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SWINBURNE UNIVERSITY OF TECHNOLOGY

RESEARCH IMPACT

JANUARY 2019

COSMIC WHODUNNIT
Why ghost galaxies die young

CATALYSING A GREENER FUTURE
Chasing the keys to affordable clean fuels

PARSING JUDGEMENT
How AI could make justice truly blind

HEARTBREAKING DISEASE
Measuring anorexia's impact on organs

MAKING THE CALL
Andrew Wood helps investigate 5G and health

RESEARCH IMPACT

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ABOUT THIS MAGAZINE

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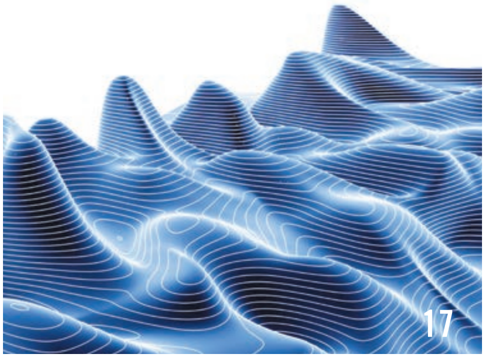
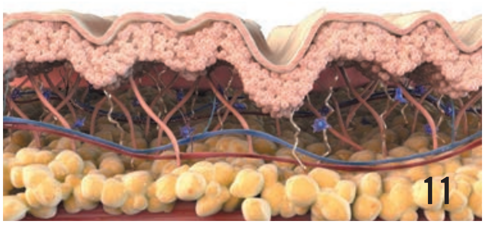
ABOUT SWINBURNE RESEARCH

Swinburne University of Technology is an internationally recognised research-intensive university that is focused on delivering research that creates economic and social impact. We are committed to delivering world-leading research outcomes and innovations in select areas of science, engineering and technology. Our researchers are producing innovative research solutions to real-world problems across a range of disciplines and sectors. Swinburne launched a number of exciting industry initiatives in 2018. For example, the Siemens MindSphere Centre for Australia at Swinburne's Factory of the Future facility will help harness the potential of Industry 4.0 by creating a space to test applications for the Internet of Things. As a testament to this continued drive towards innovation, in 2018 Swinburne's Times Higher Education ranking puts it in the top 2.25% of roughly 20,000 higher education institutions that operate globally. Swinburne's 2018 QS University World Ranking and place on the Academic Ranking of World Universities (ARWU) both put it in the top 1.93% of the roughly 20,000 higher education institutions operating globally, a figure up from 2.2% and 2% respectively in 2017. Swinburne's research future is bright. >>> research.swinburne.edu.au

SWINBURNE PRODUCTION TEAM

Scott Saunders (Editor)
Jane Sewell





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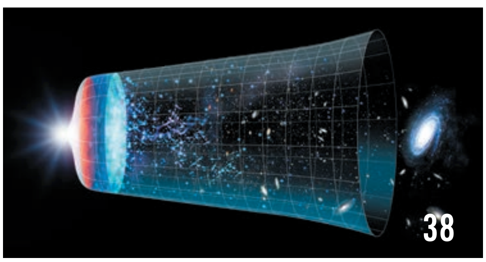


Research highlights

Features

Strategic Serendipity: Inspiring research collaboration for impact

When Swinburne gained university status, roughly 26 years ago, the future had apparently *arrived*.

We had the world wide web. We were on the cusp of ubiquitous mobile phone technology. Dolly the sheep was about to be cloned. Yes, we knew the Earth was round. We also knew how to manipulate sub-atomic particles and how to get to Mars. Edwin Hubble had long before confirmed that the universe was expanding.

It seemed, in 1992, that all our major questions about the Earth, about life and the universe, had been answered. We simply had to tidy up some loose ends.

But the more we know, the more we discover we do not know. The more humanity learns about the complexity, and simplicity, of life and the physical world, about organic and inorganic matter, about energy and space — the more we realise there is to find out.

And what is even more interesting is that new ideas often inspire applications unintended by the original researcher/innovator.

We are the beneficiaries of a steady stream of interlinked technological evolution.

This drives our research and innovation strategy here at Swinburne. Research-led innovation needs a conscious purpose: it must drive impact.

It comes from all quarters, and at Swinburne, we look for it. We build bridges to encourage it. We connect our innovation capabilities across the university. We work with industry to solve problems. And we foster collaboration in a way that inspires and multiplies individual efforts because of a deep understanding of how innovation occurs.

Panel members of the Siemens Digitalize 2018 Conference, Aleksandar Subic, Swinburne's Deputy Vice-Chancellor (R&D); Andrew Dettmer of the Australian Manufacturing Workers Union; Trish White of Engineers Australia; and David Chuter of the Innovative Manufacturing CRC.

I want to share three examples that illustrate not only Swinburne's approach but the magic of research and discovery.

Graphene

You may know a little about the story of graphene — an atomic-scale hexagonal lattice made of carbon atoms.

This is wonderful stuff!

It is the world's most conductive material, 200 times stronger than steel and one million times thinner than a human hair. Graphene is the world's first two-dimensional material.

What you may not know is how its discovery and development was dependent on a series of other seemingly unrelated discoveries.

Graphene owes its existence to developments in nanoscience and nanotechnology, whose origins can be traced to another technological innovation that changed the course of human history: the printing press.

- Widespread printed material caused a spike in demand for spectacles.
- This led to improvements in glass and lens manufacturing — via advances in understanding of the unique quantum mechanical properties of silicon dioxide.
- This led to major leaps in the development of microscopes.

We can manipulate the sub-atomic world because multi-disciplinary innovations occurred over time.

Swinburne is the leader in Australia for graphene technology, what is becoming known as intelligent material. The astonishing properties of this revolutionary new material are being investigated and applied in many ways across the university, through collaborations with other universities, and across industries.

We are making breakthroughs in the efficiency of solar cells, in coatings technology, in medical diagnostic tools, in sensor technology, and more. Our researchers are driven by a desire to change lives.

Gravitational waves

My second story is about gravitational waves. This sits at the other extreme, at the inter-galactic level, as opposed to the sub-atomic level. The discovery of gravitational waves also relates to those 15th and 16th century innovations I mentioned earlier by Dutch lens and spectacle manufacturers.

Last year, scientists detected gravitational waves — ripples in space time first predicted by Einstein. As momentous and far-reaching as this was, you could argue it was another outcome of a single original idea: the telescope.

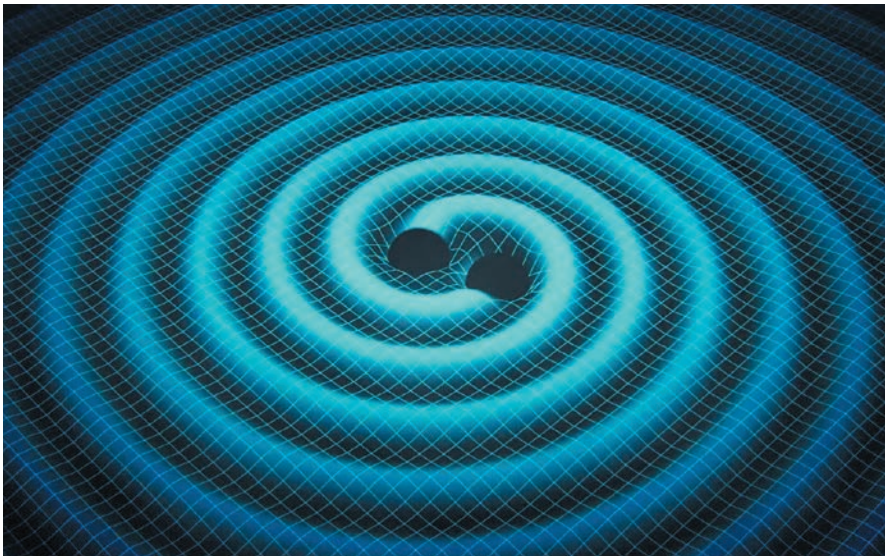
For the first time, scientists measured the violent death-spiral of two dense neutron stars — the cores of stars that have exploded and died. They used an interferometer, an investigative tool that essentially combines the light from multiple telescopes observing the same object.

They measured these neutron stars as they collided at nearly the speed of light, creating what many called the greatest fireworks show in the universe. The two stars, each the size of a city, completed 4000 orbits in the last 100 seconds of their cosmic dance, before finally colliding.

It was a landmark discovery from an international team that included almost 100 Australian scientists and it resonated with the public in a way that only black holes, dying stars and fireballs in the universe can do.

It was science at its most impressive, almost inconceivable and intensely fascinating. It also reminded us that basic science, that which isn't immediately geared towards industrial applications, remains immensely important.

Astrophysics is not a discipline you would normally associate with creating



The ARC Centre of Excellence for Gravitational Wave Discovery (OzGrav) at Swinburne will help discover cosmic events such as merging black holes (above, centre) due to their emission of gravitational waves (pictured).

immediate impact in our daily lives. However, CSIRO researchers, who mastered Fourier techniques used in astrophysics, gave us wi-fi, for example, which all of us use every day.

Swinburne's astronomers and physicists are designing new-generation instrumentation for a range of applications, stemming from ongoing discoveries in optical physics.

Our enquiries into stellar dynamics, into the structure of large-scale matter in our universe, the planets, solar systems, galaxies, have led to super-computing techniques, and to major improvements in data acquisition and signal processing.

What is at work, of course, is the co-evolution of a multitude of ideas and discoveries, and the application of multiple disciplines.

Networked innovation

My third story is about getting the team to play together. And this is why Swinburne is at the forefront of creating research impact. One can get hold of the players. But getting the players to work together is what makes the extraordinary out of the ordinary. Again, it is that co-evolution of ideas that matters.

And it is getting those ideas developing alongside their application that translates them into outcomes across the economy, across society.

We talk about serendipity. How do you promote serendipity?

This is where the humanities and social sciences are pivotal. Innovation is essentially a social process, involving the coordination and cooperation of people.

Our network group at Swinburne, the Networked Innovation Group within the Centre for Transformative Innovation, is combining the soft sciences with the hard sciences.

Our team is analysing the social networks that drive innovation. Not social media, rather, the real life networks that produce outcomes.

They recently worked with Boeing to determine influencers within the company's research and development teams, mapping a multitude of individual relationships through interviews and objective data acquisition. Using statistical modelling, they plotted the regularities and patterns. The results sometimes confirmed gut feelings. Sometimes they were very surprising.

The group is now mapping connections between Swinburne and CSIRO over the course of time, trying to understand the drivers and the impact of inter-personal relationships on innovation.

About innovation ecosystems

Exploring the unknown requires courage and a freedom from preconceived expectations. It requires imagination. Innovation requires an ecosystem to survive. This applies at an international and national level, at a company level, and at an institutional level.

It is not simply a list of good policies or institutional structures. An innovation system has to be coherent to be effective. Researchers sometimes compare an innovation ecosystem to a bird in flight, which demands wings, feathers, light bones, broad tails, and rapid metabolism.

Taken alone, any one of these factors might do nothing, or might even be a hindrance or detrimental to the creature involved. But together, they provide evolutionary advantage.

An innovation ecosystem might require four or five elements to be successful.

These elements could include broad investment, a highly educated workforce, complementary roles for government and industry, a concentration on industry sectors of sufficient weight and potential to matter to a nation, for example.

But if we found there were five elements that mattered, the ecosystem will not be effective with only four out of the five elements functioning. Rather than achieving 80% of the benefit, we may achieve, in fact, none. We may even find one or more of these elements a hindrance.

Each industry sector will be distinctive. The innovative systems for each sector will follow different paths and be driven by different factors. Swinburne's deep and long-term industry engagement enables a profound understanding of these factors.

Translation is important

There is also the truism that for every $1 spent on research, you need $10 for development and $100 for translation.

We know from consistent empirical research that higher research and development causes firms, industries and countries to experience faster rates of growth.

Governments have responded with incentives to do more R&D, and the number of R&D workers as a percentage of the population has risen. But have the outcomes been what we would all hope? According to some measurements — productivity for example — the answer is no.

We know that most of our productivity gains in fact come from new-to-the-firm innovation, in other words, laggard firms picking up new technologies and practices.

This is where Swinburne's focus on Industry 4.0 in manufacturing is driving real outcomes.

We are working with industry partners to train apprentices, to build capabilities and create new technologies. This is where innovation is translated across the university, and across industries and the economy.

Swinburne's Factory of the Future is creating Australia's first fully immersed Industry 4.0 facility that includes the Victorian Government Industry 4.0 Hub, the Federal Government supported Industry 4.0 Testlab and the Siemens MindSphere Centre for Australia.

We're immersed in the fourth industrial revolution and we want to make sure that students and researchers are equipped with the required advanced capabilities and tools to help transform Australian industry, to move our companies up the global value chain.

So our engagement with industry is not just about germinating new ideas — although our focus on practical application does solve real world problems — it is also about the flourishing of ideas.

Swinburne's Research and Innovation Strategy

In recent years Swinburne has established five new outward-facing Research Institutes that bring together our expertise across disciplines and faculties. These are in data science, health innovation, smart cities, social innovation and manufacturing futures.

They build on the depth and excellence of discipline-specific research undertaken by university research centres and groups. Underpinned by the Digital Research Innovation Capability Platform, they work as a 'whole-of-solution' shop for our industry partners, both locally and internationally.

Our driving mission is "transforming industries, shaping lives and communities" because our research is research for impact.

And it is collaboration — that co-evolution of ideas and co-creation of solutions — that informs every fibre of Swinburne's trans-disciplinary body.

And while I am sharing bird analogies, is worth reflecting on the fact that a flock has a greater flying range in formation than a single bird on its own!

Enjoy the new issue of our magazine and the inspirational stories from our researchers about the innovations and impact arising from their work.

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

On the cover

Professor Andrew Wood (front) and Dr Alireza Lajevardipour stand in an anechoic chamber where they can test the absorption of energy by the body at frequencies expected to be used by 5G technology.

Cover image: Eamon Gallagher

Swinburne in Numbers

2018 GLOBAL RANKINGS

TIMES HIGHER EDUCATION

RANKED **65**

YOUNG UNIVERSITY RANKINGS

TOP **250** in Engineering and Technology

TOP **450** of higher education institutions

QS WORLD UNIVERSITY RANKINGS

RANKED **45**

50 UNDER 50
2019

RANKED **40** in Art and Design

TOP **400** of higher education institutions (2019)

ACADEMIC RANKING OF WORLD UNIVERSITIES

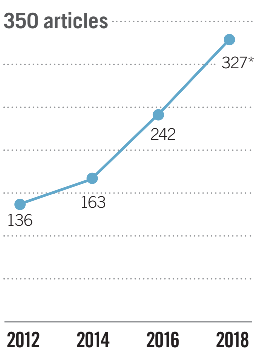
RANKED **133**

IN CIVIL ENGINEERING

TOP **400** of higher education institutions

69 RANKED in **SPACE SCIENCE** by *US News* annual published rankings

INTERNATIONAL COLLABORATIONS



*Jan–Oct 2018

TOP 5 COLLABORATORS (2013–2018)

1. Max Planck Society, Germany
2. University of California System, USA
3. Centre National de la Recherche Scientifique, France
4. Leiden University, Germany
5. California Institute of Technology, USA

EXTERNAL INCOME

$ = $4 million

$229m * estimated — TOTAL EXTERNAL RESEARCH INCOME, 2010–2018

$39m * estimated — EXTERNAL RESEARCH INCOME, 2018

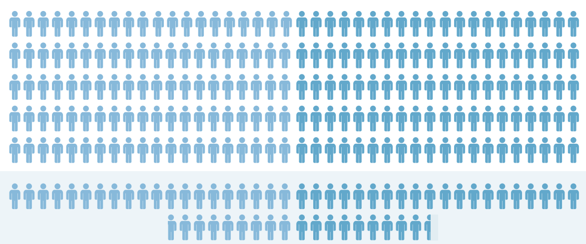
STUDENTS & STAFF

= 100 people

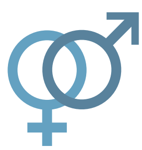
25,854 TOTAL STUDENTS IN 2018 (Jan–Oct 2018)

12,883 Male students

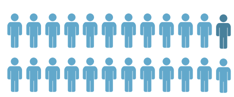
12,959 Female students



1,157 Students doing higher degrees by research



1 of 40 AUSTRALIAN INSTITUTIONS taking part in the two-year pilot program of the UK's Athena SWAN Charter for gender equity in STEMM



22.6:1 Student-to staff-ratio

686 Full-time academic staff

CAMPUSES & FACILITIES

NEW AT HAWTHORN

Innovation Precinct (Innovation Hub)

$7 million redeveloped Fire Station will be a central point for connecting Swinburne's research and innovation capabilities.

MindSphere Centre for Australia

Located in Swinburne's Factory of the Future, MindSphere is a cloud-based Industrial Internet of Things operating system that will enable students, academics and industry partners to collaborate and co-create local and global projects on the cloud-based platform.

RESEARCH DEGREES

Oct 2017–Oct 2018 (A postgraduate degree involving a supervised research project)

150 COMPLETED DEGREES

184 ACCREDITED SUPERVISORS

$8.8m * estimated

INVESTED IN STIPEND SCHOLARSHIPS IN 2018

RESEARCH WITH IMPACT

Does physical activity attenuate, or even eliminate, the association of sedentary time with mortality? A harmonised meta-analysis of data from more than 1 million men and women

Journal: *The Lancet*
Published: 2016

*data obtained 14.11.18
www.altmetric.com/details10081542/news

#8 of 29,873 papers on Altmetric from *The Lancet*

TOP 5% of all research output scored by Altmetric

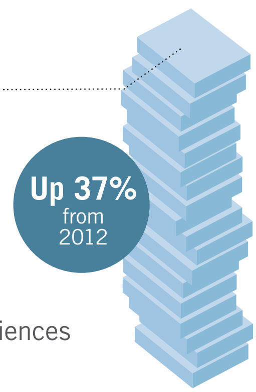
3,854 MENTIONS IN MEDIA, TWEETS, BLOGS AND POLICY PAPERS, ETC.*

STEPPING UP PUBLICATIONS

SCOPUS INDEX PUBLICATIONS

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

1551 publications
(Jan–Oct 2018)



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

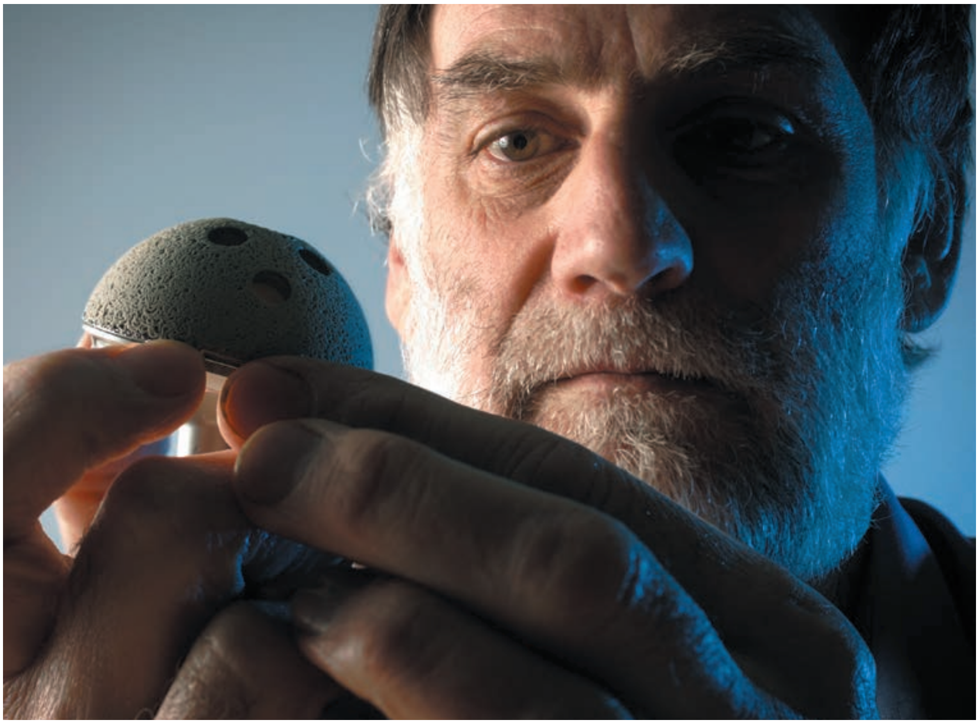
HIGHLY CITED RESEARCHERS 2018

4 researchers

Highlighted by Clarivate Analytics for having multiple highly cited papers ranking in the top 1% by citations for field and year in the Web of Science

Rich seam of engineering brilliance

A new Swinburne-led Australian Research Council (ARC) Training Centre in Surface Engineering for Advanced Materials (SEAM) will be one of the largest of its kind in the country. ARC funds of almost $5 million over five years are expected to be matched by partners. SEAM will look into a range of projects, among them biomaterials, graphene layering, high temperature coatings, and laser metal deposition for repairs and manufacturing processes, including thin films, thick coatings and additive layered materials.



Distinguished Professor Chris Berndt will lead SEAM. Collaborators include the University of South Australia, RMIT University, 13 core industry partners and 13 industry organisations, professional bodies and research organisations.

Siemens and Swinburne seed ideas in the cloud

Australia's first Internet of Things demonstration centre – MindSphere – has been built at Swinburne.

The cloud-based industrial operating system, developed by global technology giant Siemens, will allow students, academics and industry to co-create projects on a cloud-based platform. It is an extension of the $135 million software grant given by Siemens to Swinburne in 2017. Eight industry partners have signed an agreement with Siemens to become MindSphere Foundation Partners. They are: Alliance Automation, Globetech, NZ Controls, Centric PA, Spectrum Automation, Nukon, Interlate and Mescada.

Alan Duffy wins Eureka Prize for promoting science

Swinburne Associate Professor Alan Duffy has won the Celestino Eureka Prize for Promoting Understanding of Science.

Associate Professor Alan Duffy

The prize is awarded to a scientist who has shared their expertise with a broad audience, informing and engaging the public.

Duffy says that "Australia is facing many challenges that require more science not less, which is why it's so critical to promote and explain science to ensure an informed electorate can make the right choices."

Feel-good factor raises $1 million

A next-generation hydrogel condom developed with Swinburne research has secured $1 million from the NSW Medical Devices Fund (MDF) to fund manufacturing and human trials starting in late 2018.

Eudaemon Technologies, co-founded by Swinburne's Dr Simon Cook, is developing the next-generation condom, known as Project Geldom, which is made of new tough hydrogel materials to improve feeling and increase regular use.

The hydrogel's skin-like feel offers kinaesthetic advantages that can be combined with innovation in manufacturing, packaging, and distribution. The hydrogel condom will also help eliminate allergic responses while retaining the protection and safety standards of current latex condoms.

Shining light on brains in psychosis

Swinburne's Professor Susan Rossell has received National Health and Medical Research Council (NHMRC) funding to conduct research into improving cognition in people with mental illness.

The NHMRC Research Fellowship will see Rossell receive $649,175 of funding over five years to work in collaboration with St Vincent's Hospital Melbourne.

Rossell will continue her research in the field of cognitive neuropsychology, focussing on understanding and improving the cognitive problems experienced by people in psychosis and other related disorders.

Professor Susan Rossell

New artificial intelligence leader

Leading global information technology company, Wipro, and Swinburne have announced the appointment of Professor Ryszard Kowalczyk as Professorial Chair of Artificial Intelligence.

Kowalczyk's appointment follows the establishment of the Wipro-Swinburne Digital Innovation Centre to pioneer digital innovation in select industry sectors both in Australia and globally.

"This strategic investment is focused in particular on the creation of innovative digital solutions, products and services for the health and smart cities sectors," says Swinburne Deputy Vice-Chancellor (Research and Development) Professor Aleksandar Subic.

Manufacturing hub open to industry

In 2018, Swinburne's Advanced Manufacturing Industry 4.0 Hub opened at the Factory of the Future. Funded by a $2 million grant from the Future Industries Fund, it will work with businesses and universities to co-develop technology and business strategies.

Local manufacturers will be helped with digitalisation strategies, and be provided training in Industry 4.0 technologies, such as artificial intelligence, the Internet of Things, smart robotics and virtual reality. It includes MindSphere, a space for cloud-based Industrial Internet of Things operating system development (see opposite).

Casting a wider net in aged-care mental health support study

A programme aimed at improving the mental health of residents in aged care facilities by involving family members, staff and student counsellors will be trialled by a Swinburne team.

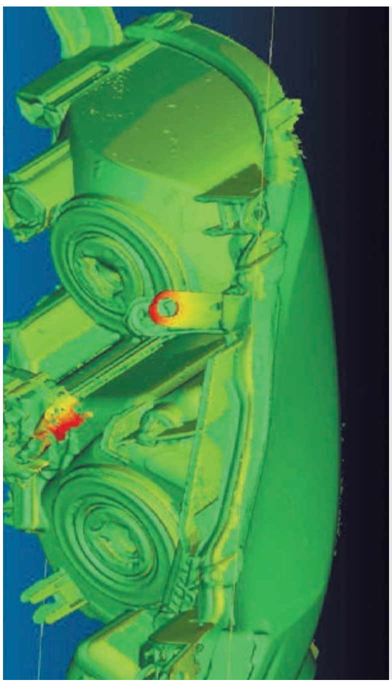
Associate Professor Sunil Bhar has been awarded $985,750 to lead the extensive aged-care mental health support trial.

The funding enables testing of clinical, health and economic impacts of depression and associated psychological conditions on residents in aged-care facilities and their family and carers.

Boost for Victorian medtech devices

The Victorian Medical Device Partnering Programme (MDPP), led by Swinburne, will receive $2 million funding over two years from LaunchVic to support the development of the medical device industry.

The project brings together Swinburne, CSIRO, the University of Melbourne, Monash University, RMIT University, the Australian National Fabrication Facility (ANFF) and BioMedical Research Victoria. It is modelled on a 10-year program implemented in South Australia by Flinders University.



Partners pile in on car Repair Bot project

Australia's largest automotive collision repair network, AMA/Gemini Group, has joined Swinburne's Repair Bot project. Repair Bot researchers will develop technologies to digitise and analyse large plastic car parts and generate an automatic fix using 3D scanning (left), robotics and additive manufacturing. Repair Bot will enable a low-cost rapid repair service for automotive plastic trim and assembly components that will be designed for a same-day fix for vehicles damaged by collisions. It has backing from the Australian Government's Innovative Manufacturing Cooperative Research Centre (IMCRC) and Swinburne's existing industry partner, Tradiebot Industries. In Australia alone, the vehicle repair industry generates more than $15 billion annually.

SEE PAGE 22 FOR MORE ON THIS PROJECT

Heads in the cloud

A new suite of artificial intelligence software developed at Swinburne will help smooth out the kinks in cloud computing.

Swinburne research into artificial intelligence has been used to develop a suite of software called Smart Cloud Broker, designed to give individuals, online retailers and other internet-based service providers the tools to manage resources on 'the cloud' simply and efficiently.

In the past, computer servers sometimes crashed during demand surges — during an online Christmas rush, for example. Roughly 10 years ago, servers began to be replaced by a vast network of computers that provide computing resources via the internet, known as the cloud.

But a challenge for businesses and individuals is selecting the right service configuration so their cloud resources don't become overloaded: for example, do you purchase resources as you need them, buy a monthly subscription, or buy in advance to get a lowest price?

For medium to large companies that use cloud-based computing, database hosting, searching and more, the number of possibilities becomes mind-boggling: the cloud-management industry in Australia alone is worth $4.4 billion.

In 2012, Professor Ryszard Kowalczyk from Swinburne's Software Systems Lab, part of the Swinburne Digital Research Innovation Capability Platform, realised that artificial intelligence (AI) could help assess myriad scenarios and even negotiate with other computers.

"We realised there was opportunity to add value with the AI technology we're developing, to not only save money, but to better utilise resources as a whole," explained Kowalczyk.

The group developed Smart Cloud Broker, which uses AI to help both users and businesses make the most of cloud resources. One component is Smart Cloud Bench, which compares cloud services by performing real-time cost and service benchmarking and helps select the best match for a businesses' needs. Another is Smart Cloud Marketplace, which is a platform on which cloud consumers and providers can trade resources, thereby balancing supply and demand.

Smart Cloud Purchaser then negotiates the best deal, using AI to forecast spot prices, and buys the resource. Finally, Smart Cloud Manager looks after a business's cloud resources in real-time, for example using AI to predict sudden demand and avert overload by purchasing more resources.

The Software Systems Lab is part of Swinburne's Digital Research Innovation Capability Platform
www.swinburne.edu.au/research/our-research/digital-capability-platform/software-systems-lab/

Analysing a world of divided loyalties

Swinburne researchers are digging deep to identify loyal customers and help companies manage rapidly evolving consumer markets.

A Swinburne research team is helping business to understand the fast-changing expectations of their customers, and to identify the constants, including the staunchest loyalty program members.

Marketplaces are shifting more rapidly than ever before. It's not easy for business to keep up. In 2017, sales in Australia's physical stores grew only 3% while online shopping grew almost 10%. Australian retailers are struggling to respond. In 2018 Myer share prices plummeted to almost a tenth of its original share float value in 2009. With the entry of digital disruptors, such as Uber and Airbnb, these changes are becoming more sudden and significant.

Associate Professor Sean Sands, Co-director of Swinburne's Customer Experience and Insight (CXI) Research Group, is helping governments, and companies, prepare for this by gleaning deeper insight into customers than traditional market research.

In 2017, a project was launched to help retailers identify high-value customers signed up to loyalty programs.

The team is mapping the behaviour of more than 20,000 Australian customers during their first six months in a loyalty program to pinpoint early signs of long-term attachment to a brand.

Once predictors are identified, companies will be able to explore how they can nurture these customers, tailor their communication strategies, and decide which customer relationships to prioritise. This information could be used by brands in different industries, from airlines to sporting organisations.

"By gathering and modelling data we help organisations think about user experience as a competitive advantage," said Sands. This, he said, is probably a core competitive advantage that Australian brands can take to the world.

The CXI Research Group was established in 2017 by the Swinburne Business School, but Sands' team of 25 researchers have worked together previously, investigating everything from users' experience of superannuation providers for government agencies, to airport retail experiences.

While augmented reality, virtual reality and artificial intelligence are poised to transform customer experiences radically again, Sands said that "brands need to ground themselves in the things that aren't changing, which is the way consumers shop".

Making model skin perfect for bandage trials

Varied Swinburne research team develops skin tissue in layers to inform bandage technology.

Professor Sally McArthur's bioengineering team have begun to make lifelike skin tissue to further studies on innovations such as cutting-edge smart bandages.

In future, a bandage could attract and trap bacteria in its polymer mesh, trigger drug delivery in response to infection, or colour-map a wound.

Humans have always been the best study subjects for these projects, but a vastly easier option is skin grown in a lab. However, according to McArthur, an expert on advanced wound dressings and biomedical manufacturing, functional lab-growth is not easy to produce.

"Real tissue grows in three dimensions and has many different cell types," she explained. "We are creating cell culture systems that replicate these more complex structures, and the corresponding tissue functions."

McArthur's team has developed holders that allow them to control the fluid flows that feed the cells to keep them alive. Sensors and viewing ports that allow scientists to observe the tissues' growth are next.

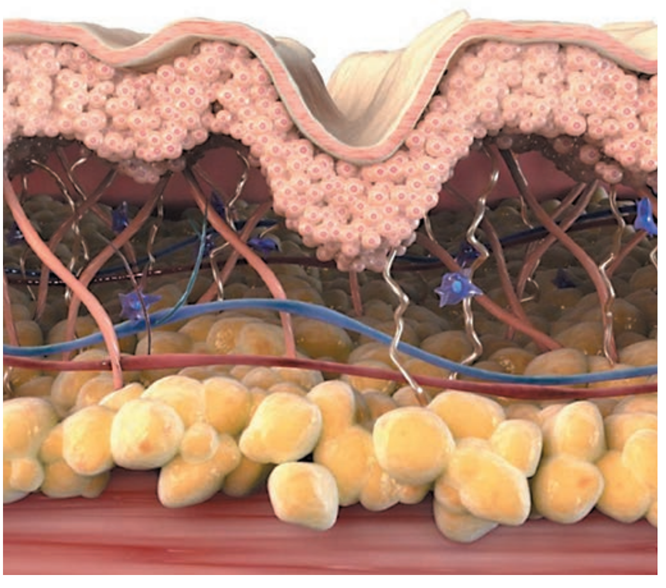
With the addition of the latter, these tissue become so-called '4D' cell culture systems, which are at the forefront of bioengineering.

"We are starting from a simplified skin system consisting of the outer skin layer and the inner layer, and using this to understand how the tissue responds to skin wounds, infections and inflammation," said McArthur. "We can then add other cell types to start to provide immune responses that might be found in the body, and then use these sensor systems to study responses to the materials commonly used to heal wounds or infections."

Technologically, 'seeing' into the tissue as it's growing is challenging, but will allow scientists to monitor changes in the tissue in response to introduced bacteria or injury. The systems also need chemical and biological sensors that are able to detect small changes in the chemicals released by the cells. To do that, McArthur's team are engineering more holders and using a range of imaging and live-staining methods so they can see important changes.

With so many aspects to tackle, McArthur, in collaboration with CSIRO's Research+Science Leaders program, has assembled a diverse team at Swinburne, with skills from molecular and cell biology through to electrical engineering, microfluidics, chemistry and biophysics, as well as experts in polymer science and biomaterials at CSIRO.

"There is huge interest globally in 3D cell culture systems," she noted. "Our goal is to develop larger-scale systems that enable the testing of materials or small tissue-interfacing devices, such as electrodes."



Lab-grown skin needs to replicate skin's complex tissues (above). This could include epidermis tissue (pink), bood vessels (blue and red) and subcutaneous fat (yellow).

A driving force for change

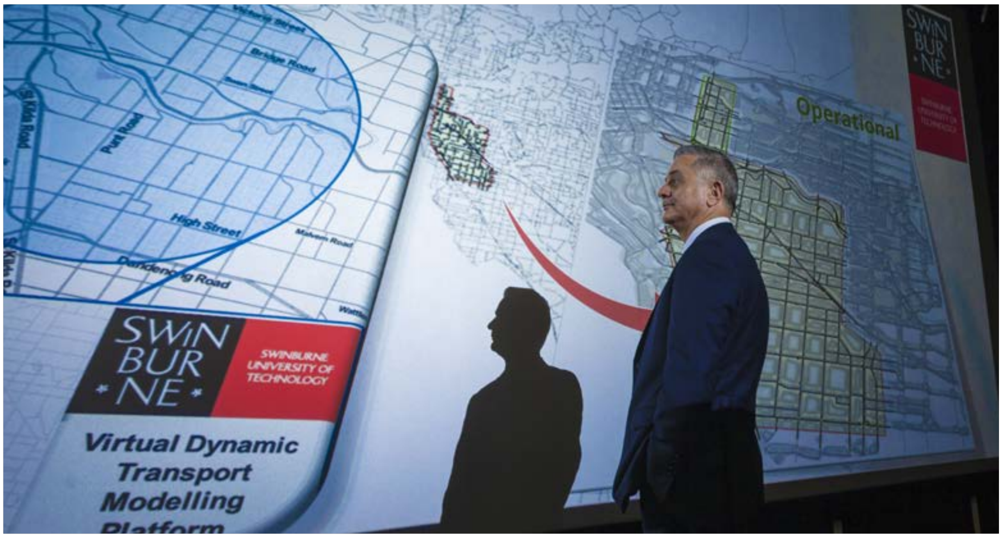
Driverless cars could make roads safer, transport cheaper, and reduce vehicle numbers dramatically.

Work by Professor Hussein Dia has suggested that more than 80% of cars could come off the road if fleets of shared, self-driving, electric vehicles become reality. As Program Leader of the Future Urban Mobility program at Swinburne's Smart Cities Research Institute, Dia is advising Australian road regulators on how to plan for this future.

In Australia, he said, data shows that peak car-sharing occurred in all major cities in roughly 2004, at least in terms of passenger-kilometres per capita. Increasing urbanisation, environmental awareness, and cost, all contributed to this fact.

Dia sees a future of fleets of shared self-driving vehicles accessed through apps powered by optimisation software calculating the most efficient route for multiple passengers.

In 2017, Dia's team simulated what could happen to Melbourne if autonomous, taxi-like vehicles were available. They found that if the majority used self-driving shared vehicles, the number of vehicles on the road could drop between 43% and 88%.



Hussein Dia envisions a transport network for Melbourne run on cheap and driver-free ride sharing, making the roads safer.

"We can meet our demand for mobility using only 12% of the existing vehicle fleet," he said. It could also free up as much as 83% of on-street parking and significantly lower carbon emissions, he noted.

Dia cited the sucess of the recent addition of the uberPOOL function to the Uber app service, in which a driver picks up and drops off multiple passengers going in the same direction.

The line will increasingly be blurred between the bus and a shared driverless car, he added. Ride-sharing is already much cheaper than taxis or single-passenger Ubers. If ride-sharing becomes common using driverless cars, Dia pointed out that the cost could come down by as much as 70%, bringing a ride-sharing service close to or below current public transport costs.

Dia also looks forward to a reduction in the 3,000 people that die daily in accidents caused by driver error globally. "We find that 90% of road accidents are due to human error, so it makes perfect sense to remove the driver, which is the key source of error."

Decanting knowledge

Swinburne researchers find out why vintners don't adopt wine science recommendations.

Communicating research results to winemakers works better over a glass of wine, according to a Swinburne study.

Information systems researcher, Professor Lisa Given, and Professor Alain Deloire, a wine scientist from a French agricultural research institution, Montpellier SupAgro, found that simple wine tastings could address important issues for research adoption in Australia's $40 billion wine industry.

Wine Australia, the government agency that funds wine research, has been struggling to get the winemakers and viticulturists to adopt new research to improve yields for more than 50 years.

"Typically, wine scientists would go out, show a number of graphs, talk about the science and say 'this is what you should do'," said Given.

She said some Australian scientists had even suggested that grapes be picked at times when there are few seasonal workers, or tried to provide advice on how to prune vines as seminars.

"What the viticulturists needed was a hands-on demonstration in the vineyard on how to prune," said Given. Meanwhile, wine scientists needed to taste the fruits of innovation.

The wine tasting technique came from Deloire, who had used it during a stint in South Africa. He used the

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same approach in 2014, when he assessed the successes of wine scientists who shared experimental wines with winemakers to demonstrate innovations in assessing berry ripening and selecting harvest dates. In 2015, the Australian Grape and Wine Authority (AGWA) commissioned the professors to extend this work.

Funding for the latest Swinburne study came from an Australian Research Council (ARC) Linkage Grant. Given and Deloire set out to solidify the credentials of their communication techniques, and to identify a range of ways to plug research and implementation gaps.

Between 2015 and 2017, the professors met 29 winemakers from four wineries from around Australia. These interviews revealed the need for more direct communication, and facilitated two-way discussions that clarified a need for more work on human resourcing issues.

"Sometimes what you think is the most interesting is not the thing that needs to be explored from the industry's perspective," said Given, "that's difficult for a lot of scientists, but we're making progress."

Taking care of business

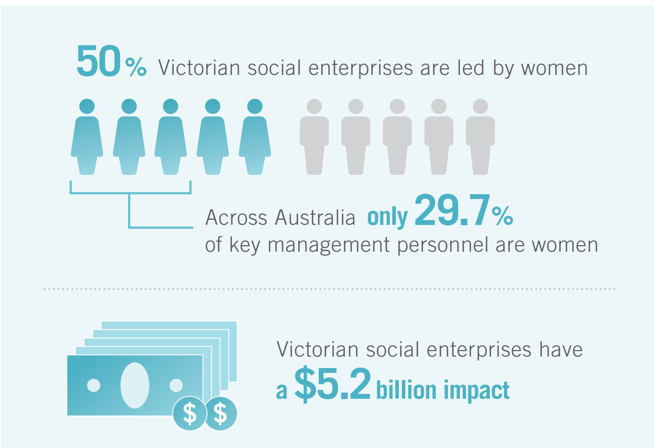
Social enterprises are contributing billions to the economy and much to inclusion, by employing marginalised groups.

Businesses established for the benefit of the community, known as social enterprises, contributed $5.2 billion to the Victorian economy in 2017. They also employed marginalised people in far higher numbers than other business categories according to a policy-shaping 2017 Swinburne report.

The Map for Impact report was commissioned by the Victorian government and led by Professor Jo Barraket, Director of the Centre for Social Impact at Swinburne. It found that social enterprises have created 60,000 jobs, more than 30% of which are held by people from marginalised groups.

Marginalised people, defined as having less access to material and social resources, including those with disabilities, the long-term unemployed, people that are culturally and linguistically diverse, and Indigenous Australians, among others. In the broader workforce, marginalised people are thought to represent roughly 24% of employees.

"The thing that really stood out was the inclusive nature of employment by social enterprises," said Barraket. "Nearly half of social enterprises are led or managed by women." By contrast, across Australia, only just over 29% of key management positions are held by females. In addition, she said, "about 19% of staff in Victorian social enterprises are people with a disability". In Victoria, roughly 10% of the workforce have a disability.



Barraket's team also produced an interactive online map of Victoria's 3500 diverse social enterprises as an ongoing resource. By doing that they could see that many enterprises worked directly in the area of employment. "For pretty much any social group in Australia that faces an equity issue in regards to work, there will be a social enterprise trying to solve that equity issue," said Barraket.

However, the scope of social enterprises was also broad — they provided vital services, such as post offices, pharmacies, and even theatres, not offered by the market or government in remote areas. According to Barraket, a newer type of social enterprise also provided environmental products, such as electricity from Hepburn Wind, a community-owned wind farm 100 km from Melbourne.

Social enterprises have been a growing part of the Victorian economy since the state government established favourable policies in the 2000s. At the time of the report, more than 50% of enterprises had been set up in the preceding five years, Barraket pointed out, and the market has been increasing in sophistication. "We are also now seeing growth in social enterprises using things like virtual reality platforms, which involve people with physical disability in the design of products such as prostheses."

Strong backing by the state continues, and the Victorian government announced its first Social Enterprise Strategy in 2017, referencing Barraket's findings.

The $10.8 million dollar strategy has called for greater coordination across government to support these initiatives.

The gold at the end of a cosmic ray

The search for dark matter turns up glistening mineral deposits.

A method for locating seams of gold and other heavy metals is the unlikely spin-off of Swinburne's involvement in a huge experiment to detect dark matter down a mine in Stawell, Victoria.

Associate Professor Alan Duffy, from Swinburne's Centre for Astrophysics and Supercomputing and a member of the Sodium iodide with Active Background REjection (SABRE) project, said cosmic radiation was effectively creating an X-ray of the Earth between the underground detector and the surface.

In the mine, the SABRE experiment seeks to detect particles of dark matter, something no-one has conclusively achieved yet. Any signal from dark matter would be minuscule, and so the SABRE team created a phenomenally sensitive detector, which, it turns out, is also sensitive to a host of cosmic particles that can help us to locate gold.

Detecting particles that aren't dark matter is unwanted noise to SABRE — which is why they located the experiment one kilometre down a mineshaft, where the rock above was thought thick enough to absorb any cosmic radiation.

However, the team found some radiation still penetrated — not ideal for isolating rare dark matter events, but creating a powerful source of information. "Nature has given us the most powerful penetrating scanner you can create, and there's no licence required," said Duffy.

These particles that make it to the Stawell Underground Physics Laboratory are muons: short-lived particles similar to electrons, but 200 times heavier. Muons are preferentially scattered by atoms with high atomic numbers and so deposits of heavy metals, such as gold, whose atomic number is six times greater than that of carbon, create shadows similar to bones in a medical x-ray image.

The idea's not entirely new, but Duffy noted that the technology "had come of age". The team's redesigned muon detector prototype is a far cry from its 1960s predecessor, a box of bulky high-voltage electronics that needed two people to lift it. Miniaturisation of electronic components driven by smartphone technology contributed to Duffy's device, which he likens in size to "a fashionable paperweight."

"The first one we built was a cylindrical piece of scintillating plastic in a paint tin. You've never seen anything that looked so rough and ready, but it just gave the most beautiful detections."

The size is perfect for lowering into mineral exploration boreholes, and because the technology is cheap and can connect via optical fibre, Duffy envisages "deploying half a dozen of them and walking away." Weeks later a picture of the minerals in the surrounding rock could be reconstructed from the data, which will require processing similar to that used in astrophysics.

Duffy is excited by plans to build a company around the device, and the team already has interest from potential partners. But, the first step is to turn their prototype into an instrument robust enough for an active mine site.

"Dark matter is ethereal," Duffy added. "It's fundamental to physics, but it's hard to think of practical uses. Yet I see real commercial outcomes in this spin-off."

School rules of engagement

A Swinburne study asks how schools encourage or discourage social justice participation.

A Swinburne study has been set up to look at the role of teachers in building a social conscience in their students.

A project, run by Professor Ninetta Santoro, will look at how teacher training prepares tertiary educators to build advocacy, activism and a drive for social change in students.

Over a year, she plans to analyse the teacher education curriculum and professional standards as well as interview 50 higher education teachers in Australia, Finland and Scotland. Santoro said she'll be asking how the curricula in each country enables, facilitates or hinders teachers from talking about social justice issues.

"Global education tends to focus on producing productive citizens in the economic sense rather than productive citizens for social change," Santoro noted.

The most recent release of the long-running Australian Election Study by Australian National University seemed to confirm this when it recorded a 25-year low in the proportion of people who discussed the 2016 election with others.

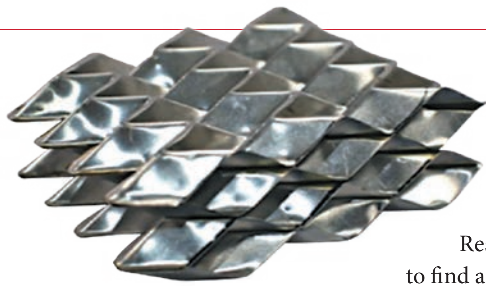
In Australia, for example, Santoro said, teacher education and teacher professional standards are highly regulated compared to some other countries. "It will be interesting to see if this regulation facilitates the development of teachers as agents of change."

Santoro's work will also examine whether educators see themselves as agents of social change and how professional standards influence this role. She expects that the potential differences in educators across the country will be driven by how much autonomy they are given, and hopes to help teacher education policy address issues of political malaise.

Santoro, who is an expert in social justice issues in education, joined Swinburne's School of Arts, Social Sciences and Humanities in 2017. Previously she has studied a range of issues, including the experiences of Indigenous school teachers and of students living in refugee communities, and has engaged in helping universities attract students from underprivileged backgrounds and operational work recruiting teachers from abroad.

A light show of strength

Origami inspired materials could toughen up trains.



Swinburne researchers are turning origami shaped two dimensional (2D) materials into useful three dimensional (3D) 'metamaterials' that could replace aluminium foam use in train manufacture.

Metamaterials are materials that combine composition and shape to produce properties different to the material alone. A prime example are foams, which become lighter than the base material, but have a reletively robust honeycomb structure.

Aluminium foam is commonly found at the core of the panels on trains, which are known as sandwich panels because they are essentially two thin tough sheets of material bordering a foam core. These are essential to the lightweight strength needed to make trains cost effective to run. But if a train were to hit something, the material properties of these panels make them quite brittle.

Professor Guoxing Lu from Swinburne's Department of Mechanical Engineering and Product Design Engineering is working on a project with the Rail Manufacturing Cooperative Research Centre to find a better metamaterial to strengthen the core of sandwich panels.

Lu's unique inspiration are the Miura-origami shapes used in very light and strong space 'deployables', such as satellite solar panels that must fold up during transport and unfold in space.

The folds are named after inventor, Japanese astrophysicist Koryo Miura, who worked on designs for folding a single flat surface, such as a sheet of paper, into a smaller robust shape.

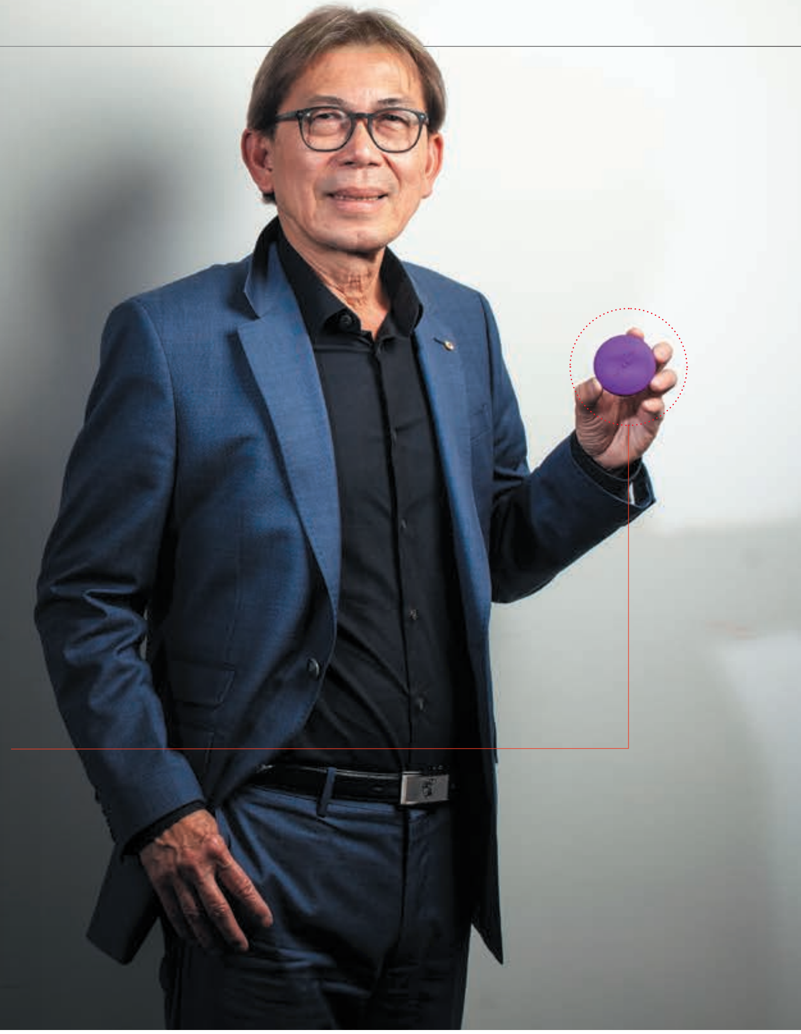
Lu is working with aluminium, one of the materials of choice in the transport industry for its low cost and light weight. His latest analytical and numerical simulations of Miura-origami aluminium 2D folded structures, welded into a 3D shaped materials, has shown better energy absorption than conventional honeycomb structures at low to moderate load intensities.

This work is being done in collaboration with Professor Zhong You from Oxford University, Professor Dora Karagiozova from the Bulgaria Academy of Science, and Professor Yan Chen from Tianjin University, China.

Such origami metamaterials, said Lu, could be fabricated by stamping, lasering or 3D printing thin metal sheets (as pictured) or carbon-based composite materials, which could then be weld together to form 3D materials.

Patent or perish

Evidence shows that Australia is producing technology worth commercialising. Swinburne's Professor Hung Nguyen urges academics to patent their work before publishing.



Hung Nguyen's biomedical devices can non-invasively monitor blood glucose levels, and detect breast cancer.

As five years of research funding from the government and tax incentives begin to mature in areas such as biotechnology, Professor Hung Nguyen AM is actively seeking to help researchers commercialise their work. The protection of a patent, according to Nguyen, is the key to attracting investment.

Nguyen, now Pro Vice-Chancellor for the Faculty of Science, Engineering and Technology at Swinburne, has been involved in the development and commercialisation of biomedical devices that can non-invasively monitor blood glucose levels in people with diabetes (see right), detect breast cancer, and enable people to control their wheelchairs by thoughts alone.

Nguyen said that having secured patent protection can assist the path to publication in high-impact journals while ensuring rights are not lost. This can help to generate funding that enables better development and research, which is vital in the biomedtech space where R&D can stretch to hundreds of millions of dollars.

In a small investment ecosystem like Australia, those funds can be hard to come by. Nonetheless, in Nguyen's field of biotechnology, Australia has ranked in the top five globally in terms of government funding for the last three years according to a report by *Scientific American*. The medical-biotechnology sector in particular has benefitted from an intensive period of government funding and substantial tax breaks for companies investing in research and development. Australian agricultural, environmental and industrial biotechnologies are also making a mark.

However, due to its size, future Australian markets are likely to be made up of premium start-ups for international buyers and investors, rather than develop big multinational companies.

"To make the most of this, academics must be savvy," said Nguyen. "Without a patent for example, it becomes much harder to attract funding and investment. Companies need to know that the idea is protected, therefore the investment is more secure."

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Making a material difference

Structural optimisation from the factory floor helps create materials for lenses, sound cloaking and beyond.

Swinburne researchers have repurposed a well-known manufacturing technology to create new materials for traffic sound absorption, superlenses and earthquake proofing.

It's already fairly common in manufacturing to simulate the incremental removal of superfluous material from a model to optimise lightweight and material-efficient design. This software-based approach is called Bidirectional Evolutionary Structural Optimisation (BESO), and is being used in the design of everything from bridges to car doors.

It can also be used to design materials unlike any seen before on Earth, according to Professor Xiaodong Huang from Swinburne's Department of Mechanical Engineering and Product Design Engineering.

"The generalised BESO method, called 'topological optimisation', can be used to determine the spatial distribution of materials needed to achieve the best performance while satisfying multiple objectives and constraints," explained Huang.

"It is an important tool in civil, aerospace, mechanical and automotive engineering, all of which demand lightweight, low-cost, high-performance structures. But, by integrating physics, the method also has great potential in other design problems."

Multi-discipline, multi-physics topological optimisation has become a hot topic in academia and industry, because of its potential to help engineer microstructural materials or 'metamaterials' so they have new and sometimes incredible properties.

By controlling electromagnetic, acoustic and mechanical waves, these materials could help find solutions for everything from perfect vibration and energy absorption to light bending for invisibility cloaking.

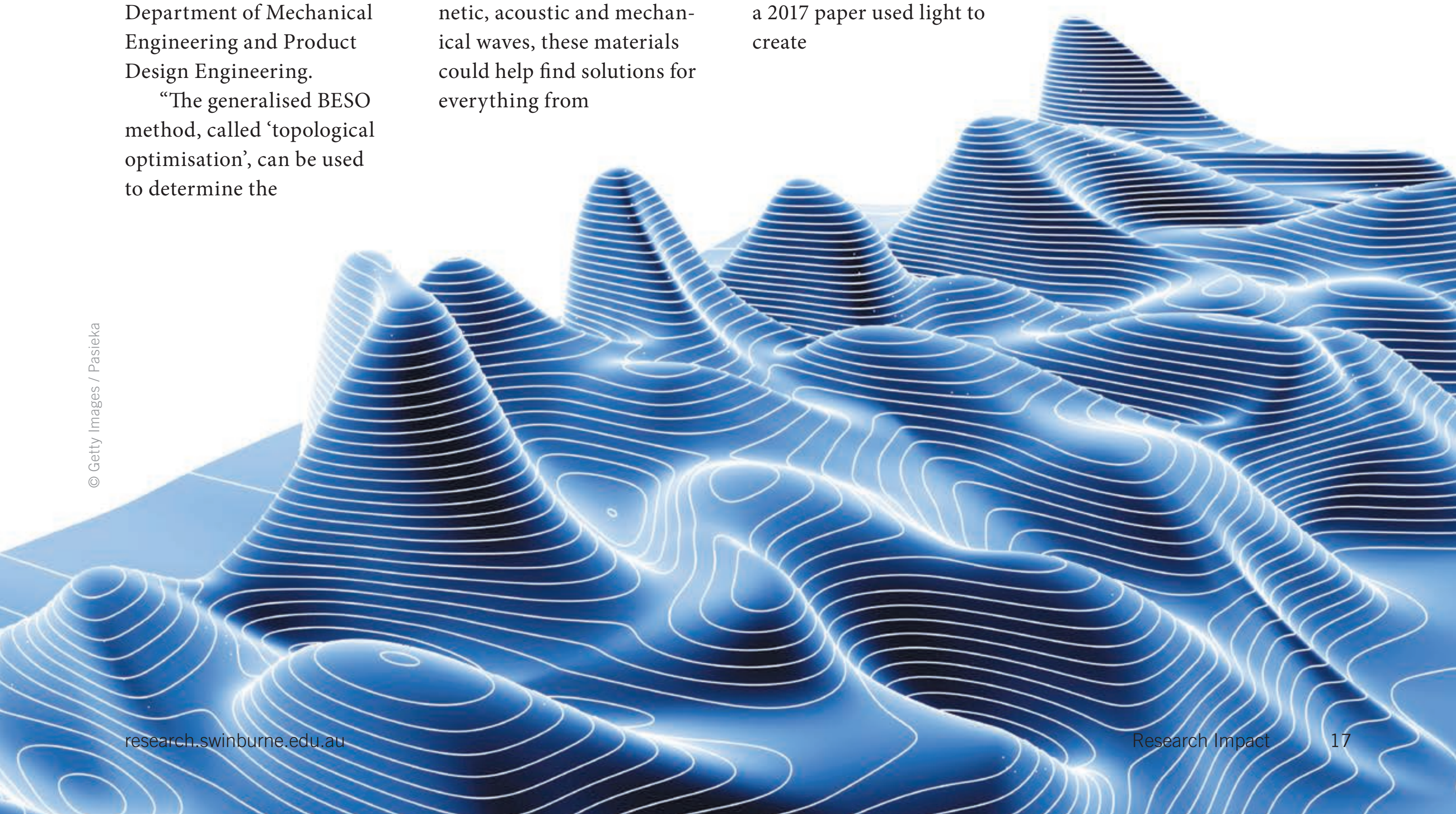
> "Metamaterials are expected to usher in a new era of engineering."

The method has brought Huang's team a string of leading research outcomes in recent years. In 2017, they co-authored a paper on the design of a 3D acoustic metamaterial that blocks low frequencies for sound cloaking in spaces such as road tunnels.

Another material from a 2017 paper used light to create the properties of a superlens — lenses that take microscopes beyond the natural diffraction limit, a constraint that limits the resolution fineness of conventional lenses.

In 2018, the team also developed an algorithm to optimise understandings of damping and the natural resonant frequency of macro-structures to improve earthquake resistance through the design of the microstructure of building materials.

Each finding is aimed at specific industrial applications, and Huang said, once commericalised, metamaterials such as theirs "are expected to usher in a new era of engineering."



BIG PICTURE THINKING

Swinburne has a new brain imaging facility that will harness a growing flood of information about our most complex organ.

Swinburne's new neuroimaging facility is being set up to take part in the next big wave in data-driven insight.

Professor Tom Johnstone — the former Director of Neuroimaging at the University of Reading in the United Kingdom — moved to Australia to become Director of the new $40 million facility in July 2018.

He said the advance of neuroscience data must be carefully managed. "Neuroscience has moved far beyond simply looking at blobs of brain activation, to looking at complex networks and interactions between neural, behavioural and physiological measures."

This produces a lot of data; a single neuroimaging dataset can measure in the terabytes, two to three orders of magnitude larger than a complete mammalian genome.

To manage Swinburne's new data collection, Johnstone has introduced the Brain Imaging Data Structure (BIDS), a global open software system put together in 2016 by a number of the world's most well-known universities. With it, neuroscientists have standardised data formats and parameters to minimise errors caused by using different processes or the rearranging of data.

"BIDS enables quality-controlled data processing pipelines that allow people from multiple centres to share and verify data," Johnstone explained. The new system will allow Swinburne to contribute to, and use information from, other institutes.

BIDS also makes computer analysis of studies vastly easier, and Swinburne's Data Science Research Institute will be collaborating with the facility to help analyse information using machine-learning programs.

Located in the Advanced Technologies Centre, the facility has been equipped with every contemporary type of technology for measuring brain activity, including a state-of-the-art magnetic resonance imaging (MRI) scanner for visualising brain structure and function, plus six electroencephalography labs, and a magnetoencephalography lab for measuring the brain's electrical activity.

Swinburne's new facility is funded by the university, the National Imaging Facility, and the Victorian Bioimaging Capability. It will build on a decade of work by Swinburne's Brain and Psychological Sciences Research Centre.

As this new capability comes online, Johnstone is working to broaden the facility's user base. "Addiction, pharmaceuticals, and the effects of diet on brain function are already a very strong focus of neuroimaging research, and Swinburne's Centre for Mental Health also focuses on clinical psychology and psychopathology."

Among the list of new projects is work on brain stimulation devices (see right), and autism.

IMPLANTING CHIPS THAT TALK STRAIGHT TO THE BRAIN

Researchers at Swinburne are working on better neural prostheses, including chip implants to restore vision.

By revealing the pathways of nerve cells linked to the brain, neuroengineer Dr Tatiana Kameneva is helping to improve brain-related 'prosthetic devices'.

Kameneva has made a number of findings that will contribute to the design of implantable chips to regulate the symptoms of irritable bowel syndrome and overcome degenerative blindness. Next she's planning to look at paralysis.

"Electrical stimulation has already been used to restore sensory functions in people who have lost their vision or hearing," Kameneva explained. Cochlear neuroprosthetics for deafness, for example, have been around for decades. Biomedical chips to treat retinitis pigmentosa — the cause of 50% of blindness in Australia — have recently begun to reach large global markets through Germany's Retina Implant AG.

Kamaneva is working to improve the technology being used to restore sight in people with both retinitis pigmentosa and macular degeneration. Both diseases lead to the slow degeneration of photoreceptor cells in the retina, but in most cases some of the retinal ganglion cells are preserved and are still capable of transmitting signals from photoreceptors to the brain. Electrical stimulation of these remaining ganglion cells can restore some vision in patients.

Kamaneva has fine-tuned the knowlege base at the foundation of this technology with both Australian colleagues and European collaborators at the Vienna University of Technology, Ecole Polytechnique Federale de Lausanne and the National Vision Research Institute.

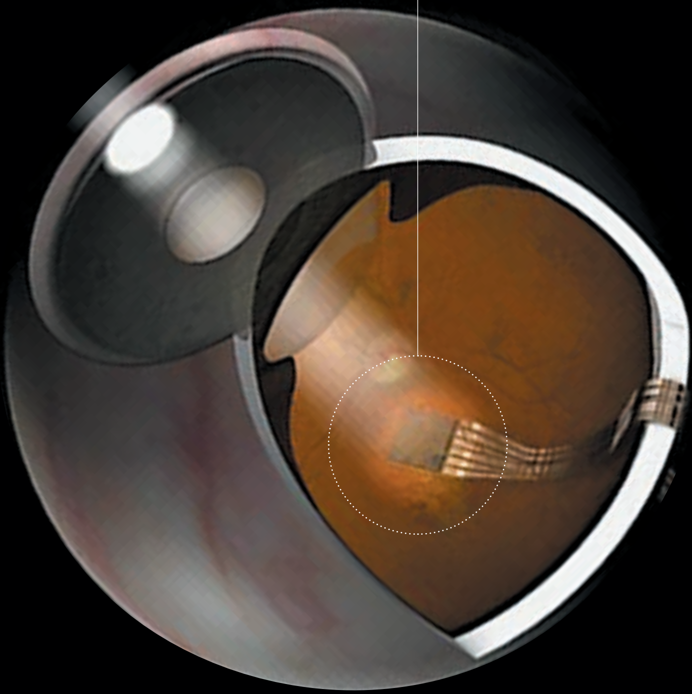
Together, they produced an important mathematical model showing that retinal ganglion cells isolated from rats have an electrical stimulation upper limit.

"Correct estimation of the optimal stimulation range plays an important role in the design of stimulation strategies in neural prosthetic devices," Kameneva explained. It leads to implants that are more effective and patient-specific she said.

Working with Swinburne collaborators, Professor Paul Stoddart and William Hart, Kamaneva also contributed to an implantable modulation device for sufferers of irritable bowel syndrome.

The group produced a model of the vagus nerve, a long nerve linking the brain to the autonomic nervous system, demonstrating how it signals intestinal inflammation to the brain for processing.

Kameneva's next collaboration will use Swinburne's advanced neuroimaging facilities (see left) to understand the brain networks that control movement to improve the lives of people with paralysis. "We will use simultaneous stimulation and recording to study brain signals during a motor task," she said, "and this will aid the development of brain-computer interfaces that improve quality of life for people with loss of limb function."



In clinical trials in 2012, a retinal implant that replaces the function of damaged photoreceptor cells by stimulating retinal ganglion cells improved sight in previously blind patients enough to help with daily activities. A version of this system has since been commercially released. Tatiana Kameneva is helping researchers to understand the stimulation limits of this type of technology.

Setting a precedent in the use of artificial intelligence

Professor Dan Hunter says it's time to look at machine learning to identify bias in criminal sentencing.

Criminal sentencing could be fairer with the help of machine learning, according to Professor Dan Hunter. The Foundation Dean of Swinburne Law School, Hunter observed that sentencing generates a vast store of data, and the process is expensive for individuals and the system, making it the perfect candidate for a technological upgrade.

Artificial intelligence (AI) could also use the enormous volume of data available on sentencing decisions to identify bias and give guidance, he said.

In 2017, Hunter co-authored a paper on using AI technology in sentencing for the *Criminal Law Journal* with Swinburne colleague, Professor Mirko Bagaric, and Dr Nigel Stobbs from the Queensland University of Technology.

The authors pointed out that sentencing decisions are influenced by more than 200 considerations. While judges and magistrates are reluctant to acknowledge it, decisions may be influenced by factors such as skin colour and socio-economic status.

Inconsistency in sentencing also erodes trust in the system. The authors cite a study of 71,000 offences suggesting one Victorian court was three times more likely to send offenders to prison for the same offence as other courts in the same jurisdiction.

"In things like bail decisions and sentencing decisions, here in Australia, particularly, we haven't come to grips with the fallibility of human decision-making," Hunter said.

"AI might suggest, 'This particular offence looks a lot like these five others that other courts have seen, why are you sentencing the offender so differently from those?'"

"Or, it could question why a non-custodial sentence is given for crime that has always previously been punished with incarceration.

"One of the huge benefits of using data-driven machine learning for criminal justice is to start unpacking those biases and making it clear that they exist."

New machine learning algorithms mean that AI can be taught to produce new answers by learning from existing data. In fact, AI programs are already hard at work in the legal system, with platforms including Neota, Logic, Kira and RAVN helping to streamline everything from compliance advice to contract review in large due-diligence projects.

AI and machine learning will probably start their criminal justice roles as decision-support systems only, Hunter said, although there's no reason to think this won't eventually move into automated sentencing.

The sanctions imposed for more than 90% of criminal offences currently do not have any judicial involvement. Most criminal matters are finalised by way of infringement notice.

It's likely that there will be some backlash against the idea of humans being sentenced by machines, said Hunter, who has been exploring the use of AI in law for more than 20 years. However, he noted that society has readily accommodated many similar technologies. Speed cameras, for example, are a form of automated sentencing that is now widely accepted.

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Dan Hunter's work aims to inform consistency on sentencing.

Mats Isaksson next to a cell designed at Swinburne to scan and fix the headlight inside.

> “The vision is an automatic repair cell that uses 3D printing to automatically repair the broken part.”

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Print a part

Industry is investing in robots to cheaply fix car headlight housings using blueprints from the cloud and 3D printing.

A fender-bender could soon mean a quick trip to a robot for a cheap same-day fix thanks to a new project driven by robotics expert Dr Mats Isaksson, a senior Research Fellow at Swinburne's Department of Mechanical Engineering and Product Design Engineering at its Manufacturing Futures Research Institute.

Isaksson has been given government funding to lead Repair Bot, a $1.2 million industry project that will harness 3D scanning, 3D printing, and robotics to automate headlight repairs.

Minor damage to the plastic lugs and brackets in a headlight assembly can cost between $200–$14,000 for parts alone, said Isaksson, and the headlight, which is still functional, will end up in landfill.

"The vision is an automatic repair cell that scans the broken plastic part, compares the scanned damaged part to an original part blueprint in the cloud, and employs 3D printing to automatically repair the broken part," he said.

Automation is predicted to add $2.2 trillion to the Australian economy by 2030. Isaksson, who spent 10 years as an R&D engineer at European automation giant, ABB Robotics, thinks the automatic repair of just about anything "is becoming a real possibility".

Consumers, insurance companies and repair shops who lack skilled plastic technicians will all stand to benefit from lower costs associated with the technology his team are developing. And, if successful, these advances could also address the concerns of a 2017 Australian Competition and Consumer Commission report that suggested widespread public dissatisfaction with rising parts costs within Australia's $24.8 billion car repair and servicing industry.

To do this, Isaksson's team are partnering with Sydney-based manufacturing innovation firm, Tradiebot Industries, and accessing federal funding from the Innovative Manufacturing Cooperative Research Centre (IMCRC).

At the moment, the researchers are busy creating a demonstrator system and looking at substances that can be 3D printed to fill breaks in polypropylene, a common plastic material used in headlight housings, while meeting strength requirements. The plan, said Isaksson, "is for the Repair Bot system to also work as a knowledge database, continuously gathering information on collision damage for future research".

In the next phase, the Swinburne project will focus on commercialisation, including the deployment of a cloud-based software solution for headlight blueprints and a purpose-built robotic system for fixing parts.

Reconciliation in the sea's bounty

Dr Emma Lee is working to create a cultural fisheries industry in Tasmania to support Indigenous people economically and to recognise their cultural heritage.

Swinburne's Dr Emma Lee is working to establish a cultural fisheries industry in Tasmania as a practical step towards reconciliation. Lee is the recipient of one of Swinburne's 2018 Aboriginal and Torres Strait Islander Research Fellowships.

Lee, who is a Trawlwulwuy woman from Tebrakunna country in north-eastern Tasmania, has argued that a cultural fishery could enable Aboriginal Tasmanians to develop economically, while maintaining traditional knowledge of how to care for sea country.

She pointed to a New Zealand model in which a significant percentage of commercial fisheries licences are allocated to Indigenous people. New Zealand's is also one of the most sustainable fisheries in the world and is worth roughly $1.6 billion in exports. Lee believes a counterpart founded in Australia's most lucrative seafood region, could be used to create a national framework that would provide resolution to many of the country's ongoing social issues.

She said Indigenous Tasmanians would like to provide shellfish and other seafood to restaurants so they can share their unique cultural stories. These arise from thousands of years of shellfish consumption by Indigenous Tasmanians that have resulted in a coastline featuring shell middens up to a kilometre long (see right).

While Aboriginal Tasmanians can access marine resources for their own food or cultural purposes, commercially they're only allowed to sell shells for necklaces.

Emma Lee.

Recently, Lee turned her attention to the legislative barriers to such cultural fisheries projects. Lee has a lengthy record of reconciliation policy experience as one of the key architects of the first joint management plan for Australia's largest wilderness, the Tasmanian Wilderness World Heritage Area.

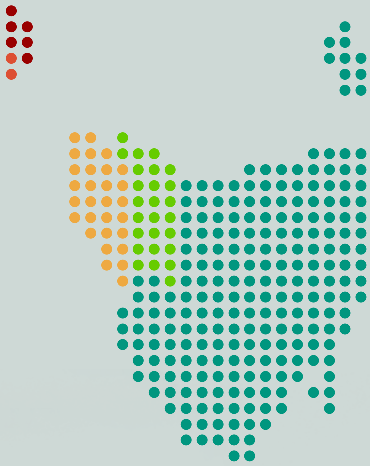
To test the waters Lee employed an Indigenous research methodology to build relationships through wide-ranging stakeholder workshops. "I am a firm believer that on a full and satisfied belly we can come to understand each other as people who bring cultural strengths and assets to the table." Last year this included a seafood and Indigenous storytelling event held at the annual Dark Mofo festival in Hobart.

During this process, Lee said local restaurateurs, the fisheries industry and government all expressed interest in the idea, particularly because the seafood can be sold at premium prices, its saleability enhanced by its local provenance and Indigenous links.

Lee's next step is to compare global examples of commercialising Indigenous foods and to look at developing a specialised training centre for future Indigenous fisheries.

Southern seafood

Tasmanian's seafood sector is the most valuable in Australia and harnessing its Indigenous links could add more value. Annually, the total gross catch is worth more than $731 million (2015–16).



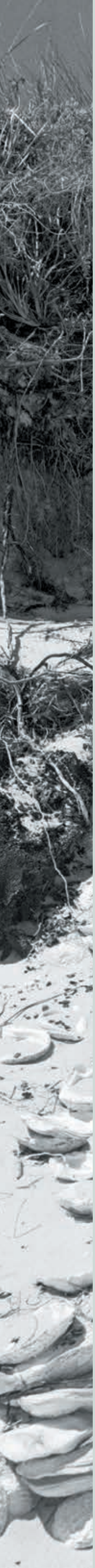
Percentage of annual gross catch 2015–16
(● = roughly 0.3%)

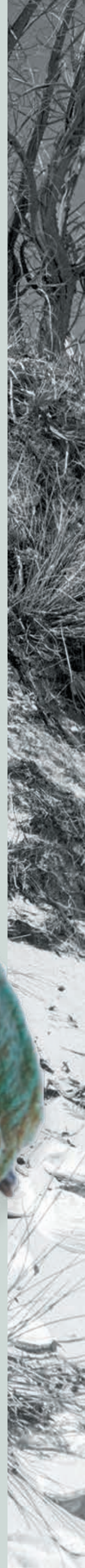
- Atlantic Salmon
- Oysters
- Rock Lobster and Crab
- Abalone
- Other

Evidence of seafood consumption by the ancestors of Indigenous Tasmanians shows up in historic refuse heaps known as middens. This oyster shell midden was shot in 1957 at Hazards Beach, Tasmania.

25%
of the annual global yield of abalone comes from Tasmania

Tasmania has the world's largest sustainable wild abalone fishery





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A GUIDING HAND FOR SWINBURNE START-UPS

A former Silicon Valley chief technical officer is inviting entrepreneurs to Melbourne to mentor the teams behind Swinburne start-ups.

With two successful start-ups and 10 years as an entrepreneur in Silicon Valley under her belt, Dr Elicia Wong wants Swinburne to be a productive start-up incubator.

In 2017, as Director of Research Innovation and Entrepreneurship, she launched the Entrepreneur in Residence mentoring program, which is bringing international mentors to Melbourne to help researchers develop potentially scalable companies.

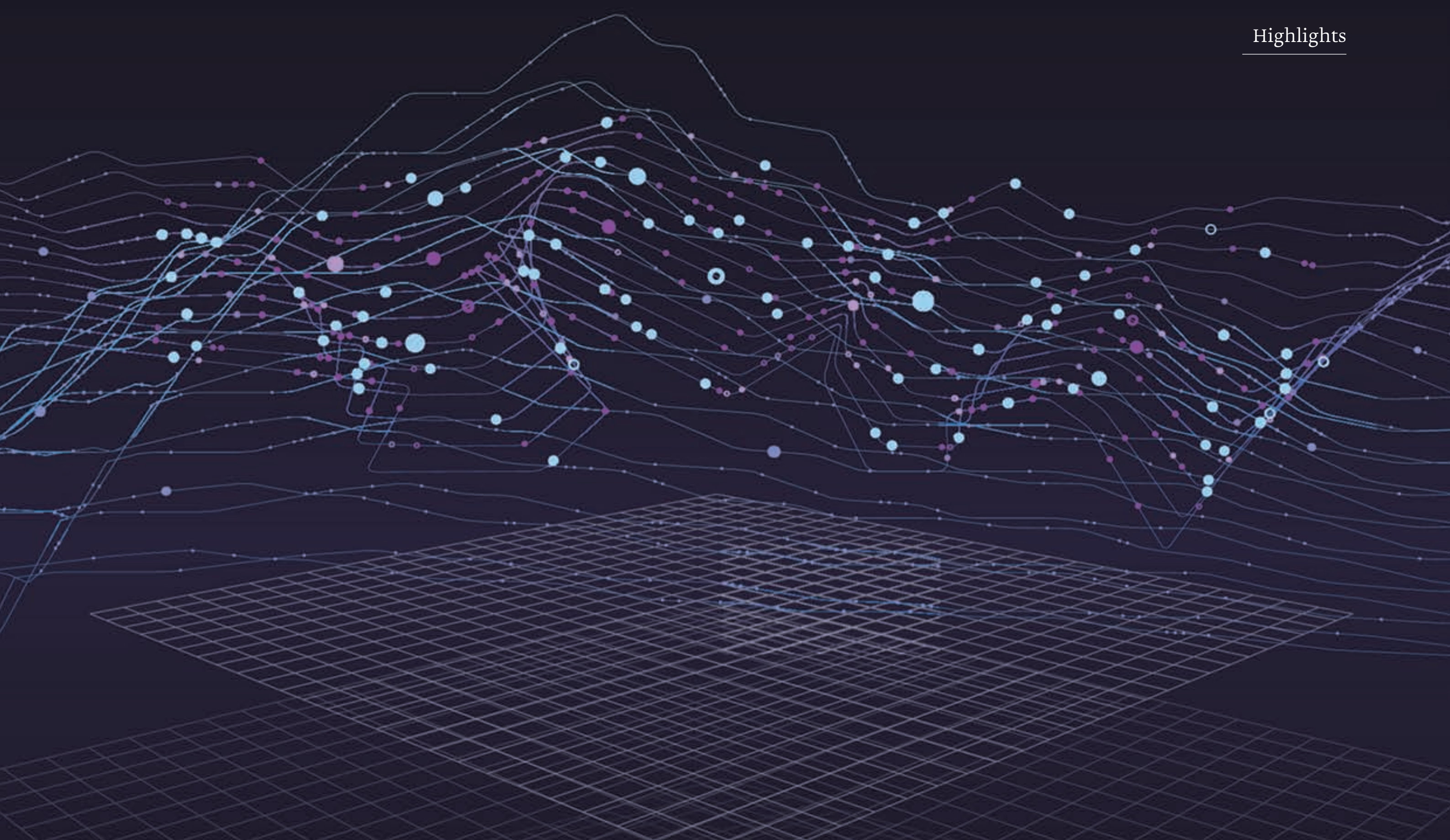
Already on board is Kostas Anagnostakis, the founder and CEO of Niometrics, a Singapore-based start-up that has had 500 million people subscribe to its multi-faceted data analytic software programmes in the last 10 years. In 2009, Anagnostakis started with five engineers in one Singapore office. Niometrics now operates in eight locations around the world, and has around 120 employees.

Most successful tech titans have founders who were mentored, explained Wong, who also had a mentor when she was at Oxford University as a Postdoctoral Fellow. After her postdoc, she commercialised sensor ensembles and, later, organic semiconductor-based sensors for life science industries, launching two start-ups in Silicon Valley.

> “The startup economy is poised to play an important role in national strategy for economic diversification and growth.”

“As an accessible coach, these mentors are expected to share their business know-how and insight on global trends in all sorts of industries from biotech, fintech, medtech, hightech and social enterprise,” said Wong.

She believes the start-up economy is poised to play a huge role in the national strategy for economic diversification and growth. She adds that the program is “attractive to established entrepreneurs as it provides a new route for exploring businesses and connections in the Asia Pacific region.”



Tech tracking for the next big thing

An artificial intelligence program reading Australia's patent data could soon flag big breakthroughs before they happen.

A Swinburne team is analysing text data from Australia's patent office to predict the evolution of technologies.

Associate Professor Kai Qin and his team work at Swinburne's new Intelligent Data Analytics Lab, part of the Swinburne Digital Research Innovation Capability Platform.

The data scientists bring deep neural-network machine-learning algorithms and rapidly maturing natural language processing technology to government agency, IP Australia. Their hope is to develop software that scans the agency's past 20 years of patents as well as scientific article texts, including specifications and claims.

"Our model will tackle the natural language processing needed to analyse the patent data and any associated scientific articles," said Qin. "But it will be the modelling parameters that are hardest to identify."

This project follows a successful 2017 Swinburne collaboration with IP Australia and the University of Melbourne (see box). A Swinburne group created a world-first trademark database, TM-Link, linking trademark application numbers across countries. This provided insights into the foreign trade interests of Australian businesses, by showing how trademarks are used in different markets, while also opening research into trademark trends.

For Qin's patent project, analysing information regarding failed technologies, as well as success stories, could indicate which technologies the country should invest in. On a broader scale, the work could reveal why scientific knowledge progresses in certain directions and triggers for faster or slower growth across fields.

These results, funded by an ARC Linkage Project grant, could ultimately improve IP Australia's database search, reveal new technologies and potential collaborators for business analytics companies, and help academic economists to understand how knowledge travels and accumulates.

TRACKING TRADEMARKS

A 2017 collaboration between IP Australia, Swinburne and the University of Melbourne resulted in TM-Link, the first trademark database of its kind. The databases' neural network was designed to identify equivalent trade marks in different jurisdictions, assigning a common identification marker by considering similar trademark text, applicant names and classes. The database already includes more than 10 million entries and helps track trademark use across regions. It confirms its findings based on text and imagery, using state of-the-art imaging technology. A trademark labelling game also improves the algorithm's training data by asking users to confirm a match between suggested pairs of trademarks.

WHAT 5G MEANS FOR OUR HEALTH

Mobile speeds are soon to reach ten times today's performance. Swinburne researchers are racing to ensure that the technology's impact on our bodies is understood.

Much to the excitement of Australians, solid plans to roll out fast 5G mobile communication technology were announced in 2018. Behind the scenes, studies modelling the absorption patterns of 5G electromagnetic energy in human tissue authored by Professor Andrew Wood's Swinburne team has helped form the basis for international discussions on safety regulation and design.

Wood's team, which is part of the multi-institutional Australian Centre for Electromagnetic Bioeffects Research (ACEBR), is a key contributor to the International Commission on Non-Ionizing Radiation Protection (ICNIRP) review, which is expected to be released in 2019.

"We believe the main biological effect of the electromagnetic radiation from mobile phones is a rise in temperature," Wood explained. "There are also concerns that there could be more subtle effects, such as links between long-term exposure and certain types of cancer, but while there is some evidence from epidemiological and animal studies, these remain controversial."

> "As the frequency goes up ... the skin and eyes, rather than the brain, become the main organs of health concern."

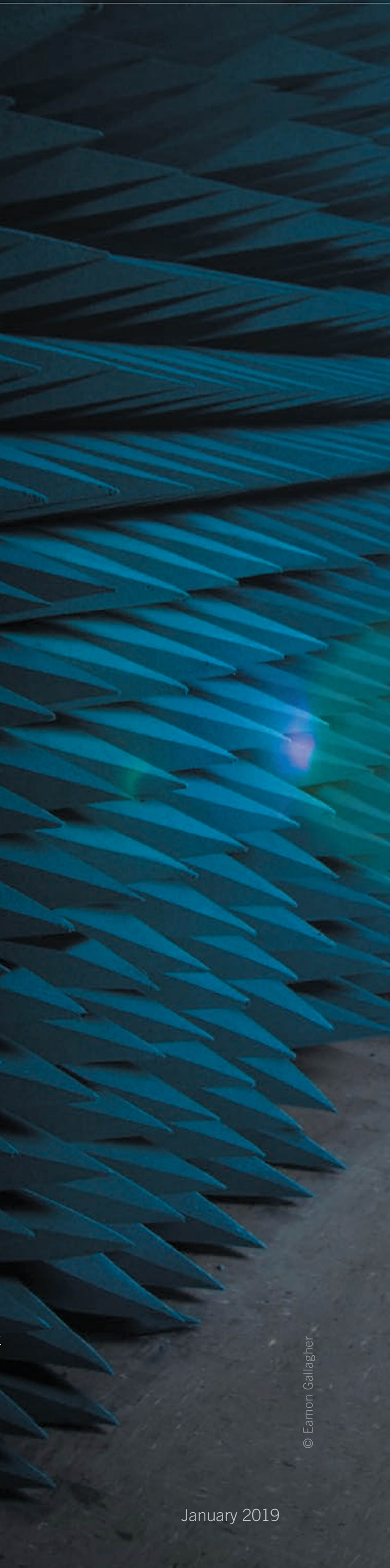
5G mobile technology promises a ten-fold increase in data transmission rates compared to current 4G networks, which will be achieved by using a higher transmission frequency. The physiological effects of electromagnetic radiation change with frequency, so the advent of 5G triggered a major international review of relevant radiation safety guidelines, for which it's agreed that there is insufficient data for a meaningful health risk assessment.

But Wood's team have yet to see major red flags at, or below, the commonly accepted electromagnetic radiation limit in the current international standards that apply to mobile technologies.

"As the frequency goes up, the depth of penetration into biological tissues goes down, so the skin and eyes, rather than the brain, become the main organs of health concern," Wood said. "The major hurdle is that the power levels involved in mobile and wireless telecommunications are incredibly low, which, at most, produce temperature rises in tissue of a few tenths of a degree. Picking up unambiguous biological changes is therefore very difficult."

However, it will be important to balance the risk and reward, he noted. "Wireless technologies bring enormous benefits, and being over-cautious would potentially deny these benefits to needy communities."

Moving forward, the team plans to continue to model the bioeffects of 5G electromagnetic radiation. Their plans for future work range from building skin models and biomolecular work on cells using fluorescent dye, to computational simulations that scale up from single cells to humans.



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Swinburne's anechoic chamber in its Radiofrequency Dosimetry Laboratory dampens the noise of other radio frequency (RF) signals so that Andrew Wood (right) and Alireza Lajevardipour can test energy absorption in specific regions of the body. The lab contains equipment used at the former Telstra Research Laboratories and the lab is still used by Telstra for compliance checking.

IN SITU
ELECTROCHEMICAL CELL
See page 33

Rosalie Hocking uses the x-ray absorbtion spectroscopy beamline at the Australian Synchrotron in Clayton, Melbourne.

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SEEKING DISORDER AS A CATALYST FOR CHANGE

Dr Rosalie Hocking is shining a light on disordered minerals to find catalysts that can make water into clean fuels.

Green chemists dream of replicating the reactions of photosynthesis. Of the possible outcomes, one of the most talked about is the ability to make affordable hydrogen fuels from water. In theory, the only by-product of burning hydrogen is water. But right now most hydrogen is either extracted from fossil fuels or made using energy intensive processes powered by fossil fuels.

However, if scientists such as Swinburne's Dr Rosalie Hocking could find a way to make hydrogen in a similar way to the steps plants take during photosynthesis, many of our issues with fossil fuel emissions could evaporate.

To create sugars for their own use, plants absorb carbon dioxide from the atmosphere and suck up water through their roots. In the choroplasts of the leaves, pairs of water molecules split into two hydrogen molecules and one oxygen molecule (see page 32). The molecules only do this with an input of energy. In plants, chlorophylls with manganese clusters and various enzymes serve as photocatalysts to speed up the reaction, all within a protein complex known as photosystem II. Plants are then provided with their basic energy unit when hydrogen reacts with CO_2 to form glucose in another set of reactions. Even with sunlight, however, these reactions are slow.

It's the first and most difficult part of the equation — the reaction that splits water into hydrogen and oxygen — that fascinates Hocking, a senior lecturer at Swinburne, and the recipient of a Vice-Chancellor's Women in STEM Fellowship. She's searching for a substance to act as a chlorophyll-like catalyst to speed up water-splitting reactions. But as her team looks at the crystal structures of possible catalysts, a couple of odd, misfit minerals have come into focus.

MANGANESE-LIKE MISFIT

In 2011, Hocking's data from an x-ray spectroscopy beamline at the Australian Synchrotron in Melbourne, showed something striking about a mineral called Birnessite (manganese oxide). The mineral, it turned out, has distinct similarities in catalytic reactivity to the manganese in photosystem II. Robust, inexpensive and abundant, Hocking and her collaborators concluded that this Birnessite could potentially help in water-splitting if stimulated by electricity.

"Actually, people knew for a long time that Birnessite was similar to parts of photosystem II," says Hocking. "But, early on, they tested a stable version of this material, found that it was 'dead' in terms of catalytic activity and then moved on."

She thinks a lot of useful catalysts have been hiding in this way. "When you make a manganese oxide in a chemistry lab, you might use a fairly pure system in distilled water," she explains. "But when these phases are made in nature, there's calcium around, potassium, sodium, a bit of iron. It's messy and it's the messiness that changes the reactivity.

"A lot of our research has shown that if you stabilise a system, you reduce the reactivity and make it less able to do the business of catalysis — it's thermodynamically happy and doesn't want to accept or release electrons."

Birnessite is among a handful of other metal oxides found to be capable of splitting water, including ruthenium oxide, iridium oxide and cobalt oxide.

A 2015 study by researchers at Florida State University and The University of California, Berkeley, showed a way of layering Birnessite to efficiently capture solar energy to split water.

One of the researchers involved in this study suggested that future roofs might be covered in this mineral, and that it could turn rain water into energy with the help of the sun.

But realising this prediction is a long way off. Catalysts useful to artificial photosynthesis are still little understood and often require very high temperatures to work. Hocking says, for example, that if the classical catalysts were going to work in the way photosynthesis does, she thinks we would have seen it already. "If you look at a lot of industrial catalysts, they tend to catalyse reactions that don't involve nearly as much energy," she explains. "The mechanisms in these types of catalysts must be fundamentally different."

WIELDING BEAMS OF LIGHT

Catalysts are among Hocking's specialities. Trained as an x-ray spectroscopist at Stanford University in the United States, she uses a form of light known as synchrotron radiation to understand materials.

The light of synchrotron beamlines, generated by accelerating electrons to almost the speed of light in facilities the size of football fields, reveals x-ray structural data impossible to observe in any other way. "People often call me to say they have a great new catalyst, but they need help to study its structure, because they don't know how to use the beamline," says Hocking.

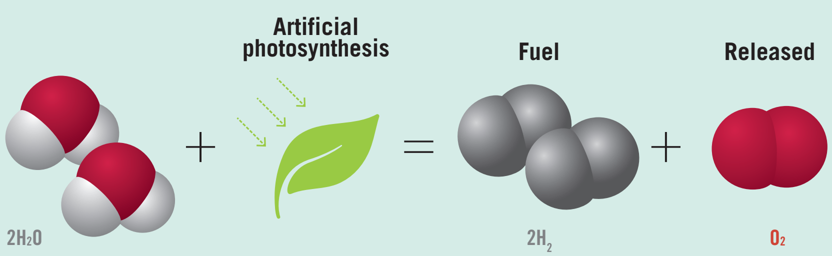
"Being an x-ray spectroscopist gives me the advantage of seeing lots of other researchers' materials. And I would always take notice of the commonalities and differences between them."

Hocking thinks science may have overlooked catalysts like Birnessite because their structure is too messy for most chemists' tastes. She says that chemists are trained from early on to seek out order in molecules to better understand them, and so they have an inbuilt bias towards ordered crystalline versions of minerals.

"Think about a first-year chemistry

CREATING FUEL FROM WATER

One part of the chain of reactions that makes up photosynthesis splits water into hydrogen and oxygen. Green chemists think that if they can harness this reaction effectively using a catalyst they can create clean hydrogen fuels.



textbook," says Hocking. "We are teaching students about the radii of ions and atoms, and that comes directly from x-ray crystallography, an analytical technique that can only be applied to materials that are completely ordered. These concepts underlie some of our very first assumptions as chemists." According to Hocking, chemists are really good at characterising solids that are crystalline and are pretty good with molecular systems in solution, "but we are terrible at everything in between! And in doing so we've ignored a lot of things."

Another potentially very messy mineral is iron sulphide, which is found in sulphur emanating from low-oxygen environments, such as swamp water. Iron sulphides' prevalence in extra-terrestrial objects has led to suggestions that it may also be linked to the very first blossoming of life on Earth, and thus the early evolution of photosynthesis. Iron sulphides also help regulate metabolic processes in living systems by accepting or releasing electrons.

Despite their simple composition of iron and sulphur atoms, iron sulphides can take on a surprising number of different structures, but may have also fallen into a chemistry blind spot. "Iron sulfide phases have been overlooked because scientists looked at their very stable forms instead of their natural states, which are extremely disordered with many impurities. With iron sulphides being rediscovered as functional electro-catalyst materials, it's reasonable to ask 'What did we miss decades ago?'"

Hocking's recent work has focussed on 'metastable' forms of manganese and iron sulphides. These materials transform into another state over time. Her Swinburne lab is trying to tweak metastable iron sulphides to be more disordered using tricks like rapid precipitation, or by adding soapy surfactants that interfere with crystal formation. "It's easy to make things non-crystalline," Hocking jokes.

X-RAY ABSORPTION SPECTROSCOPY AT THE AUSTRALIAN SYNCHROTRON

At the Australian Synchrotron a particle accelerator is used to accelerate electrons so that they emit x-ray particles and produce x-ray beams. When the beam is bounced off a crystal sample it diffracts the x-rays, and from the resulting diffraction pattern the inner structure of the crystal can be calculated down to the atomic level. Spectroscopic simulation software determines corresponding readings in previously measured materials, giving researchers a very detailed idea of the structure of their sample.

An *in situ* electrochemical cell developed by Rosalie Hocking can be fitted to an x-ray spectroscopy beamline. The study material is then mounted at the back and the x-ray beam mathematically measures a potential catalyst's structure while electrodes help capture responses to electrical potential simultaneously.

> It's easy. You just have to reverse what you have been trained to do as a chemist your whole life.

"You just have to try to reverse what you've been trained to do as a chemist your entire life".

BIG MACHINERY AND BEYOND

Understanding these new compounds using the huge machinery at the synchrotron can be slow. "They take a long time to set up, and it's difficult to get your electrochemistry and spectroscopy right at the same time," says Hocking. The team may only get three or four days a year to run crucial tests. "My record for staying up is more than I should admit, 48 hours or so."

Adding to the difficulty is the fact the characterising 'disordered' compounds is a lot of extra work. For a crystalline order, researchers can look for a group of atoms, known as a unit cell, which can reproduce the entire crystal structure when repeated in three dimensions. For more disordered materials these experiments just don't work. Often the materials are described as amorphous, meaning they have no unit cell, so they can't be analysed in conventional ways.

"This is where synchrotron based x-ray absorption spectroscopy can be quite useful," explains Hocking. "We can use the high-energy light to home in on the metal parts of a sample and understand the nanostructure in that region. In our group, we combine x-ray spectroscopy with electron microscopy to understand disorder."

Hocking and her collaborator, Dr Alexandr Simonov at Monash University, have also spent the last five years developing a device, called an *in situ* electrochemical cell, to measure a potential catalyst's structure and response to electrical potential simultaneously. The team can use it to link a material's atomic framework with the number of times a catalyst performs a reaction before becoming inactivated.

It has already produced results. "There are some surprising differences in materials that we hadn't noticed," says Hocking. "We are also able to see whole material responses, changes in its structure, or oxidation state, rather than just the active sites that people usually focus on in catalysis."

She hopes that using this new technology on overlooked disordered minerals will speed up the process of identifying many game-changing results. "I'm not a terribly tidy woman," she adds, "and my group joke about me being interested in disordered materials when I'm a little disordered myself." But if she finds the key to splitting water, Hocking's finding will be far from a joke.

GREEN CHEMISTS TAKE AIM AT INDUSTRIAL CHEMICAL EMISSIONS

Green chemists are hard at work on harnessing catalysts to solve many problems. For example, newly developed iron sulphide catalysts can be used in industrial processes to produce important chemicals, says Dr Hocking. "If we took solar generated electricity and CO_2 and used a catalyst such as iron sulfide to translate CO_2 into commodity chemicals, it would be great for Australia because we have a lot of sunlight and we could turn the deserts into CO_2 sinks and manufacturing powerhouses," she says. "Globally we need to look hard at investing in some of these types of issues to try to find solutions. The chemical industry is responsible for a lot of CO_2 emissions. To make a system that does this we need industrialists working alongside academics to try and translate some of the research into new products."

Associate Professor Kay Cook is comparing child support programmes around the world and **how governments handle these complex financial arrangements between ex-partners.**

THE FINANCIAL FALLOUT OF SEPARATION ISSUES

It's the oldest story in the book: two people meet, fall in love, have kids. Later, they fall out of love and want nothing to do with each other, but like it or not, the couple will be linked until their children are raised — a job that requires a lot of time, money, generosity and love.

What is a government's role when parents are at odds? According to Associate Professor Kay Cook, a leading researcher on child support, who joined Swinburne's Department of Social Sciences in 2018, no country has found a comprehensive answer.

Cook, who is also Co-director of the International Network of Child Support Scholars, has launched a project examining the personal, practical and institutional barriers faced by parents needing child support payments. Her work is partly funded by an $841,000 ARC Future Fellowship designated to areas of Australian importance, but her project draws on expertise from across the world, particularly on policies in the United Kingdom and the United States.

"What's been striking so far," she says, "is that on one level the challenges are fairly similar. It doesn't matter if it's Nigeria or Norway, if a person doesn't want to pay there is often nothing making them." Cook points out that advocates in many countries report substantial barriers to accessing entitlements and pursuing full payment. To unpick this, she has already interviewed experts from 16 countries to explore whether there are common challenges.

A Canadian child support administrator (who can't be identified because of the ethical requirements of the project) suggests there are common issues. "Our caseload, like caseloads in many other countries, is falling, despite increasing levels of child poverty. I don't think it is because absent fathers are paying child support so mums don't need us," she says. "There are clearly other dynamics today — and families are quite different to the families of 25 years ago when these programmes were set up. We are trying to find out what is going on. I think Kay's research will provide us with some really interesting insights."

A GLOBAL INVESTIGATION

Cook will interview women who report having problems with child support and

> As a policy, this has to deal with many of the big issues of life: caring for children; gender roles; responsibility for earning...and, people's emotions.

Gender equity

Associate Professor Kay Cook says gaps in child support policy significantly exacerbate Australia's gender-based income inequity. Because of the high cost of childcare, couples in Australia are encouraged to have a stay-at-home parent, at least part of the time. Gendered parental leave policies and a sizable gender wage gap mean that it often seems logical that the mother take time off. If families separate, mothers often carry on being the primary carer, but many fathers don't feel like they should be financially supporting their ex-partner. The result is that some people don't pay the full child support amount, which often exacerbates the gap between incomes based on gender. One aim, says Cook, is to develop a framework through which countries can assess policies in terms of gender equity.

look closely at case studies in Australia and the United Kingdom. Her research draws on the knowledge that child support policymakers weigh three competing factors: cutting child poverty, reducing welfare spending and compelling parents to meet their responsibilities. Governments, she says, tend to emphasise one point over the others.

The United Kingdom has emphasised the second point and since 2013 has effectively required parents to pay fees of up to 20% for the payer and 4% for the recipient to participate in a formal child support administrative arrangement. The idea, says Cook, is to encourage parents to manage their affairs outside of this system. Meanwhile, the government in the United Kingdom continues to pay welfare, but has removed any link to the amount of child support received by parents. This perhaps ultimately reduces child poverty in cases of child support non-compliance, but means government steps back from financial equity issue between former couples.

The United States, by contrast, emphasises point three and takes a more punitive approach, with some states penalising parents who don't pay. "You get poor fathers with children to several women with a high child support order. There's often no scaling that recognises you can't pay 20% of your income times eight. And then they are jailed for non-compliance," says Cook. It's the other extreme, she says.

In Australia, the child support has been a running source of debate for more than a decade. Much of that has focused on a formula to calculate the costs of children and how to stretch parental income that used to pay for one household across two.

The standardised child support formula was adjusted roughly 10 years ago and counts the reported income of both the father and mother, the number of nights children spend with each parent, and the projected costs of each child based on age. But both parents have been granted the same self-support amount, regardless of care-time or income. The result is that the lower-income single parents end up with less.

"One of the major problems is that the standardised self-support amount doesn't take into consideration any of the opportunity costs that are lost for primary carers, usually women, who often have the care time during the work-week, while men often have the children every second weekend and half the school holidays, which doesn't at all interfere with their earnings," says Cook.

She has examined the arguments, particularly those made by fathers, and what they say about expectations before and after separation. In the most extreme cases, she found a pushback against the entire rationale for the child support system — the idea that money needs to be redistributed from the income haves to the income have-nots, in this case often to mothers.

“Some fathers don’t agree with the principle of child support at all,” she says. They argue that we’re all equal now, so women should be working more. But women often can’t work as much because they frequently have more care responsibilities and face high childcare costs.

Even when they are working they can’t earn as much due to the gender wage gap and lower paid feminised occupations.”

Kay Cook.

DRIVING POLICY CHANGES

Cook’s previous research is already re-shaping Australian policy. For example, she has been able to identify and articulate a major inequity within the tax system — the fact that child support counts as income when the government calculates family tax benefits. The more child support you get, the less family tax benefit you get.

More than half the people in the child support system transfer that money privately between one another, says Cook, so this tax issue can be problematic. “The government doesn’t know whether or not it has actually been paid. They just assume it’s 100% compliant, even though the best-case scenario, based on fathers’ reports, is that only 73% say they pay in full and on time.”

Parents who receive child support above a certain amount lose 50 cents in every dollar they are entitled to under Family Tax Benefit Part A, a benefit to help with the cost of raising children given to all parents who meet the requirements. This creates a significant problem when they are receiving less than assumed. A related issue is that the government calculates how much child support people should be paying based on their tax return. If no tax return is lodged, they calculate it based on the payers’ last filed tax return indexed for wage growth.

In 2015, Cook’s findings helped shape the recommendations of an Australian Parliamentary Inquiry into the Child Support Program, including the suggestion that the government collect comprehensive demographic information on all child support clients to help design a better service, and make data publicly available, so the scheme could be researched, evaluated and understood. She also contributed to the inquiry recommending the Australian National Audit Office examine whether the Australian Taxation Office and the Department of Human Services were cooperating effectively to address cases where fathers liable for child support did not lodge tax returns. The government agreed with all three recommendations, and is investigating.

Working with the National Council of Single Mothers and their Children (NCSMC), Cook also held a forum in 2016 to advocate for child support issues among policy stakeholders. Information from the forum has formed the basis for a campaign, led by NCSMC chief executive, Terese Edwards, to lobby for stricter enforcement on separated fathers who do not lodge tax returns.

Cook started out studying health promotion, first in Australia and then in Canada, looking at policies that shape wellbeing and health. She returned to Australia to complete a doctorate investigating welfare entitlements for single parents. While working with the Brotherhood of St Laurence on an ARC Linkage project in 2013 however, she noticed that many single mothers reported to her that they found their child support income erratic, and in some cases the difference between having money for food or not. She decided the subject deserved a more nuanced investigation.

Cook says while all countries differ in how they approach child support policies, none have really come to grips with the fact it’s not just a financial matter. It’s often a highly emotional issue. “We’ve turned [child support] into a technical problem to be solved through a formula,” says Cook. “But, as a policy, this has to deal with many of the big issues of life: caring for children; gender roles; responsibility for earning; responsibility for caring; the welfare of children; and, people’s emotions.”

GALACTIC GHOSTS

Associate Professor Ivo Labbé helped discover an odd type of dead galaxy. Using a variety of the world's most powerful telescopes, he's looking into why they die in infancy.

Associate Professor Ivo Labbé is hunting dead galaxies from the dawn of time. These cosmic relics passed their active star-making years and mysteriously ‘died’ more than 12 billion years ago, when they should have had at least another 10 billion years of life.

Labbé joined Swinburne’s Centre for Astrophysics and Supercomputing in 2018 to find the very faint markers of galaxies that met their demise in our universe’s infancy, when the cosmos itself was only a billion years old or so. His hope is that identifying these galaxies will help solve the mystery of how and why they lived fast and died young.

Born in the Netherlands, Labbé admits he “rolled into astronomy by accident”. As an undergraduate student at Leiden University, he was unclear on what kind of career path to pursue, but settled on studying physics because it underpins the workings of so much of our everyday technology, from our electric lights to our laptops and phones. “I figured these physicists are getting something right, so they must be clever cookies,” he says, laughing. While there, he made the change to astronomy and his passion was ignited. A masters and PhD at Leiden followed, and Labbé recalls plastering the walls of his dormitory with images of the cosmos he was studying.

Labbé has brought that enthusiasm to Swinburne with the aim of using just such images to unravel a conundrum about the life-cycle of odd dead galaxies, which he helped to discover just a couple of years ago.

Until recently, astronomers thought they had a pretty good handle on how galaxies form, grow, and then eventually, die. Our universe is known to be about 13.8 billion years old, with our galaxy, the Milky Way, thought to be only slightly younger, at 13.5 billion years of age.

The conventional wisdom was that all galaxies followed a similar life path to the Milky Way: the galaxy would start forming from a cloud of gas in the early universe, housing just a small collection of stars. It would then spend a good few billion years as a stellar factory, converting more and more gas from the neighbourhood into new stars, and getting bigger in the process. This growth rate was thought to speed up, until it hits a peak, roughly around 10 billion years ago, “when the whole universe was brimming with newly formed stars,” says Labbé. Eventually, after another five to ten billion years, or so, this activity grinds to a halt, and the galaxy is effectively dead.

That picture holds true for the mature, but likely not dead, Milky Way, and most of the galaxies that astronomers have spotted to date. But a couple of years ago, Labbé and his colleagues discovered that some galaxies — the peculiar ghosts that captivate him — defy this pattern. Instead of going through their life-cycle at the normal, sedate pace that takes 10–15 billion years, they raced through life at an astonishing speed and died when the cosmos had barely aged beyond its first billion years.

Labbé and his colleagues stumbled on this bizarre finding when, as a postdoc based at the Carnegie Institution of Science in Washington, DC, he led the ZFOURGE Project. Through this international collaboration he met many of his current Swinburne colleagues. The team were racing to find the most distant galaxy ever, using the Magellan optical telescope, hosted by Carnegie.

In astronomy, the farther away from Earth you peer with your telescope, the further back you can see in time. That’s because light from far-flung stars and galaxies takes so long to travel through space that, when it finally reaches our telescopes, it is a snapshot of how the universe appeared in the ancient past.

So, when Labbé trained the Magellan telescope on a particularly remote galaxy — snapped during the first billion years of our universe’s existence — he was pretty sure that he’d be viewing a young galaxy, newly born and just starting to cook its stars. But he was wrong.

What the team actually saw, stunned them: their ‘young’ galaxy had already grown to an enormous size, bigger than many much older galaxies, and had already stopped forming stars, and died. This was despite the fact the universe itself had not been around long enough for the galaxy to have matured so rapidly. “It’s something that was really quite unexpected,” says Labbé, “It’s like seeing a 200lb baby who is already old and grey, with a beard!”

Questions flew: How could this galaxy have grown at such a super-fast rate, effectively ageing instantly? And what caused it to die and become a ghost? But before tackling these puzzles, the team had to definitively prove that their eyes and the image from their optical telescope, weren’t deceiving them. To do this, Labbé needed access to state-of-the-art equipment that could confirm whether such ‘candidate ghosts’ really are as far away, and as dead, as they appeared to be in pictures.

Pinning down the age and distance to a galaxy requires a spectrograph, an instrument that splits the light coming from stars into its component wavelengths. Different kinds of stars have varying “spectral fingerprints”, explains Labbé, which give astronomers invaluable insight into the type of star they are looking at — young or old — and the galaxy’s location.

A spectrograph brought Labbé to Australia; astronomers at Swinburne have privileged access to the MOSFIRE spectrograph, which sits on one of the Keck telescopes in Hawaii. Over the past few years, as part of Swinburne’s ZFIRE project, led by Swinburne’s Distinguished Professor Karl Glazebrook, Labbé has been homing in on candidate ghosts he first picked out from optical images taken with the Magellan telescope. This involves carrying out a detailed spectral analysis of each one by focusing on them with the Keck telescope for a long period. “You basically point the telescope at them and burn a hole in the sky,” says Labbé.

ZFIRE grabbed worldwide attention last year when Labbé and his colleagues confirmed that these prematurely-deceased galaxies are real — a result that was published in *Nature*. “People for the first time really got the proof that there were these ghost galaxies that were fully grown and are already dead, in the early universe,” says Labbé.

“It’s like seeing a 200lb baby who is already old and grey, with a beard!”

Discovering the first youthful ghost was a huge success for the ZFIRE team, but it was also an immense challenge to spot these faintest of objects in the sky, taking many nights of telescope-time in Hawaii, spread over many years. Now the team has added several more verified ghosts to their haul. “Our results show that there was already very significant activity in this super-young universe,” says Labbé.

But to really get to grips with what actually happened to prematurely age these ghost stars, they need many more examples to study in detail, taken from even earlier in cosmic history. This brings a new problem: older stars tend to emit light in the infrared, but detecting infrared light with even the best ground-based telescopes, such as Keck, is extremely tough because everything in the telescope’s surroundings, people, and even the telescope’s own instruments, also generate heat and infrared light, blinding the viewer with background light. “It’s like trying to look directly into car headlights,” says Labbé.

Astronomers get around this by cooling parts of their ground-based telescopes as best they can; but there is a fundamental limit to how well telescopes stuck on Earth can perform. It’s far better to put your telescope in space, away from infrared disturbances, for a cleaner signal that enables astronomers to probe deeper into the cosmos, and peer further back into the past.

So, to hunt for thousands of new candidate ghost galaxies at even earlier times in the first billion years since our universe was born, Labbé and his colleagues are now pushing two ageing NASA space telescopes to their limits: the Hubble Telescope, which takes optical images, and tends to pick out young stars, and the Spitzer Space Telescope, which is sensitive to the infrared light given out by older stars. “This is basically to break ground in the earliest part of the universe,” says Labbé. “That’s where the current frontier is.”

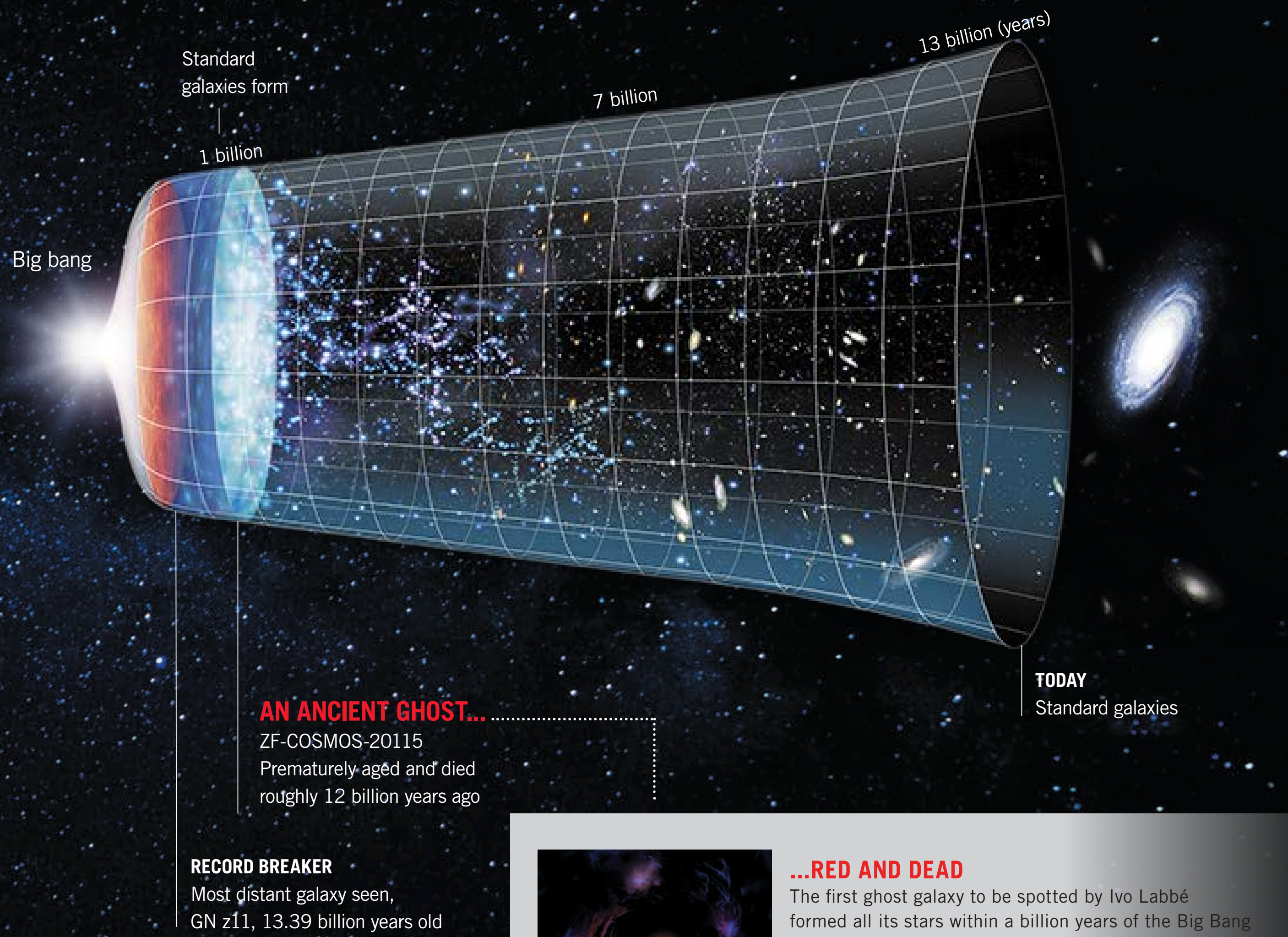
And it is only just starting. NASA’s James Webb Space Telescope, scheduled to launch in March 2021, will carry a spectrograph on board. Labbé hopes that the Swinburne team will be able to use this to confirm their new ghost-candidates, scouted out using Hubble and Spitzer, are real, and to provide glorious new detail about the ghosts’ properties.

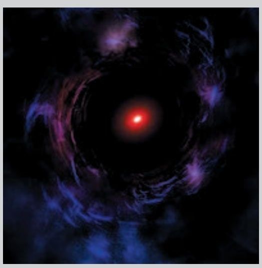
“This is where it becomes really interesting,” says Labbé. He notes that the quest for the most distant and earliest galaxies was revolutionised by advances in telescope technology over the past decade, and now, thanks to the new space telescope, it will gather speed.

“James Webb (telescope) will go a long way towards answering the question: how did we get here? All the way from the beginning, from the first stars to the first galaxies,” says Labbé. “We’re on the brink of filling in that final chapter of our cosmic history.”

FROM BANG TO PREMATURE BUST

Standard galaxies follow a leisurely life-cycle of 10–15 billion years. The first stars began to form out of gas and cluster in young galaxies about 100 million years after the birth of the universe. New, young galaxies appear blue. Blue stars are at least three times the mass of our Sun. They are hot, massive and bright, but are short-lived, burning through their fuel quickly and dying after a few hundred million years. Red stars use their hydrogen fuel slowly and will continue to shine for billions of years. So as standard galaxies age, they slowly shift in colour from blue to red. Ghost galaxies are startling because, despite being 'young' in age, they are red, meaning that they have whizzed through the standard galactic life-cycle in a tenth of the normal time.



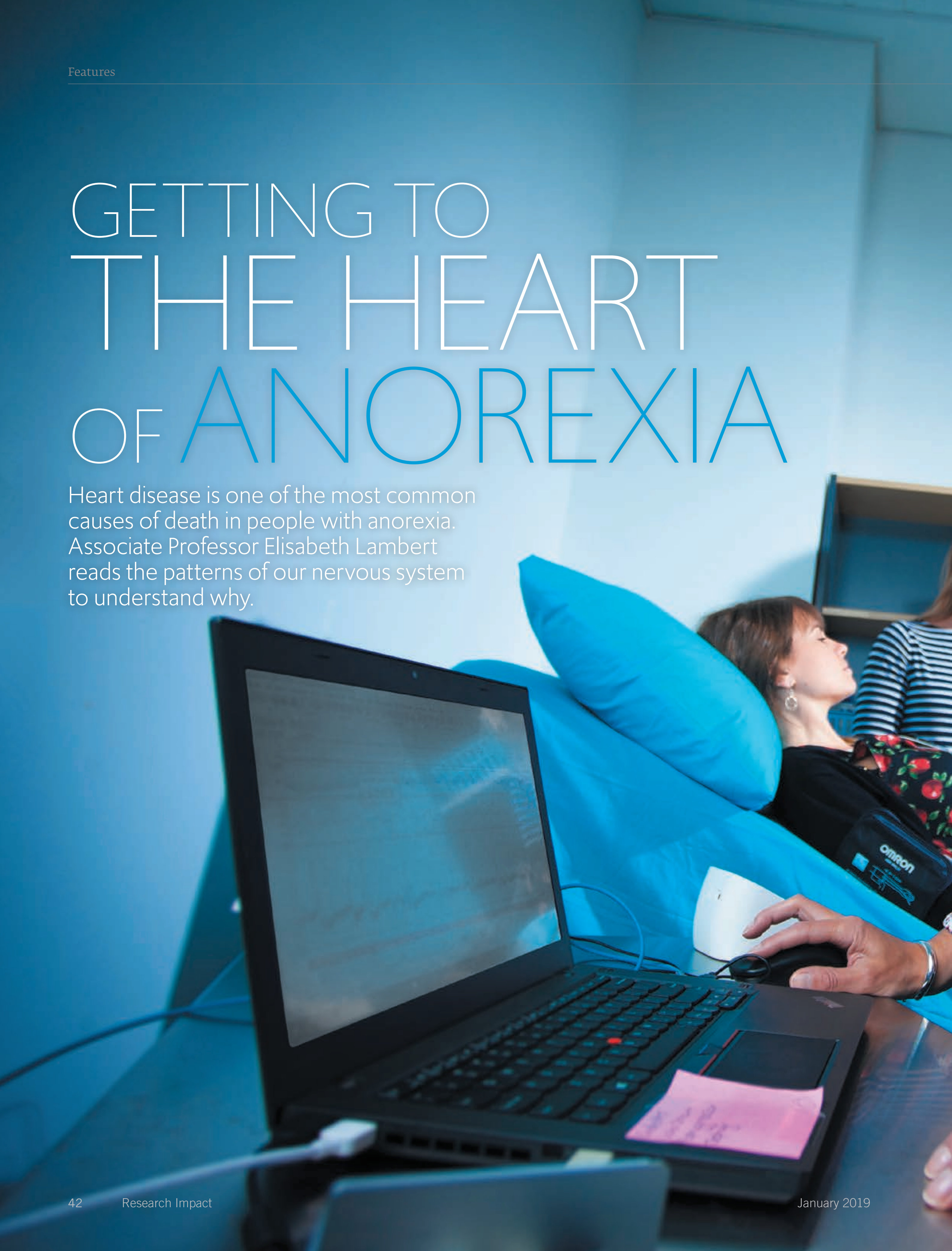


...RED AND DEAD

The first ghost galaxy to be spotted by Ivo Labbé formed all its stars within a billion years of the Big Bang — rapidly growing to a monster size, with three to five times as many stars as our own Milky Way. It quickly blew off the gas needed to make more stars, leaving it as a small, dense, red galaxy. It was already deceased by the time the universe was 1.6 billion years old. This is an artist's conception of galaxy ZF-COSMOS-20115.

GETTING TO THE HEART OF ANOREXIA

Heart disease is one of the most common causes of death in people with anorexia. Associate Professor Elisabeth Lambert reads the patterns of our nervous system to understand why.



Elisabeth Lambert is an expert in reading electrical nerve impulses recorded using a technique called microneurography. She is studying why anorexia sufferers experience cardiovascular complications.

Eamon Gallagher

A two-year research project at Swinburne is investigating the physiology of anorexia nervosa with the aim of reducing the alarmingly high number of heart disease deaths caused by the condition.

As many as 30,000 people in Australia suffer from anorexia nervosa, and about 6% of these die as a consequence of the disease, the highest mortality rate of any psychiatric disorder. Globally, suicide accounts for up to 20% of anorexia deaths, considered the leading cause of mortality. As a result, treatment is often primarily psychologically based. But an additional 5% of deaths are due to sudden cardiovascular complications, while a further unknown number die later of cardiovascular disease.

"She's not only able to work out the rate at which nerves fire in response to certain stressors, but also identify tell-tale firing patterns."

Anorexia is characterised by excessive dieting, purging and, often, over-exercising. "Of course, this starvation places a lot of stress on the body," explains Associate Professor Elisabeth Lambert, who is heading up the study through Swinburne's Iverson Health Innovation Research Institute. "Ultimately, the disease can affect every organ system and so potentially can result in many very serious medical complications." These can have immediate impacts on the heart, but also long-term cumulative effects on cardiac health that compound with time.

Lambert hopes to catch those most at risk of this by identifying a particular set of predictive markers. "We want to see if there are disturbances in the function of the nerves of the autonomic nervous system and if this is the cause of the dysfunction of the heart and metabolic abnormalities associated with anorexia."

PATTERN RECOGNITION

Lambert's professional expertise is in the areas of neurophysiology and cardiology. She joined Swinburne in 2017 after almost 20 years with the Melbourne-based Baker Heart and Diabetes Institute, with whom she still has strong links. She brings to Swinburne highly specialised experience in a technique known as microneurography.

The slightly invasive technique requires an electrode to be inserted directly into the peroneal nerve behind the knee in test subjects. This allows researchers to measure electrical impulses in the nerves of the autonomic nervous system (ANS), which regulates body functions that we're not conscious of controlling, such as the maintenance of our blood pressure or breathing rate. It is also the only direct way to measure the activity of the sympathetic nervous system (SNS) – the part of the ANS that controls many of our body's base functions and activates the neuronal and hormonal stress reaction to risk known as the 'fight-or-flight' response.

Microneurography readings, says Lambert, offer a way of examining the body's activity at rest and in response to physiological stressors on the heart, such as hypertension, obesity and, of course, anorexia. That in turn, she says, offers the opportunity to identify the mechanisms responsible for aberrant nerve behaviour and can direct therapy in order to reverse or prevent associated problems.

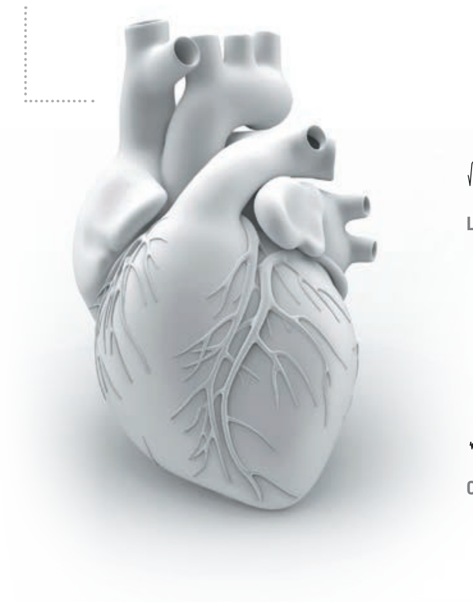
There are only three groups in Australia proficient in microneurography, and Lambert's capabilities in the area, built up during two decades, are considered to be world-leading. She's not only able to work out the rate at which nerves fire in response to certain stressors, but also identify tell-tale firing patterns in obese and lean people (see opposite, top right).

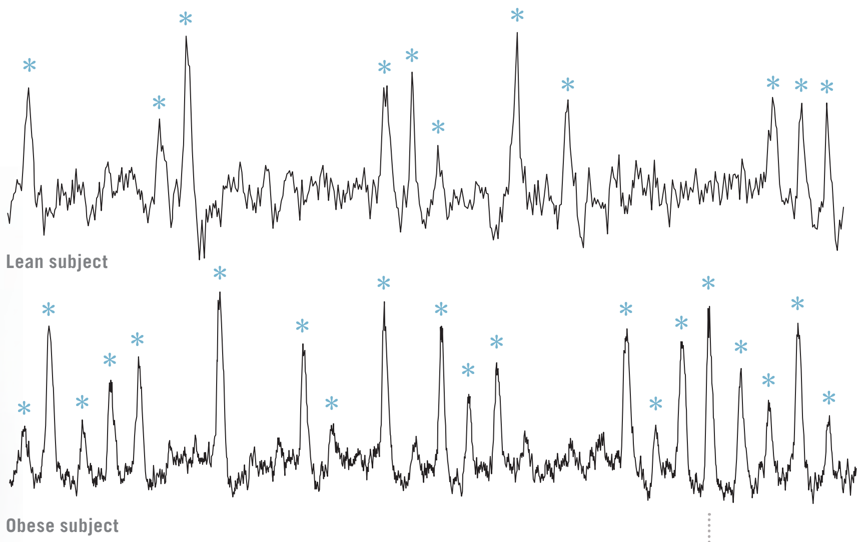
Lambert learned to spot these markers while exploring how SNS regulation can underpin the development and maintenance of cardiovascular disease risk in obese individuals. This work had shown an elevated level of activity of nerves in the SNS of overweight, but otherwise healthy, young adults. This in turn was associated with subtle damage to the kidneys and heart.

The link for Lambert is that people with anorexia develop metabolic abnormalities that resemble that of overweight people. This includes the way lipids show up in blood tests, she says. At first, it may sound counterintuitive to think there are similarities between the impact of overeating and undereating. "But the thing is that eating too much or not eating too much may put pressure on the body and impact similarly on, for instance, kidney or heart function," says Lambert.

SYMPATHETIC HEARTS

Elisabeth Lambert has already linked the degree of sympathetic nervous system activation with mild organ damage to the vasculature, the kidneys and the heart.





NERVES IN FIGHT OR FLIGHT

Ten seconds of sympathetic nerve impuses, which are linked to the body's flight or fight response to danger, show 11 bursts (*) of activity in a lean individual (top) and 20 in an obese subject (bottom). Swinburne researchers think they may find similar patterns in anorexia sufferers.

"Now we want to investigate individuals with anorexia because we think that they may present with similar problems associated with sympathetic nervous activation."

Lambert even thinks she may be able to tinker with nerve activity directly through the use of drugs, exercise and diet. "Our current investigations explore several ways of altering SNS activity in obese individuals," she says. "The aim is to reveal whether these approaches could be beneficial in reversing or slowing down the progression of cardiometabolic disease."

Like most Swinburne projects, Lambert's project is highly collaborative with specialist clinical groups outside the university. She is working to recruit test subjects with the Melbourne Clinic's Eating Disorder Unit and psychiatric department of St Vincent's Hospital, Melbourne.

"We will look at patients who used to have anorexia, who are currently well but went through that strain and stress [of the disease] and we will try to see if we can pick up some abnormalities in the heart and so on." The study will also be recruiting people presently in an acute stage of anorexia to see if they can map differences at that point as well.

Lambert's work in anorexia builds on a broader program investigating the disorder within Swinburne's Centre for Mental Health, which is headed by neuropsychologist Professor Susan Rossell.

"The centre has a large anorexia and body image program, and this particular [microneurography] project adds a new dimension to it," explains Professor Gavin Lambert (who is married to Elisabeth), Director of Swinburne's Iverson Health Innovation Research Institute.

Bringing microneurography into the centre's capabilities also potentially adds a powerful dimension to other areas at Swinburne. "It's relevant for high blood pressure, heart failure, diabetes," he says. "It could be relevant for people with panic disorder and people with depression."

By combining this capability with Swinburne's already formidable multimillion dollar Neuroimaging Facility (see page 18) and expertise within the Centre for Mental Health, it should be possible to determine the brain regions that are actually governing the firing rate of particular nerves. That means being able to determine the pathways in the brain involved in generating sympathetic nerve activity. And that, of course, could set researchers on the path to finding treatments for the physical impacts of not just anorexia, but many other disorders involving the sympathetic nervous system.

CODE BLOCKS TO FRAME ART FORGERS

A Swinburne cyber security expert is adapting **BLOCKCHAIN TECHNOLOGY** to vouch for the authenticity of physical objects, including valuable artworks.

© Ivan Kamzyst / Alamy Stock Vector

Sometimes an art forgery is so sophisticated, it fools even the experts. For example, in 2011, Sotheby's brokered a deal for a darkly coloured gentleman's portrait said to be by 17th century painter Frans Hals the Elder. The buyer paid roughly AU$15 million (US$10.9 million). In 2016, amid a string of similar scandals, this work was discovered to be made partially of synthetic paint, making its supposed provenance impossible.

This was not an isolated case. In the past decade, many other prestigious London auction houses and New York galleries have also been caught out selling paintings, purportedly by artists ranging from old masters to modern abstract expressionists, that have been shown to be fakes. Swinburne researchers have developed an electronic system that promises to make life more difficult for art forgers. Professor Yang Xiang, Dean of the Digital Research Innovation Capability Platform, and his colleagues in the Data Science Research Institute, are using the same cyber security approach used by Bitcoin to guarantee the provenance and authenticity of works of art. The system should not only improve logistics for the art trade — an $82 billion dollar annual global market — but provide additional benefits to artists, such as ongoing royalties.

Swinburne and its partner, Melbourne-based start-up ArtChain Global, announced the secure art-trading platform in 2018. "We anticipate this new system will be a game-changing technology," Xiang says. "The Swinburne-developed secure digital technology underpinning the platform has applications far beyond the art world, potentially ranging from logistics to healthcare," he adds.

ARTCHAIN ENTERS THE MARKET

Xiang's partnership with ArtChain Global came about in late 2017, when the Melbourne-based group approached the cyber security researcher to ask if Swinburne had any capabilities with a computer technology called blockchain. "We have a number of researchers

"IF THERE IS A FAKE, VERY MINOR FEATURES CAN BE DETECTED BY AI"

working on R&D blockchain projects, so it was a perfect fit," Xiang says.

Blockchain is best known in the context of Bitcoin and its competitor online virtual currencies. Blockchain creates the secure environment within which these 'cryptocurrencies' can be stored and traded. "Cryptocurrencies are the first real-world application of blockchain technology," Xiang says.

"To describe how blockchain works, I like to use a marriage ceremony as an example," Xiang says. On the big day, friends and family all witnesses the event and can each verify that the ceremony took place.

In the case of a cryptocurrency transaction, a distributed network of invited computers act as the witnesses, each recording that an exchange of funds took place. Just as everyone invited to the wedding remembers the event, the computers all hold an identical copy of the transaction record. If anybody tried to fraudulently manipulate a cryptocurrency record, the doctored copy would no longer match all the other computers' version and the change would be rejected. "Bitcoin is the first application that shows blockchain's potential," says Xiang. But the same idea could underpin almost any type of transaction, he says.

Including the trade of art. "Although there are so many high-value transactions, one of the key problems in this industry is the authenticity of the artworks and collectables," he says. Developing an art-trading platform based on blockchain would eliminate that concern. Using blockchain would be akin to having multiple witnesses on hand to observe the artist selling a piece to a dealer or collector, and then witnessing each onward sale of the piece.

Technologically, adapting blockchain code for a new application is not too difficult, as there are several open source blockchain platforms available for use, says Xiang. The biggest challenge has been developing protocols to robustly connect the physical artwork to its digital blockchain record. The team has applied cutting-edge electronic technologies to overcome this challenge, Xiang explains.

The first level of security comes from attaching to the object a smart, internet-enabled electronic tag, connecting the artwork to the internet of things (IoT). These tags, which give the artwork a unique online identify, can also be integrated with GPS tracking modules, so its physical location is always known.

As a further security measure, the team has developed an artificial intelligence (AI) program that analyses high-resolution camera images of the real artwork. "If there is a fake, very minor features not recognisable by human eyes can be detected by AI," Xiang says. AI, which is based on deep learning algorithms, was trained to spot fakes by allowing it to analyse a huge library of images. Attributes such as colour saturation, brightness and depth are all analysed to detect minor differences between the real version and the copy. The system is already working quite well in the lab, says Xiang. Real-world testing began in 2018.

The art-trading platform will integrate all these new technologies into a single interface. "We have developed a combined system that utilises AI and IoT, plus the blockchain," Xiang says. "So the whole system involves multiple new technologies, all done at Swinburne."

ONGOING ROYALTIES

John Young, a Melbourne artist and studio owner, has been consulting for ArtChain Global as the platform was developed. "I am very optimistic about its possibilities," says Young. "There are several areas where this is clearly a very good thing." Not least, of course, is confirming the authenticity of an artwork.

Although forged work, claimed to be painted by figures such as Jackson Pollock, tend to grab headlines, these high-profile cases are the tip of the iceberg when it comes to art copying. A more prevalent threat for

Visitors at the Rijksmuseum in Amsterdam admire works by Johannes Vermeer, whose paintings were replicated by the infamous Dutch forger, Han van Meegeren.

today's working artists is having online images of their artworks copied and used without permission, attribution or payment.

"I have had people lift work from my website, then blow it up to full size and use it as a shop window display," Young says.

Registering a work on ArtChain would be a safeguard, providing a timeline and proving that Young was the creator of the work.

Aside from its security credentials, the other key feature is the way the blockchain record grows over time. Each time an object is traded — be it a Bitcoin or a painting — a new line item (or 'block') is added to the end of the existing record file. The record itself therefore serves as a chronological history of the object's ownership and its provenance.

"For the art market, provenance is very important," Young says. "A work held in a collection for 50 years is sometimes seen as more valuable than a piece that has been continually traded on the secondary market."

The growing blockchain record has other potential advantages for the art trade. It allows for royalty payments for the artist for each onward sale of their work. Items sold by artists early in their career can significantly increase in value over time as the artist makes a name. "Traditionally the artist cannot get any benefit from that, says Xiang. "In the blockchain platform, we embedded a new royalty system. Because blockchain cannot be manipulated or changed by third parties, the artist can collect the royalties many years later," he says.

Artists will need to be educated about blockchain based art transactions before they are likely to embrace it, Young says. "Like any start-up technology, users need some convincing in terms of trust." But Xiang says the reception to the system so far has been positive among artists.

ArtChain also plans to expand into Asian countries.

FROM ART TO ANTIMALARIALS

For Xiang and his team, the blockchain-based art-trading platform is just the beginning of their work in this area. "The fundamental technology is applicable to many other areas, in particular in supply chains," says Xiang.

Their system for combining, AI, IoT and blockchain could be readily adapted for the trade of other collectable items, such as jewellery.

The technology could also become an indispensable tool in stemming the expanding trade in counterfeit medicines.

Fake versions of antimalarial drugs, containing little or no active ingredient, are of particular concern, according to the World Health Organization, which found that substandard and counterfeit medicines may cause up to 116,000 malaria deaths each year in sub-Saharan Africa alone.

Developing countries are particularly vulnerable to fake drug imports, as they often lack the resources to detect the crime. But, even in tightly regulated countries such as Australia, a small number of counterfeit medicines can sometimes be slipped into the healthcare system.

The same blockchain-IoT technology Xiang has developed to record the authenticity and provenance of artworks could be used to secure the pharmaceutical supply chain, providing traceability of each drug carton back to the original manufacturer. A blockchain-based platform like this could augment efforts to control the problem by regulators and pharmaceutical companies, which already includes making packaging harder to fake.

"In the next few months we will have connections with other industries, particularly in the area of healthcare, education, transportation and logistics," Xiang says.

Science that strolls the streets

From 3D printed headphones to Australia's $50 note, the fruits of Swinburne research are out and about.

INDRA MOSQUITO ZAPPER

Swinburne's Paul Eterovich has designed an insect control device powered by renewable wind, sun and mechanical energy. It was developed primarily to tackle the challenges of high malaria and dengue infection rates in India. Eterovich hopes to develop the technology further next year through India's Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI).

DIALYSIS WEBSITE

Almost 11,000 Australians were reliant upon dialysis at the end of 2011, tying them to their local clinic. Last year Swinburne was approached by dialysis expert, Greg Collette, to create the Travel Dialysis Review website to help those living with dialysis to travel the world. The website empowers people to help each other find the right services around the world through user-generated reviews.
>> traveldialysisreview.com

STICKING TO A SAFE PATH

Swinburne design student, Xia Zhang, has worked with industry to develop Leef, a walking stick attached to a digital app to allow carers to monitor its user's activity. The stick has an inbuilt alarm and provision for wi-fi connection. Zhang is working to commercialise the product.

WINE VITAMINS

Each year winemaking produces 11 million tonnes globally of solid wine waste or grape pomace (the skin, seeds, stems and pulp left over). In 2015, Swinburne researchers, led by Professor Enzo Palombo, and CSIRO, developed a system for converting wine waste into compounds using four fungi. Viridi Innovations has now used this knowledge to set up commercial systems to extract antioxidants for health supplement companies.
>> www.viridi.com.au

GAINING CURRENCY

Swinburne Indigenous studies expert Dr Karen Hughes has led the research behind the design of one side of the new Australian $50 note. The note features elements relevant to the life of celebrated Indigenous Australian David Unaipon.

An inventor, scholar, author, lay preacher and activist, Unaipon has featured on the $50 note since 1995. Hughes has been working with the Reserve Bank of Australia on the development of the new note since 2015.

SMART CLOUD BROKER

Smart Cloud Broker is a suite of software tools that allows consumers to better manage server space on the 'cloud' by comparing services. Developed by Swinburne in collaboration with the federal government's Smart Services CRC and AARNET, its four platforms help users understand cloud performance and pricing, and make migration decisions based on price, specification and performance.
>> www.smartcloudbroker.com

HEARABLES^{3D}

Mechanical engineer, Philip Kinsella, began working on a system for generating custom-fit in-ear devices in 2014 as part of his PhD at Swinburne. His invention involves a portable 3D scanning system that uses cameras to scan the ear. A printed earbud designed to simply replace the common silicone tips is then 3D printed for either headphones or hearing aids. Casual or close-fitting sports versions will be available. The Hearables^{3D} system is patented and will probably be available in Australia next year.

Swinburne Innovation Precinct

Research-led innovation delivers social and economic impact

The 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 the Design Factory Melbourne, Digital Innovation Lab, Victorian Industry 4.0 SME Hub, Siemens MindSphere Centre for Australia and DXC Digital Transformation Centre, form a foundation for this process.

The 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

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