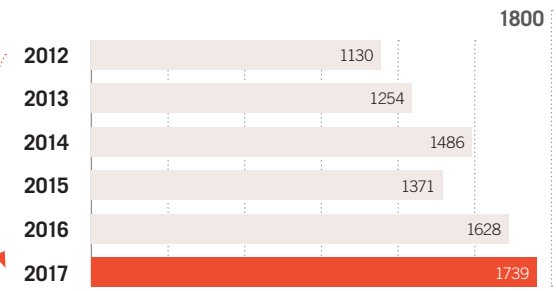
*A report covering 2008–2013 released by the Commonwealth Government in five year blocks.

STEPPING UP PUBLICATIONS

SCOPUS INDEX PUBLICATIONS

Peer-reviewed literature on the world's largest abstract and citation database

65% increase over six years



TOP 100 of the world's academic institutions in physical sciences based on article count

RESEARCH WITH IMPACT

Observation of a 50-Solar-Mass Binary Black Hole Coalescene at Redshift 0.2

JOURNAL: *Physical Review Letters*
PUBLISHED: 2017

4539 SOCIAL MEDIA TWEETS, SHARES, LIKES AND COMMENTS

CAMPUSES & FACILITIES

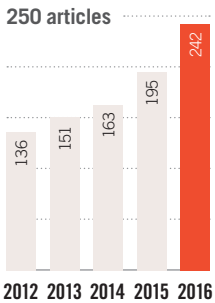
WANTRINA
Flexible Green Trades Complex
$10 million to establish

Knox Innovation, Opportunity and Sustainability Centre
$10.3 million to build

HAWTHORN
Advanced Manufacturing and Design Centre
$100 million to build

Advanced Technologies Centre
$140 million to build

INTERNATIONAL COLLABORATIONS



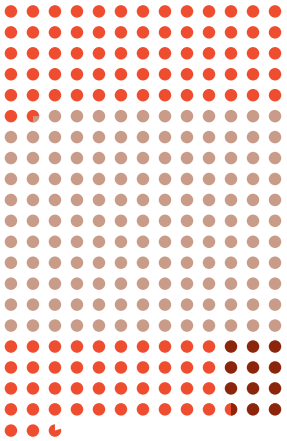
TOP 5 COLLABORATORS

1. Max Planck Society, Germany
2. Leiden University, Netherlands
3. University of Oxford, UK
4. French National Centre for Scientific Research, France
5. University of California Santa Cruz, USA

*Data for 2017 unavailable at time of print

STUDENTS & STAFF

● = 100 people



26,280
TOTAL STUDENT LOAD IN 2017
(equivalent full-time student load)

14,124
On-campus students (EFTSL)

1152
Higher degrees by research students

20:1
Student-to staff-ratio

701
Full-time academic staff

HIGHER DEGREES BY RESEARCH

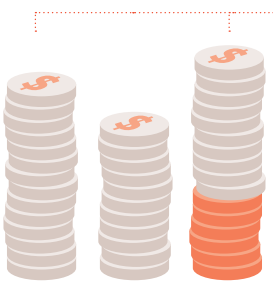
(A postgraduate degree involving a supervised research project)

137
COMPLETED DEGREES IN 2017

$8.5m
INVESTED IN STIPEND SCHOLARSHIPS IN 2017

EXTERNAL INCOME

$ = $5 million



$205m
TOTAL EXTERNAL RESEARCH INCOME, 2009–2017

$30m
EXTERNAL RESEARCH INCOME, 2017

$135m
In 2017, Swinburne was given a record industrial software grant for advanced manufacturing from engineering company Siemens.

News briefs

$135 million grant to digitalise Swinburne's Factory of the Future

Swinburne University of Technology has further cemented its reputation as a world leader in advanced manufacturing, receiving a record $135 million industrial software grant from engineering giant Siemens.

The grant will be used to digitise Swinburne's Factory of the Future, creating Australia's first fully immersed Industry 4.0 facility.

The factory will give students and researchers access to the same apparatus used by leading companies on advanced projects, developing the skills needed to thrive in the highly competitive digital manufacturing sphere.

Professor Tom Spurling wins ANZAAS Medal for scientific achievement

Swinburne's Professor of Innovation Studies, Tom Spurling AM, has been awarded the prestigious 2017 Australian and New Zealand Association for the Advancement of Science (ANZAAS) Medal.

The award recognises Professor Spurling's contribution to science over the past 55 years.

Most notably acknowledged for his role in developing and commercialising plastic banknotes, Professor Spurling is widely regarded as an expert in the commercialisation of research, including breakthroughs such as 30-day contact lenses and the MIEX water purification process.

The world's largest ground-based optical telescopes at Hawaii's W. M. Keck Observatory are available for use by Swinburne researchers after the renewal of a collaborative agreement with Caltech for another five years.

Partnership with Caltech

Pioneering research into supernovae, galaxy formation, fast radio bursts and gravitational waves has been boosted with the renewal of Swinburne's partnership with Caltech for five more years.

The new agreement covers access to the world's largest ground-based optical telescopes at Hawaii's W. M. Keck Observatory until 2023. The observatory's instrumentation has enabled astronomers to make amazing discoveries about the Universe.

The agreement also encompasses collaborative research on strategic projects, including advanced visualisation and machine-learning techniques, data-driven discovery, and training programs.

NHMRC fellowship awarded to Swinburne mental health researcher

Swinburne researcher, Dr Eric Tan, received a fellowship valued at over $320,000 from the National Health and Medical Research Council (NHMRC) for his work on schizophrenia.

Based at Swinburne's Centre for Mental Health, Dr Tan's work aims to characterise speech patterns in people with schizophrenia.

"The overarching goal is to develop a model for the prediction of relapse based on these speech parameters," he says.

This is a joint project between Swinburne's Centre for Mental Health, Data Science Research Institute, and The Alfred and St Vincent's Hospitals.

Dr Eric Tan, Centre for Mental Health

Swinburne researcher wins gold at crime prevention awards

Swinburne researchers have collaborated with Victoria Police and Forensicare to win gold at the 2017 Australian Crime and Violence Prevention Awards for work on the project 'Enhancing Police Responses to Family Violence'.

The awards highlight best practice in preventing and reducing violence in Australia.

The team from Swinburne's Centre for Behavioural Science developed tools to help Victoria Police improve family violence risk assessment and management.

Superintendent Stuart Bateson, who worked closely on the project, believes it has improved police operations. See page 8 for more.

Dr Troy McEwan led the Enhancing Police Responses to Family Violence Project, which won gold at the 2017 Australian Crime and Violence Prevention Awards (ACVPA).

Beth Webster elected to Academy of the Social Sciences in Australia

Swinburne's Professor Beth Webster has been admitted to the Academy of the Social Sciences in Australia for her distinguished contributions to the economics of innovation.

Professor Webster is Pro Vice-Chancellor of Research Impact and Policy, and Director of the Centre for Transformative Innovation.

She contributes to policy debates and is regularly published in journals on innovation economics and firm performance.

Professor Webster joins the Academy alongside 45 other Australian researchers, bringing the Academy's total number to 637 distinguished social scientists.

Swinburne ranks in the top 250 for THE engineering and technology

Swinburne has ranked in the top 250 in the 2018 Times Higher Education (THE) engineering and technology subject ranking.

These rankings judge world-class universities across all their core missions – teaching, research, knowledge transfer and international outlook.

Acting Faculty Pro Vice-Chancellor of Swinburne's Faculty of Science, Engineering and Technology, Professor Sarah Maddison, says the university is proud of this achievement.

"Swinburne's engineering courses take a world-leading approach to engineering education, with a high level of industry engagement that produces quality graduates."

Karl Glazebrook honoured by peers

Distinguished Professor and Director of Swinburne's Centre for Astrophysics and Supercomputing, Professor Karl Glazebrook, has been elected as a Fellow of the Australian Academy of Science.

One of 21 scientists elected by their Academy peers, Professor Glazebrook is a world-leading observational astronomer whose research has significantly advanced our understanding of the evolution of galaxies and the Universe across cosmic time.

The Fellowship is one of the highest honours an Australian scientist can receive in the field of natural science.

Swinburne ranks in top 2%

Swinburne has ranked 337th in the Academic Ranking of World Universities (ARWU), and is now in the top 2% of universities in the world.

"Our research has been recognised internationally as among the best in the world, which is a deserving recognition of the great work our researchers are doing," says Deputy Vice-Chancellor (Research and Development), Professor Aleksandar Subic.

These rankings confirm that despite its young age, Swinburne is recognised as a world-class university with exceptional research and industry engagement.

Swinburne leaders named ATSE Fellows

The Australian Academy of Technological Sciences and Engineering (ATSE) has named Swinburne Vice-Chancellor, Professor Linda Kristjanson AO, and Director of the Manufacturing Futures Research Institute, Professor Bronwyn Fox, as Fellows.

The ATSE described Professor Kristjanson as an "inspiring leader" of Swinburne and Professor Fox as an "outstanding materials science researcher" passionate about translating research that advances Australia's manufacturing sector.

Swinburne Chancellor, Graham Goldsmith, said the prestigious fellowships are a fitting acknowledgement of the pair's contributions to their respective fields.

How to stop the rot

The search for how bacteria can greatly accelerate corrosion of marine vessels and structures is driving a significant research area.

The harmful effects of bacterial infections on humans are well studied, but it's less well known that the presence of certain microbes in seawater can undermine the integrity of ships, submarines and other marine vessels.

The phenomenon known as microbiologically influenced corrosion (MIC) occurs when a biofilm of microbes grows on the surface of a structure. Its effect is being studied by Associate Professor Scott Wade and colleagues, including Dr M. Awais Javed and Professor Linda Blackall, at Swinburne University of Technology.

"MIC can dramatically speed up corrosion rates, with structures sometimes being compromised in just a few months. It affects not just metals, although that's what my research focuses on, but also plastics, stone, almost everything."

Corrosion has been estimated by industry group NACE International to cost 3.4% of global GDP, approximately AUD$57 billion annually for Australia alone.

Vulnerable structures include the hull of ships and submarines, and any parts or objects that come into prolonged contact with seawater, including bilges, engine drive shafts, pipes, pumps and key infrastructure in harbours and ports such as steel support piles and retaining walls.

Associate Professor Wade has worked to gain a better understanding of the processes involved, and how to devise and test potential solutions.

"We used to think that just a couple of specific microbial species were involved in MIC, but now we know that it's many more," he explained. "One thing that's unclear is the role of pollution and environmental factors on microbial populations and how this relates to MIC."

Given the scale of the problem, Wade's research has received considerable interest and funding from industry and defence sectors. Australia's Defence Materials Technology Centre (DMTC) is playing a key collaborative role and the benefit of the research was recently recognized with a high commendation at the 2017 Maritime Australia Industry Innovation Awards. Associate Professor Wade's research results have already been used by the Royal Australian Navy and shipbuilders, ASC.

As for solutions, Wade said that avoiding the build-up of microbial biofilms, for example by steam cleaning, is potentially a good start. He is also exploring the use of biocides, special toxic coatings that leach copper, or other sterilising treatments, such as those that make use of ultraviolet light.

E. coli in a biofilm observed through an electron microscope. Their corrosive effect on surfaces has enormous industry costs.

Certainty in flux

As microfluidic devices shrink to the nanoscale, classical fluid dynamics go out the window.

Highly miniaturised 'lab-on-a-chip' devices capable of complex laboratory analyses and medical diagnoses are the ultimate goal of scientists in the emerging field of nanofluidics. Theoretician, Professor Billy Todd, has led Swinburne's foray into this revolutionary area of research, which steps beyond the predictable world of continuum classical physics into the fuzzy realm of statistical mechanics.

"Nanofluidics is the study of the flow of liquids in nanometre-sized channels," explained Todd. "At this scale, the classical laws of hydrodynamics break down and new methodologies are required to predict the movement and transport of fluids, such as water flowing inside carbon nanotubes or graphene nanochannels."

Todd has developed new theoretical and computational

methods to predict the behaviour of atomic and molecular fluids in nanofluidic systems using statistical mechanics — a physical principle that deals with the prediction of properties of large systems of particles that cannot be handled by continuum methods of physics, such as hydrodynamics.

"In nanoscale confinements, forces between the fluid molecules and atoms on the confining surface become important, as are friction and energy dissipation. All of these aspects need to be understood in order to manipulate fluids efficiently in nanofluidic devices," said Todd.

Along with colleague, Professor Peter Daivis at RMIT, Todd and his team of students and postdoctoral researchers have made a number of important contributions in this field in recent years. This includes the development of non-equilibrium molecular dynamics (NEMD) algorithms to simulate a broad class of nanofluidic flows for atomic and molecular liquids, and a book covering the essentials of non-equilibrium molecular dynamics.

"I think nanofluidics is a vibrant field," said Todd. "The US, Europe, the UK and Asia are investing heavily in nanofluidic research, and while Australia has yet to seize the opportunity on a large scale, Swinburne University of Technology is well regarded internationally for its work, particularly around nanotechnology and physical chemistry."

The driver for the significant investments in nanofluidics internationally is the remarkable potential of applications such as lab-on-a-chip devices, in which arrays of nanofluidic 'chips' are used to measure the properties of biological solutions.

"Controlling the transport of fluids and improving the miniaturisation of such devices remains an important technological challenge, and our work can potentially provide insight into the microscopic mechanisms at play when conventional fluid dynamics modelling is unable to make accurate predictions," said Todd.

"I think the future is bright for those who have the tenacity and patience to tackle difficult and scientifically challenging problems."

Examining the roots of family violence

World-leading research into the psychology of offenders sheds light on stalking risk and improves the effectiveness of response and treatment.

Pioneering research into family violence by Swinburne University of Technology's Centre for Forensic Behavioural Science has led to markedly better outcomes for victims.

The centre works in collaboration with senior psychologists from Victoria's forensic mental health services, the police force, and the state's primary health network, and was recognised in the 2017 Australian Crime & Violence Prevention Awards.

Family or domestic violence has become a top priority for government and law enforcement agencies. Yet the roll-out of effective support and solutions has been challenging. As the first responders to incidents of family violence, police often bear much of the burden of what in many ways is a public health issue, but without the benefit of the necessary training. Dr Troy McEwan and her team at the Centre for Forensic Behavioural Science have been working to address this problem.

As first responders to incidents of family violence, police often bear the burden of this major public health issue.

"Our research focusses on improving understanding and assessment of stalking and family violence, with the aim of improving prevention and intervention," said Dr McEwan.

"One of the major challenges is translating our findings into practice. The gap between a study and what psychologists or police actually do on the ground can be huge. We put a lot of time into developing strategies to translate our research findings, through face-to-face training and online education courses."

A key part of the centre's work is developing and evaluating risk assessment tools, such as the Stalking Risk Profile, which is now used by mental health, policing and correctional agencies around the world, and the Screening Assessment for Stalking and Harassment which is used by front-line police and victim support agencies in the United Kingdom, United States, Germany, Denmark, Sweden, Italy and Japan.

"We are working with partners to develop systems that ensure that day-to-day practice is based on sound evidence," explained McEwan. "That work is enormously complex and involves lots of people. It is a largely unseen part of being an effective academic, but is hugely important to ensuring our research has direct impact."

Staying within earshot of solutions

Swinburne PhD program a good fit for students with a translational research bent

Scanner data is projected on to a mathematical model to produce a good quality representation of the ear.

Personalised earphone buds and hearing aids, 3D-printed for a perfect fit, were the promising first fruit of a design-led PhD program at Swinburne University of Technology.

The aim was to turn out PhDs who will move easily into industry after graduating, explained the program director, Professor Paul Stoddart, a Swinburne biomedical engineer.

The concept worked for Philip Kinsella; even before he graduated, the university helped him set up a spin-out company to commercialise his method for creating custom-fit earpieces.

The design-led approach started with students spending time with potential industry partners to identify real-world problems. Kinsella's own project stemmed from discussions with Melbourne hearing aid company, Blamey Saunders Hears. He learned that the current process for custom making hearing aids — injecting a soft polymer to take an impression of the ear, creating a mould from that impression, then creating the custom hearing aid itself — left a lot to be desired. The multi-step process was expensive and prone to errors that resulted in implants that were ill-fitting and uncomfortable.

Along with industrial designer, Dr Charlie Ranscombe, Professor Stoddart and Kinsella decided they could modernise the process. Kinsella developed a custom scanner capable of precisely capturing ear shape, and scanned many volunteers' ears in the lab. "He assembled a database of ears, then developed a sophisticated mathematical model of the ear," Stoddart said. That model meant the scanner could be used almost anywhere, and didn't need a highly skilled operator. "You can project the scanner data on to the mathematical model to produce a good quality representation of the ear."

An automated algorithm then calculated where to position the hearing aid or earphone speaker within the implant, which was produced on a 3D printer. "What he's developed is a process where we can mass-customise inserts for in-ear devices," Stoddart said.

Since Kinsella began his PhD, ten more students have followed a similar design-led PhD pathway, thanks to Australian Research Council funding for a Training Centre in Biodevices. Stoddart is currently exploring options for offering the design-led PhD model to Swinburne students interested in translational research projects in other fields.

Green signals good for marketing

Future-focused consumers are more likely to spend their money on products with environmental credentials.

Using renewable energy to make a product improves its consumer appeal, according to research from Swinburne University of Technology.

Simon Pervan, Associate Professor of Marketing, and his PhD student, Suni Mydock, found that when university students viewed advertisements for earphones, they were more likely to express an intention to buy the earphones if they were advertised as having been made with renewable energy.

"The study proved that products made with renewables are preferable," said Associate Professor Pervan.

Marketing products made from recyclable or recycled materials was popular in the 1990s and 2000s. But over-hyped environmental credentials — so-called greenwash — is thought to have undermined the effectiveness of such marketing.

However, until now there has been very little research into whether green credentials are good for business. "We didn't know if consumers thought it was important that a product was made with renewables, because it hadn't been looked at

Associate Professor Simon Pervan.

before," said Associate Professor Pervan.

The researchers also wanted to find out if consumer behaviour depended on personality type.

They hypothesized that people who believe they have control over outcomes, rather than outcomes being due to external forces, would be more likely to be interested in products made with renewable energy.

"We thought that they would be more receptive to this type of appeal," said Associate Professor Pervan. However, they found there was no difference in interest in products made with renewables between the two personality types.

Later, a second study into personality found that people focused on the future were more willing to pay a higher price for a product made with renewable energy compared to those who were not.

"Someone who focuses on the future is more interested in big-picture appeals," said Associate Professor Pervan.

While he is optimistic about the appeal of products with green credentials, he has reservations.

"Marketing needs to be developed with caution to ensure it doesn't become greenwash, which creates a sceptical and then cynical public," he said.

Cosmic clashes bring a community together

It's been a good year for gravitational wave research. A new centre based at Swinburne captured all the action.

The promise of Swinburne's new research centre, OzGrav, was realised when the Universe delivered an extraordinary event, a collision between two neutron stars, in August 2017.

Barely a year old, OzGrav, the Australian Research Council Centre of Excellence for Gravitational Wave Discovery, swung into action, spreading the news of the impending collision through their network of Australian researchers.

As the two neutron stars spiralled towards each other, telescopes across Australia, from rural New South Wales to the remote north of Western Australia, homed in on the resulting fireworks display. Meanwhile, theorists primed Swinburne's OzStar petaflop supercomputer to crunch the data.

"The stars completed the last thousand orbits of their death spiral in just a few seconds," said OzGrav's Director, Professor Matthew Bailes.

The event was a new triumph in the detection of gravitational waves, OzGrav's reason for being.

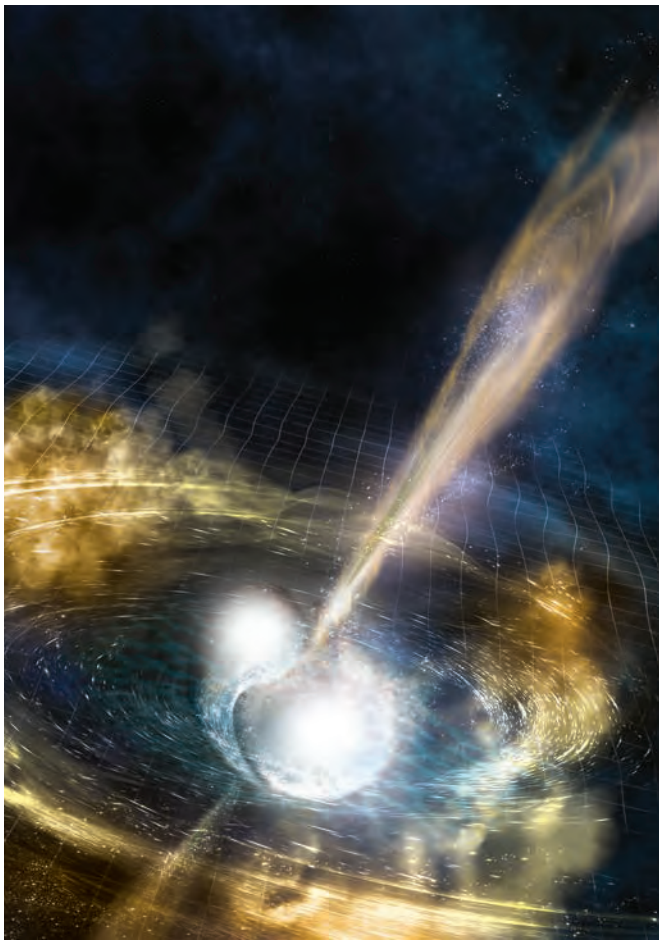
Previously, gravitational waves from black hole collisions had been detected, but the neutron star collision emitted radiation visible through conventional telescopes. It was the first time the radiation that accompanies a gravitational wave event had been detected.

The resulting avalanche of data from telescopes across Australia and the world has unveiled secret after secret about the Universe.

Neutron star collisions are probably the main origin of the gold and silver on Earth, for example.

The smash also tells us about the Universe's expansion and explains the mysterious short-duration gamma-ray bursts that have puzzled astronomers for 50 years.

That so many Australian scientists observed the neutron star collision is a tribute to OzGrav's success in bringing together a community, said Professor Bailes.



An artist's impression of the two neutron stars colliding.

"We had to not just make the instrument better, but do science with it. We needed to recruit astrophysicists, and the missing ingredient, the people who process data.

Because of his experience as the Director of Swinburne's Centre for Astrophysics and Supercomputing, Bailes knew that Swinburne was the perfect place to base the new centre, to make use of the supercomputer, OzStar.

DATA DRIVEN

Arranging and analysing masses of data creates tools to predict traffic patterns, and the likelihood of market success.

Predicting where the next traffic snarl will form and understanding how good ideas become useful products are among the projects of researchers at Swinburne's Data Science Research Institute.

The interdisciplinary Institute, led by Professor Timos Sellis, is using data science to transform the way that businesses and governments operate.

Data is a common factor underlying the digital disruption sweeping the world, including in manufacturing, commerce and science, said Professor Sellis. The outcomes of the Data Science Research Institute's work have been similarly wide-ranging.

The project on traffic analysis is combining complex data to improve traffic flow in the aftermath of car accidents. "We bring together data about the weather, where people go typically throughout the day, and from where they start, to their destination, to understand typical traffic patterns," said Professor Sellis.

Analysing this data, Swinburne researchers used algorithms to predict the effect of weather or a car accident on city traffic. Such predictions cannot currently be made by data-rich programs such as Google Maps, and are useful for the future consideration of governments and town planners.

Swinburne researchers have also used machine learning, a burgeoning tool in which computers make predictions based on patterns detected in large amounts of data, to understand and quantify seemingly intangible concepts, such as the transfer of knowledge.

The Institute has partnered with Swinburne's Centre for Transformative Innovation (CTI) to understand how knowledge flows from research to commercialisation. "CTI is looking at all the research articles published around the world, the patents that companies or people file, and the products that companies have developed," said Professor Sellis. The work has piqued the interest of organisations such as IP Australia, the federal agency responsible for administering intellectual property rights.

Using machine learning, the researchers analysed how innovations in a given field develop. This includes quantifying the prevalence of concepts present in research publications, as well as the ideas developed in new patents, and analysing both for connections. "The analysis of this data is much more complex than just analysing numbers," said Professor Sellis.

A SMART LOOK AT THE CITY'S MOVING PARTS

A new multidisciplinary Institute will investigate the growing city as a whole

Investigating how autonomous cars could reduce the number of vehicles on the road is just one of the many innovative ideas being studied at Swinburne's brand new Smart Cities Research Institute.

Tackling the challenges of congestion, pollution and energy use, the Smart Cities Research Institute will investigate not just new technologies, but how citizens can be involved.

Professor Mark Burry, who recently joined Swinburne to be the Institute's Director, came with an impressive list of credentials, including having been a senior architect on the Sagrada Família Basilica in Barcelona and a former Australian Federation Fellow.

"Smart cities typically focus on new technologies but we are interested in understanding how new technologies can help citizens to engage," said Professor Burry.

"Rather than cities designed for citizens, let's have the cities designed with them. It's a major opportunity, but we haven't really exploited it. We could use the internet more effectively to give people more choices."

One approach is to use games to find out what people are thinking, as an alternative to questionnaires. This might be as an app which citizens play while waiting for the bus. Through the game the app learns more about the needs of the citizen, which can then be used in city planning (see page 15).

The next big technological revolution will be the autonomous car and the Institute will use simulation studies to find out if these will reduce congestion.

It will also consider strategies for increasing housing density around transport hubs and demonstrate to residents that higher densities can create benefits such as a greater variety of shops and restaurants within walking distance.

"Instead of nimbyism we want to encourage 'imbyism' - in my backyard," said Professor Burry.

Investigating housing to suit new household arrangements will be another priority, according to Burry. Millennials, for example, have a greater sense of sharing and seem to have fewer possessions than their parents, so they may need less storage space, while recently divorced singles in their 40s and 50s who can no longer afford a family home may prefer house-sharing.

The Smart Cities Research Institute will address four key areas: urban mobility, smart spaces at home and work, infrastructure and delivery systems, and new urban governance structures.

Operating as a virtual Institute, it aims to foster collaboration between disciplines and with outside partners such as government, industry and CSIRO.

"Everything we do is project based rather than pure research based and at least two disciplines will be engaged in each project. We will always involve an outside party," said Professor Burry.

On the pulse of material fabrication

Ultrafast laser processing offers the promise of precision fabrication using light alone.

Swinburne researchers studying the detailed mechanics of interactions between light and matter are making significant contributions to 3D laser printing.

Touted as the potential technology for the factory of the future, the current generation of 3D laser printers is based on the principle that a raw material, typically a powder, is converted into a solid by focused laser light. They give a tantalising glimpse of a future where high-precision products are created inexpensively on demand from digital files in comparatively tiny 'factories' in ordinary shop-fronts. Yet there remain many ways in which current technology could be improved if only the physics of light–matter interaction were better understood.

The work of Professor Saulius Juodkazis and his team at Swinburne's Centre for Micro-Photonics has focused on this largely unexplored area of material science.

"One of the technological problems of the current generation of 3D laser printer is the need to add photo-initiators to the raw material to absorb laser light, since the host material on its own is transparent at the wavelength of the laser," said Professor Juodkazis.

"But photo-initiators are toxic, which has limited the application of this technology in biomedical fields where the potential is huge.

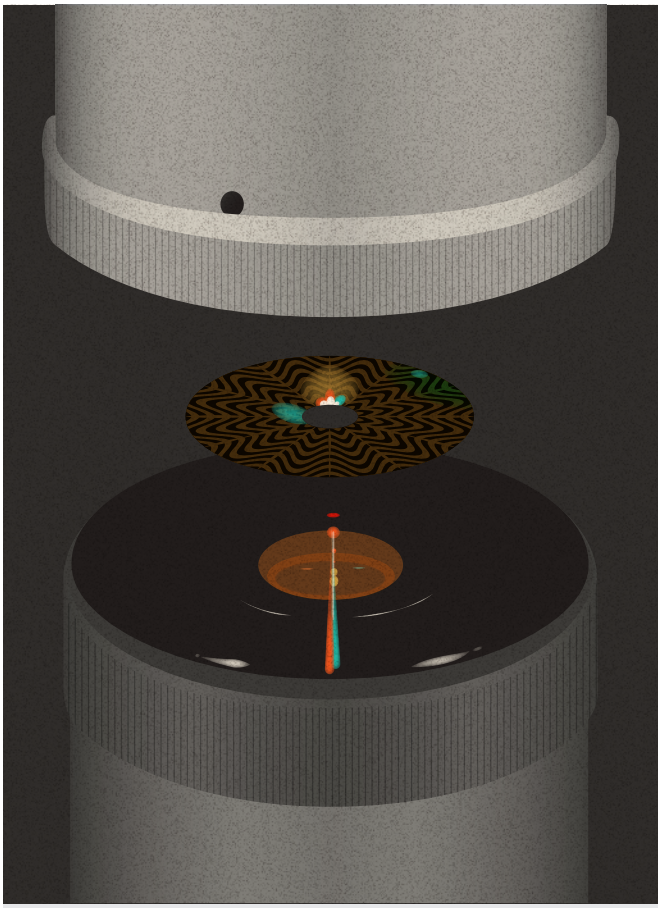
"Our work shows that with ultrashort laser pulses, photo-initiators are not required. We can control and tailor light–matter interactions solely via the properties of light."

By adjusting the intensity, wavelength, repetition and scan speed of the laser pulses, Professor Juodkazis's team has been able to prove the concept on solid transparent workpieces such as polymer blocks and glass, producing high-precision pieces for microfluidic applications.

"Ultrafast laser processing has the highest precision in delivering light energy to material," explained Professor Juodkazis. "It allowed us to tailor and structure materials from tens of nanometres in size right up to sub-millimetre size, making it unique in bridging the domains of nanotechnology, microtechnology and conventional precision material processing."

Professor Juodkazis's work homed in on what exactly happens when a highly focused laser pulse interacts with material at the nanometre scale. The laser irradiation spot experiences a rapid and extreme rise in temperature and pressure, which can produce exotic high-pressure material phases that sometimes last for only a fraction of a second.

"Swinburne has the only ultra-short pulse laser with industrial-grade power and repetition rate in Australia," said Professor Juodkazis. "Based on our research and this facility, we have a number of collaborations, including with Workshop-of-Photonics in Lithuania, which started with a patent licence transfer for laser fabricated surfaces for sensors. We also work with Laser Systems in Japan on industrial laser cutting applications, and with Flewsolutions in Brisbane on sensors and laser fabrication."



Swinburne trials a 3D printing device that delivers ultrashort laser pulses, cutting out the need for toxic molecules.

3D laser printing with light

1. 3D printers start with a raw material, for laser fusing (or sintering) it's typically a powder of either plastic or metal.
2. Toxic photo-initiators, molecules that creates reactive species when exposed to radiation, are usually added to the powder to help it absorb laser light. This step can be skipped with new ultrafast laser manufacturing.
3. A layer of powder is laid down
4. A focused laser light fuses (or sinters) part of the layer into a solid shape in a process known as photopolymerisation.
5. This process is repeated until a 3D shape is created.

When the city's your playground

A free mobile game invites players to explore Melbourne, with the play contributing to better urban design.

A new augmented reality game developed by a designer at Swinburne University of Technology allows players to unlock a hidden city in Melbourne's laneways.

Wayfinder Live 2017 is a free game that uses a mix of real-world visual clues and digital elements. Dr Troy Innocent created it to explore how cities can be turned into playable environments. He won the 2017 City of Melbourne Knowledge Fellowship for the work.

The location-based game was played through the main hubs of the Melbourne central business district, where players used the mobile app to find and scan hidden artworks. The secret 'urban codes' represented fragments of a mythical city called Ludea.

Wayfinder Live 2017 was commissioned for Melbourne International Games week and won the City of Melbourne Knowledge Fellowship for its creator.

While Pokemon Go! requires the player to focus on their mobile screen, Innocent said that Wayfinder Live 2017 invites players to explore the city in a new way by switching between the urban environment and mobile device. When a player is within 100 metres of a scannable artwork, the app sends an alert.

"The game alters the player's perception of the city and also encourages them to reflect on how the city is constantly changing," said Dr Innocent.

Commissioned by the Victorian Government for Melbourne International Games Week in October 2017, the treasure-hunt style game requires players to choose from three teams, each representing a different ideology of how the city should be run.

The player must race to scan 16 urban codes hidden throughout the city to create a map before opposing teams.

When the player scans a new code, a 32-section digital map unfolds with sounds and narrative text. Players earn in-game currency that allows them to take control of locations for their team.

In addition to turning the urban environment into a virtual game, Dr Innocent said that Wayfinder Live 2017 presents a novel way of gathering insights from the public about how to design better urban spaces.

"Play is a good way to engage people, and we can use this information to improve public spaces," Dr Innocent said.

Over the 12-month fellowship, Dr Innocent will further explore how urban information systems can be turned into games that collect feedback from citizens about how to create a stronger sense of community in cities.

"If I'm changing the way people relate [to] or experience the city then I think that's a contribution to quality of living," said Dr Innocent.

A GREENER HOME? THERE'S AN APP FOR THAT

Being a committed environmentalist does not automatically mean a smaller household footprint. But renovating could help.

The homes of committed environmentalists have a similar carbon footprint to other Australians, Swinburne researchers have found. Scientists argue that more needs to be done to make environmental improvements the status quo in Australian homes.

After surveying 1,250 households, Professor Peter Newton from Swinburne Centre for Urban Transitions was surprised to find that people professing to have strong environmental concerns used almost the same amount of resources as people with little interest in environmental issues.

"People might say they have pro-environmental attitudes but when you look at consumption of electricity, gas and water; travel; housing space; and appliances, we found there was no difference between committed greens and environmental skeptics," said Professor Newton.

Since behavioural change is not guaranteed to reduce carbon consumption, Professor Kath Hulse, Director of the Centre for Urban Transitions, has investigated the benefits of communicating energy efficiency strategies to home renovators.

While building regulations mandate energy efficiency in new homes, houses built before 2004 are poor performers. Renovations present a prime opportunity to improve the energy rating of existing homes, but it is often not a high priority for homeowners, said Professor Hulse.

She found that renovators are primarily interested in comfort and livability but also have an eye to future resale.

"Energy efficiency is not top of their list. People are conscious of budget, but they also want comfort. It's a funny mix of financial and emotional factors," she said.

Professor Hulse's research found that communication about how to make homes more energy efficient could be made more pertinent to homeowners.

> "Our prototype treats energy efficiency as mainstream."

"The issue is people are spending money on a renovation and want to see where the money goes, but some things, like insulation, you can't see. It's not glamorous," she said.

Professor Hulse and her team discovered renovators gather their information via digital media and so are developing a 'renovator accelerator': an advice website that will be made into an app for mobile phones.

"People spend a lot of time researching at the early stage of the project, so this is the ideal time to help people incorporate energy efficiency into their project," said Professor Hulse.

"Our prototype treats energy efficiency as mainstream — not special, not different, and not more costly," she said.

The website will even tell you how much your home value is likely to increase after implementing energy efficient initiatives.

It is expected the prototype will be completed this year.

This research is part of the Cooperative Research Centre for Low Carbon Living's work on engaging communities in improving energy efficiency.

Learning from an AFL pack

Research to improve efficient collaborative digital networks took a lead from Australian sporting culture.

When it comes to business networks in the digital age, Swinburne researchers have gained insights from an unexpected source: real-life interactions in a football club.

A team of analysts from the Swinburne Centre for Transformative Innovation, led by Associate Professor Dean Lusher, has used insights from face-to-face socialising to inform innovation in multinational organisations such as Boeing.

Associate Professor Lusher, who is also Deputy Director of the Social Innovation Research Institute, said the term 'social networks' encompassed more than just social media. "They also capture the daily interactions we have at work, such as whom we go to for advice to solve a problem, gossip to, or enjoy spending time with after hours."

Associate Professor Dean Lusher will use his research on interpersonal relationships in organisations, including the Australian Football League, to inform his work with Boeing.

Associate Professor Lusher's team, a world leader in social network analysis, is working with Boeing to study their research and development networks hoping to unpick the most efficient methods of collaboration.

"When you're innovating, trying to solve complex problems and transfer knowledge, how do you do that across geographical, language and cultural barriers? Part of that comes down to interpersonal relations," he said.

Associate Professor Lusher's research on interpersonal relations in the structure and culture of organisations, including the Australian Football League, will inform his work with Boeing.

His team analysed the effectiveness of the AFL's racial and religious vilification laws across nine clubs. "We wanted to understand the way teams work together and interact, whether people from diverse backgrounds are socially included in the team, and the potential for divisions to destabilise teams," he said.

To do this, the researchers used network visualisation maps as well as exponential random graph models (ERGM), a class of statistical model that takes into account dependent connections between people. "Most standard statistical tests have an assumption that what I do is completely independent of what you do, but in a network, people are connected, and what one person does is related to what another does."

> "We wanted to understand the way teams work together, and the potential for divisions to destabilise teams."

The research found a general lack of understanding among players about reconciliation and multiculturalism, and that Indigenous players felt more marginalised from their clubs than their non-Indigenous teammates.

"AFL teams are culturally popular organisations, but the same sort of social dynamics occur in many workplaces across Australia, such as financial institutions or business teams who are trying to develop products," he said.

"There's the opportunity to instigate organisational change by understanding what's happening internally and how well informal social networks align with formal organisational charts."

A study found children using touchscreens performed as well or better in nearly all key cognitive measures as those taught using flash cards.

Shattering the screen myth

Screen-time is not inherently bad for children. It's a lack of interactivity that is problematic.

Generalisations about how too much 'screen-time' affects development fail to recognise the ways in which screen-based activities can help children learn, Swinburne University of Technology research has suggested.

A series of studies by Swinburne's Babylab have demonstrated that, in the right circumstances, interactive touchscreens can be used to teach young children at least as effectively as real-world tasks.

Babylab Director, Jordy Kaufman, an Associate Professor in the Centre for Mental Health, said children learned as much playing a touchscreen version of the problem-solving game Tower of Hanoi as when using the physical puzzle.

He said the resulting paper, published in the journal *Computers in Human Behaviour* in 2016, was among the first to counter the idea that screens were not an effective way to learn.

"Everyone talks about it, but screen-time is a very limited concept," Associate Professor Kaufman said.

"We should be making sure kids aren't too sedentary, that can certainly be affected by the amount of time they spend watching screens. But people should be focused on the type of screen-time, not the amount of screen-time."

He said screens were of educational value when the information presented by them met four criteria: it was interactive, engaging, relevant to the child's life and encouraged them to want to learn more.

The Babylab's work includes being commissioned by the Commonwealth government to evaluate the Early Learning Languages Australia (ELLA) program, which uses touchscreen apps designed to enhance interest in learning among preschool-aged children.

It found children using touchscreens performed as well or better in nearly all key cognitive measures as those taught using flash cards. The digitally taught were found to have superior response speed, brain activity, level of engagement and time spent on task, indicating the level of interest in the game.

"The results seemed to suggest they had a deeper level of learning when using the touchscreen," Associate Professor Kaufman said.

Additional data from an eye-tracking device worn while completing the tasks suggested touchscreens were more effective for those aged four and five than younger children.

Earlier work by the Babylab examined how children respond to video chat programs, and whether they felt it was analogous with a real-world conversation.

It found children's anxiety about being separated from a loved one could in part be addressed by using video calling. "We found with a video call it was almost like being there for the child. An audio call wasn't sufficient — it had to be a video call to make a difference," Associate Professor Kaufman said.

"It's another example that shows it's not the screen, it's what you do with it that makes the difference."

A foothold on diabetes management

An affordable shoe insert can provide early warning before injuries are sustained.

A shoe insole developed by a Swinburne University of Technology engineer has the potential to transform the lives of diabetes patients by monitoring their every step, and improving diagnostics.

Using 88 sensors that measure pressure distribution patterns and changes across the foot via balance scores, the insole can give real-time biofeedback to users via a smartphone app.

Franz Konstantin Fuss, Professor of Health and Sports Technologies with Swinburne's Faculty of Health, Arts & Design, said the product was on the verge of being commercialised.

Peripheral neuropathy in people with diabetes reduces nerve function, which can lead to foot ulcers when the pain signal is not adequately transmitted to the brain. The insole would allow the information to be wirelessly uploaded for assessment, sparing patients the need to visit diagnostic labs.

Professor Fuss said the smart phone app connected to the insole could also give diabetics an immediate alert — a beeping noise — if they were walking in a potentially damaging way, allowing them to pause and re-balance.

He said it could also be used to help treat people with Parkinson's disease and other neurological disorders, and to assist elderly people with a high risk of falling.

"If you have this data, it could also be used by governments and insurance companies to adjust health care systems to better deal with these types of diseases," he said.

Currently, there are low-end models that provide little definition, and a laboratory model that costs about $2500 for a single insole, and requires software worth about $50,000. The Swinburne insole is expected to eventually retail for about $100 for each foot.

"This is a new type of manufacturing. There are just three companies in the world that can offer these types of services, and five years ago they didn't exist," Professor Fuss said.

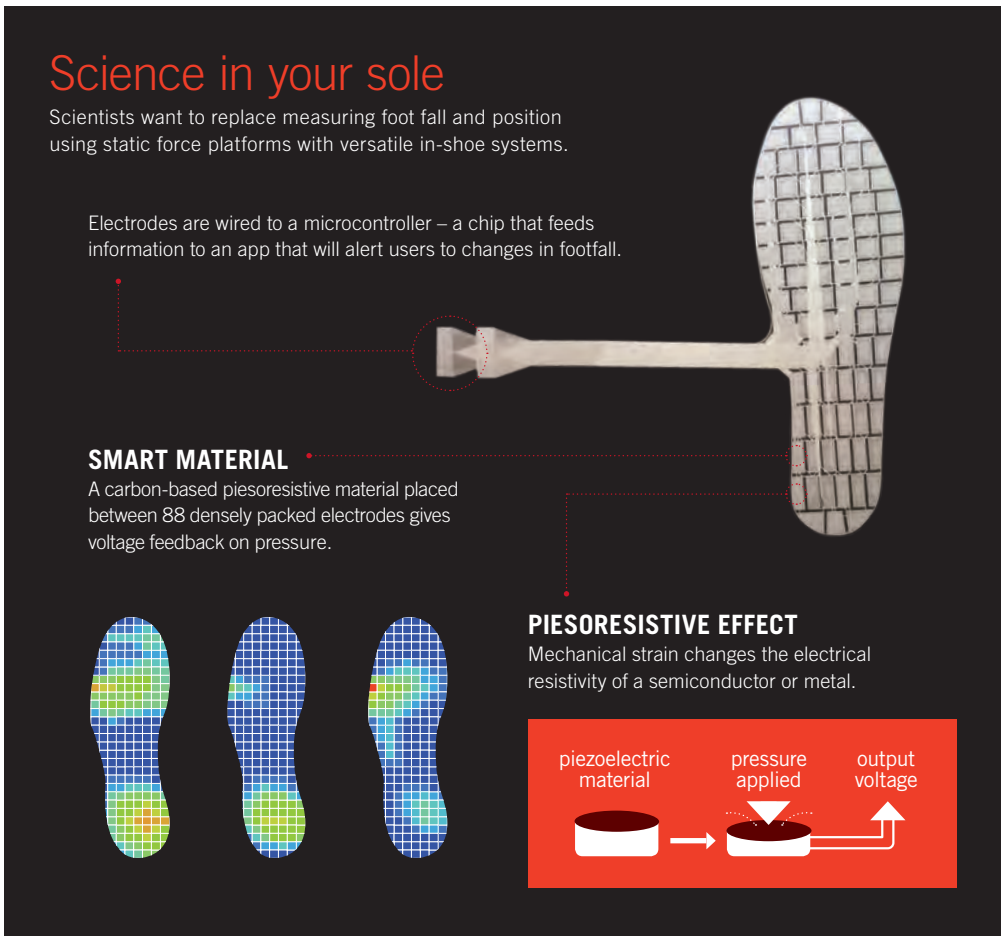
Professor Fuss said the product could also fill a gap in the commercial sports market for an affordable, high-resolution smart shoe insole.

He said it would give athletes fine-grained information about leg speed, steps taken and weight distribution.

The insole will be professionally trialled in 2018 with reigning AFL premiers, Richmond Football Club and the Cairns Taipans basketball team.

The insole is not the first sports product Professor Fuss has developed using high-resolution sensors. His first foray into the area was smart climbing walls, followed by a smart cricket ball that measures a multitude of physical and skill-related performance parameters.

Designed to help spin bowlers perfect their technique, it is being used by district cricket clubs in Melbourne and is being considered by the English Cricket Board for future use.



One of the sets designed by Professor Kim Vincs, a creative technology researcher at Swinburne. She has used digital scenography to provide an alternative to physical sets in regional locations.

MAKING A SCENE

A 3D digital stage backdrop has made it possible for regional audiences to enjoy opera performance with all the effects.

Opera productions are well known for their lavish sets and larger-than-life characters, but touring costs make it difficult for theatrical companies to take shows outside big cities.

A team from Swinburne University of Technology has created a 3D digital backdrop to bring groundbreaking theatre to rural audiences.

The virtual scenery was created for Victorian Opera's production of The Snow Queen, which premiered at The Cube, Wodonga, in north-east Victoria in November 2017.

Professor Kim Vincs, Director of digital scenography for The Snow Queen and creative technology researcher at Swinburne University of Technology, said that the digital scenography could replace the enormous, heavy backdrops used in opera performances.

"It doesn't cost as much to take the show on the road," said Vincs. "The performance can be shown anywhere with just a computer, projector and screen."

Using a game-building tool called Unreal Engine, Vincs and her team of digital artists from Swinburne's Department of Film and Animation built a virtual scene that was projected on to a screen at the back of the stage.

When the audience wore 3D glasses, the stereoscopic scenery created an illusion of volume and scale that conventional stage sets cannot achieve.

The team also used the tool to create a digitally animated Snow Queen character, with vocals provided by a singer on the side of the stage. The performers interacted with elements of the backdrop to tell the story.

In addition to opening artistic possibilities, using a digital backdrop allowed the team to work more closely with the chorus members from the Albury-Wodonga community.

"We were able to spend more time working with the community instead of building and moving sets," said Vincs.

Vincs said that taking an art-based approach to developing new technologies has its advantages. The fast-paced workflow enables the researchers to test new technology and come up with novel solutions.

"You're constantly evolving, developing and customising the technology for the theatre as you go," said Vincs.

The Snow Queen is the last of three 3D scenography projects Vincs created for Victorian Opera, including The Flying Dutchman and Four Saints in Three Acts. The project was funded by the Australian government through the Australian Research Council's Linkage Projects funding scheme.

The queen in the Victorian Opera's production of The Snow Queen, was an entirely digital creation.

Mutual learning for Indigenous inmates and students

A program specifically designed to address the needs of Aboriginal men in the prison system may be expanded after initial success.

A ground-breaking program to improve self-confidence, hope and re-integration prospects of Aboriginal and Torres Strait Islander men in a maximum-security prison is likely to be expanded to other institutions after positive preliminary results.

The program was designed by the Indigenous Group of Learning, which was established by Dr Justin Trounson, of Swinburne University of Technology, and his collaborator, Emily Munro-Harrison, of the University of Melbourne. The academics worked alongside the Castan Centre for Human Rights Law, and received funding from the Bennelong Foundation. The group's initial goal was to provide educational support and a positive learning space for Aboriginal men at Port Phillip Prison, on the outskirts of Melbourne.

Dr Trounson, Swinburne's inaugural Aboriginal and Torres Strait Islander Research Fellow, who is a psychologist, said the pilot program in early 2016 brought together volunteer student psychologists, many of them Indigenous, and prisoners, to develop a two-way learning experience in a culturally safe space.

"There are a lot of education and rehabilitation programs in prisons, but they often don't cater effectively for Aboriginal and Torres Strait Islander people. We were looking to fill that space," he said.

> "Preliminary results suggest it has improved self-confidence, sense of cultural identity and connection to community."

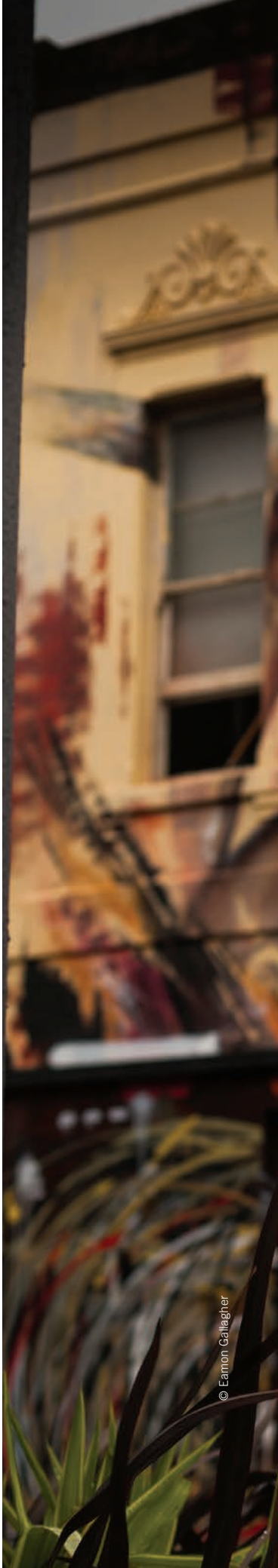
"It's the first of its kind that we're aware of that engages students from a wide range of areas of study to come in under supervision to help these men connect to services inside and outside the prison."

The program involves two-hour sessions each week that can include educational games, traditional painting, reading and discussing hopes, dreams and opportunities for life beyond prison.

More than 50 Indigenous men have been a part of the program. Preliminary results suggest it has improved self-confidence. Several said it had strengthened their sense of cultural identity and connection to the community. Dr Trounson said the early data also suggested a decline in the number of prison incidents attributed to poor behaviour.

In addition, he said the program appeared to have changed the way the student volunteers viewed the prisoners. Several indicated they now hoped to work in Indigenous-specific programs after graduating.

Supported by Dr Andrew Peters, a Swinburne Indigenous Studies and Tourism lecturer who is helping evaluate the program, the researchers are looking to expand to other prisons, and are developing models for others working in the area.



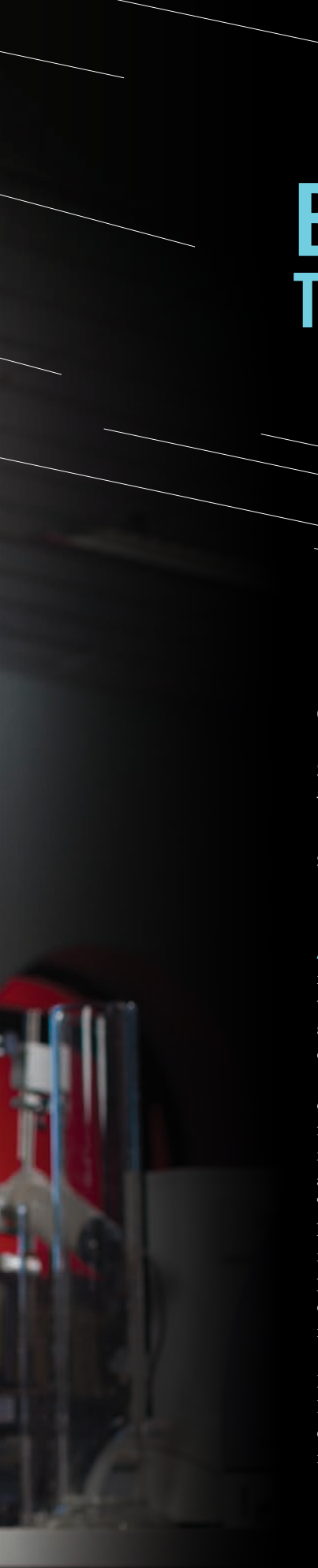
Psychologist Dr Justin Trounson helped set up the Indigenous Group of Learning, which has been providing eductional support and positive learning at Port Phillip Prison.

Multidisciplinary Research

The Manufacturing Futures Research Institute is one of five multidisciplinary and collaborative Research Institutes at Swinburne. The other four Research Institutes are focused on select disciplines which include Data Science, Health Innovation, Social Innovation and Smart Cities. The Swinburne Innovation Precinct has also been established to help start-ups and new business exploit the innovation being developed at the Institutes.

Professor Bronwyn Fox holds a sample of graphene coated fabric developed at the Manufacturing Futures Research Institute.

BUILDING THE FACTORY OF THE FUTURE



By riding the data revolution, a Research Institute at Swinburne is leading the way in intelligent manufacturing and smart products.

A new company called Imagine Intelligent Materials that specialises in making a graphene coating for textiles has emerged from an Institute at Swinburne University of Technology.

Imagine Intelligent Materials creates smart multi-functional fabrics whose graphene coating makes it possible to sense leaks and monitor structural integrity. The fabrics have applications in landfills, tailings dams or tunnels. Because of the electrical properties of the coating, a tear can be detected with an electronic sensor.

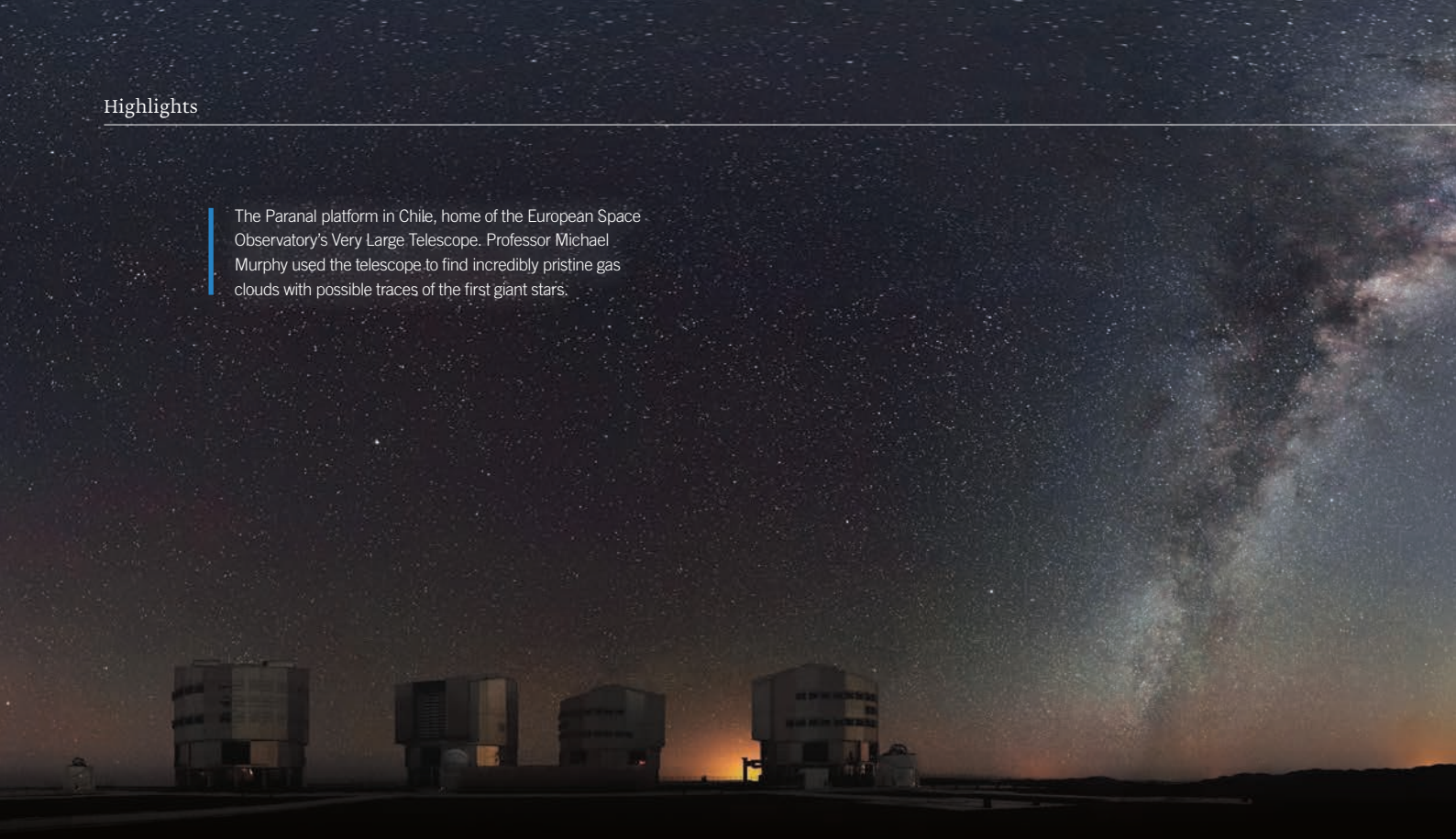
The Manufacturing Futures Research Institute at Swinburne's Hawthorn campus was founded in November 2016, with a mission to revive Australian manufacturing. There was a recognition that the sector needed to become more competitive by adding high-technology and data analytics to both products and the process for making them.

"Our focus is the 'digitisation' of manufacturing processes and products," explained its Director, Professor Bronwyn Fox. "As [industry body] the Advanced Manufacturing Growth Centre have highlighted, 41% of world trade is based on intermediate products and there's a big opportunity there for Australia to play a value-added role. We want to connect Australian firms to global supply chains."

Fox's team is in the process of setting up a fabrication facility with the capacity to produce 10 tonnes of graphene a year via a cost-efficient process called thermal exfoliation. It is also aiming to become the world's first graphene certification centre. A further three partners, one in aerospace and two in automotive, are working with the Institute to develop smart carbon fibre composites.

The Institute will also be home to the first 'Industry 4.0' lab in Australia where cutting edge data-driven technologies will be tested. The 4.0 refers to the so-called fourth industrial revolution which is empowered by data connectivity.

For example, a project with the Japanese drinks company Asahi, renowned for its beer, is investigating how data analytics and algorithms can be used to improve process control. Furthermore, the German technology giant, Siemens, has recently entered a record AU$135 million partnership with the Institute to explore opportunities for digitisation of the Factory of the Future and Industry 4.0 related research, including the Internet of Things.



The Paranal platform in Chile, home of the European Space Observatory's Very Large Telescope. Professor Michael Murphy used the telescope to find incredibly pristine gas clouds with possible traces of the first giant stars.

HUNT FOR THE ORIGINAL STARS

Ejected elements contaminating clouds of cosmic gas were an important clue for tracking down the Universe's first stars.

Astronomers from Swinburne University of Technology have for the first time found traces of the original stars in the Universe, in ancient, relatively pristine gas clouds. The discovery will help scientists understand how today's stars and galaxies formed.

The traces originate from a vastly different epoch in the Universe's history, more than 13 billion years ago, in which galaxies had not yet formed and the only stars were hot behemoths that burned up quickly and ended in huge explosions.

In the beginning, the Universe contained only the three lightest elements: hydrogen, helium and lithium. All heavier elements were created in the cores of stars and then flung out as those stars exploded, contaminating nearby gas clouds.

So many stars have exploded during the Universe's lifetime that nearly all cosmic gas is now contaminated with their remains.

So, it was pristine gas clouds that Professor Michael Murphy, from Swinburne's Centre for Astrophysics and Supercomputing, was looking for as he studied data from the Very Large Telescope in Chile.

"We were actually looking for gas with no contamination and we didn't find any. But we found gas clouds that are almost pristine — perhaps contaminated only by the first stars," Murphy said.

"They're actually more exciting than those with no contamination."

Glimpsing such gas clouds was rare, as they are dark and around 12 billion light years away. They can only be detected when they come between Earth and a quasar, an extremely bright object that is even further away. The chemicals in the gas cloud absorb colours from the quasar light in a unique pattern. This pattern is like a DNA sequence from the star that caused the original contamination.

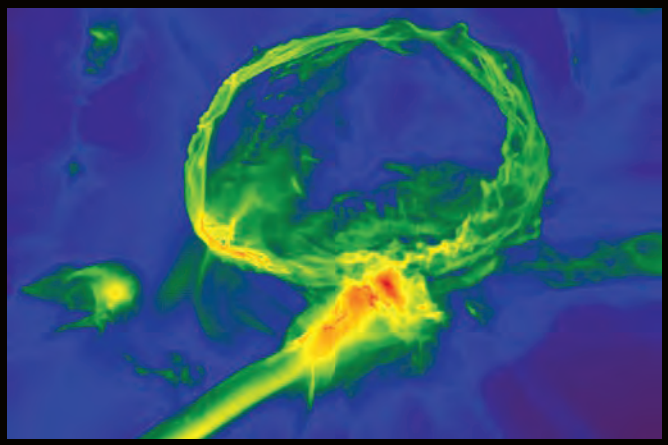
Murphy hypothesised that the faint traces of contamination in his recently discovered clouds were from the first giant stars, and hoped they would offer a window into the life and death of these giants.

"We don't have a direct way of understanding those stars, yet they set in motion many processes, such as how galaxies formed, and the stars that populate them today," Murphy said.

As he continues his hunt for the original stars, Murphy is hoping to find evidence of an especially spectacular explosion called a pair-instability supernova, which many theories predict produced the first elements heavier than lithium.

"They're much theorised about, but we've never seen one. They occur in high-mass stars with low contaminants, and produce electron-positron pairs in a runaway reaction when they explode," Murphy said.

His first data were too faint to pick out the unusually high levels of magnesium which are the tell-tale signature of a pair-instability supernova. But, through Swinburne's partnership with one of the world's largest telescopes, the Keck telescope in Hawaii, he is continuing the search and optimistic that he will find enough ancient gas to finally confirm pair-instability supernovae did exist.



Murphy is hoping to better understand the first supanovae, such as the one simulated above, and how they may have spread the first traces of heavy elements.

A LICENCE TO PRINT HOUSES

Building a house could soon be a case of 'click to print', thanks to the 3D concrete printers being pioneered at Swinburne University of Technology.

The transformative technology of 3D printing is shaking up many sectors of industry, but it's nothing compared to the disruption coming to construction. Professor Jay Sanjayan, Director of Swinburne's Centre for Sustainable Infrastructure and Professor of Concrete Structures at Swinburne University of Technology, leads a $1.3 million collaboration between seven Australian universities to develop 3D printing of concrete.

"Construction remains largely manual work, which makes it very expensive, and makes the global need for housing and infrastructure very hard to meet," Professor Sanjayan said. "Construction is open to be disrupted by automation, and 3D printing is one technology that can help."

Although 3D printers are commercially available for manufacturing, there are significant differences between printing aeroplane parts and printing a house. "Rather than factory conditions, we have to print out in the weather," Professor Sanjayan said. "Instead of a few kilos of materials, we have to handle tonnes. And although we don't need the same accuracy as the aerospace industry, we have to trade that for low cost."

To address the challenges, Professor Sanjayan has explored two approaches. The interim option is 'powder bed' 3D printing, in which the printer spreads a thin layer of concrete powder, then prints a water-based 'ink' that sets the concrete where the ink is applied. Layer by layer, the process is repeated. The challenge was to automate the collection and reuse of the vast quantities of unreacted powder that each print run generated, Sanjayan said.

> "Instead of a few kilos of materials, we have to handle tonnes."

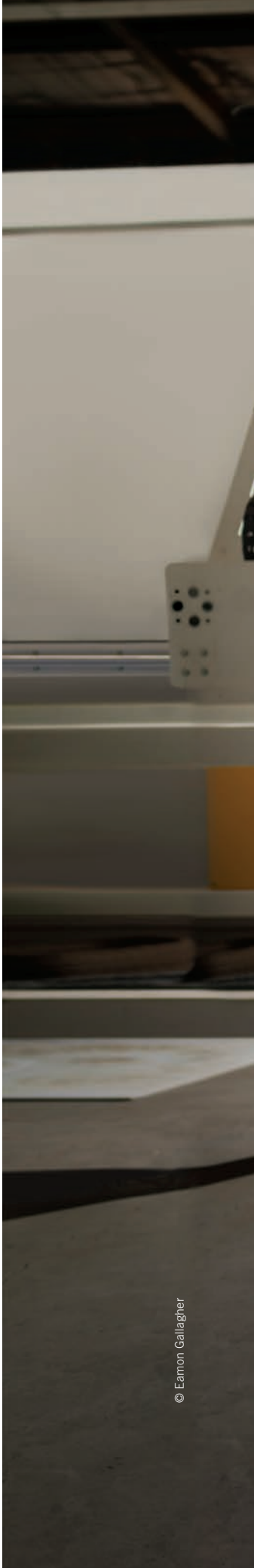
Powder bed was a good option for forming pre-cast sections of a building in a factory. "We can make very intricate structures." But it was not a process that could take place out in the wind and rain.

For on-site concrete printing, a machine is needed that extrudes liquid concrete, Professor Sanjayan said. "Here, the main issue is the concrete itself," he said. The concrete must remain liquid inside the printer, but set as soon as it is printed to retain its shape and so the next layer can be applied.

Traditional concrete doesn't behave this way. Currently, the most common approach is to heavily dose the concrete with chemical retardants that keep it liquid, then heavily dose with accelerators as it is extruded. But this approach compromises the mechanical properties of the finished product.

"We are coming up with new types of cement that have these properties intrinsically," Professor Sanjayan said. Though he's not able to disclose the details yet, one option is to use a geopolymer cement, a material made from an industrial waste called fly ash.

"Architects already design everything by computer," Sanjayan said. "Instead of printing their plans out on paper, with 3D printing we'll just press a button and the machine builds it — that's the ultimate dream."



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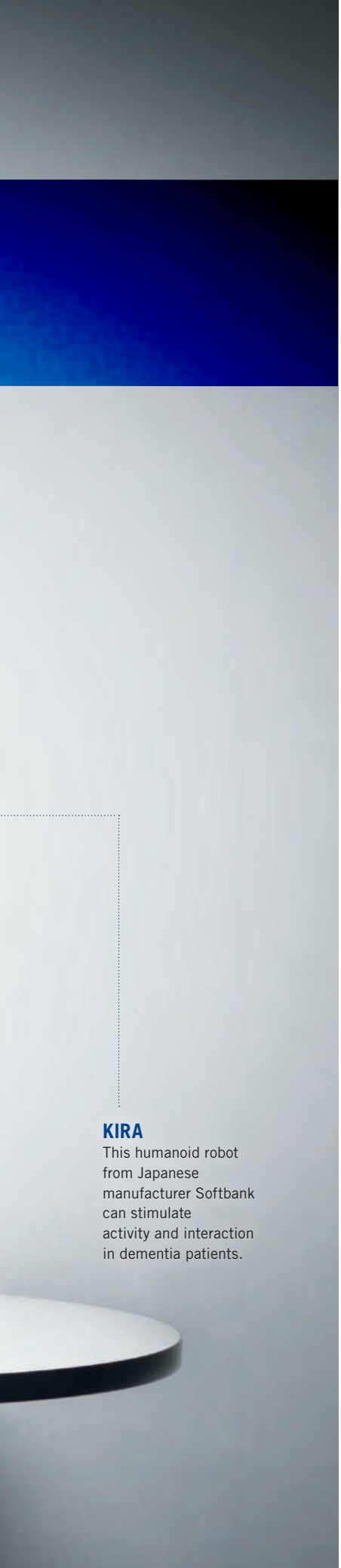
A concrete difference

Concrete and cement are words we tend to use interchangeably, but cement is actually one of the ingredients that goes into concrete, binding the mixture. Concrete typically contains about 10% cement, 70% aggregate (sand and stones) and about 20% water.

Professor Jay Sanjayan, Director of Swinburne's Centre for Sustainable Infrastructure and Professor of Concrete Structures leads a $1.3 million collaboration to develop 3D printing of concrete.

The Robot therapist is in

How a **pint-sized humanoid** is helping people of all ages get on their feet



KIRA
This humanoid robot from Japanese manufacturer Softbank can stimulate activity and interaction in dementia patients.

In a community room, a group of seniors living with dementia gathered around and watched as an instructor showed them how to do hip stretches. Raising one arm at a time, they followed the instructor's movements, seemingly unfazed that the instructor was a robot.

Researchers from Swinburne University of Technology are exploring the use of humanoid robots in care settings to determine whether intelligent machines can increase the quality of life for older adults and augment the role of human practitioners.

WINNING HEARTS AND MINDS

Associate Professor Sonja Pedell is the researcher involved in the dementia study. As the Director of Swinburne's Future Self and Design Living Lab, Associate Professor Pedell focuses on technology development and design, especially new technologies that can benefit elderly users.

"Our main aims are to increase quality of life for older adults by looking at built environments as well as technologies and social interactions," says Pedell. "We aim to combine these layers into a holistic solution. Another goal is to become an Australian leader in advocacy for older adults because ageism is a huge problem in our society."

Associate Professor Pedell, a psychologist, has been examining how the NAO humanoid robot can stimulate mobility and interactions among people with dementia. Originally developed in 2006 by France's Aldebaran Robotics (now SoftBank Robotics), the 58-cm-tall NAO is an endearing, walking, talking robot equipped with ultrasonic, tactile and other sensors as well as voice-recognition functions. NAO has played in the annual RoboCup soccer tournament, welcomed guests at a robot hotel in Japan, appeared in performing arts shows and served as a research platform in universities around the world. Some 10,000 NAOs have been sold around the world, and the droid is currently in its fifth generation.

In her research, Pedell introduced NAO to 30 seniors with dementia in a group setting. She and her collaborators created a female persona for the machine, naming it Kira. The robot was set up on a table and controlled via laptop in such a way that the remote control was not obvious. The exercises and dances performed by Kira elicited a positive response from the seniors, who showed interest in it, clapping along with it and trying to communicate with it.

"For me it meant that they had found something they were interested in and it wasn't imposed on them," says Pedell.

Another group of seniors in an 'ageing-well' program were similarly enamoured with little Kira. When the researchers returned for a follow-up visit, they found the participants had begun to knit and crochet clothes for Kira.

"It was important for me that they could make use of the technology demonstrating their skills and interests. They loved measuring the robot as part of the activity. We had a hilarious range of clothes — little woollen hats, jumpers, jackets and dresses."

One woman told Pedell, "I love her.

Devices such as Paro, a robotic seal pup laden with tactile sensors, have been shown in some studies to improve **quality of life** among some elderly populations.

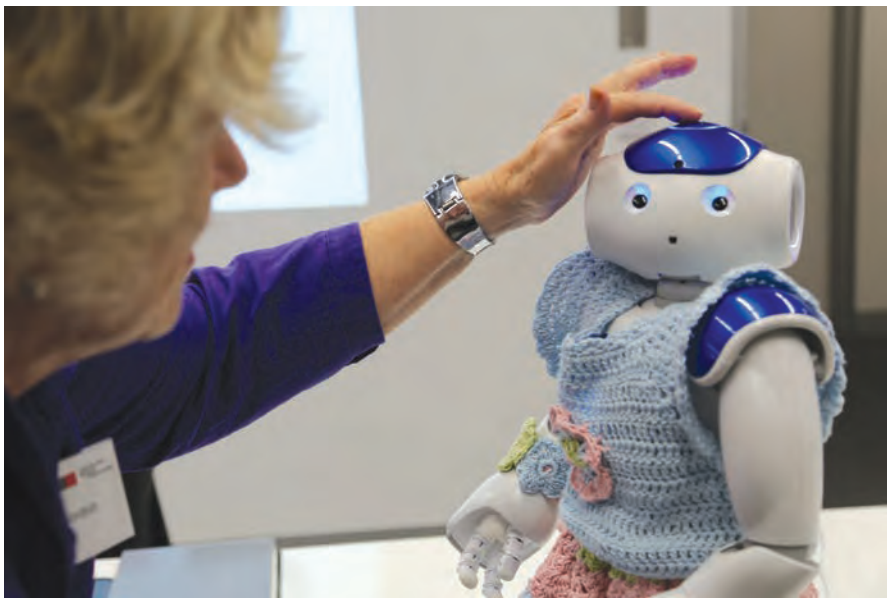
I would like to take her home with me." When asked what she would do with Kira at home, the woman's response was, "I would dance with her."

A paper presented at a 2015 conference sponsored by the International Association of Societies of Design Research said that the integration of robots in such care settings is "promising as long as interactions are carefully planned, designed and matched to familiar settings." It added: "Robots used in dementia groups are more suitable to be deployed for short spurts of interaction and entertainment than long-term engagement."

Robots for elderly care have been trialled in countries such as Japan, with its rapid increase in the elderly proportion of the population. Devices such as Paro, a robotic seal pup laden with tactile sensors, have been shown in some studies to improve quality of life among some elderly populations. Pedell, however, is wary about making any sweeping claims about how robots or any other form of technology can help engage elderly people.

While enhancing independence and social interaction are helpful, there isn't one solution that can do everything, she notes.

"I think of robots as very engaging and useful in a group setting, but I would be hesitant to make a home visit with a single person who hasn't had any interaction with robots," says Pedell.



A group of seniors with dementia were so engaged by Kira – a 58cm tall, walking and talking robot with touch sensors and speech recognition sofware – they crocheted clothes for 'her'.

"I think robots can help increase social interaction and feeling in touch with the world, but they can't replace it."

The Living Lab is preparing to open a space next year where researchers will evaluate a range of robots and other products in an everyday living environment. An advisory group of 12 people over the age of 70 will help researchers determine what it's really like to live with devices designed to help the elderly.

> "There's often a therapist there who will be trying to get the child to do particular exercises," says McCarthy. "The child won't necessarily follow a parents' instructions, but will very **happily take instructions from a robot**. So the robot is sort of acting like a mediator."

MEET YOUR NEW ROBOT COACH

NAO is also helping younger generations of patients and their caregivers. Dr Chris McCarthy, a lecturer in Swinburne's department of Computer Science and Software Engineering, is examining how the little humanoid can help children with cerebral palsy, aged 4 to 17, who have undergone corrective surgery. Most of the children walk with the assistance of a frame, but to regain lower-limb strength after surgery, they face many hours of gruelling physical rehabilitation therapy over weeks or months. The experience can be both stressful and frustrating for the children and their parents.

McCarthy has been trialling NAO as a therapy assistant at the Royal Children's Hospital (RCH) Melbourne. The goal here is twofold: to motivate children to complete more physiotherapy sessions so they can recover more completely in shorter periods; and if the robot is effective, freeing up physiotherapists so they can see more patients per day. McCarthy's approach of using a humanoid robot as a coach is unusual in that robots used in physical therapy are typically strength-boosting machines. For instance, the Hybrid Assistive Limb (HAL),

developed by Japanese startup, Cyberdyne, is a powered exoskeleton that has been used to enhance mobility for disabled and elderly users.

The NAO project, set up with a grant from the Transport Accident Commission in Victoria, aims to get injured children out of hospital as quickly as possible. It is based on an application by Leon Sterling, a Emeritus Professor in Swinburne's Faculty of Science, Engineering and Technology, along with Adam Scheinberg of the RCH rehabilitation department.

NAO has been pitching in with children's twice-daily exercise sessions. With the help of a therapist or parent controlling it via tablet, NAO has been demonstrating physiotherapy moves, such as how to form a body bridge by raising the hips off the floor, or getting a child to pick up a toy and bring it closer. NAO encourages kids with comments such as "When we're done, I will show you my awesome dance moves!" While NAO is following a programmed routine, customised comments are possible. For instance, if a child likes basketball, it might say, "Slam dunk, Derek!"

McCarthy believes NAO's engaging physical form and software programming are helping it win young friends. He asked physiotherapists to position the robot according to how they thought it should move, and those movements were captured by NAO's software. There were limitations: NAO doesn't walk the way humans do, so locomotion isn't part of the NAO sessions. Meanwhile, McCarthy's team designed NAO's interactions to make it seem more like a partner going through the rehab program along with the children. He's keen to point out that the goal isn't to replace the human rehabilitation expert, but merely to augment that service.

"There's often a therapist there who will be trying to get the child to do particular exercises," says McCarthy. "The child won't necessarily follow their instructions, but will very happily take instructions from a robot. So the robot is sort of acting like a mediator."

McCarthy and his collaborators have a year of data from the sessions with more

Interactive instructors

Dementia is a condition increasing in frequency across the globe. Methods to effect better quality of life for patients are keenly sought. However programming robots to substitute for human interaction may be counterproductive. Instead, Sonja Pedell of The Future Self and Design Lab at Swinburne sought to facilitate more human interaction via the robot.

EXERCISE/PHYSIOTHERAPY
Patients copied Kira's movements and displayed pride at doing things better. Pedell suggests that this may be less confronting than one-on-one human interaction.

DANCING
Robot Kira performed Give Me a Home Among the Gumtrees. Pedell noted positive verbal responses even from advanced dementia patients.

INTERACTION
In a 'meet and greet', the group showed a high level of interest in the meaning of Kira's behaviours and referred to the robot as 'her'.

INTERGRATION
When Kira started using a walking frame participants responded with surprise and a discussion around walkers, which Pedell's researchers observed, effectively broke the ice.

The structure, order and timing of the interaction was carefully planned. The NAO robot was programmed to dance and perform 16 physical exercises. Professor Pedell noted positive responses to human-like interactions with the robot.

McCarthy would also like to enhance its functionality so that it could do things like **respond to a child's feelings** during the rehab sessions.

than 50 patients as well as feedback from eight therapists. They rated NAO as useful and easy to use, and the anecdotal evidence suggests better patient compliance.

"Where has the robot been? We've had five years battling with rehab," one parent told McCarthy, while another told of her child's willingness to copy the exercises from the robot without argument.

McCarthy says it will be essential to promote continued cooperation even after the novelty wears off. "The novelty won't sustain. But over time, the children look for it to be responsive to what they say, so if you can tap into that and provide useful things back, they'll keep going. It seems like a genuine interaction to them, at least to the younger children."

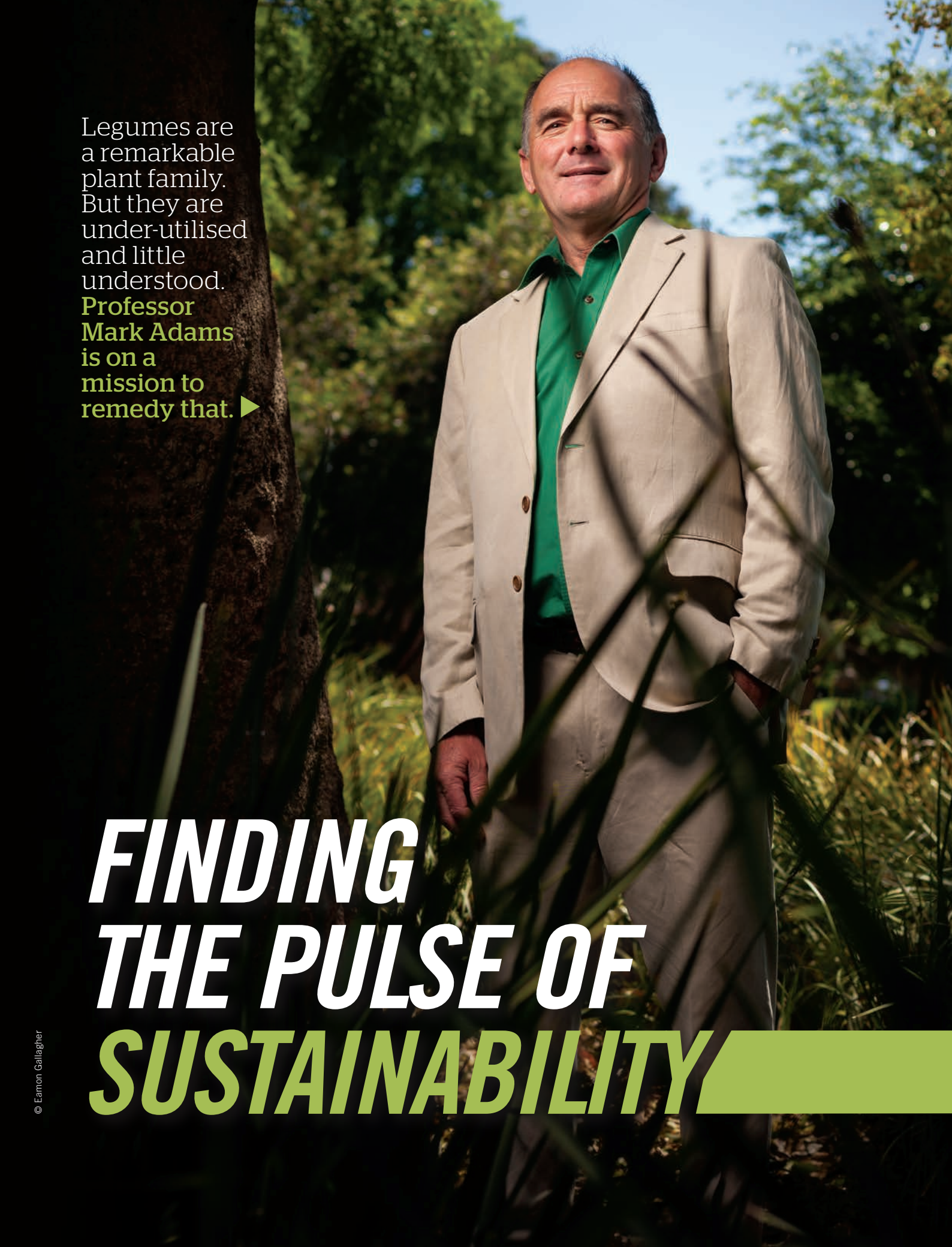
FUTURE DIRECTIONS

After introducing NAO to patients more frequently so it becomes part of their daily routine, McCarthy hopes to begin a randomised clinical trial to determine precisely how effective NAO can be with pediatric rehabilitation. That would complement previous research from the University of Portsmouth in the UK that has demonstrated how NAO can help improve social skills in children with autism-spectrum disorders. Researchers investigated how to increase the robot's autonomy to reduce the burden on therapists and to give patients a consistent therapeutic experience.

Having established NAO's basic role, McCarthy would also like to enhance its functionality so that it could do things like respond to a child's feelings during the rehab sessions. This could begin with the therapist changing the robot's mode via tablet, basically nudging it if the child needs a joke, a break, or a less demanding exercise. That could improve overall emotional wellbeing. An added benefit would be programming a monitoring function into NAO so it could track how many repetitions a child does per session, which would help therapists in decision-making for their care. As cloud-based artificial intelligence services proliferate, McCarthy expects to see a greater range of functions available to machines like NAO. But the goal is always better patient outcomes.

"We're really looking at what kinds of therapeutic benefits are being created through this," McCarthy says. "What we've got so far is data saying it's integrated well into the clinical setting. The therapists, parents and patients like it, but we need to go to the next step and show, for example, that children could be spending a day less in hospital because they've reached their target. That would be a great outcome. If the robot can make the child a bit more motivated, then we may see a lot more exercises per session, which is the ultimate goal."

Participants in an exercise group led by Kira and a therapist. The human therapist was retained in case the participants found the robot difficult to follow.



Legumes are a remarkable plant family. But they are under-utilised and little understood. **Professor Mark Adams is on a mission to remedy that.** ▶

FINDING THE PULSE OF SUSTAINABILITY

Mark Adams really likes beans. And peas. And lentils too. In fact he is a big fan of the whole plant family that pulses belong to: fabaceae. Adams is Professor of BioScience and Innovation at Swinburne University of Technology and he is looking into how legumes can play a role in helping us to meet our planet's current challenges.

"Legumes can help with a whole lot of stuff. They can help reduce your water and fertiliser demand, and help produce our dietary needs and wants," Professor Adams says.

The fabaceae include such staple edible members as the pulses and extend to other less obvious relatives such as wattle trees, liquorice and gorse. They are puny grasses such as alfalfa and mighty trees such as the Australian blackwood. They reach every continent on Earth, except frozen Antarctica, and their 19,000 species comprise as much as 7% of all flowering plants.

Common to this vast family is the fact that their roots are festooned with little baubles: nodules. Inside, in an oxygen-free environment, are bacteria, known collectively as rhizobia, that take nitrogen from the soil and turn it into useful molecules for the plant, such as amino acids and pigments.

As a rule, non-fabaceae plants rely on bacteria having recently been at work in the soil converting nitrogen to a useful form. They can't 'fix' their own nitrogen.

But all plants need the pigments, for example chlorophyll and rubisco, to absorb carbon dioxide from the air and turn it into sugars and growth for the plant.

"Trees can't take up the carbon without the nitrogen," says Professor Adams. "In plant leaves, sometimes as much as half of all the nitrogen is in the form of the photosynthetic enzymes and pigments. These enzymes and pigments are responsible for absorbing the energy from the Sun and then acquiring the carbon from the atmosphere. So we're not talking little stuff."

For thousands of years, atmospheric carbon dioxide levels have remained stable as plants absorbed carbon dioxide (CO_2) roughly in balance with processes that released it. But with humans' discovery of fossil fuels, carbon dioxide levels have soared. All the forests in the world are not keeping pace with modern society.

The implications of an overabundance of CO_2 are well known: more heat from the Sun will be trapped here on Earth and our weather patterns and life-sustaining ecosystems catastrophically disrupted.

"The world's forests are the biggest carbon sink that we know of. Every study has concluded, if you do your budgets, we know roughly how much we send up to the atmosphere; the tricky part is figuring out what comes back. The amount we send up we can work out because we know how much fossil fuel we consume and all the rest. But the harder part is always working out how much is being reabsorbed."

If you are just growing legumes, *you're using atmospheric N_2*. There's virtually no downside.

Key to the reabsorption equations, Professor Adams argues, is the availability of nitrogen.

"Plants can't do anything without nitrogen. They can't photosynthesise; they can't transport water; every aspect of plant metabolism requires nitrogen."

Professor Adams has been studying how nitrogen availability affects plants' ability to absorb carbon. He's trying to sort out exactly how legumes and other plants will respond to changing environmental conditions.

He says that while nitrogen's role was always clear, research in the last 20 years has focused on the more immediate question of carbon. But as the complexity of our understanding of the carbon cycle has matured, nitrogen's vital role is being reassessed.

And just as the carbon cycle has been altered by human activity, so too has the nitrogen cycle.

The discovery in the 20th century of the Haber-Bosch process (see box) dramatically changed the way humans grew food. With nitrogen-rich fertiliser suddenly on-tap, crops could grow faster and more productively and millions more mouths could be fed. But millions more tonnes of nitrogen were suddenly pulled out of the atmosphere and combined into polluting or bioavailable forms with unconsidered consequences.

In 1910, human activity released perhaps one million tonnes of nitrogen as fertiliser. In 2013, it was more like 110 million tonnes.

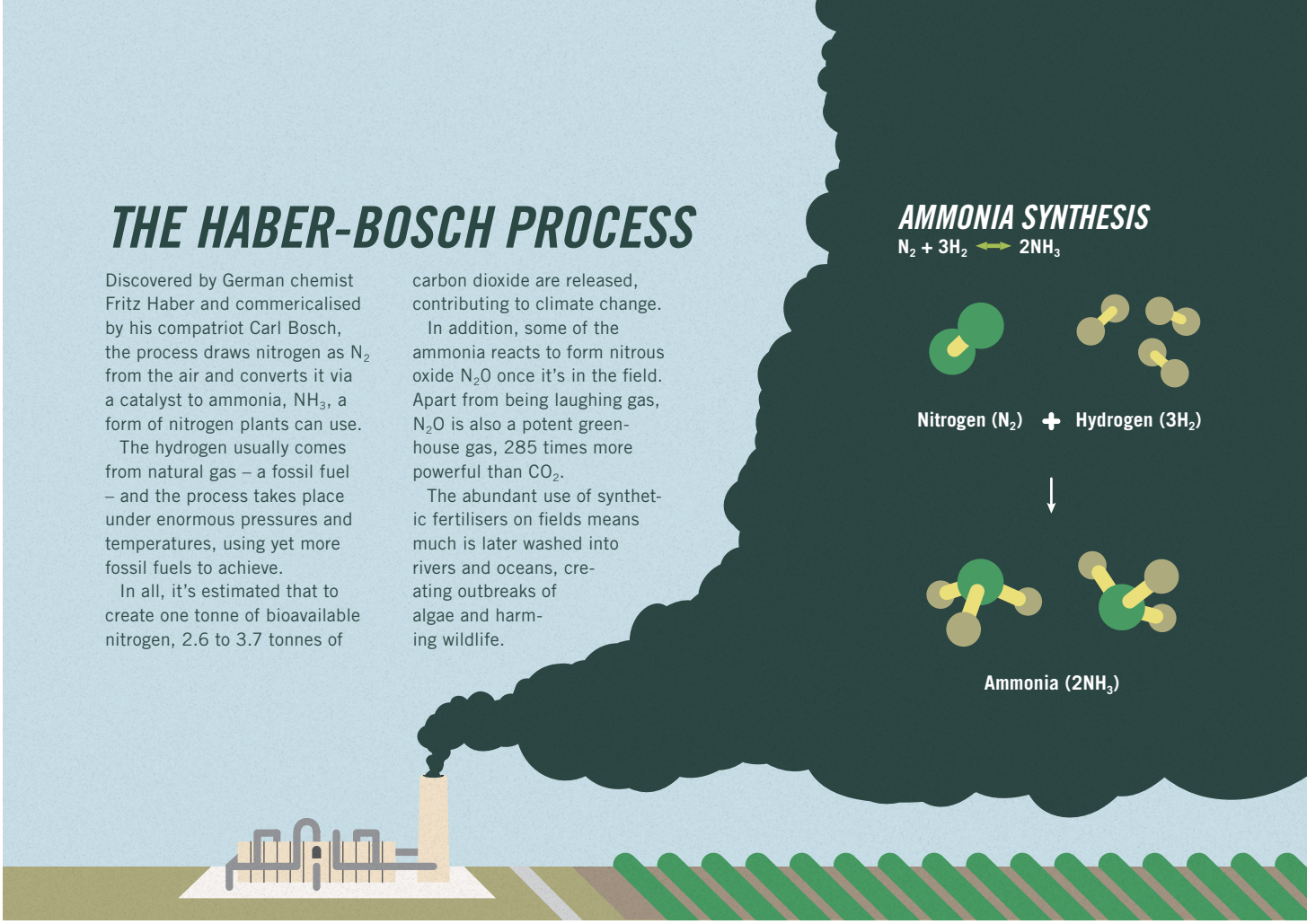
It is only now that questions are being raised as to what levels are sustainable, whether there are environmental impacts from too much available nitrogen, and how plants will respond to it.

GREEN BEANS

By rights, Professor Adams says, legumes should rule the world. They evolved on three or four independent occasions somewhere around 70 million years ago. Because they can make their own vital nitrogen supplies, they are not limited by the poverty of the soils they find themselves in. And, as recently uncovered by Adams, they are better at using water too. Perhaps because they're not so tied to soil nitrogen availability, they shut off their photosynthesis when they choose, meaning on a baking hot day, they can close their leaf pores and save some water.

"There's a slew of recent papers where people are looking at the distribution of legumes and the question is: why aren't they the preeminent group? It could just be that 60 to 70 million years isn't long enough. Give them a billion years and maybe they will be." Adams says we know so little about legumes that the answer to the question is yet to be uncovered.

He works in the arid lands of outback Australia, where the red earth is dotted with



spindly trees that may limit their growth for years before bursting forth in a wet season. He says out there, on plots he has maintained for decades, he studies how the acacias manage in such a tough environment.

"We've got more than 1,200 species of Acacia in Australia and the amount that we know about them would fit in a tea cup," Professor Adams says.

"Nearly every trip there's another Acacia," and he recounts the usual discussion: "'Which one is this one? I don't know. Does anyone know? No.' Then you go and ask the people in the botanic gardens and even they're not sure."

But he says the outback legumes are an "incredible national treasure" that could contribute much to the Australian economy and to efforts to mitigate climate change. Wattle-seed flour was used by the traditional owners, but has not been adopted by mainstream Australians; Mulga "is probably the best fuel wood you'll ever find"; even watering the Acacia to bring on a carbon-absorbing growth-spurt could have potential on global carbon markets.

Further exploring just the known legumes has much to offer in the way of carbon mitigation, says Professor Adams.

"If we changed people's diets to include more legumes and less wheat and corn, it would be a good thing. If you are just growing legumes, you're using atmospheric N_2. There's virtually no downside," says Professor Adams.

Rotating cereal crops with leguminous crops would top up the soil with nitrogen without any need for synthetic fertiliser.

"The beauty of legumes is that biological nitrogen fixation is self-regulating. Once the plant has enough, it shuts it down. So if we were only relying on biological nitrogen fixation for our agricultural nitrogen we would have a much more sustainable system because it's end-product inhibition."

The pulses could even be used to feed cattle instead of grain, which has the double benefit of fixing nitrogen in the soil and producing meat. He says that creating fertiliser, applying it to fields, growing grain, and feeding it to cattle involves releasing greenhouse gases at every step along the way. By growing legumes and then letting the cattle loose in the paddock, some of those steps and their associated greenhouse gases are removed, but with the same end result: fertilised fields and steak for dinner.

Directly eating the pulses — chick-pea curry for dinner instead of beef vindaloo — would remove yet another step and the associated greenhouse gases.

Adams admits that while the idea has scientific merit, getting humans to change their diets is a big ask. "Cultural changes are very difficult," he acknowledges.

But with more research into legumes, the opportunities are ripe for the picking. Crop yields could be improved and new uses, such as for automotive fuels, could be discovered.

The humble bean may have more global value than anyone realised and Mark Adams may be just the man to show its potential to the world.

Computing expert Professor Yang Xiang is leading global efforts to **detect and block malicious software** before it causes damage to companies and governments.

Organised crime has become more sophisticated over the past few decades. The guns, drugs and thugs that feature in Hollywood films still lurk, but working alongside them are hackers hell-bent on cashing in on the global internet trade.

Malicious software, or malware, written for the purpose of damaging or stealing private information, is operated by large organised crime networks, and can greatly damage companies and individuals.

Thankfully, the brightest minds in computing are fighting back against malware syndicates. Professor Yang Xiang, who joined Swinburne in July 2017 as Dean of the Digital Research & Innovation Capability Platform, has been at the forefront of cyber-security research for 20 years, developing new and ingenious ways to block or destroy malware attacks.

Professor Xiang became interested in computing when he touched the first-generation Apple Macintosh computers in his high school, and he went on to forge a successful career in Australia, receiving his PhD in Computer Science from Deakin University in 2007. A brief look at his list of more than 200 publications reveals the diversity of research that he has been involved in, from online healthcare and hotel management systems to programs that manage email overloads and filter out spam messages. He has even contributed to very topical work analysing how information or disinformation (fake news) spreads across social media. However, Xiang's greatest efforts have been in learning how to beat cyber criminals at their own game.

PROTECTION THROUGH INNOVATION

The work undertaken by Xiang and his many colleagues requires not only the best technical knowledge and skills, but also a fervent imagination and a willingness to draw on inspiration from wide fields of research in computing science and beyond. In early work, he developed countermeasures to combat so-called 'IP spoofing', whereby criminals imitate a trusted host in order to gain access to private files. As his career progressed he became a world expert in Distributed Denial of Service (DDoS), a type of cyber-attack in which the perpetrator may use thousands of different internet addresses to flood a victim's computer with attack code.

DDoS attacks are difficult to distinguish from regular network traffic, especially if they are implemented slowly over time.

"If there is a sudden high-rate DDoS attack, network administrators can see the flood of traffic relatively easy, but for low-rate attacks the traffic comes in small lumps that accumulate gradually, meaning it is more difficult to spot the anomalies," says Xiang. To create an algorithm sensitive enough to detect these low-rate attacks, Xiang and co-workers borrowed a concept from physics called entropy, which represents the level of disorder in the universe. "We essentially measure the level of disorder in the network traffic, and the areas of high entropy indicate an attack."

Another way to spot malware is to arrange potentially dangerous files with similar properties into groups. This so-called malware classification can be done automatically by computer software, but might miss some of the full potential of the malware. To improve malware classification, Xiang and co-workers have turned to a 'deep learning' approach, inspired by artificial intelligence research aiming to develop electronic brains that learn and make decisions on their own.

In 2016 a DDoS attack caused the website of the Australian Bureau of Statistics to crash.

"Deep learning has two advantages," says Xiang. "Firstly, it can analyse a huge number of malware samples without any human input. Secondly, it can provide us with very precise predictions regarding new versions of malware that are likely to appear. Previous malware classification algorithms were missing some of these finer details."

While Professor Xiang's efforts have undoubtedly helped prevent many attacks over the past 20 years, malware is still a problem if organisations don't take the necessary precautions. For example, in 2016 a DDoS attack caused the website of the Australian Bureau of Statistics to crash in the middle of its five-yearly census. "By the time they realised there was a DDoS attack, they couldn't fix it, and had to shut down the server," says Xiang. "Our technical solutions have to be implemented before the attacks; otherwise it's just too late."

REDUCING RANSOMS

In recent years, a particularly damaging form of malware, ransomware, has made headlines and millions of dollars for criminal hackers. In May 2017, a ransomware program called WannaCry targeted computers running Microsoft Windows around the world. This affected many organisations including the UK's National Health Service and the German

rail network, costing the global economy billions of dollars.

Ransomware works by using strong encryption algorithms to lock files and demands payments to unlock them. For many companies, this can be extremely damaging, because their online resources are even more important than their physical assets.

"Ransomware is not that new," says Xiang. "We first noticed it three years ago when it hit lots of small and medium-sized Australian businesses. Only recently did WannaCry make ransomware a global problem."

Xiang also believes that the problem has grown because criminals can demand payments in the virtual currency Bitcoin. "Bitcoin transactions are anonymous and untraceable, so it makes it much easier for criminals to gather money," he says.

What's more, for many companies simply paying the ransom might be an easier option than trying to fight the ransomware criminals. "Implementing a whole-company security system to protect against cyber-crime can be very expensive," says Xiang. "So in some cases companies will simply pay the few thousand dollars demanded by the ransomware because it's cheaper! If many companies do the same thing, it just helps the criminal industry to grow. However, it is very difficult for us to track who pays the ransom — a company might do it, but they would never say so because it would damage their image."

PRIVATE SECTOR INSIGHTS

To make sure that he keeps up-to-date with all the challenges on the frontline of malware defence, it is vital for Professor Xiang to maintain strong links with private companies. His most fruitful collaboration, which has lasted seven years, is with Dr Jonathan Oliver, a Director and senior data scientist at the security software company Trend Micro.

"Working with Trend Micro enables us to follow the most recent trends in cyber-security and to identify real-world problems," says Xiang. "It means we can conduct 'application-driven research' solving immediate, real problems." For example, because Trend Micro works with many other companies to improve security, they can provide Xiang and co-workers with some information regarding how many companies are hit by ransomware.

From Trend Micro's perspective, the in-depth research knowledge of academics like Xiang is essential to support and promote their work protecting other companies from harm.

"Hackers can feed compromised data into the algorithms... for example, if a self-driven car is fed compromised data it could go off road, or hit somebody."

"Cybercriminals have considerable resources, and their motivation is primarily financial," says Oliver. "At the same time the internet is constantly changing. Unfortunately, in the race to get new services and products out, security often gets left behind. This drives the need for the security industry and security research."

In an effort to ensure that companies place more priority on their security, Professor Xiang and Dr Oliver collaborated on a large Australian Research Council grant focused on web threats between 2012 and 2015. They produced some ground-breaking findings regarding abuse on social networks, and did vital research into the ransomware threats facing Australia.

This project led to positive outcomes for both the academic team and the company. "While Xiang was able to drive his team's academic research, we at Trend Micro were able to develop a ransomware alerting system open for anyone in Australia to sign up to. It was very popular," says Oliver. "Overall, I would suggest that the best research occurs when it is driven by real-world security concerns from industry, but is also combined with academic rigor. Yang and I look at the problems from different perspectives, which is mutually beneficial."

DIGGING DEEPER IN THE CODE

Professor Xiang's most recent projects aim to expand his toolkit of techniques for spotting and eliminating malware threats. Most notably, he is using deep learning algorithms to analyze not only the source codes of network traffic, but also the underlying binary code which is made up of just zeros and ones. "These fundamental codes beneath the source codes are much harder to analyse, but will give us a better indication of vulnerabilities," he says.

One project, in collaboration with Australia's leading digital research network, Data61, the government's Defence Science and Technology Group, and the University of Melbourne, is examining the problem of 'adversarial machine-learning'. This term describes a situation where machine-learning algorithms, similar to the ones that Xiang develops himself, could be turned to malicious uses.

"Machine-learning algorithms are now used widely, for example in Apple's Siri application," says Xiang. "Hackers can feed compromised data into the algorithms, causing them to produce false outcomes. This is potentially very dangerous. For example, if a self-driven car is fed compromised data it could go off road, or hit somebody."

Despite the immense challenges of his work, Professor Xiang remains optimistic that he and his co-workers around the world will continue to prevent most threats from having a serious impact. "The problem of cyber-security has always been there, and will still be there in the future," he says "Cyber criminals are becoming more and more professional, but so are we. We just need to make sure we keep winning the race when it matters!"

RISE OF MALWARE

Professor Yang Xiang is developing deep learning algorithms to spot malware attacks as they happen.

DISTRIBUTED DENIAL OF SERVICE (DDoS)

Distributed Denial of Service (DDoS) is a type of cyber-attack in which the perpetrator may use thousands of different internet addresses to flood a victim's computer with an attack code.

An alleged DDoS attack on Australia during the first online census led the Australian Bureau of Statistics to shut down its website. The map to the right shows the origin of international attacks on 9 August 2016, the night of the Australian census.

SOURCES OF DDoS ATTACKS ON AUSTRALIA, 9 AUGUST 2016 (CENSUS NIGHT)

RANSOMWARE

Professor Yang Xiang thinks that the rise of untraceable crypto-currency such as Bitcoin is increasing the use of ransomware — a type of malware that works by using strong encryption algorithms to lock files, demanding payments to unlock them.

RANSOMWARE ATTACKS, 2014-2016 (MILLIONS)

60% of malware payloads were ransomware in Q1 2017.

WannaCry

STARTED: 12 May 2017
COUNTRIES AFFECTED: 150+
SYSTEMS AFFECTED: 230,000+
RANSOM: $US300 within 3 days, $US600 within 7 days
TYPE: WannaCry is considered a network 'worm' because it also includes a transport mechanism to automatically spread.
TARGET: Microsoft operating systems that had either had a backdoor installed in the months previously or were running old operating systems.

NotPetya

STARTED: 27 June 2017
COUNTRIES AFFECTED: 60+ (est.)
SYSTEMS AFFECTED: 16,000+
RANSOM: $US10,000+
TYPE: NotPetya is not officially considered ransomware as there was no way for the attackers to unlock computers. The cyber attack appeared to be focussed on destruction rather than financial motivation.
TARGET: Microsoft operating systems seeded through a software update mechanism built into an accounting program from the Ukraine.

72% of infected businesses lost access to data for two days or more

Mapping the enterprise of recovery

Professor Jane Farmer is working to understand how social enterprises help people and to distill findings into a 'how-to' kit for communities and government.

"There was one story where a guy came in with a walking frame, and after some time, he developed strength and confidence, was up and walking around by himself.

"Sounds like a bible story, right?"

Professor Jane Farmer has a large collection of similar anecdotes. As the Director of the Swinburne Social Innovation Research Institute, she is particularly interested in schemes to enable people in Australia's rural and regional towns. In the anecdote above, the disabled man was rehabilitated through working with an employer that exists to improve the lives of its disadvantaged employees, a so-called 'social enterprise'.

Professor Farmer wants to know how these organisations improve the wellbeing of their employees and volunteers, and how this can be replicated. The employees of the social enterprises in Farmer's study come from a range of backgrounds, many coping with physical and mental health challenges. Some have current or previous addiction issues. Others come through the corrections system. What's common is that social enterprise employees can have low self-confidence, communication difficulties, emotional problems, which can often lead to the ramifications of abuse and neglect.

"There's a whole lot of darkness in some of these lives. If people had terrible trauma and abuse, a lot of their stories start with that, but then, they talk about recovery," says Farmer.

The social enterprises play a central role in this recovery through facilitating social interaction, providing skills training, and offering support and a welcoming, secure environment.

Aside from the common-sense notion that this is beneficial to employees, there is a lack of research into understanding how those benefits are achieved.

"It can be easy to lose track of how it works," says Michael Langdon, the Chief Executive of Access Australia, a social enterprise group and employment service provider working with Farmer. "If there is a staff turnover, for instance, or if it moves campus, you can be left thinking 'what was so good about that spot that isn't working here?' And if you haven't collected the data, you don't really know."

With the support of a coveted Australian Research Council (ARC) grant and a team of nine researchers from Australian and Scottish institutions, Farmer is embarking on the first fully-fledged, data-driven investigation into how social enterprises achieve wellbeing for and with their participants. With AUD$257,000 in backing over three years, the researchers will shadow employees from Victoria and Tasmania with the aim of understanding which environments, situations, and physical spaces provide the most tangible benefits. The concept of social enterprise is being embraced by the Victorian government, which has recently pledged AUD$5 million to nurture the 20,000 social enterprises that are based in the state.

CAUGHT ON CAMERA

Professor Farmer's Research Fellow, Tracy De Cotta, is responsible for collecting data from the Victorian-based organisations: "To begin with, I'm getting people to do a mental mapping exercise. I'll have a blank piece of paper and I'll ask them to draw me their day."

She says it gets them thinking about their routine, and gives the researchers a baseline of their daily life.

The communication difficulties experienced by many of De Cotta's interviewees demanded that she innovate. "Traditional data collection would involve us interviewing them, transcribing it, and gaining insights through their language. But when language is missing, we've got to find another way to gauge how they're feeling, which is why we're using the camera."

A 360°, GPS-enabled camera allows De Cotta — and, remotely, her Tasmanian-based colleagues — to walk with the employees around the social enterprise and converse with them naturally, all the while recording their speech, experiences, body language and physical location.

"Afterwards, we can watch that. There's my interpretation of their behaviour when I'm doing the walking interview with them, and also the other researchers can watch the film and analyse the reactions, rather than just having a transcript."

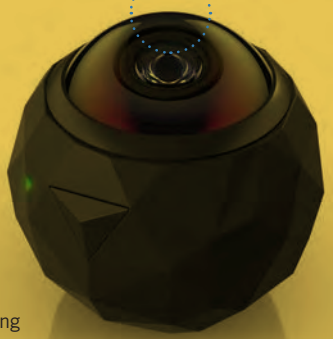
After taking a tour of their workplace, the researchers go with the employees out into the community. An integral aspect of Farmer's study is also to find out how they affect the local community. All of the social enterprises have employees engaged in work and life experiences that interact with the local community's function. In the social enterprises, employees do woodwork such as building fences or benches, delivering meals to local government buildings, or washing fleet cars. Asking the employees to walk them around their town gives the scientists first-hand insights into their lives and, importantly, how they feel about themselves, their work, and how their lives intersect with what is going on in the community. As they benefit by getting well, they are also likely to be benefitting the community's general wellbeing.

"One of the deep-seated, awesome things about the project is that it's built on the multidisciplinary 'spaces of wellbeing theory'," explains Professor Farmer.

"The theory was built by a cross-disciplinary researcher called Sarah Atkinson. She discovered that the literature on wellbeing lives in a number of different disciplines. There's evidence about wellbeing in psychology and medicine, but also in social sciences and geography.

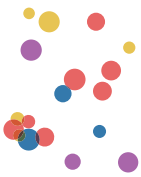
"She pulled the literature together and identified four universal dimensions of wellbeing: interaction, capability, security, and therapy. So, when we go into the social enterprises, we're looking for that — where are people developing capability? Where are they getting interaction? Therapy? Security?"

She says that the researchers examine the kinds of stories the employees share.



Tech for talk

The 360fly (right) was developed in a robotics lab and has a 360° horizontal and 240° vertical view — one of the widest in the world. It allowed Swinburne researchers to non-invasively capture 3D footage of walking conversations and play it back for analysis and geo-tagging. This will lead to maps visualising the effects of social enterprises in communities.



"This means that **social enterprises** can be compared using numerical evaluations of what spaces provide the most benefit to their occupiers."

"They might be saying 'I used to take drugs. I used to hang out on that corner, but now I've come here, and I've made friends.'

"They might say 'see that park bench there? Me and my mates made that. I didn't know how to do woodwork before I came to the social enterprise, but now I know how to make things.' The bench becomes symbolic of the fact they've grown capability. It's also symbolic of interaction because they made it with their mates at the social enterprise. If it's located in the community, like a park, they understand that the public values their work — and them — important for self-esteem."

Considering the past trauma and psychological difficulties suffered by their subjects, the researchers need to exercise caution in their data collection, as well as empathy and compassion. "I think the questions we're asking, even though they interrogate their feelings, are positively structured," says De Cotta. "I'm not trying to drag up their past. If they want to share it, they do."

Farmer and her collaborators plan to combine each piece of reaction data with their physical location in a geographical information system (or GIS), thereby aggregating the masses of qualitative information — opinions and experiences of an environment — into collations of quantitative data relating to where people get integration, capability, security and therapy. This means that social enterprises can be compared using numerical evaluations of what spaces provide the most benefit to their occupiers.

"With this data, we can produce a map of the organisation and the community, overlay the quantitative data and show topographical visualisations or heatmaps of which places and spaces are those benefitting the people the most," says Farmer.

"Another great thing about data visualisation is that it's equalising and accessible. You can show it to the people at the social enterprise, and they'll look at it and say 'Wow! That's cool!' And you'll get the same reaction from researchers and politicians — pictures are accessible to everyone."

HELPFUL COMPARSION

In her own words, Farmer is a "social scientist with a long history of looking at how communities can address disadvantage."

"I grew up in a rural community," she says. "And today, I can relate to a lot of the things I see in those environments. At the same time, I'm really interested in peoples' stories, and every one of these communities is a setting for amazing stories."

Before moving to Australia from Scotland in 2010, Farmer was the Co-Director of the Centre for Rural Health Research at the University of the Highlands and Islands. It was there that she spearheaded the project Older People for Older People (O4O), a large-scale multidisciplinary study that could perhaps be described as the spiritual predecessor to her current research. It was also there that she met health geographer Sarah-Anne Munoz, Scottish partner investigator on the ARC social enterprise project and a major collaborator and inspiration in the project.

The team aims to make their data practically useful. There are plans to build an interactive app that a policymaker can use to walk around an area and receive geographically relevant stories from social enterprise employees. Ultimately, the team aims to produce guidelines to help design future social enterprises.

The significance of winning the ARC funding isn't lost on Farmer: "It's a bit of a coup to get ARC funding." But mostly she's just glad that she has the means to continue such meaningful work. "It's a brilliant project. It's got good things at the heart of it."

LOCATING VALUE

In 2012 and 2013 the federal Productivity Comission flagged a paucity of methodologies for measuring the disadvantage and the non-profit sector. The Swinburne Social Innovation Research Institute is taking up the challenge and looking at how to map the effect of social enterprises (such as 'men's sheds'). They want to understand how these may be producing health and well-being benefits for disadvantaged participants at the site and in the community. A series of case studies in regional Victoria looked into how social enterprises produced well-being in participants such as integration, capability, security and therapy. Over five visits they did analysis, talked to focus groups, did walking interviews and data location-tagged the values they observed.

INTEGRATION
Inter-relations that help embed individuals in social networks.

CAPABILITY
Inter-relations that facilitate physical and social mobility; skills to lead a flourishing life; helping to overcome stigmatisation

THERAPY
Inter-relations that help with physical, mental and emotional healing

SECURITY
Inter-relations that increase understanding of, and offer protection from, contemporary social and environmental risks

> The disability service boys had a game of basketball..they were colliding with each other, they didn't give a damn they just keep going…unreal. –**PHIL**

OLIVER: I used to play video games, but what the Shed has done, is everyone knows me, and I know how to talk to a lot of the people around here, and it's…and I've got my own little business too…cup holding business…I make cup holders…so… it's community based…For me it's about being part of the community. I never wanted to be treated differently, I couldn't care less if I had a disability or not, I still have to wake up with a disability, it's not going to change so, you might as well be treated the same way.

PHIL: We go in here for some relaxing…for exercise…we used to have a lady come in and we used to go in here for exercises… it was like a bit of combination, but it was like Tai Chi, it's got a bit of like martial arts defence mechanism. It certainly made me feel good. You see this leg moves better than it was, It just needed exercising, she wasn't aggressive with the movements, not aggressive so they can't harm you…

PHIL ON BEING LESS DEFENSIVE

SPONSORSHIP HELPS FIX WHEELCHAIRS

ERIC AND OLIVER PLAY CRICKET

ERIC: I walk – well, I drive – my chair to Green Town Road near Spotlight and then get on the bus and come out here.

INTERVIEWER: Did you used to do that before?

OLIVER: Me, no I didn't.

ERIC: No. I never used to. My mum took me everywhere until I moved to my own place four years ago. Wasn't it? Yeah and Xavier showed me how to get the bus and stuff and then, it was a month or so wasn't it? ...and then I can do it on my own now. We go to Melbourne for the day on our own, and then we come back.

OLIVER: When we see the gardener that we know, yeah we talk about other stuff. That interaction we have in the street….just stop by and have a chat…

ERIC: We'd probably never have done that before.

> I would never have darkened the door of a bank before this. –**PHIL**

PHIL'S CHEMIST EXPERIENCE IMPROVES

PLAYING TO THEIR STRENGTHS

Swinburne is cutting a new path to health innovation, creating an Institute that cherry-picks **the best researchers for multidisciplinary projects**.

Nina Eikelis
Medical researcher
Looking into the blood of young overweight and obese adults.

© Eamon Gallagher

Medical researcher Associate Professor Elisabeth Lambert was shocked to read last year of a study showing that, compared to the general population in Australia, adults with intellectual disabilities are twice as likely to die from potentially avoidable causes.

The research, published in the journal *BMJ Open* in January 2017, identified that the life expectancy of adults with intellectual disabilities was 27 years shorter than for other Australians.

Now, with the support of Swinburne University of Technology's new Iverson Health Innovation Research Institute, Lambert is setting up a research project aimed at identifying the reasons behind those alarming statistics. She hopes the work will ultimately improve the quality of life of people with intellectual disabilities by helping guide the development of programs that respond to the underlying health issues they face.

"People with intellectual disabilities do not necessarily have any physical disability," says Associate Professor Lambert, who joined Swinburne as a senior Research Fellow in February 2017. "Realistically, there is no reason why those people should have a shorter life expectancy than the rest of the population, or die from causes that can absolutely be avoided."

A NEW INSTITUTE

The focus of Lambert's new study is the sort of real-world health challenge the Iverson has been created to tackle. One of Swinburne University of Technology's five new virtual Institutes (see page 26), it is named after Professor Don Iverson, the founding Dean of the University's Faculty of Health Arts and Design, who died not long before the Institute's launch. His perspectives on health and research are clear in the framework of the new Institute. Described as a "visionary academic", Professor Iverson was one of the architects of Australia's national breast cancer research program and was passionate about the capabilities of cross-disciplinary research and the seamless connection between health, the humanities, and design.

"I think one of the great aspects of the Iverson is that it has a very proactive and modern view and is not stuck in [separated] silos of activity," says the Institute's founding

The Iverson Health Innovation Research Institute brings an interdisciplinary cohort together from health, sciences, engineering and design to solve real-world health challenges.

Simon Moulton
Bioengineering Program Leader
Developing heat-sensitive hydrogels for peptide and drug delivery.

Gavin Lambert
Director and neurochemist
Looking into new approaches to treating fatty liver disease.

Sarah Phillips
Medical researcher
Exploring large clinical datasets and improving data security.

Jason Howitt
Neurobiologist
Therapeutically targeting autism with macrocephaly (a brain growth problem).

Elisabeth Lambert
Clinical researcher
Looking into why the life expectancy of adults with intellectual disabilities is 27 years shorter than for other Australians.

Penny Schofield
Behavioural scientist
Further developing mobile app REMIND to improve adherence to medications.

IMPROVING IMPLANTS

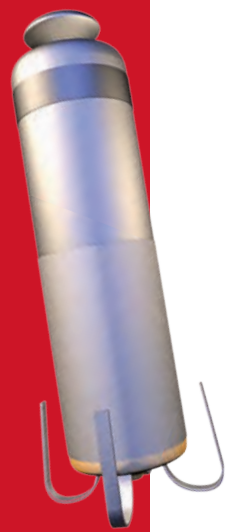
Simon Moulton, Swinburne's Professor of Biomedical Electromaterials Science who leads Iverson's Bioengineering Program, is developing a coating for implanted electronic devices that safely shields them from the body's inflammatory response.

Moulton explains that implanted electrodes absorb biological materials produced by the body's natural defences. These build up and encase the device impeding the transmission of electrical signals. It means devices need to be replaced because their function is reduced.

The Swinburne-led project is already having remarkable success with the development of a compound found in the synovial fluid that bathes human joints.

"We've shown in our published work that we can produce a 99% reduction in biomaterial absorption when exposed to protein solutions and human blood plasma," Moulton explains. "But we also see no decrease in electrical efficiency of the devices."

The technology has wide-reaching implications for the future development of implantable electrodes for bionic devices such as deep-brain stimulation devices and cochlear implants.



Better coatings could improve the longevity of devices such as pacemakers (right).

Director, Professor Gavin Lambert (who is married to Elisabeth Lambert). A highly experienced neurochemist and clinical research scientist, he is the former Head of the Human Neurotransmitters Laboratory at the Baker Heart & Diabetes Institute (the Baker Institute).

"[The Iverson] also has the advantage of not being confined if you need expertise," Professor Lambert says, citing a current project, supported by the institute, investigating the development of intelligent shoe insoles capable of identifying pressure points to help diagnose the circulation problems commonly found in people with diabetes (see page 19). "On that project we are working with clinicians, people who specialise in gait analysis, specialists in diabetes, occupational therapists and then the electronic engineers who actually have to make the sensors. "In many ways this describes the approach the Iverson has."

THE HEART OF THE PROBLEM

Associate Professor Elisabeth Lambert's expertise is in cardiovascular disease and diabetes, having previously worked for many years at the Baker Institute as well. In common with the rest of the population, the primary cause of death in people with intellectual disabilities is cardiovascular disease (CVD), and this is where she will mainly direct her study. Just as there are many ways to reduce the risk factors associated with CVD in the general population, it should be the same for those with intellectual disabilities.

"We want to understand the factors that have an impact on the health of people with intellectual disabilities, to explain why they have an elevated mortality rate," she says. "There may be issues from a socioeconomic point of view or issues accessing health services. They may have more stress, exercise less, smoke more, poor adherence to medication. There are a lot of possible reasons.

"We would love to identify some of those influencing factors, because we know some of those premature deaths are preventable."

The project is partnering with the non-profit Victoria-based disability service, Yooralla. As part of its service to people with intellectual disabilities, Yooralla offers annual health checks, and Associate Professor Lambert is presently seeking permission from those people who use this service, and their advocates, to access these medical records. Those who agree will be sent questionnaires to assess lifestyle influences on their health.

Another member of the multi-disciplinary team assembled for the project is a researcher from Swinburne's School of Health Sciences who has experience in intellectual disabilities and policies surrounding health promotion and support issues. Associate Professor Lambert is also bringing on board Swinburne statisticians and analysts who'll be able to crunch the data she collects. It's expected that the collection of data for the project will run for at least three years.

REMIND was a pilot system Schofield devised to ensure CML sufferers **ADHERED FIRMLY TO THEIR REQUIRED DRUG REGIME.**

CRUNCHING THE DATA

The Iverson's research has general themes focused in one or more of Australia's most rapidly growing health areas. They cover: chronic disease and disability; personalised health; bioengineering; and digital health.

A common thread through these is big data. And that, says Professor Lambert, will be one of the Iverson's strengths. "At Swinburne we have access to a lot of people with mathematics, and data science expertise," he says, explaining that Swinburne's astronomers, for instance, have skills, developed through analysing data about gravitational waves, that may be relevant to health-related big data.

While Swinburne's historic strengths in engineering are expected to make major contributions to Iverson projects they'll also be benefitting from recent large expansions by the university in the area of allied health, Professor Lambert says. This includes physiotherapy, nursing and dietetics, all of which are particularly valuable for any organisation now trying to focus on health innovation.

"The fact that we don't have a hospital or a medical school means we can reach out and work with any health provider," he says. And so the Iverson has ongoing partnerships and programs underway with The Baker Institute, Peter MacCallum Cancer Centre and the Victorian Comprehensive Cancer Centre. It is also working on projects with Medibank that involve using data collected by the health insurer and applying it to projects aimed at improved health outcomes.

In the area of personalised health, the Iverson is already coordinating a range of digital health initiatives at Swinburne aimed at addressing problems in mental health, oncology, cardiovascular disease, diabetes, pain and Alzheimer's. It is close to developing a medication adherence solution which also has commercial potential.

TAKING THEIR MEDICINE

Failure to correctly take medications can seriously compromise health, and cost the community a lot of money. It's estimated that medication errors — patients either incorrectly taking prescribed medications or taking medications that are contraindicated — cost $1.2 billion annually in hospital admissions.

Several years ago Professor Penny Schofield, a behavioural scientist, developed a mobile health system (m-system) that she called REMIND, to improve oral drug adherence and patient self-management among sufferers of chronic myeloid leukemia (CML).

Previously, this adult blood cancer was a certain death sentence. But about 10 years ago, a hugely successful treatment was discovered in the form of a drug called Imatinib. It doesn't cure the disease but if patients faithfully take at least 90% of what's prescribed to them, they can have an otherwise normal lifespan.

However, Schofield says, if they don't stick strictly to that adherence rate the disease progresses to what's known as a blastic form, after which they usually die within six months.

REMIND was a pilot system Schofield devised to ensure CML sufferers adhered firmly to their required drug regime. Although the project was clinically successful, funds were not available to take it to a commercially available stage, partly because it was relevant only to sufferers of CML, which is a particularly rare condition.

Shortly after the Iverson was launched, however, Professor Schofield was one of the first researchers the Institute approached, to discuss resurrecting the REMIND project for a broader range of diseases and conditions. "Swinburne has now invested substantially in rebuilding REMIND and is moving towards commercialising it," Schofield says.

Schofield joined Swinburne as Professor of Health Psychology, although she's since been partially seconded back to Peter Mac. Her m-health system, which not only helps ensure patients stick strictly to their medication requirements, also gathers data about when and why patients fail to take their medication and feeds that information back to clinicians. The aim is to integrate the m-health platform with routine clinical care. It has potential application for a wide range of chronic illnesses, including cardiovascular disease and HIV, which is now no longer necessarily deadly, provided patients adhere to medication regimes.

The experience has been particularly rewarding. "Swinburne is not just interested in generating the research evidence, but generating a product with commercial value, and this to me is quite novel," she explains.

Professor Schofield spent 30 years in research where publication was a major source of her professional output. But realises that was only part of the research process, albeit a very important one. "What I get excited about now is solving real-world problems, I don't just want to generate the evidence for someone else to solve the problem." And the opportunities to achieve that, at Swinburne, she says, make the possibilities for researchers particularly exciting.

SWEETER PILL TO SWALLOW

Iverson's ProfessorPenny Schofield knows perfect adherence to a critical treatment for chronic myeloid leukemia is reported to be as low as 14%. She has developed REMIND to help patients with this and hopes to extend its usefulness to other medication regimens. Research has shown up to 50% of medications for chronic disease are not taken as prescribed. This contributes to more than a billion dollars in hospital admissions every year.

Lab stars in the limelite

From learning apps to soil improvers, the fruits of Swinburne research are hitting the market

LIMELITE

Professor Blair Kuys from the School of Design at Swinburne worked with lighting company LimeLite to produce a bespoke range of 3D-printed lights. Several technical challenges needed to be overcome, including keeping the lighting electrics cool and creating a process that could manufacture at volume. The result is a design that is impossible to produce with any other method and best of all for LimeLite, there is no risk of an unpopular design languishing on the shelf as each piece is made to order.

>> www.limelitesales.com.au

QUITCH

Taking learning to the students, Associate Professor Grainne Oates from the Faculty of Business and Law at Swinburne developed Quitch. It's an app in which students play games based on the curriculum of their course, competing with each other to top the leaderboard. Teachers are kept up to date on student performance with an analytics interface. With a demonstrated 12 per cent lift in student retention, the app is finding customers and interest worldwide.

>> www.quitch.com

HIDDEN UNIVERSE

This film has been seen by 1.5 million people in 43 cinemas across the world and it started in the astronomy labs of Swinburne. In-house scientific animator Russell Scott worked with astronomer Associate Professor Chris Fluke and others to produce a scientifically accurate, 3D, IMAX journey through space. The Swinburne team worked with the European Southern Observatory, film producers December Media, and distributor MacGillivray to bring space to the very big screen for the first time.

>> www.hiddenuniversemovie.com

SOIL POLYMER

Sometimes rain doesn't soak into the Earth. Instead, it sits on the surface, repelled from the soil by chemistry. This repellence causes uneven wetting of the soil, patchy seed germination and therefore reduced crop yields. Professor David Mainwaring and Dr Pandiyan Murugaraj with support from the Grains Research and Development Corporation, CRC for Polymers, and BASF, have developed a polymer which adjusts the soil chemistry, allowing even wetting of the soil and a bumper crop for farmers. The polymer will be available in late 2018.

>> www.basf.com

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Research-led innovation delivers social and economic impact

Swinburne Innovation Precinct supports Swinburne's bold Research and Innovation Strategy, bringing together industry and university to deliver research-led innovation outcomes.

It drives social and economic impact through the creation of commercial businesses, products and services; research-focussed industry collaborations; and student and staff entrepreneur experiences. Swinburne's presence and partnerships in Tel Aviv and Silicon Valley enable Swinburne to immerse in two of the world's most mature innovation ecosystems.

The Innovation Precinct connects Swinburne's significant innovation capabilities, integrating manufacturing, design and digital innovation, and creating conditions for co-creation and value-add for industry. The industry-leading Factory of the Future, along with Design Factory Melbourne and the Digital Innovation Lab, form a foundation for this process.

The newly opened Swinburne Innovation Hub, housed in a historic fire station on the Hawthorn campus, is the centre of Innovation Precinct activity. Comprising of 1,000 square metres of space dedicated to innovation, the hub hosts an incubator for startups, an Entrepreneur in Residence program, design and prototyping studios, and co-working and co-creation spaces.

Want to know more?
Visit www.swinburne.edu.au/innovation-precinct

SWINBURNE UNIVERSITY OF TECHNOLOGY

Factory of the Future
Solving complex design, materials, automation and inspection challenges

Swinburne Innovation Hub (The Fire Station)
Centre of Innovation Precinct activity, hosting the Swinburne Incubator, co-creation space for industry projects, and the Entrepreneur in Residence program

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Advanced Technologies Centre
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Digital Innovation Lab
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Delivers innovation and entrepreneurship programs across the professional life-cycle

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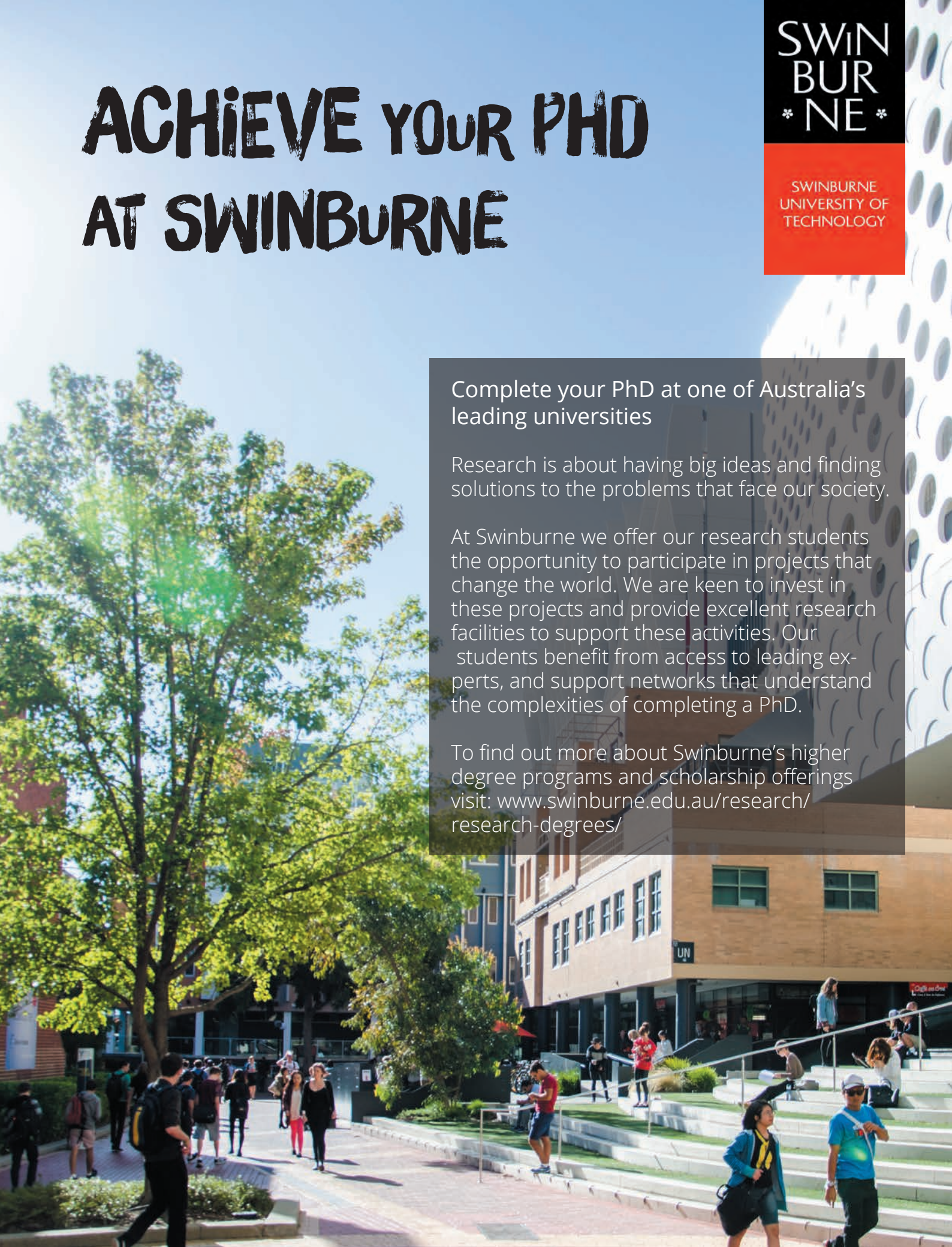
To find out more about Swinburne's higher degree programs and scholarship offerings visit: www.swinburne.edu.au/research/research-degrees/



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