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SWINBURNE UNIVERSITY OF TECHNOLOGY

RESEARCH IMPACT

2020

URBAN VISION
Making a sustainable metropolis

ONE-SHOT WONDER
Parasite treatment for free-ranging herds

PUMP PATROL
Tool to keep groundwater free of fuel

SEA SPRAY
Barnacle-beating ship coating

APPETITE FOR DATA

Diabetes dashboard empowers patients

RESEARCH IMPACT

PHONE: +61 3 9214 5552
WEB: www.research.swinburne.edu.au
FACEBOOK: www.facebook.com/swinburneuniversityoftechnology
TWITTER: www.twitter.com/Swinburne
EMAIL: research@swin.edu.au

ADMINISTRATION

Research and editorial enquiries
Scott Saunders — Research Communications Coordinator
tel: +61 3 9214 8468 | email: scottsaunders@swin.edu.au

Industry research engagement enquiries
Ros Hore — Director, Industry Research Engagement and Business Development
tel: +61 3 9214 3332 | email: rhore@swin.edu.au

Swinburne Alumni
Louise McCarthy — Director, Alumni and Operations
tel: +61 3 9214 3777 | email: louisemccarthy@swin.edu.au

ABOUT THIS MAGAZINE

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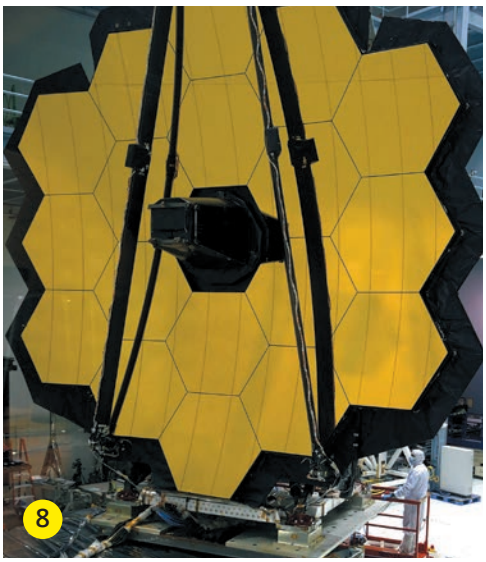
227 Elizabeth Street, Suite 8.03, Level 8, Sydney, NSW 2000, Australia.

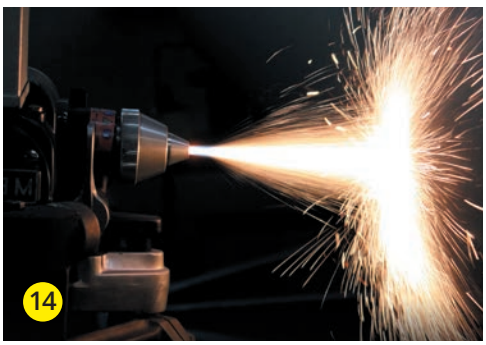
ABOUT SWINBURNE

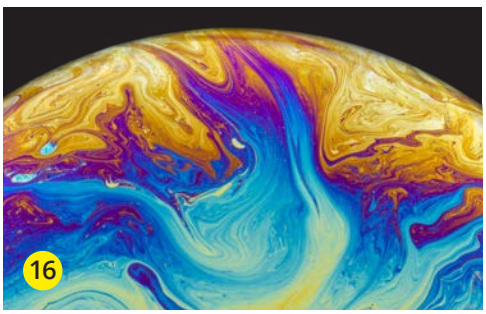
Swinburne University of Technology is an internationally recognised research-intensive university that is focused on delivering research that creates economic and social impact. Our researchers are producing innovative research solutions to real-world problems across a range of disciplines and sectors. In 2019, Swinburne was listed within the top 3% of roughly 20,000 higher education institutions by the Academic Ranking of World Universities (ARWU), Times Higher Education (THE) University World Rankings and QS World University Rankings. We are committed to delivering world-leading research outcomes and innovations in select areas of science, engineering and technology. In 2019, Swinburne launched the Capgemini Swinburne Blockchain Centre of Excellence, a joint venture between Swinburne and Capgemini that addresses complex business problems in a range of diverse industries using strategic blockchain developments. The Data for Social Good Cloud Innovation Centre, launched in partnership with Amazon Web Services, uses innovative cloud technologies and intelligent data analytics to solve real-world health, cities and social challenges. We also won the highly prestigious Australian Business Award for Business Innovation for our national leadership and expertise in Industry 4.0. Swinburne's research future is bright. >>> research.swinburne.edu.au

SWINBURNE PRODUCTION TEAM

Scott Saunders (Editor)
Jane Sewell







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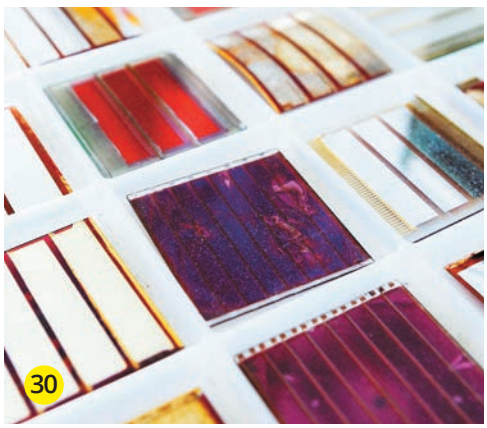


Research highlights

Features

Inventions

On the road to discovery, innovating at the intersections

The past 20 years have marked the most frenzied period of innovation and creativity in history.

Connectivity has exponentially hastened human progress. Examples abound: from super-conductive materials to squeezable metal and advances in quantum computing and astrophysics.

In just the past few years, we've seen breakthroughs in gene editing and in human tissue regeneration. In the foreseeable future, it will be possible to repair nerve damage and to artificially grow entire limbs and organs. SpaceX proved that recycled rockets and boosters are practical and possible and, importantly, result in a saving of $18 million per launch. Recently, scientists were able to measure, via gravitational waves, the violent death of two neutron stars 130 million light years from Earth. We've made gargantuan strides in almost every field.

Aleksandar Subic, pushing Swinburne's mission to innovate and disrupt, through inclusion and diversity.

"Diverse teams harness the power of convergence"

I mention connectivity, because it is connectivity, the crux of research-led innovation that has given birth to Swinburne's research and innovation ecosystem. It is the foundation for our approach to creating social and economic impact, encouraging collaboration at the intersection of disciplines, cultures, backgrounds and approaches.

The Medici Effect

The Swinburne story began more than 100 years ago, with a technical college committed to innovative education, strong industry engagement and social inclusion.

From the beginning, the vision of our founder, George Swinburne, was that the institution would be defined by who we included, not by whom we excluded. Inclusion and diversity go right to the heart of who we are.

Then, 27 years ago we became a university, as the world was on the cusp of the current creativity explosion.

And that brings us back to connectivity. Some years ago, a Harvard researcher and author on diversity, innovation, and creativity, Frans Johansson, provided a significant insight into how breakthrough creativity occurs. He dubbed it the 'Medici Effect', evoking the flourishing of ideas and creativity in Florence under the Medici family from the 15th Century onwards.

Johansson was referring to the discovery that many of the world's most innovative ideas occur at the intersection of different disciplines, different cultures and different fields. Breakthrough ideas rely on a diversity of perspectives: they rely on inclusion and diversity.

In other words, we have the best chance of coming up with great new ideas when we mix diverse approaches, fields, cultures and backgrounds — something we have always instinctively known at Swinburne.

BioPen

Three recent breakthroughs and co-creations help illustrate this point.

The first is a hand-held 'pen' 3D printer filled with stem cell ink that can be used to 'draw' new cartilage into damaged knees.

The BioPen has been jointly developed by the Aikenhead Centre for Medical Discovery, the University of Wollongong, the University of Melbourne, and importantly incorporating BioSphere, a novel stem cell technology developed by Swinburne and St Vincent's Hospital in Melbourne to refine the cell numbers for tissue regeneration.

The BioPen paves the way for the repair of damaged bones, muscles, tendons, and a reduced need for joint replacements.

This game-changing innovation represents the convergence of science, engineering and medicine to deliver a breakthrough technology for repairing cartilage damage using the latest discoveries in stem cell science, tissue engineering and 3D printing.

Blockchain for healthcare

The second example is the revolutionary use of blockchain technology in the healthcare industry.

Currently, Swinburne researchers are developing a blockchain platform solution focused on the complex area of healthcare billing and payment reconciliation.

This multi-disciplinary project aims to ensure the accuracy and provenance of all healthcare delivery activities for complete and transparent healthcare bill submissions to private health insurers and government.

This innovation is just another Swinburne project driving transformations in Health 4.0, improving the industry and supporting greater efficiencies and trust around healthcare delivery for all.

We are also fueling this work with our very own Medici Effect.

Facett

Our third example is a less widely known (but equally inspirational) co-creation and its impact for society and industry is immediately apparent.

Last year, a new hearing aid, known as Facett was launched in Melbourne. It is a low-cost, beautifully designed product that incorporates easy, magnetically-attached battery modules and can be tuned by users through an app.

It is the result of an interdisciplinary collaboration, led by Melbourne-based scientists Professor Peter Blamey, and Dr Elaine Saunders, involving industry partner Extel Technologies, RMIT designers, and researchers from the ARC Training Centre in Biodevices here at Swinburne, and Swinburne's Factory of the Future.

Facett, a user-tuned, low-cost, beautifully designed hearing aid, was developed through collaboration.

Facett also came about because of a Medici occurrence: its creation has been a collaboration between diverse perspectives, between science and design, between research and industry. It is the product of decades of work and many scientific advances.

Global connections and collaborations

Our research-led innovation strategy is designed to foster many more of these sorts of successes. As Louis Pasteur said: "Chance favours only the prepared mind." So our strategy builds capabilities, establishes partnerships, supports deep research and solves industry problems through collaboration.

Our research institutes enable and facilitate interdisciplinary collaboration across the university. The institutes are focused on five areas: Data Science, Health Innovation, Smart Cities, Social Innovation, and Manufacturing Futures.

These drive multidisciplinary and interdisciplinary research, creating teams to tackle big challenges. Our goal is transformative economic and social impact. And so our research takes on national and global priorities for industry growth and for society's betterment.

Then there is the Swinburne Innovation Precinct. It is not just a place, but an organising concept, encompassing these research institutes and much more. It is also a mindset. It is where individuals are given the freedom to step back from their habitual way of viewing concepts and problems. At the precinct they are able to create intersections with other fields, other cultures and ideas.

We are making history in other ways too. About two years ago, Swinburne established a presence in Silicon Valley in the United States, becoming the first Australian university to partner with CSIRO in the most mature innovation ecosystem in the world, a vital component in our strategy.

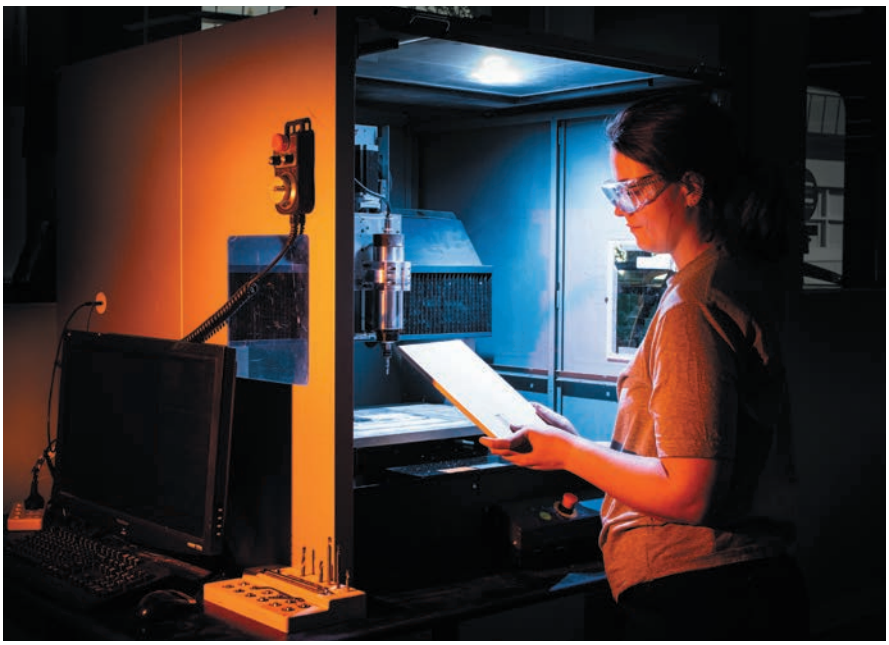
The CSIRO–Swinburne partnership is seeing Swinburne PhD students and early-career researchers, who are co-funded by industry, working on projects with leading Silicon Valley-based organisations. California is the sixth largest economy in the world, and arguably the most disruptive. This is about immersion, about working with like-minded disruptors, and about enabling our researchers to transform industries with work that is profound and lasting.

Swinburne's Factory of the Future, part of our precinct too, is creating Australia's first fully immersed Industry 4.0 facility. It's funded by a $135 million grant from Siemens, one of the largest-ever industrial

digitalisation grants in Australia's history, which is enabling us to also establish the world's first Industry 4.0 Testlab for 3D printing of carbon fibre composite industrial parts (see page 12). The Victorian Government is also investing in Swinburne, with a $2 million grant to establish the Advanced Manufacturing Industry 4.0 SME Hub. But this is not only about technology disruption; it's about the future of work and the future of our society. It's about real-life innovation.

We're immersed in the Fourth Industrial Revolution and we want to make sure that students and researchers are equipped with the advanced capabilities and tools to support Australian industry and to move our companies up the global value chain.

Through investment in partnerships and immersion in the world's most mature innovation ecosystems, we are learning a great deal and fast-tracking our development.



Swinburne strives to promote strong links between technological advances and industrial production.

Innovation as a social process

We are a comparatively young university. But in the world of innovation, that's not a bad thing. In just a few short years, Swinburne has fostered a number of powerful and potentially world-changing collaborations.

We have built these from a commanding legacy of entrepreneurship and innovation, and we have focused on industry, on science and on technology. Having a youthful openness has given us a significant advantage.

Innovation is essentially a social process. It involves relationships, and the coordination and cooperation of people. In the newly-evolving global innovation ecosystem, we have been able to build diverse teams.

One can get hold of the best players from within and outside our organisations. But getting the players to work together and play as a team is what makes the extraordinary out of the ordinary.

Our Networked Innovation Group within the Centre for Transformative Innovation is combining the soft and hard sciences in order to analyse the social networks that drive innovation. Not social media, but the real-life networks that produce outcomes.

Because we are taking the time to understand innovation, and what ignites and sustains it, we are changing the way we work and engage, moving Swinburne to the very forefront of research-led innovation.

Ecosystem edge

A vast amount of study has shown that diverse teams harness the power of convergence. But coming up with an idea is one thing, executing it is another. The research is clear on this too: diverse and inclusive teams, cutting across functions and identity, are also more successful in execution. This may be because they have wider experience and wider networks, and are willing to use non-traditional channels to get things done.

One cannot inject an ability to innovate or be creative. You can, however, provide the right environment: a favourable ecosystem, an enabler of ideas and capabilities, and a place where ideas will turn into novel products and services.

This is what our strategy is about. Our research and innovation vision is to create real impact that transforms industries, shapes lives and contributes to communities.

Innovation needs a conscious purpose: it must drive impact and positive change. But it comes from all quarters. At Swinburne, we look for it. We build bridges to encourage it.

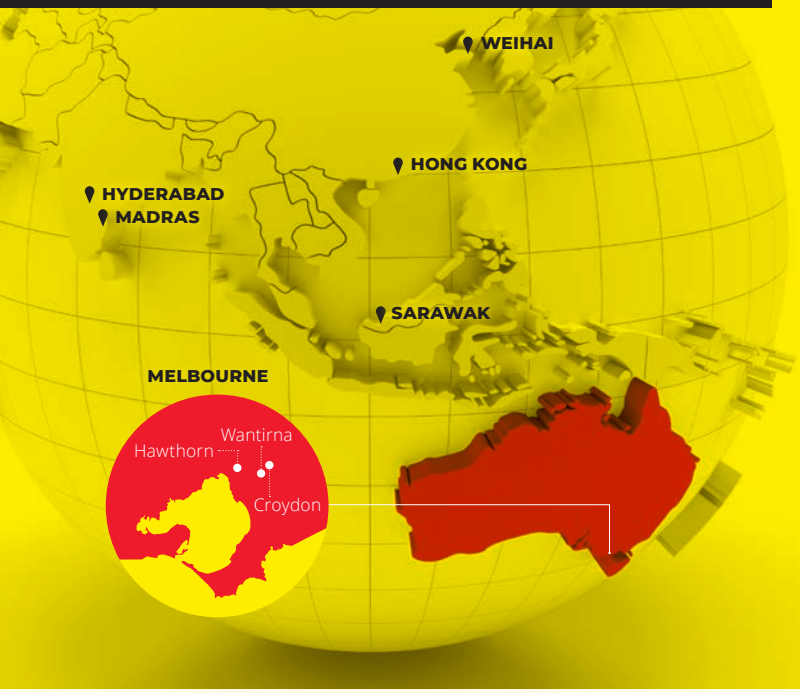
Professor Aleksandar Subic
Deputy Vice-Chancellor (Research and Enterprise)

On the cover

Professor Nilmini Wickramasinghe is developing an app incorporating artificial intelligence to predict future blood glucose levels and give advice to people with diabetes.

Cover image: Eamon Gallagher

SWINBURNE IN NUMBERS



Research centres worldwide

USA: SILICON VALLEY, SAN FRANCISCO
CSIRO-Swinburne Strategic Partnership

CHINA: WEIHAI AND HONG KONG
- Joint Research Centre in Advanced Manufacturing with Shandong University Weihai, Weihai Economic and Technological Development Zone and the Australian Education Management Group
- Hong Kong Productivity Council PhD Hub

MALAYSIA: SARAWAK
Swinburne Sarawak Campus

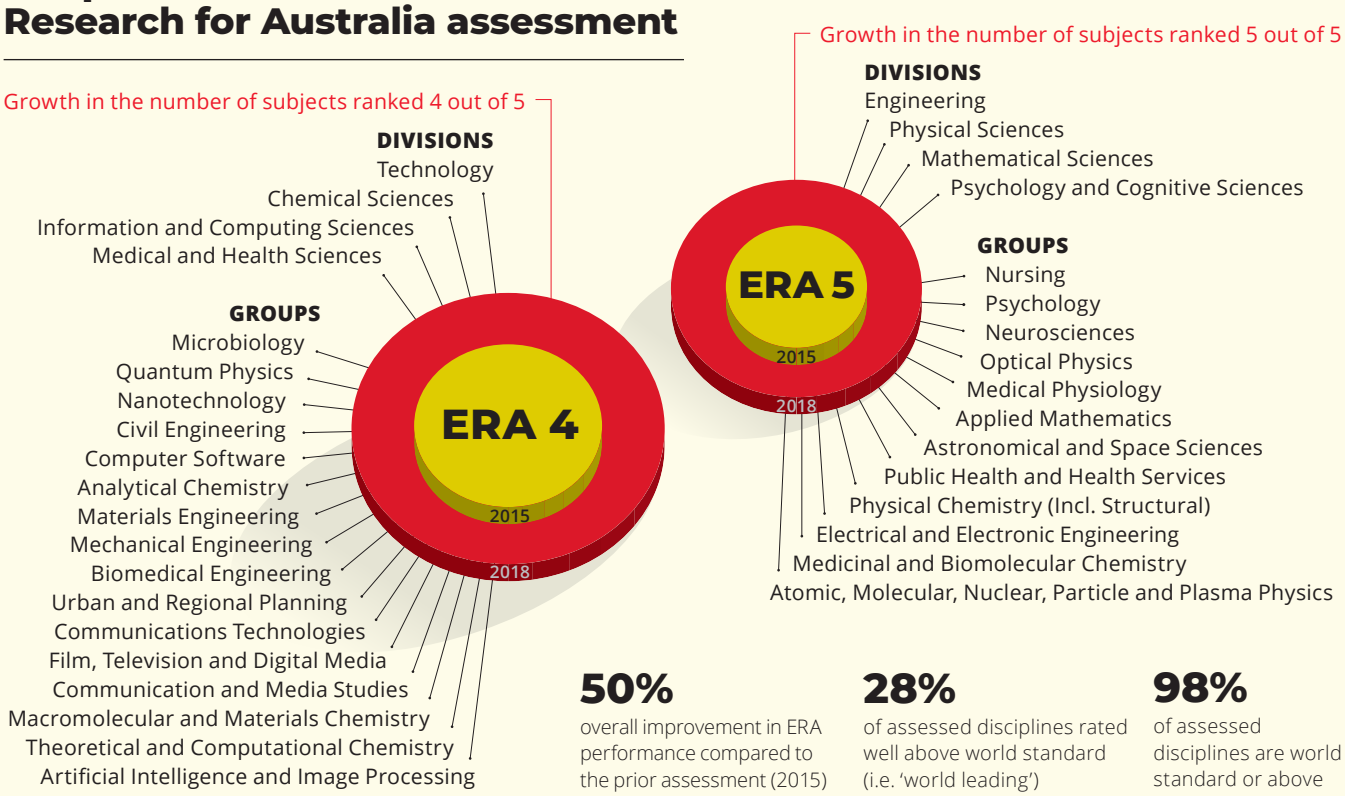
INDIA: MADRAS AND HYDERABAD
- Joint Research Centre with Indian Institute of Technology, Madras (IITM)
- Joint Research Hub with Indian Institute of Technology, Hyderabad (IITH)

GERMANY: STUTTGART
Arena 2036 Research Hub, University of Stuttgart

SWINBURNE UNIVERSITY OF TECHNOLOGY, AUSTRALIA

Recent updates
- Composites Industry 4.0 Testlab **$3.5 million (see p12)**
- Training Centre in Surface Engineering for Advanced Materials **$8.39 million (see p14)**
- Advanced Manufacturing Industry 4.0 SME Hub **$2 million (see p19)**
- OzSTAR supercomputer **$4 million**

A rapid rise in the Excellence in Research for Australia assessment



50%
overall improvement in ERA performance compared to the prior assessment (2015)

28%
of assessed disciplines rated well above world standard (i.e. 'world leading')

98%
of assessed disciplines are world standard or above

Globally ranked

2019 US News Best Global Universities
Rank 69
Space Science

ACADEMIC RANKING OF WORLD UNIVERSITIES (2020)

TOP 400

TOP 100
Civil Engineering

TIMES HIGHER EDUCATION (2020)

TOP 400

TOP 200
Engineering and Technology

TOP 300
Computer Science

QS WORLD UNIVERSITY RANKINGS (2020)

TOP 400

Ranked 42
Art and Design

International collaborators

Top 5 collaborators (2014–2019)

- Chinese Academy of Sciences, China
- National Aeronautics and Space Administration (NASA), USA
- Max Planck Society, Germany
- Centre National de la Recherche Scientifique (CNRS), France
- California Institute of Technology, USA

International articles

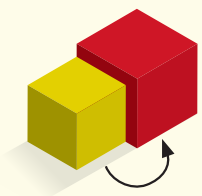
Swinburne has a growing number of articles published with international collaborators.
(Data source: InCites)

Scopus indexed publications

(Data source: Scopus)

1893
Journal articles
(2019)

1371
Journal articles
(2015)



38%
increase

Research degrees

(Oct 2018–Oct 2019)

Completed degrees
186

Accredited supervisors
928

Invested in SUPRA stipend scholarships** **$4.5M** estimated

** SUPRA: Swinburne University Postgraduate Research Awards

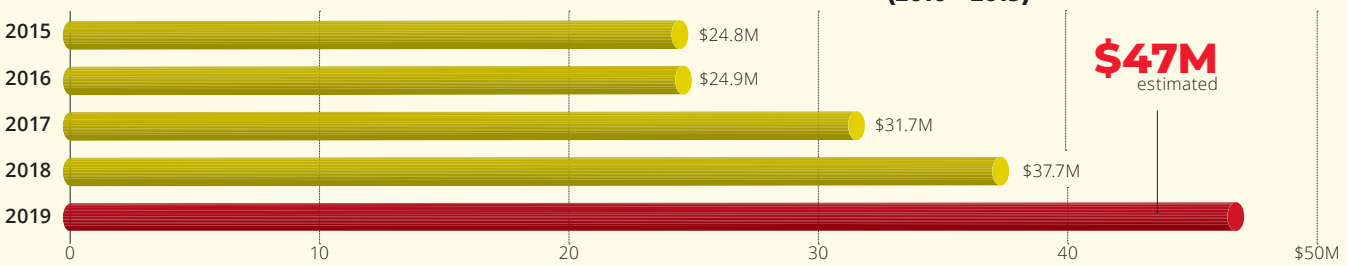
Highly cited researchers

in 11 disciplines (see p8)

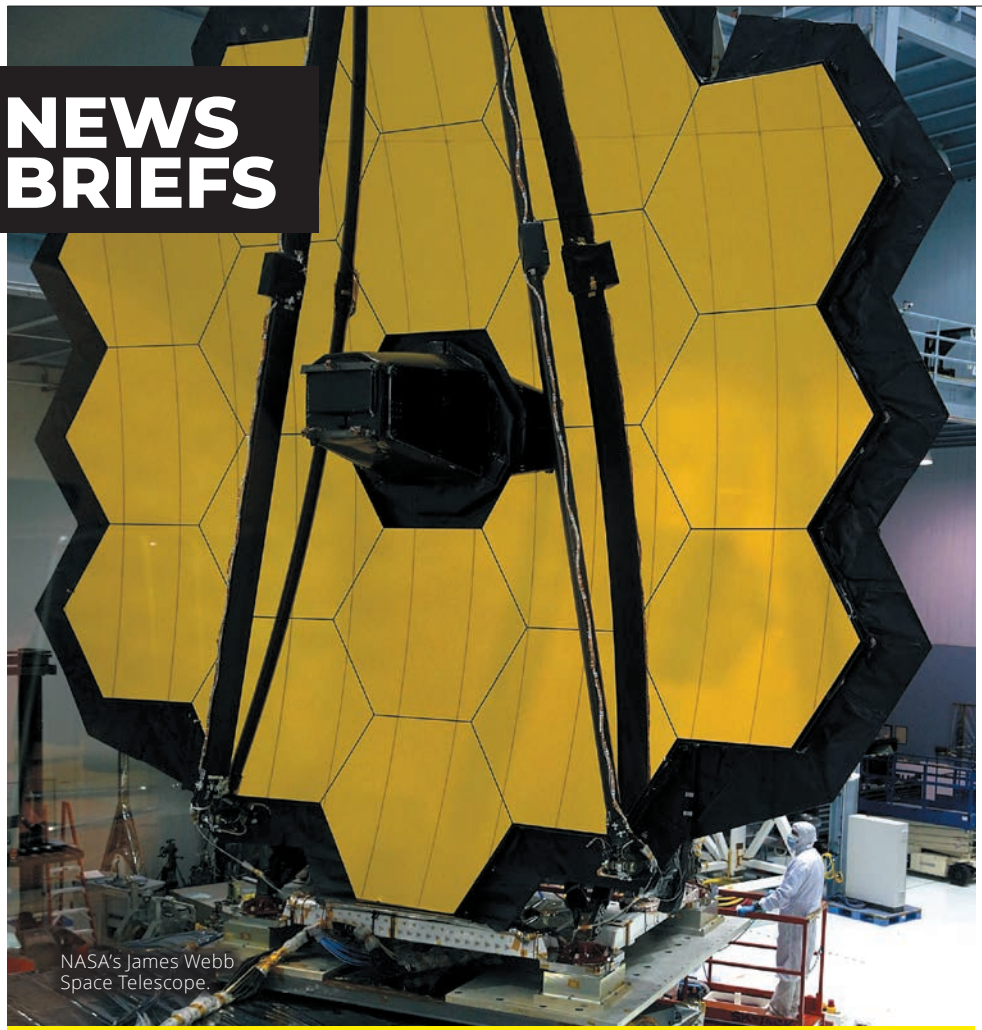
** Highly Cited Researchers for 2019 by Clarivate Analytics Web of Science Group.

External income growth

Total external research income (2010 – 2019) **$274.4M** estimated



NEWS BRIEFS



NASA's James Webb Space Telescope.

SWINBURNE'S SCIENCE STARS

Swinburne researchers were among the nation's top achievers singled out in ***The Australian***'s 2019 ***Research*** magazine based on data compiled from Google Scholar by research analytics firm, League of Scholars.

Swinburne is named as a leading institution in engineering and computer science, theoretical computer science, physics and mathematics, and American literature and studies.

Pro Vice-Chancellor (Research Quality) Professor Qing-Long Han and Associate Professor Ivo Labbé were among the top 40 'Lifetime Achievers', while Dr Simon Stevenson was one of 40 'Rising Stars' of research. Han is an expert in automation and control theory. Labbé's astrophysics research includes the study of distant galaxies using big telescopes, such as NASA's James Webb Space Telescope (see above). Stevenson is studying gravitational wave data to see what it reveals about the death of massive stars.

Seven other Swinburne researchers were also recognised as leaders in their respective fields.

Lifetime Achievers: Professor Qing-Long Han (automation and control theory) and Associate Professor Ivo Labbé (astrophysics); **Rising Star:** Dr Simon Stevenson (gravitational waves and the death of massive stars); **Subject Leaders:** Professor Jinjun Chen (theoretical computer science), Professor Tsong Yueh Chen (software systems), Professor Damien Hicks (plasma and fusion), Professor KinTak Lau (composite materials), Associate Professor Chris Mason (ethics), Professor Yang Xiang (computer hardware design) and Associate Professor Tonghua Zhang (nonlinear science).

PROFESSOR NAMED IEEE FELLOW

Swinburne's Pro Vice-Chancellor (Research Quality) Professor Qing-Long Han has been named a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) for his contributions to the control and filtering of networked systems. Professor Han's work has been key to improving the reliability, efficiency and productivity of industrial control systems.

The IEEE is the world's largest technical professional organisation and an IEEE Fellowship is the highest grade of membership, with just a few included from Australia.

RESEARCHERS RECOGNISED

Ten Swinburne researchers were listed as Highly Cited Researchers for 2019 by Clarivate Analytics' Web of Science Group.

The global list identifies scientists who have produced multiple papers that rank in the top 1% by citations for their research field and the relevant year in the Web of Science.

The researchers are: Professor Vo V Anh (mathematics), Professor Chris Blake (cross-field), Dr Derui Ding (engineering), Dr Xiaohua Ge (cross-Field), Professor Qing-Long Han (computer science) (engineering), Associate Professor Ivo Labbé (space science), Professor Saad Mekhilef (engineering), Professor Neville Owen (social sciences), Professor Takemi Sugiyama (social sciences) and Dr Xian-Ming Zhang (engineering).

Swinburne has progressed from having one highly cited researcher in 2015, to 10 across 11 disciplines in 2019.

ATTRACTING AWARDS

Swinburne has been given the 2019 Australian Business Award (ABA) for Business Innovation for its Industry 4.0 initiatives.

The ABA program honours high-performing organisations that implement world-class business initiatives and develop innovative products and services.

"Swinburne has made a real difference through its strategic industry links, preparing our business partners, as well as the current and future workforce for Industry 4.0 transformations," notes Swinburne's Deputy Vice-Chancellor (Research and Enterprise), Professor Aleksandar Subic.

SWINBURNE PHYSICIST PROFESSOR MARGARET REID WINS MOYAL MEDAL

Swinburne researcher, Professor Margaret Reid, has become the first woman physicist to be awarded the Moyal Medal, recognising her outstanding contributions to the field of physics.

The prestigious science award is given annually and named after the late Australian mathematician and mathematical physicist Professor José Enrique Moyal.

"It is such an honour to be awarded," says Professor Reid. "It was the nicest professional email and invitation I have ever received! I was totally surprised."

Professor Reid is currently a Professor of Physics at Swinburne and a fellow of the Australian Academy of Science.

Professor Margaret Reid

STEMMING DATA AND PRODUCTIVITY LEAKS

Two Swinburne research projects, one aimed at detecting and preventing data leaks, and another on optimising supply chains and innovation, have been awarded $950,000 by the Australian Research Council (ARC).

The first project is exploring how to detect and prevent sensitive cloud data leaks.

The second is investigating global supply chain challenges for manufacturing companies in Australia and optimal designs for coordinating innovation in globally dispersed organisations.

Data will be collected in partnership with aircraft and communications manufacturer Boeing and the University of Kentucky in the United States.

SHAKING UP THE MILK SUPPLY CHAIN

Swinburne will lead research to help Australia's $13.7 billion dairy industry move milk from the farm to fridge faster.

The 'Live Inbound Milk Supply Chain Monitoring and Logistics for Productivity and Competitiveness' project has received $600,000 from the federal government's Cooperative Research Centres Projects (CRC-P).

The two-and-a-half-year collaboration with Bega Cheese, Telstra, and three Australian milk suppliers will develop an Internet of Things-based system that links farms, milk carriers and a milk processor, and allows live monitoring and supply forecasting.

CLIMBING THE RANKS

Swinburne has continued to rise in the Academic Ranking of World Universities (ARWU), placed 367th overall in 2019, up 19 places from 2018, positioning it in the top 3% of universities worldwide.

In the 2020 Times Higher Education (THE) World University Rankings by subject, Swinburne also ranked in the top 176—200 in Engineering and Technology, improving on its top 250 position from 2019 and putting it among the top 2% in the world. THE also ranked Computer Science in the 251—300 band, an improvement from its previous 301—400 ranking, and Swinburne Arts and Humanities was ranked in the 301—400 band globally.

METAL PARTS IN MINUTES

In 2019, a revolutionary 3D metal parts printer, LightSPEE3D (above), was installed at Swinburne's Factory of the Future.

It is the first 3D metal parts printer to use supersonic deposition, in which metal particles, fired faster than the speed of sound, are layered to create industrial quality components in minutes.

The collaboration with Australian 3D metal-printing company SPEE3D, which hosts Swinburne students as interns, will help manufacturers print products more efficiently. The printer's installation was supported by the Victorian State Government and its Future Industries Sector Growth Funding Program.

SEE PAGE 19 FOR MORE ON THE FACTORY OF THE FUTURE

Incubator for Victoria's medtech

A new branch of the Medical Device Partnering Program (MDPP) is being hosted by Swinburne.

To fast-track the development of Victoria's medtech research, South Australia's Medical Device Partnering Program (MDPP) has opened a branch in Victoria, led by Swinburne's Professor Sally McArthur.

MDPP is an ideas incubator. Since its 2008 launch at Flinders University in South Australia, it has facilitated 90 short-term projects ranging from smart devices that monitor cardiac heath in people with sleep apnoea, to bringing a new cancer probe to clinical trial.

Victoria was the logical place for the successful program to expand after 11 years of operation, said McArthur. "It has all this amazing fundamental research going on in the medical space, and so many great ideas and manufacturing companies looking for new opportunities."

A lot of the MDPP's effort goes into facilitating partnerships. Project leaders bring ideas to be evaluated for clinical value and whether the idea is practical and commercially viable. MDPP also helps projects approach interested parties. Promising projects are shortlisted for a workshop.

"We then bring all the people we've had conversations with — clinicians, researchers, allied health professionals and the client — around a table. Then we start a conversation to understand the challenges and people can bounce ideas off each other," explained McArthur, who also holds a dual appointment as a CSIRO Research+Science Leader.

Following the workshop, an independent panel assesses whether the project will receive up to 250 hours of technical expertise, which can include proof-of-concept research, prototyping, product validation, or small clinical evaluations.

Since its launch in January 2019, the Victorian MDPP has attracted 49 ideas, run 15 workshops and funded three projects. One of these is Medical Connect, which developed a prototype commercial-aircraft hybrid stretcher to bypass the need for specialist air ambulances to transport patients.

Sally McArthur (centre, back), and her MDPP team.

The MDPP's role in producing physical prototypes is invaluable, said Andrew Heath, founder and director of Medical Connect. "What we liked most was the opportunity to partner with significant industry experience that could help us to take our idea, test assumptions and provide essential technical knowledge."

The Victorian MDPP is hosted by Swinburne, in partnership with Melbourne, Monash, RMIT and LaTrobe Universities, Biomedical Research Victoria, the Australian National Fabrication Facility Victoria (ANFF-Vic), Baker Health and Diabetes Institute, Bionics Institute and St Vincent's Hospital. The program will receive $2 million in funding over two years through Victoria's start-up agency, LaunchVic.

Micro-cracks can spark battery fires

Crushing lithium-ion batteries has brought insights that should make electric vehicles safer.

Swinburne researchers have systematically crushed lithium-ion batteries to figure out how fires start in electric vehicles.

Lithium-ion batteries are currently standard in electric vehicles, due to their high energy density and longevity. But they are highly energetic and soaked with flammable electrolyte solutions that can cause fires or explosions during an accident. "A number of recent fires in Boeing 747s, Tesla Model Xs and Samsung Galaxy Note7s have raised alarm," said Associate Professor Weixiang Shen, who is part of Swinburne's Faculty of Science Engineering and Technology.

However, he said, for safety, many tests of electric vehicle batteries are performed when the battery is only partly charged. But electric vehicle crashes may well involve fully charged batteries, and this, as Swinburne crushing tests have revealed, creates a different set of reactions.

In July 2019, Shen and PhD student Sheng Yang from Swinburne were part of a group

that showed that microscopic damage — micro-cracks and micro-holes appearing in response to pressure — can start runaway temperatures in highly-charged lithium-ion batteries. When the battery is less charged however, it took structural damage to initiate these effects.

With collaborators from the National Engineering Laboratory for Electric Vehicles at the Beijing Institute of Technology in China, the researchers looked at cylindrical Li-ion batteries.

The group focused on crushing the main cylindrical body of the battery with a number of machines, simulating three different impact types and examining their effects on the battery.

When the battery was 100% charged, they found internal short circuits created temperature changes at the microscopic damage stage, before major structural damage took place. Moreover, once structural damage began to occur, temperatures took off.

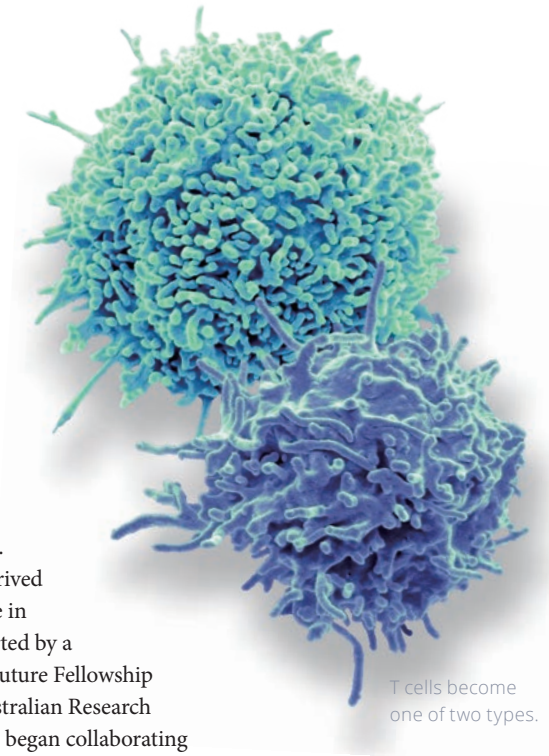
In one test, a battery went from 48.1°C to 745.5°C in four seconds after major structural damage had begun. "That's enough to cause the batteries to burn and smoke," said Shen.

One of the advantages of this insight, he added, is that slow temperature changes at the microscopic damage stage could provide early warning of an impending problem with a battery. Shen hopes that it will also help reveal the mechanisms behind recent battery fires.

"This improved model of how internal short circuits work should provide valuable guidance for the safety, design and evaluation of the lithium-ion battery pack," he said.

New maths for understanding cell types

A nuclear physicist applies his modelling expertise to cell biology to reveal when a cell 'decides' its destiny.



T cells become one of two types.

© STEVE GSCHMEISSNER / SCIENCE PHOTO LIBRARY

A new mathematical model could help researchers uncover when a dividing cell's future form is chosen — for example, when a T cell 'decides' it will become a short-term fighter or long-term protector cell when fighting an infection. Importantly, the new statistical framework will narrow the search for mechanisms that trigger different cell types.

Its unlikely creator is nuclear physicist, Professor Damien Hicks. "I wanted to challenge myself," he recalled, of his decision to move into bioinformatics after more than a decade trying to ignite nuclear fusion reactions at the world's largest laser facility in California.

Hicks arrived at Swinburne in 2014, supported by a prestigious Future Fellowship from the Australian Research Council, and began collaborating on T cells with Dr Sarah Russell, a cell biologist who works across both Swinburne and the Peter MacCallum Cancer Centre.

Russell explained that during an immune response, dormant T cells begin dividing. They eventually become one of two cell types: 'effector' cells that attack an infection, or 'memory' cells that remember the response in case of future infection.

Memory cells last for longer and help make the body's future responses to similar diseases more effective. "So it would be very useful to manipulate how many of them are produced, or to be able to insert them into the body," she explained.

Russell had previously found that, once triggered, T cells behave in the same way for up to seven generations.

Hicks now wants to figure out which of these generations sets the cell's future form. "Just knowing when would be a huge step, otherwise researchers trying to find the mechanisms behind cell types are just searching blindly," he noted.

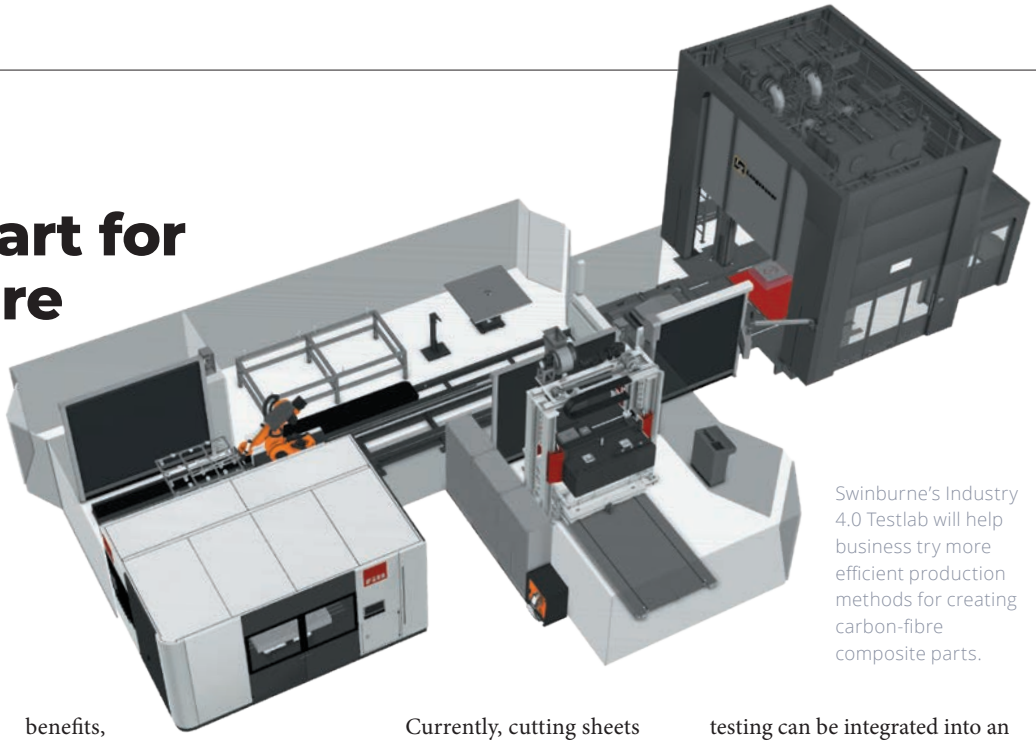
A new analytical approach was required. "I had to invent it," said Hicks. Luckily, being Melbourne-based meant Hicks could also draw on advice from the likes of statistician Professor Terry Speed at the Walter and Eliza Hall Institute (WEHI), founder of one of the world's leading bioinformatics labs at University of California, Berkley.

So far, Russell and Hicks have tested the model, and showed that the size of later-generations T cells is set by the progenitor. Russell and Hicks are now working out when T cells choose an activated form, and Hicks is also using his models to help WEHI better understand the development of drug resistance in leukaemia patients.

Hicks's insight adds to a cascade of recent breakthroughs in single-cell lineage tracing.

A flying start for carbon fibre

Testing digitalised, 3D printing systems for carbon fibre composite parts will streamline the move to stronger, lighter transport.



Swinburne's Industry 4.0 Testlab will help business try more efficient production methods for creating carbon-fibre composite parts.

Carbon fibre is five times stronger than steel and half its weight. This means that the Boeing 787 Dreamliner, which makes extensive use of parts made from carbon fibre composites, uses 20% less fuel than conventional aluminium planes of the same size.

For Qantas' Dreamliners, the increased fuel efficiency means they can fly non-stop routes including Perth to London, the third-longest commercial flight currently in operation and the world's longest Dreamliner flight.

Swinburne's partner, Boeing, the world's largest aircraft manufacturer, can see the benefits, and they aren't the only ones. "Carbon fibre composites have been used for decades, but their use has grown exponentially in recent years in applications like the 787 Dreamliner," explained Professor Bronwyn Fox.

Fox heads Swinburne's Manufacturing Futures Research Institute. She pointed out that Boeing Australia's Melbourne factory is one of the few places in the world to manufacture some of its carbon fibre composite parts, but fabrication rates globally aren't able to keep up with increasing demand for these materials.

Currently, cutting sheets of carbon fibre material in the right form is slow and labour-intensive, she explained. "If industry is going to expand from producing, say a dozen carbon fibre aircraft per month to a hundred or more, manufacturing systems have to change."

Swinburne will open an Industry 4.0 Testlab in mid-2020 that will help businesses pilot new manufacturing methods for carbon fibre composite parts. In it will be a 3D printing machine that thermally bonds layers of carbon fibre tape, reducing waste from about 60% to 10%. The testing can be integrated into an existing forming and injection moulding processes for high production rates.

"We can use a computer-automated printing process to directly create the final shape in the carbon fibre fabric," explained Fox. "It avoids the huge wastage of conventional cutting and speeds up the process."

Swinburne is a lead partner in the Australian Industry 4.0 Testlab Network, comprising six labs working to move Australia's manufacturing sector towards digitisation and automation as part of what is being called the Fourth Industrial Revolution.

Creating cities in cyberspace

A new high-tech communication centre dubbed iHUB will help urban-development experts share knowledge on how to create better cities.

Urban planners need to be able to share knowledge more quickly to create better cities, according to Peter Newton, a Professor of Sustainable Urbanism at Swinburne. Based upon current projections, Australia's four biggest cities — Melbourne, Sydney, Brisbane and Perth — will need to absorb almost 10 million new residents by 2050. "We're among the most urban countries in the world and our cities are the fastest growing in the OECD," said Newton. Because of this, he pointed out, "there is a huge stream of infrastructure and property projects that are being developed without sufficient scrutiny or assessment, because it is currently proving impossible to assemble that level of expertise in the time that industry and government are allocating for 'getting it done'."

The solution is a new online hub to bring together expertise with digital tools to share knowledge. Newton, along with Professor Mark Burry AO, Director of Swinburne's Smart Cities Research

Institute, will lead iHUB, which will integrate Monash University (Melbourne), the University of New South Wales (Sydney), Curtin University (Perth) and the University of Queensland (Brisbane). The universities will co-ordinate technology acquisition, funded by $1.8 million from the Australian Research Council.

The initial phase will involve installing the computing capabilities required to display high-resolution images, models, designs and other information, as well as high bandwidth for real-time communication and data processing. This will allow up to 64 presentations to be shared simultaneously.

What will the result look like? It could, explained Newton, involve an expert in housing models in Brisbane, an expert in urban runoff and drainage in Sydney, and a user in Melbourne with knowledge of local development and zoning regulations, collectively exploring the implications of urban densification.

Eventually, Newton wants iHUB to integrate more than 20 prototype urban planning software tools and databases developed by federally-funded projects, including the Cooperative Research Centre (CRC) for Construction Innovation, CRC for Low Carbon Living, CRC for Water Sensitive Cities, CRC for Spatial Information, Australian Urban Research Infrastructure Network and National Climate Change Adaptation Research Facility.

Getting into the rhythm of a cosmic mystery

Real-time recording technology should finally help explain what creates thousands of hugely energetic bursts from the cosmos every day.

A new artificial-intelligence (AI) system has been giving researchers the first detailed, real-time recordings of fast radio bursts (FRBs), echoes of unexplained events from millions of light-years away that emit radiation ten billion times brighter than anything found in our galaxy.

In 2007, Professor Matthew Bailes was part of the team that first discovered and recorded FRBs. While visiting the CSIRO Parkes Observatory in New South Wales, a former student of Bailes, Duncan Lorimer, had shown him some puzzling results in archival data. Within days they'd recorded FRBs and sparked a new sub-field of astronomy focused on identifying their source.

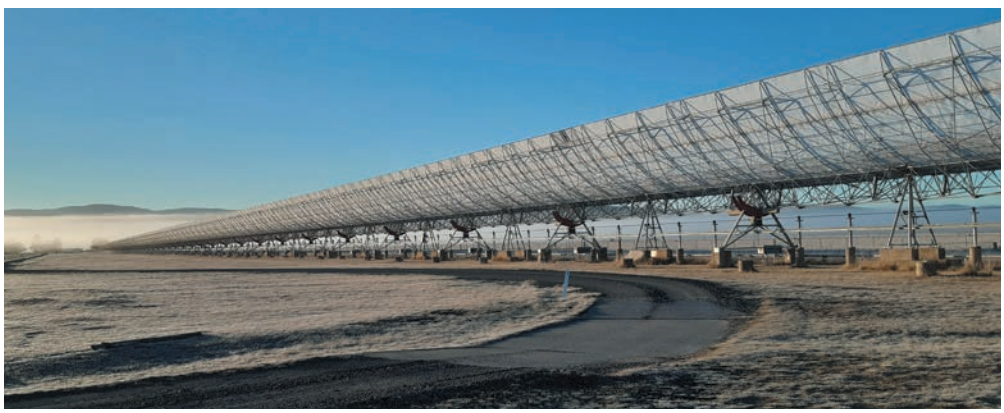
Today, Bailes leads the Pulsar and Fast Radio Burst research group at Swinburne's Centre for Astrophysics and Supercomputing — one of many groups around the world working with cutting-edge arrays and radio telescopes to figure out what creates the energetic blasts. "Our money is on neutron stars," noted Bailes.

By early 2019, fewer than 100 FRBs had been detected, but Bailes's group thinks: "There are something like 5,000 FRBs hitting the atmosphere every day." This number isn't reflected on record, because astronomers can't monitor the whole sky.

In 2015, to capture more sky, Bailes's group partnered with the University of Sydney to use its Molonglo Radio Telescope, a 1,600-metre, trough-shaped telescope near Canberra. Their reconfiguration of the telescope means it now collects more than 20 gigabytes of data every second. That's more than the team can store, let alone analyse in a realistic timeframe.

To tackle this, in 2019, Swinburne PhD student, Wael Farah, began training AI software with thousands of radio wave bursts, including real signals from pulsars and 'anti-signals' from mobile phones. The system he developed can now sift through Molonglo's data in real time, recognising FRBs within seconds. It discovered its first during development.

Farah's AI technology is already producing new insights. In July 2019, it revealed that the bursts are more structured than expected — there are pulses separated by milliseconds within the bursts. This finding hints that the sources are not one-off explosions, but must involve some rapid energy build-ups and releases, perhaps resulting from a complex magnetic field.



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The reconfigured Molonglo Radio Telescope near Canberra now gathers more than 20 GB of data every second.

Seamless translation of research into surface technologies

A new training centre in surface engineering will help researchers work with industry.

The ARC Industrial Transformation Training Centre in Surface Engineering for Advanced Materials (SEAM) is developing new surface treatments. These can range from thin (<10 µm) films, with applications in optics, and protective coatings of several hundreds of micrometres, to 3D manufacturing overlays that can be millimetres thick.

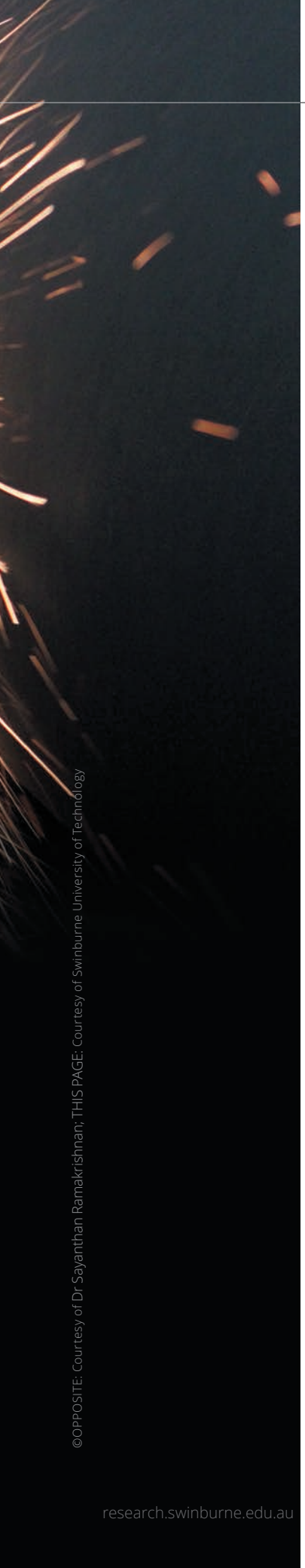
Launched in August 2019, the centre is already working to extend the lifespan of mining equipment with hydraulic cylinder re-manufacturing and repair company, D & T Hydraulics & Engineering. Together they are developing coatings for the large hydraulic actuators that hold up the walls of underground mines. They are creating coatings that are highly wear- and corrosion-resistant to enhance the lifespan of the actuators.

The centre is also partnering with specialist surface-engineering company, LaserBond, to remanufacture some metallic mining equipment parts. The idea is to create coatings that can be renovated when they become worn, using laser welding and deposition technologies. This will help industry avoid having to replace the equipment entirely, saving both time and money.

SEAM now has a headcount of 70+ technicians, administrators and researchers, and is growing, noted SEAM Director, Distinguished Professor Chris Berndt. "Industry has been banging on my door ever since they heard of the idea," he chuckled.

There is particular demand for researchers trained specifically to be conduits between industry and academia, he said. "Our early career professionals will be 'plug and play' for modern industrial manufacturing environments," he explained. When fully operational, SEAM will be home to roughly 24 PhD students and five post-doctoral researchers.

The new centre launched with $4.89 million from the Australian Research Council under the Industrial Transformation Training Centre program. Equivalent cash support comes from Swinburne, RMIT University and University of South Australia, as well as 13 industry partners, and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Australian Nuclear Science and Technology Organisation.



Finding the right flow to print buildings

Swinburne researchers are developing 'flow-on-demand' concrete to 3D print buildings and minimise construction waste.

Manipulating electromagnetic fields could be one way to control concrete stiffness as future machines 3D print buildings, according to Dr Sayanthan Ramakrishnan.

"Fresh concrete is wet and flows easily, then develops its strength by hardening passively over time," explained Ramakrishnan, who works at Swinburne's Centre for Smart Infrastructure and Digital Construction (CSIDC). "For 3D printing, we need it to flow during printing, but to harden very quickly as we go."

Although the research is in its early stages, Ramakrishnan has had some success controlling hardening by introducing substances that can be manipulated using electromagnetic fields.

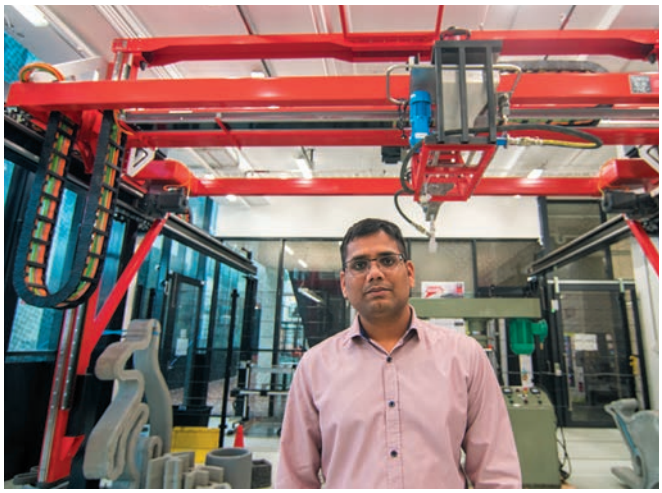
One current factor is that the alternative chemical additives being considered by 3D printers might change concrete's chemistry and affect its durability, Ramakrishnan explained. Calcium silicate and water form an extended network of bonds that bind cement's ingredients together, which is the basis for its strength. Electromagnetic fields physically control the flow of concrete so there is minimal impact on this hydration process. Reapplying a magnetic field might also allow a reversible softening of concrete for recycling and repair, Ramakrishnan added.

If it works, this system could pave the way for 'construction robots' that rapidly translate digital architectural designs into precisely constructed buildings, and eliminate the need for the supporting formwork needed in traditional concrete construction.

> "Printing buildings, could reduce up to 60% of construction waste"

Concrete is the single most widely used material in the world, with a carbon footprint to match. Printing buildings, could reduce up to 60% of construction waste. "What if a construction robot comes to your building site and printed the whole building in days, leaving the site without any mess? No manual handling, no health and safety risks, no waste," Ramakrishnan envisaged.

The digital construction team is led by CSIDC's Director and leading concrete technology researcher, Professor Jay Sanjayan. Swinburne has recently built Australia's first large-scale concrete 3D printing facility. Its biggest printer can currently print a concrete structure up to 8 x 5 x 2.2 metres, using six degrees of movement to create curved and complicated forms.



Dr Sayanthan Ramakrishnan in Australia's first large 3D concrete printing facility.

Quantum knots in two-dimensional forms of superfluid, the equivalent of the very thin film on a soap bubble (left), could form the basis for qubits.

The knotty question of qubits

Vortices in low temperature superfluids could provide the 'bits' we need for quantum computers.

Qubits — quantum computer bits — are the quantum equivalent of the zeroes (0s) and ones (1s) that are the foundation of existing computers. Quantum computers need qubits to encode and communicate data. Associate Professor Tapio Simula is looking into one likely candidate: non-Abelian anyons.

> "The lack of stability in qubits is the key issue currently impeding commercial development of quantum computing technology"

These quasi-particles are formed by particle exchanges in two-dimensional system, and they have been predicted mathematically, but never seen.

The lack of stability in qubits is the key issue currently impeding commercial development of quantum computing technology, Simula explained. Current quantum computers and their components require careful engineering and isolation. The qubits used easily lose their special quantum properties if exposed to disruption from vibrations, temperature fluctuations, or electromagnetic waves. This could change, though, if we could find and control appropriate, stable qubits.

Quantum physicists think that non-Abelian anyons may weave themselves into energetic knots and braids as they move in two dimensions. Like a tangled shoelace, this geometry theoretically makes them especially robust against outside influence. Additionally, non-Abelian anyons in these two-dimensional states have a memory: they retain topological records of their past states, helping encode quantum information across long distances.

Simula is looking for these knots in very cold two-dimensional forms of superfluid — the equivalent of the very thin film on a soap bubble. As superfluids flow without friction, the vortices that form when they are stirred continue to rotate indefinitely. As a result, each vortex can be moved in special patterns involving non-Abelian anyons. These different discrete 'quantised motions' might be used as qubits.

Quantum computers might one day tackle problems too complex for our existing computers to handle. These include new ways to model financial data and finding the optimal path across global systems for ultra-efficient logistics.

Simula is the recent recipient of an Australian ARC Future Fellowship granted to researchers in areas of national importance.

Easy wheezy — a straightforward passage to asthma control

A take-home device that measures wheeze could help millions to manage their respiratory diseases.

Researchers at Swinburne have created a device that lets users assess and track their own respiratory condition. The device is currently in clinical trials in hospitals in Melbourne, Sydney and the UK.

Developed in partnership with the health technology company, Respiri, the system consists of a mobile app and portable sensor that assesses wheeze, a high-pitched whistling sound on the breath that's a tell-tale sign of airflow obstruction.

In 2016, asthma attacks triggered by a severe thunderstorm in Melbourne, Australia, resulted in 10 deaths. Eight thousand people were admitted to hospital. Project lead, Professor Bruce Thompson, Dean of Swinburne's School of Health Sciences, said many hospital presentations could have been prevented by the device.

He added that more than 11,500 lung function tests were performed at the Alfred Hospital in Melbourne each year while he was head scientist there — and even that was not enough.

"We have a pretty good handle on the pathophysiology of many respiratory conditions, and we have good medications that can alter the trajectory of the disease, but the problem lies in-between," he explained. "We urgently need better tests to assess lung function, detect disease early and prevent disease progression."

The wheeze sensor works like a stethoscope — contact microphones pick up breath sounds from the lungs at the windpipe. A proprietary algorithm then detects deviations from normal/healthy breathing and gives users a 'wheezing rate'. Thompson said that it's already been shown to be as accurate as what is achieved with a stethoscope.

Approximately 10% of Australians are asthma suffers. There is no cure for the long-term condition, but appropriate medications can keep coughing, wheezing and chest tightness under control, preventing asthma attacks. This is particularly important in children, as poorly controlled asthma permanently changes the lungs and can exacerbate respiratory problems as an adult.

Yet, only one in 10 asthma patients have well-controlled asthma, Thompson noted. Most patients don't take the required type or dose of medication. Exacerbations can be life-threatening and are known to increase the chances of having future asthma attacks.

The app also works as a daily monitoring tool that helps patients self-manage their asthma, and helps physicians determine medication doses. The app can detect whether a patient is at high risk of an attack and provide advice by combining wheeze information with a number of factors, including: activity data collected by a smartphone; a simple asthma control survey; a smart inhaler, which records when medication is taken; and warnings from the Bureau of Meteorology.

Thompson's team is now working to show that severe asthma patients experience fewer attacks when using the device.

Wheezo smartphone-enabled digital wheeze monitor

Respiri's Acoustic Respiratory Monitoring (ARM) technology detects and measures the presence of wheeze. The snake-like lines to the right signal wheeze.

Fear not the robot

Professor Angela Ndalianis says we need to figure out how to make peace with robots.

Why are we so afraid of robots? It's not just anxiety about the job-killing potential of automation and the rise of artificial intelligence that makes people fear robots: it's deeply embedded in Western culture. Yet in Japan, they are adored.

Professor Angela Ndalianis, Director of the Centre For Transformative Media Technologies at Swinburne has spent years trying to understand the cultures around the acceptance and rejection of robots with leading roboticists at universities and research centres in Osaka, Tokyo and Nagoya. She will soon use this knowledge to help to stage a major robot retrospective at Melbourne's Australian Centre for the Moving Image (ACMI).

Karakuri were mechanised puppets popular in 17th Century Japan.

"[Robots are] so much part of Japan's history that they've rarely seen them in the negative light that Westerners see them," said Ndalianis. "It's part of their theatre tradition, their art tradition, and very embedded in the community."

She has credited Japan's long tradition of *karakuri*, mechanised puppets and clockwork automata that became popular in the 17th century — although antecedents date back to the 1420s, when *karakuri* (meaning 'mechanism' or 'trick') were used in festival floats and for personal use by the aristocracy. By the 1820s, puppets were widely used in religious festivals, where they performed re-enactments of traditional myths and legends, and heavily influenced Japanese theatre.

> Ndalianis is working to understand the cultures around the acceptance and rejection of robots

Meanwhile, the West has a long tradition fearing 'forbidden knowledge' and the dangers of human hubris, which often lead to the downfall of the great. From Greek myths like Prometheus and Pygmalion, to the bible, the Judeo-Christian tradition is littered with examples — but it took Mary Shelley's *Frankenstein* in the 19th Century to spawn a thousand plotlines in literature and cinema that have given us everything from the rogue replicants in *Blade Runner* to the domestic servants in *I, Robot* who ultimately take over human affairs.

Robots are already used today in wide-ranging fields such as precision agriculture, mining, medical procedures, construction, biosecurity, transportation and even for companionship. A recent report by AlphaBeta also estimates that automation could boost Australia's productivity and national income by up to $2.2 trillion by 2030 and result in improved health and safety, the development of new products and services, new types of jobs and new business models. According to market intelligence company, International Data Corporation, the global robotics market is expected to double to $315.5 billion by 2021.

In her work, Ndalianis has pointed out that there's a lot to learn from Japan, which already abounds with humanoid entertainment robots, animal-like pet robots like Sony's AIBO, androids for dentist training, guard robots, and many more.

It's no surprise more than half of the world's industrial robots are in Japan, she said, and that it exports more robots than the next five biggest robot manufacturing nations — Germany, France, Italy, United States and South Korea — combined. And social robots "bring up new challenges that will have profound impacts on humans, some intended and some unintended. So there's a lot we can learn from looking at the Japanese experience. It can show us the relationship people might have with robots in the future."

Future-proofing Australia's smaller manufacturers

Swinburne's Factory of the Future is building strategies for creating next-gen products and new service models for small- to medium-sized enterprises.

A Swinburne program is creating business strategies aimed at helping Australia's small- and medium- sized enterprises (SMEs) make advanced products and add revenue streams through selling additional services.

In the age of Industry 4.0, manufacturers have been moving towards smart service provision and manufacturing using artificial intelligence, data technologies, and the Internet of Things, noted Associate Professor Nico Adams, Director of Swinburne's Factory of the Future (FoF). These changes will increase global GDP by approximately 14%, or US $15 trillion, by 2030.

In this environment, Australian SMEs — which account for nearly 90% of the country's manufacturers — will be asked to make to big changes.

"In the future, SMEs may not offer just a physical product," Adams explained. "For example, an air-conditioning manufacturer might move from selling just a physical 'reverse cycle' to adding an offer to keep a house at a certain temperature all year, as an ongoing service." This, he said, will allow smaller businesses to compete more with 'bigger fish' based on value proposition.

"In Australia, there are about 5000 top-tier manufacturing companies connected to the world's supply chain. We're targeting companies who aim to be the next 5000."

In development with the Federal Government since early 2019, the FoF can help business test ways to move toward future industry. Here, SMEs can work with the Advanced Manufacturing Industry 4.0 Hub and the Industry 4.0 Testlab to devise tailor-made strategies for incorporating advanced technologies.

As of late 2019, the Hub has interacted with more than 100 businesses. Four are currently working on a more detailed strategy, noted Adams.

"Ultimately, we de-risk the implementation of new Industry 4.0 technology, through collaboration," he explained.

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FROM LEFT:
Craig Webster, David Smoors, Vikram Sachdave, Shanti Krishnan, Hasan Baran Kaptan, Vince Lorefice and Professor Nico Adams.

Accounting for the bigger picture

Annual reports that also track non-financial value — such as a company's environmental impact — are slowly taking off. They could change the world, according to Professor Carol Adams.

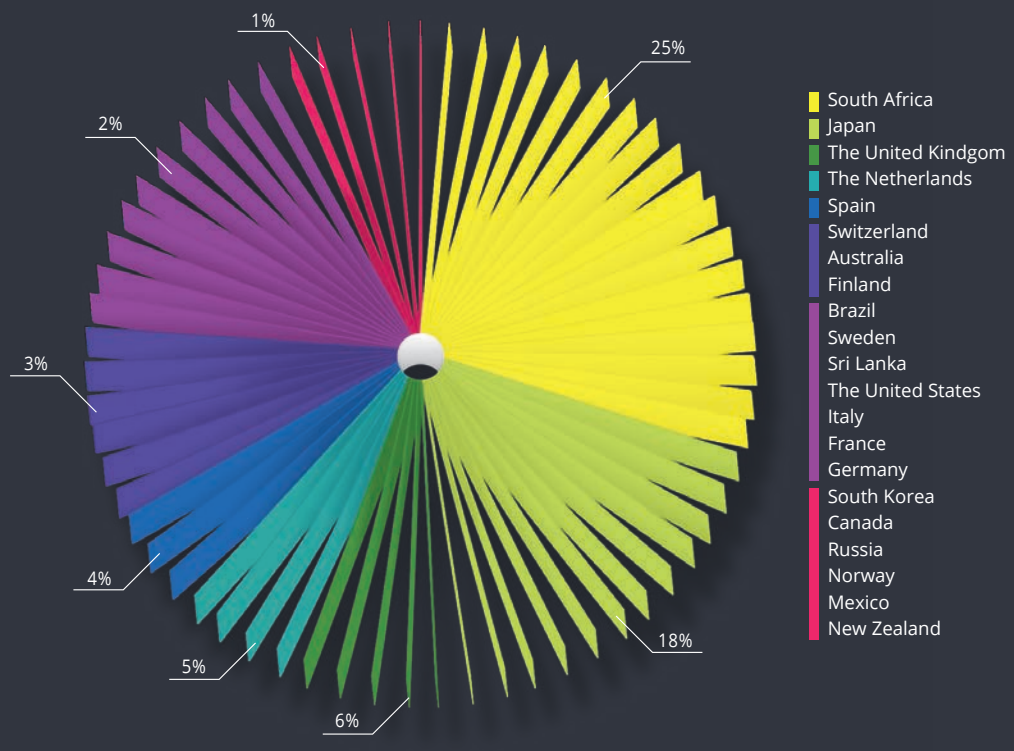
A quiet revolution is happening in business accounting, and it will bring non-financial issues to the attention of the market.

Traditionally, a firm's annual reports focused mainly on profit and loss, according to Professor Carol Adams from Swinburne Business School. However, many firms are now tracking information on elements such as environmental or human capital.

These 'integrated reports' appeared to be becoming more common in 2018, noted a study co-authored by Adams.

She pointed out that, today, indicators of environmental, social and human resourcing provide real insights into a company's expected future financial performance. In fact, in 2009, only about 19% of market value for a business could be accounted for by physical and financial assets, as opposed to 83% in 1975. "Investment decisions are not based on financials alone," Adams explained. "Much of the value created by an organisation isn't reflected on the balance sheet. Integrated reporting provides a framework for firms to think about what value means to them, and the financial, human, and natural resources they rely on to create it."

This type of reporting could also bring sustainability issues to the attention of boards and shareholders, noted Adams, who also chairs the Stakeholder Council of the Global Reporting Initiative, a body that sets global standards on sustainability issues.



The 2018 distribution of integrated reports (reports detailing more than just financial information) identified by country.

While the idea of integrated reporting has been around for decades, in 2013 it gained traction when a global standardising framework was established. Reports that include non-financial information increased 11% between 2014 and 2018.

To look more closely, Adams and two French colleagues, Associate Professor Delphine Gibassier at Audencia Business School, Nantes, and Dr Tiphaine Jérôme at University Grenoble, Alpes, looked at 1,367 integrated reports. Of the 72 countries examined, South Africa and Japan together made up 43% of the reports. The UK, Netherlands, Spain and Australia were the next largest group. Considering their economic clout, Canada, Germany and the USA were relative laggards.

It's mostly about political will, said Adams. "Uptake is greatest when required under stock exchange listing rules and/or corporate governance codes," she explained. "As an example, South African firms were early adopters because integrated reporting was made mandatory for companies listed on the Johannesburg Stock Exchange through the King Code." This is down to Mervyn King, the British economist who led corporate governance reforms shortly after South Africa became a democracy, and later chaired the international body responsible for standardising integrated reports.

*SOURCE: INTEGRATED REPORTING AND THE CAPITALS' DIFFUSION

Food for thought: cognitive diet on trial

A Swinburne-led pilot has demonstrated that a Mediterranean diet and exercise regime could prevent the equivalent of 4.6 years of cognitive decline.

Can an ageing population switch to a Mediterranean diet, pick up regular exercise, and slow their cognitive decline? A successful Swinburne-led trial showed it can.

Government figures predict that by 2056, more than 1.1 million Australians will have dementia, racking up more than $1 trillion in healthcare costs over the next four decades or so. It's currently Australia's second-leading cause of death.

In 2015, a pilot study at Swinburne introduced healthy eating and exercise interventions to 102 elderly people living independently in retirement facilities.

"Research shows a decline in cognitive abilities, including certain types of memory and attention, starts in the mid-20s to a varying extent," explained Chief Investigator Professor Andrew Pipingas, Head of Neurocognitive Ageing Research at Swinburne's Centre for Human Psychopharmacology. "But the degree of decline depends largely on lifestyle habits that people can change."

During the intervention, dietitians provided meal planning and cooking guidance for a Mediterranean style diet (see 'What is a Mediterranean diet?'), while exercise specialists designed walking and stretching routines that gradually trained participants to walk more than 30 minutes per day.

After six months, those involved demonstrated much better spatial working memory in a standardised memory test known as the Swinburne University Computerised Cognitive Assessment Battery. Question response times also improved by 46 milliseconds on average, which is the equivalent to preventing 4.6 years of cognitive decline.

In July 2019, the study expanded to a two-year program, rebranded 'MedWalk', and was awarded $1.77 million from the National Health and Medical Research Council (NHMRC). The number of trial sites has almost doubled.

Given Australia's dementia projections, Pipingas said that the attention given to prevention has surged within the last few years.

He stressed that MedWalk should also demonstrate that people can adhere to the changes on their own. To do this, the intervention incorporates behaviour change counselling in the first year. Participants will be left to their own devices in the second year.

"Many people are now at risk of severe cognitive decline, and of later being transferred to a higher-cost aged-care facility," said Pipingas. "This is about transforming the future of the aging society in Australia."

© CLAUDIA TOTIR/MOMENT / GETTY IMAGES

What is a Mediterranean diet?

A Mediterranean diet involves the substantial intake of fruits, vegetables, and fish, and a lower consumption of dairy, red meat, and sugars.

Some guidelines:

- Use olive oil for cooking and dressing vegetables and salad
- Have more than two serves of vegetables and fresh fruit daily
- Snack on dried fruit, nuts and seeds
- Have more than three weekly servings of legumes and of seafood (one of oily fish)
- Consume Greek yoghurt, low-fat cheese (feta, ricotta, hard cheese) and milk daily
- Consume wholegrains (unlimited)
- White meats should be chosen over red and processed meat
- More than two times a week cook with tomato, garlic and onion
- Eliminate or limit the consumption of sweetened soft drinks
- For alcohol drinkers, choose red wine

Setting language goals for women's sport

The right tone of conversation about female athletes is among recent guiding principles for gender equality.

From media coverage to banter between parents, considering the way we speak about women in sport is one key way to promote gender equality, Associate Professor Emma Sherry, from Swinburne Business School, has found.

In her work, Sherry has consistently pointed out that sport is a powerful lens through which to look at gender politics. "It might seem like a really small thing, but the message that derogatory language sends to that football club or community sports organisation is that women are less than men," she explained. "There are some people in the community that internalise that message, then take it further and treat women differently. In some cases that can end up in physical harm."

In 2018, Sherry led a group developing a set of principles for the State Government of Victoria on how to promote and evaluate gender equality at sports clubs and recreation centres.

The principles are partly a response to the 2016 Victorian Royal Commission into Family Violence, which heard that one in six Australian women and one in 16 Australian men had been subjected to partner violence. A 2018 bill helped establish the Respect Victoria campaign, which is working to stop violence by looking at culture.

The principles encourage sports organisations to be proactively inclusive. Over the past two years, Victoria has rolled them out in a pilot project with a number of state sport organisations, local government authorities and regional sports assemblies.

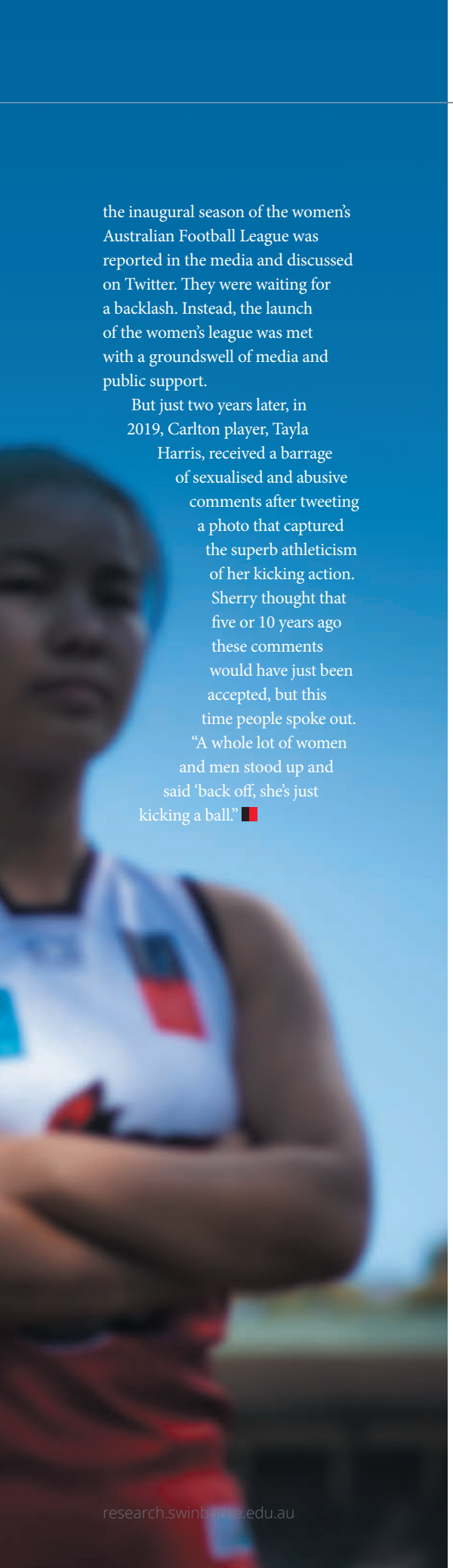
"It's not a panacea, but I think it creates an environment where people call out bad behaviours and encourage gender equality," Sherry said.

She has already seen changes, she added. Her previous work had highlighted media images of sporting women in poses that failed to reflect their sporting prowess. Sherry found that female athletes and commentators are also consistently trolled on Twitter. In 2017, with colleagues from La Trobe University, she tracked how

Associate Professor Emma Sherry with players from the Swinburne Razorbacks.

the inaugural season of the women's Australian Football League was reported in the media and discussed on Twitter. They were waiting for a backlash. Instead, the launch of the women's league was met with a groundswell of media and public support.

But just two years later, in 2019, Carlton player, Tayla Harris, received a barrage of sexualised and abusive comments after tweeting a photo that captured the superb athleticism of her kicking action. Sherry thought that five or 10 years ago these comments would have just been accepted, but this time people spoke out. "A whole lot of women and men stood up and said 'back off, she's just kicking a ball."



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Rural women could mean business

How do we boost rural economies by helping more women start their own enterprises?

A Swinburne initiative has looked at why women with entrepreneurial ambitions don't start businesses in rural regions. It found a gap in 'gender blind' programs.

Only one third of new Australian businesses are started by women, and the proportion in rural regions is even lower said Professor Robyn Eversole, an anthropologist and Deputy Director of Swinburne's Centre for Social Impact. Women are a huge untapped resource in rural communities, she added. This follows a pattern seen around the world, said Eversole. "Global data shows that women are less likely to start businesses than men, receive significantly less investment than men, and their businesses are less likely to grow."

Independent reports suggest that boosting Australian female entrepreneurship to parity with men could be worth as much as $135 billion to the economy. In 2018, Eversole headed up an initiative to empower rural women in disadvantaged regions, supported by the Collier Charitable Fund. In rural areas, women tended to be found mainly in part-time jobs for which they are overqualified, noted Eversole. "They often say, 'I'd love to start a business, but…' and it's that 'but' that we need to understand."

Eversole served as an expert adviser to the Australian House of Representatives Inquiry into Regional Development and Decentralisation during this period, and noted that governments already recognise that encouraging women into business will improve local economies. A number of state and federal business development programs provide training, mentoring and business advice. These are designed to be gender-blind, giving support equally to men and women, yet these initiatives have not fixed the disparity in outcome.

To explore why, in 2018 Eversole and her colleagues ran workshops with women entrepreneurs in Tasmania and in Sarawak, Malaysia, focussing on their aspirations, experiences and assessments of the support available. Participants identified gaps in the programs and co-designed new initiatives.

The team found that while the content of gender-blind development initiatives was useful, their format tended to cater to male needs. "The learning activities simply delivered content without opportunities to connect with others," said Eversole. For example, they might deliver classes to train people to write better business plans. While women appreciated learning such skills, many said that because they were in a minority as businesswomen, they preferred more peer group support. "They wanted to meet women who had succeeded and women who had failed, and also to help other women," said Eversole. "We want to encourage 'gender aware' programs that work for them."

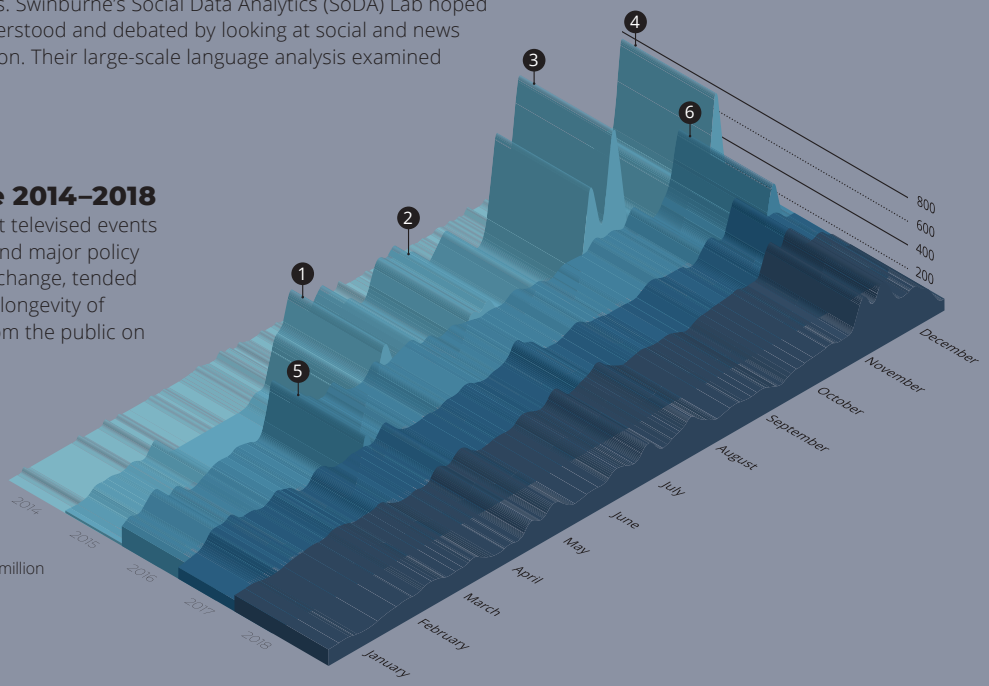
The Swinburne project inspired the women to create new networking groups or better utilise existing ones. Eversole now plans to work with business, government and community stakeholders to make their initiatives more gender aware, and to help more female-led business to flourish.

VISUALISING TALK ON FAMILY VIOLENCE

Victoria's Royal Commission into Family Violence began in 2015 after a number of high-profile deaths caused by violence within families. Swinburne's Social Data Analytics (SoDA) Lab hoped to draw insights on how the topic is understood and debated by looking at social and news media in the years around the commission. Their large-scale language analysis examined changes in focus over time.

Tweets on family violence 2014–2018

SoDA analysis of tweets (right) found that televised events featuring public figures and advocates, and major policy announcements that implied significant change, tended to have the strongest influence over the longevity of Twitter interest and volume of tweets from the public on family violence.



1. **2015:** TV host on *The Project*, Waleed Aly, expressed disappointment over the lack of funding for domestic violence in the government budget and Rosie Batty called for an end to victim blaming
2. **2015:** The Royal Commission hearing begins
3. **2015:** The Federal Government announces $42 million investment into family violence organisations
4. **2015:** TV show *Q&A* airs a special on men as victims of domestic violence
5. **2016:** Victoria's Royal Commission into Family Violence findings released
6. **2016:** Victoria's 10-year domestic violence plan released

Putting humanitarian work on the map

Mapping everyday good deeds can help community organisations target areas in need.

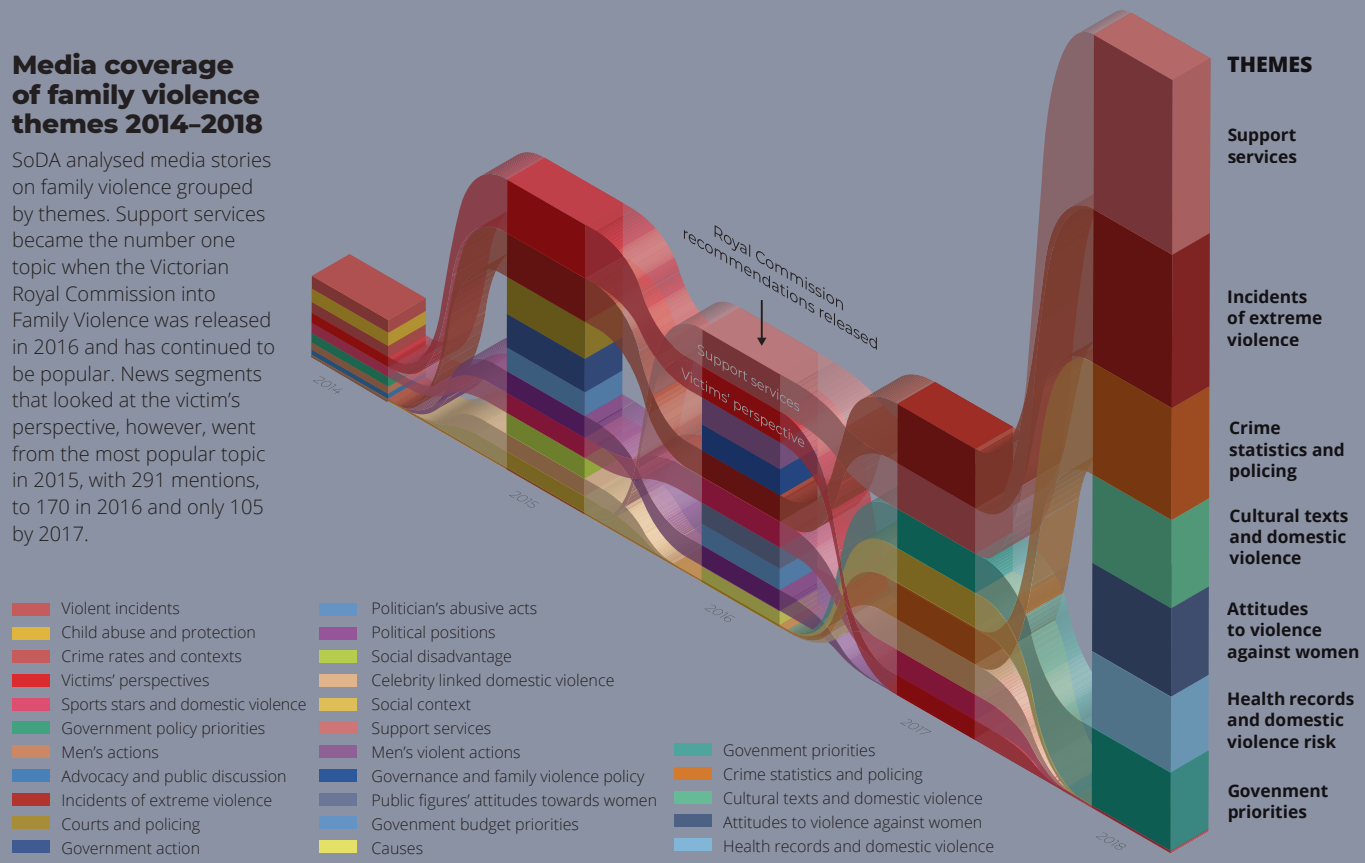
Australia's community services have reaped the rewards of data crunching projects that transform complex social information into visual tools.

"By linking data from government, health organisations, community groups, and the public, we can build useful analytic tools on hard-to-quantify data," said Associate Professor Amir Aryani, who leads Swinburne's Social Data Analytics (SoDA) Lab.

One project explored how family violence is presented in the news and on social media. "We have so much material in language that is messy and nuanced," explained Professor Anthony McCosker, Deputy Director of Swinburne's Social Innovation Research Institute. "We want to shape big data into something that makes sense to people. But it's hard to turn words into numbers." McCosker's team, including data scientist, Dr Arezou Paneh, used topic modelling to extract key themes around domestic violence from government reports, and then searched

Media coverage of family violence themes 2014–2018

SoDA analysed media stories on family violence grouped by themes. Support services became the number one topic when the Victorian Royal Commission into Family Violence was released in 2016 and has continued to be popular. News segments that looked at the victim's perspective, however, went from the most popular topic in 2015, with 291 mentions, to 170 in 2016 and only 105 by 2017.



SOURCE: PROJECT SOPHIA, SWINBURNE SOCIAL INNOVATION RESEARCH INSTITUTE

for these in news stories and Twitter posts (see above).

"Data visualisation makes studies of this scale possible," said Paneh. "We had 100,000 tweets and 11,000 media stories and by identifying a theme in each one, we could make and test hypotheses." By drawing on this immense source of "natural language", rather than a limited set of contrived survey responses, the team could see how the discussion changed over time.

Between 2014 and 2018, people became more engaged in domestic violence discussions following televised events featuring public figures, or after policy announcements that heralded major change. For example, Twitter activity spiked in 2016 when a Royal Commission released its report on family violence in Australia. Engagement has since remained high, but the discussion has shifted towards causes and contexts, possibly as people aim to understand the roots of family violence.

McCosker was also interested in the hidden information, such as everyday acts of charity. By mapping Instagram posts around Melbourne, using the hashtags #volunteer and #charity, in 2018 the SoDA Lab team highlighted humanitarian hot spots around the city centre, and along the Yarra River. A map displaying the social and economic status of Melbourne's suburbs, overlaid with the locations of Instagram posts about fundraising, showed that, of the 235 posts, only one was within an economically disadvantaged area. Providers such as the Red Cross, a project partner, can use these insights to mobilise volunteers where they are most needed.

SoDA Lab ultimately aims to build a data collaboration platform to enhance visualisations for community services across Australia. Swinburne's collaboration with Family Life, an NGO working towards building family resilience, has already helped connect hospitals, social services and families. And SoDA Lab hopes this will be just one piece of the network, aiming to add data on issues ranging from social connectedness to mental health.

Slicker way to sense fuel in the water

A new optical fibre-based sensing system has provided the possibility of affordable real-time groundwater monitoring for petrol station leaks.

Swinburne researchers have made a device to monitor groundwater contamination from petrol station fuel leaks and spills, in real time. The new system can reduce the manpower needed to monitor groundwater, and has the potential to prevent major health problems.

There are more than 6,300 petrol stations across Australia, and according to a 2011 State Auditor-General report more than 770 service stations in New South Wales were actually or potentially contaminated. That's a serious health concern, said Swinburne's Associate Professor Mahnaz Shafiei, as hydrocarbons from fuel can contaminate drinking water and damage the liver, kidneys and heart, and have been linked to increased cancer risk.

According to Shafiei: "The capacity to measure hydrocarbon content in industrial environments is a major challenge." Shafiei is based in Swinburne's Department of Telecommunications, Electrical, Robotics and Biomedical Engineering. She explained that current hydrocarbon sensing devices cost tens of thousands of dollars. Instead, Australian petrol stations monitor leakage of their underground fuel tanks manually by collecting samples from on-site wells a few times a year. It's a labour-intensive, expensive process, and infrequent testing means that it can take months to detect serious issues.

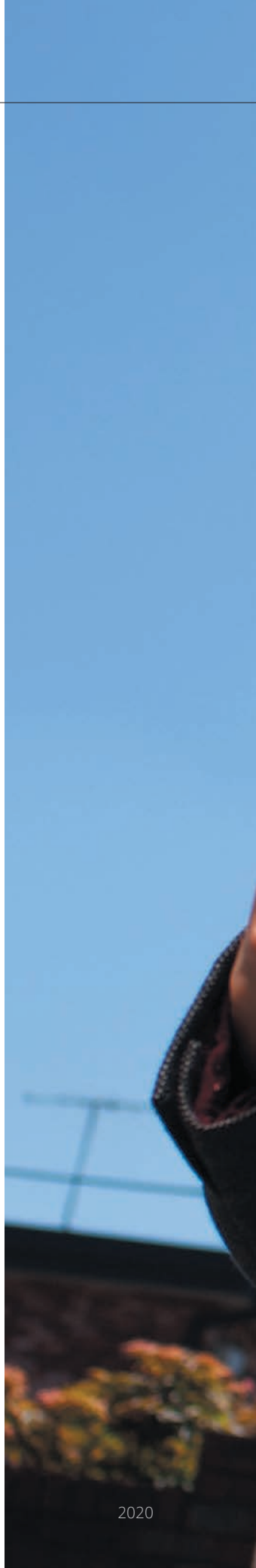
> "According to a 2011 report, more than 770 service stations in New South Wales were actually or potentially contaminated"

Roughly two years ago, discussions on real-time and affordable monitoring commenced between the Internet of Things (IoT) and Sensor Technology Labs at Swinburne and the Leighton O'Brien Company, a multinational specialising in analytics software and services for the oil industry. The collaboration led to Shafiei's work on a proof-of-concept sensing device for urban and industrial environments.

For the physical sensing device, Shafiei used a silicone polymer-coated rod bound to an optical fibre by helical wrapping with a Kevlar thread. A laser source is connected to one end of the fibre and an optical power meter to the other. This sensing system is designed to be placed inside groundwater monitoring wells, where, upon exposure to contaminated water, the silicone polymer swells and induces a micro-bending of the optical fibre. The resulting loss in the optical fibre's light transmission power can be used as a sensing response.

However, to produce a complete monitoring system, Shafiei and her collaborators, Dr Ali Yavari, Professor Dimitrios Georgakopoulos, and Professor Paul Stoddart developed a combination of the polymer-based optical sensing tool, data analysis and IoT software, which can be deployed to cloud infrastructure such as Amazon Web Services and Microsoft Azure.

The cost of introducing and maintaining this full-time monitoring system would be no more than the cost of the infrequent manual inspections, said Shafiei. "We are working on devices that incorporate even cheaper materials, but the current technology could be deployed today," she said.



Detecting petrol in groundwater

❶ A silicone polymer-coated rod bound to an optical fibre by helical wrapping of Kevlar thread is the basis of Associate Professor Mahnaz Shafiei's petrol sensing technology.

❷ Upon exposure to contaminated water, the silicone polymer swells and induces a micro-bending of the optical fibre.

❸ The resulting loss in the optical fibre's light transmission power can be analysed by software.

Managing the ebb and flow of renewables

Renewable energy's uneven input into the grid creates waste. Swinburne's cutting-edge artificial intelligence should halve this oversupply.

To manage the fluctuations in renewable energy input, Swinburne's Professor Saad Mekhilef has created a series of cutting-edge artificial intelligence (AI) systems, and will adapt them to the Australian climate.

Improved prediction of input from growing renewable energy sources, such as solar and wind power, will translate to big savings, explained Mekhilef. Utilities oversupply the grid to maintain stability in the face of intermittent power supply — in Australia the oversupply comprises more than 10%, and in countries with less reliable infrastructure, it can be as high as 20%. "That's a lot of waste. It's impossible to make it zero, but we're aiming to go as low as 5%," he said.

In 2018, 21% of total electricity generation in Australia came from renewables, and renewable energy consumption saw a steady annual growth of roughly 3% in the ten years leading up to 2017. However, 2018 was a landmark year, with a 100% increase in investment in large-scale renewable energy projects. Mekhilef hopes to be able to aid power suppliers in this developing environment.

> "Utilities oversupply the grid to maintain stability in the face of intermittent power supply — in Australia the oversupply comprises more than 10%"

Mekhilef, who recently signed on to head up Swinburne's new Energy Research Centre, developed a predictive system for renewables power generation with the Malaysian Sustainable Energy Development Authority. He used 11 years of wind data and five years of meteorological data from NASA to model the climate and compare it with generation in various Malaysian regions.

"We have found AI gives better results than conventional methods that extrapolate from previous data," Mekhilef explained. "We manage to get up to 90% accuracy in generation prediction even under very different weather conditions."

Mekhilef has also developed other algorithms for predicting solar radiation and wind density that outperform comparable methods and has a patent pending on an inverter, the devices that turn electricity from coal plants, solar panels or a wind turbines into

mains power. His inverters communicate with each other about how much active (useful) or reactive (not useful) power they are generating, and can be controlled remotely, improving grid stability. And, he is looking into making energy technology cheaper by designing inverters and converters with fewer components.

Mekhilef's philosophy of making simple, usable technology has a measurable impact — on average, his most impactful papers have been cited 61 times. Industry too has noticed and Mekhilef is working on cutting-edge electric battery solutions for car manufacturers Proton and Nissan.

"This kind of innovation can be applied anywhere," he noted. "But it's still inspiring and encouraging that so many people find our work relevant to them."

Solar prediction test

A model uses parameters such as sunshine duration and air temperature to predict solar radiation. Tested against real data (right) in Kuala Terengganu, Malaysia, it proved highly accurate. It could help reduce energy waste due to unpredictable energy supply from renewables.

Cumulative installed solar capacity in Australia

Energy supply in Australia from large solar systems (5 Megawatts or more) is growing.

Intelligent ways to soak up the sun

Environmentally friendly solar panels using organic dyes aren't commercially viable yet. But artificial intelligence and chemistry can make them a reality, explains Professor Feng Wang.

Organic solar cells are closer to use than ever before, and Professor Feng Wang believes artificial intelligence (AI) can speed up the search for the right material.

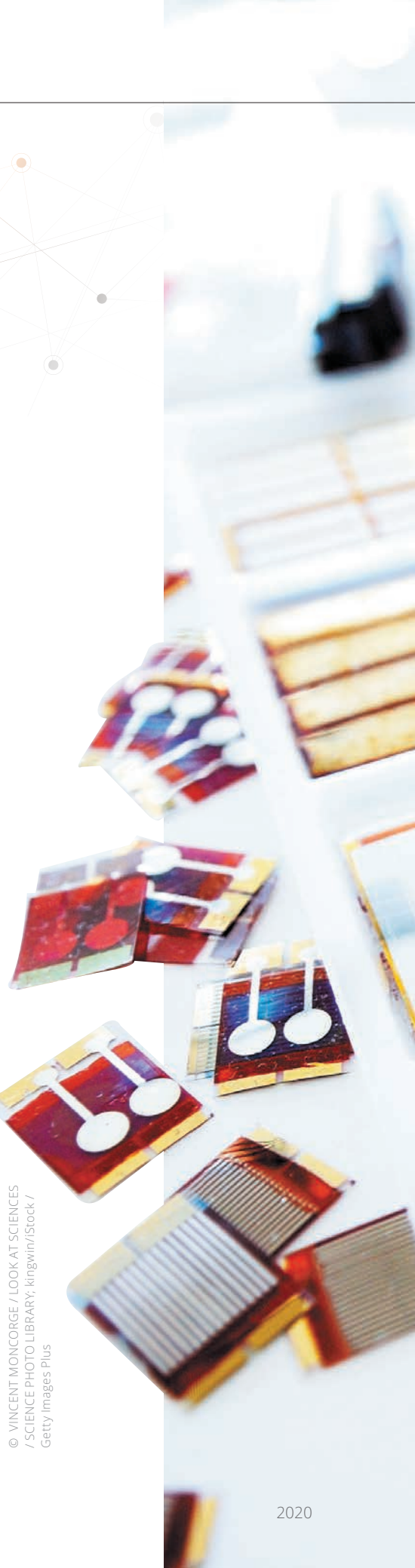
Although harnessing solar energy is more sustainable than burning coal, almost all conventional rooftop solar panels capture the sun's energy with a layer of silicon, which is expensive and energy-intensive to make, demanding temperatures well above 1,000°C. Organic solar cells, which, instead of silicon, have a light-capturing layer made of carbon-based molecules known as dyes, are cheaper, easier and much less energy-intensive to make — the dye layer can be applied as an ink, using rapid roll-to-roll machines like those used to print newspapers.

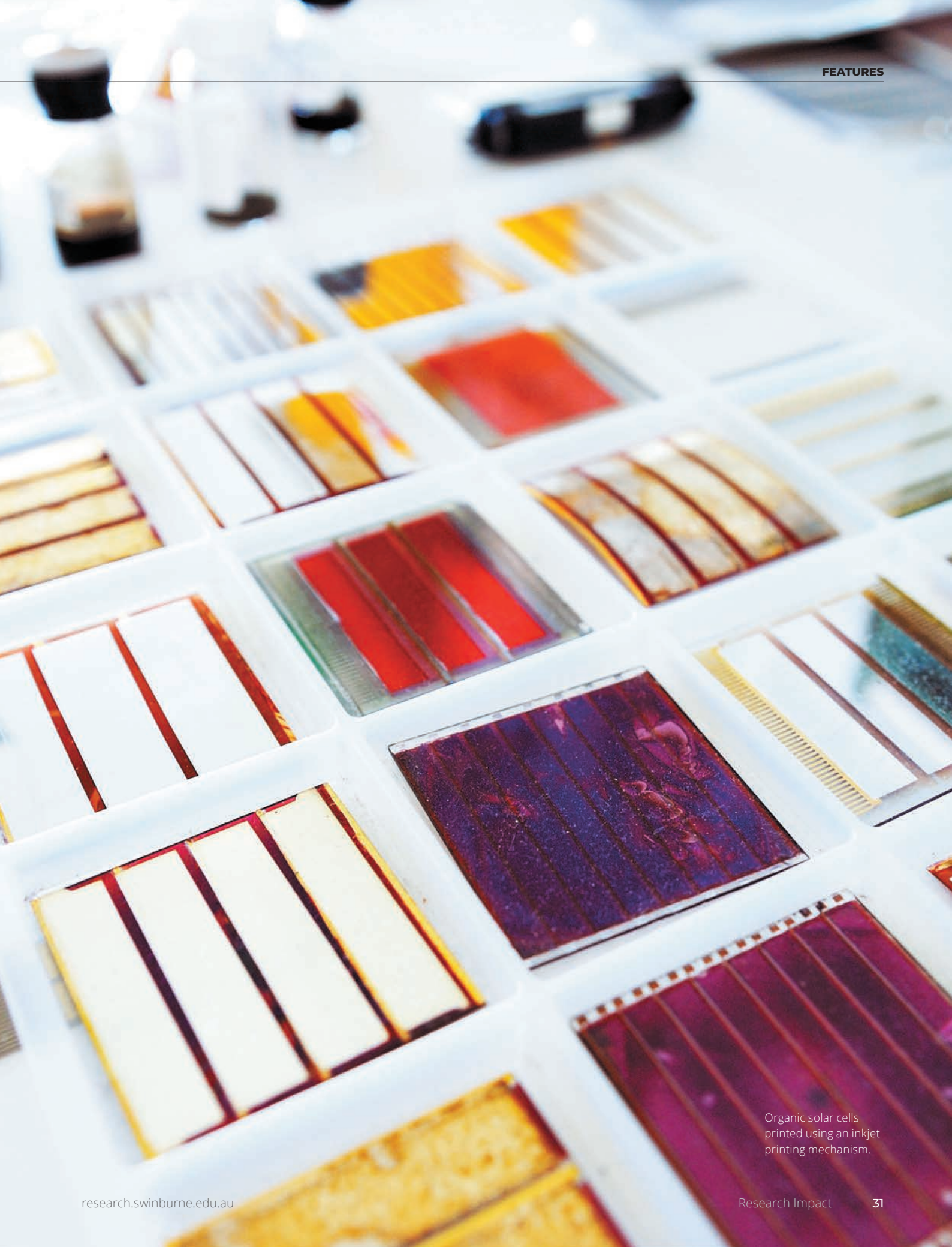
"Currently, the big issue with commercialising organic solar cells is that their conversion rate for turning solar energy into electricity is very low compared to silicon," explains Wang. Whereas rooftop silicon cells convert solar energy into electricity at almost 20% efficiency, organic solar cells have recently been closer to 10%.

In the past few years, a handful of organic solar materials have been discovered that achieved efficiencies in the high teens. In 2018, one group co-led by researchers from Nankai University and the National Center for Nanoscience and Technology in China published on a material in *Science* that claimed an efficiency of 17% — in the right ballpark for potential commercial viability, if the material proves durable enough. These discoveries, she adds, have inspired new optimism in the sector, suggesting there could be even more efficient organic solar materials waiting to be discovered.

Molecule pick and mix

One problem is that there are millions of dyes with potential for use in solar cells — making and testing even a small fraction of these in





Organic solar cells printed using an inkjet printing mechanism.

the lab is a huge task. Until now, organic solar materials have typically been discovered by accident, or by researchers applying their chemical intuition.

However, the reason some dyes can capture more energy from sunlight, is simply down to the combination and arrangement of their atoms, says Wang, who leads research in intelligent atomic design at Swinburne's Centre for Translational Atomaterials (CTAM). The dyes typically used in organic dye sensitised solar cells are a combination of two units, an electron donor unit and an electron acceptor unit, which are physically connected by an electrically conductive 'bridge'.

The bridging component contributes to sunlight absorption, and helps ensure the electric charges generated when light is absorbed can easily flow through the material to be gathered by the solar panel's electrodes. The amount of solar energy captured depends on the exact combination of donor, acceptor and bridge components.

However, even just understanding the best molecules from which to build the bridge is daunting. For example, 26 building blocks have previously been identified that can be combined to make bridges of different lengths, but, just like the 26 letters of the alphabet fill a dictionary with different words, the number of possible bridge configurations is overwhelming. "With 26 building blocks, you have millions of possible dyes. We can't calculate millions yet," says Wang.

This is where AI could help, she says. Some bridge structures have already been synthesised and tested in the lab, others

The inventors of Dyemaker, from left, Professor Feng Wang, Dr Rui Zhou, and Minh Tai Nguyen.

have been computationally simulated. "If we can use this existing data, the computer can learn. We can use machine learning to pick up the trends and give us suggestions," says Wang. The AI will generate a shortlist of promising potential bridge structures that can be made and tested.

Together with Dr Rui Zhou, from Swinburne's Department of Computer Science and Software Engineering, and his student, Minh Tai Nguyen, Wang is developing a computer program to do this called Dyemaker.

"We have a basic prototype, a graphical user interface that can already start to help us design new compounds," Wang says. A chemist can use the prototype to manually try different combinations of electron donor, electron acceptor and bridge components, and the program will calculate the dye's sunlight absorbing properties.

The next step will be to incorporate the AI into this shell, and to plug data that the AI algorithm can learn from. "Once we learn the strategy, we can tap into other solar material databases, such as the Harvard clean energy database," explains Wang.

The Harvard clean energy dataset is one of the world's most comprehensive and lists millions of organic solar structures that have had their properties measured in the lab or predicted by computer modelling. At that point, the computer should be able to automatically and intelligently combine different dye components to predict combinations with optimal light harvesting performance.

Identifying the best bridge components will be just the start of AI's contribution to organic solar cell design, Wang predicts. This project will be the proof of concept she says. Then other aspects of organic solar cell design can be optimised using the same approach, by plugging into different datasets. (The larger the dataset the AI has to learn from, the more useful its predictions should be.)

Powerful predictions

Wang's ambitions to combine AI and chemistry don't end with solar harvesting materials. She hopes to use the same AI technologies to optimise organic compounds in areas such as materials and drug design.

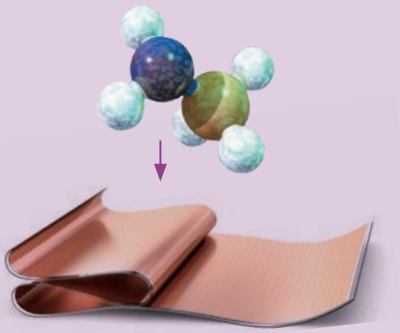
"In chemistry, we have a golden rule: structure dictates properties and functionality," says Wang. Better predictive mechanisms and computer modelling of chemical components could have implications for many of the projects underway in Wang's lab, which range from designing more active chemical catalysts to reporting on anti-cancer drug-protein binding. So AI should help to plug a huge gap in chemistry research, explains Wang. Theoretical chemists like herself, she explains, take a bottom-up approach, using computers to simulate different combinations of atoms to create new materials and predict their properties. Experimental chemists take a top-down approach, making a series of materials with particular structures, then testing their properties to try to identify performance trends. But the two approaches don't quite meet.

"Between the top-down and bottom-up approach, there's a big gap," Wang says. Experimental chemists can't fully drill down to probe the properties of each individual molecule within a substance to establish clear structure—property relationships. Whereas, computers often don't have the power to simulate the behaviour of large assemblies of molecules interacting as they would in real materials for theoretical chemists.

But as AI becomes more sophisticated, it's becoming ever-more capable of simulating the complexities of real-world materials, says Wang: "We are getting better and better at closing this gap." She predicts, effective applications of AI to chemistry will bring with them a trove of world-changing discoveries.

Rolling the solar dye

If the right dye can be found, dye-sensitised solar cells show promise for portable power applications due to their potential for flexibility, easy production and low cost.



A NEW rust treatment gets its sea legs

The Royal Australian Navy spends millions of dollars each year repairing rust. **A high-temperature coating from Swinburne** might help keep vessels shipshape.

The cost of fixing the effects of corrosion on Royal Australian Navy vessels hit an estimated $516 million in 2015 — nearly 40% of the navy's total maintenance budget. Associate Professor Scott Wade, from Swinburne's Bioengineering Research Group, and his industry collaborators, think they can slash that figure with a dense coating designed to protect some of the expensive moving parts of naval vessels.

The team has created a high velocity oxygen fuel (HVOF) thermal spray coating, comprised of powdered metals and other compounds, such as tungsten carbide, nickel and cobalt chrome that are known for their durable and protective properties. The HVOF coating process involves using "a giant flamethrower" to create extremely high temperatures and speeds — roughly 2,000 degrees Celsius at 800 metres per second.


HI-LIFT

Both the composition and the spraying process are crucial. "The spray hits the surface and solidifies, creating an extremely well-adhered coating," explains Wade. Optimising spray parameters such as temperature and velocity results in the dense coating layers that have few air gaps between the particles, making sea water less likely to enter and cause corrosion.

"Corrosion is a significant problem worldwide," adds Wade, an applied physicist who has been looking at corrosion for more than 15 years. He started out developing optical-fibre based sensors to monitor corrosion in aircraft, and over the years has carried out corrosion research for big industry, as well as port and harbour authorities.

Marine environments are harsh, he notes. In addition to being exposed to the weather and rust-inducing salt, biofouling "occurs when you put anything in an immersed environment and a combination of microbes, plants, algae, and animals attach to the surface". These marine hitchhikers increase drag, slowing vessels, increasing fuel consumption and breaking parts. They also release corrosive gases, such as hydrogen sulphide, or make the pH of underlying metal surfaces more acidic and prone to corrosion. Wade explains that the chemicals are all just "part of [biofouling species'] natural metabolism, by-products of them converting food to energy". However, they're not usually good for man-made structures.

FLEET OF COLLABORATORS

Every vessel in the navy's nearly 50-strong fleet, ranging from surface warships to submarines, is vulnerable to corrosion or biofouling. So, five years ago, Wade and a team at Swinburne began working on better coatings with collaborators from the Defence Science and Technology Group (DST), Defence Materials Technology Centre (DMTC), the engineers, MacTaggart Scott Australia, and United Surface Technologies (UST). Because of long-standing ties with DST, DMTC, and UST, Wade says the collaboration happened organically. "We all just came together out of a mutual interest," he says.

Anti-fouling paints, coatings, and surface treatments, must be non-toxic to the environment, adhere well, and be resistant to high-contact degradation, both chemical and mechanical, says Wade. The last criteria is especially key when it comes to hydraulics, the workhorses of a ship, where pressurised fluids are used to generate a large amount of power in order to carry out various tasks. "There are many critical hydraulic systems used in marine vessels, such as in hatches and doors, steering, stabilising, and propulsion systems," he says. "If these systems undergo biofouling, they can easily be damaged or stuck, which renders them, and sometimes the ship, inoperable."

MacTaggart Scott, the company that provides marine hydraulics to the Australian navy, has been grappling with biofouling and corrosion-related failure for years, says Wade. They have been working to overcome issues, especially in light of relatively new structures, such as landing helicopter docks on ships. "One of the problems with building new ships is a lack of knowledge about possible corrosion problems. So, the ships get built and then the problems come up, and companies like MacTaggart Scott need help to solve them."

One difficulty for engineers is that removing biofouling creates a new set of problems. "They tried to clean off the fouling, but in doing so would damage the underlying protective coating, which accelerated corrosion," says marine

A fight most foul

Marine biofouling species attach to vessel surfaces, changing the chemical composition in that area (see below), increasing corrosion and also damage from barnacles. After nine months in water, rods coated using standard electrolytic hard chrome (right) featured much more biofouling than those using a new, less porous, high velocity oxygen fuel (HVOF) thermal spray coating (far right).

1. Planktonic cells can attatch to a naval vessel's surface in seconds
2. In minutes first colonisers become attached
3. Within hours to days they grow and begin cell division
4. The production of hydrating polymers to maintain an optimal cell environment exacerbates corrosion
5. Secondary colonisers such as barnacles happen in days to months and microbes disperse to new sites

Standard coating

High velocity oxygen fuel (HVOF) thermal spray coating

Scott Wade tests to see if a new high-velocity oxygen-fuel, thermal spray coating prevents build-up.

> “More than nine months after installation, the high velocity oxygen fuel thermal spray coatings have shown significantly improved resistance, with virtually no corrosion at all.”

scientist Dr Richard Piola from the DST, a government-funded organisation for national security research and development. Piola has been working with Wade’s team for the last four years.

“So, it’s kind of damned if you do, damned if you don’t,” he says. The solution was clearly a better type of coating. Antifouling agents commonly used today, such as hard chrome plating and smooth paint coatings, which make it difficult for organisms to attach to surfaces or remain attached when the vessel is travelling at high speeds, just aren’t good enough when it comes to protecting hydraulic components “where you need hard, high-wear coatings”, says Wade. Ceramic coatings like aluminia-titania, for example, are good at withstanding wear and are generally corrosion resistant, but tend to be brittle and are easily removed when biofouling is scraped off surfaces. In addition, other coatings that contain copper, zinc or tributyltin can be toxic to all marine organisms, not just biofouling species.

REAL WORLD TRIALS

The group have already verified their new HVOF against industry standards, using a mixture of hot water immersion and salt spray, among other testing methods.

In a series of long-term field trials carried out between 2015 and 2019 in Adelaide, Melbourne, and Cairns, which provided a range of environmental conditions and water temperatures, scientists immersed more than 100 HVOF-coated samples — including rods and full hydraulic actuator prototypes. “The findings were overwhelmingly positive,” says Wade. Control rods covered in conventional ceramic coatings accumulated significantly greater levels of biofouling compared to the HVOF coatings.

In October 2018, the technology was applied for the first time in a real setting. Safety rails aboard the main deck of HMAS Canberra, the Royal Australian Navy’s flagship, were sprayed with HVOF, while others were given the traditional electrolytic hard chrome (EHC) coating.

“More than nine months after installation, the HVOF coatings have shown significantly improved resistance, with virtually no corrosion at all, compared to EHC-coated components, which were badly corroded after only a few months,” says Wade. The trial continues, and the team hopes it will provide a good long-term assessment of the technology.

The researchers also want to see if HVOF coatings can be used on different components (such as propeller shafts) and other marine vessels (like submarines), or if it can help with other problems. MacTaggart Scott Australia and United Surface Technologies, are also in talks to commercialise the technology.

In October 2019, the collaboration won two national awards — the National Defence Innovation Award and the Innovation Award for Platforms and Propulsion — at Pacific 2019, an international exposition for the maritime and naval defence forces, run by Australian government agencies.

Wade says: “As a research-intensive academic, it’s not often you get to work on a project from initial blue-sky conception all the way through to developing a commercially viable product.” The self-professed ‘rust lover’ adds that despite his battle with it, “microbial corrosion is amazing: it involves chemistry, microbiology and metallurgy. I love working on problems that have a practical application, while also being able to look into the fundamental science at the same time.”

Professor Nilmini Wickramasinghe is developing an app incorporating artificial intelligence to predict a diabetes patient's future blood glucose levels (based on prior activity and food intake) and to give advice on food and exercise.

TAKE-HOME LESSONS ON DIABETES DATA

Twenty years in the making, **an app for better diabetes self-management could ease the burden** on Australia's healthcare system.

There were no smartphones when Professor Nilmini Wickramasinghe began working on what developed into DiaMonD (Diabetes Monitoring Device), an app for diabetes self-management with a feedback mechanism between patients and clinicians. However, over almost 20 years, the project has evolved into a very modern solution to Australia's fastest growing chronic condition.

A 2018 study at Austin Health, a major tertiary health service in Melbourne's north-east, found that 34% of patients had diabetes. Professor Greg Johnson, CEO for Diabetes Australia, suggested then that diabetes now accounts for about one third of all hospital admissions. Type 2 diabetes, a combination of insulin resistance and impaired insulin production, represents 85% of all cases, but is largely preventable. It is strongly associated with high blood pressure, abnormal cholesterol levels, and excess weight, so prevention and self-management measures have the potential to ease a huge burden on hospitals.

"Early detection and proactive management of diabetes is essential," says Wickramasinghe. The DiaMonD app does this by gathering, recording, storing and charting all information relevant to a user's diabetes. That includes blood sugar level readings collected from a glucometer (a personal glucose meter) and entered either manually or via a Bluetooth connection. This is recorded against the time and content of meals and other relevant information, such as exercise. It also lets patients send details about their blood sugar readings to a nominated care coordinator to receive recommendations for diet, exercise and insulin titration, the amount of insulin a diabetic must self administer.

"You have lots of options," Wickramasinghe says. "If you don't want to enter all of that, the app will graph blood glucose levels over time, and all this information is then sent to the nominated healthcare professional." A feedback system allows a nurse or doctor to send back almost instantaneous responses. These could range from "well done, everything looks fine" to "please come in for a check-up." What makes the system particularly beneficial is that outcomes can be closely connected to patient behaviours and activities, which is linked to cognitive feedback that can result in changed behaviours.

The results of a recent Australian trial for women with gestational diabetes mellitus (GDM), which is usually a short-term disease that develops during pregnancy that has huge potential health implications for the developing foetus, were reported in 2019 in the journal *JMIR Diabetes*.

"A wonderful initiative," reported one patient for the paper. Another user appreciated the privacy and reassurance during her pregnancy, saying that being able to check and record blood glucose levels any time of day was convenient: "Could maintain privacy at work, no need to duck out to have conversations and report [blood glucose level]." And that knowing that someone would contact her if there was a concern was helpful.

"We've always been very clear we're not going to cure diabetes, but we're going to help those people with diabetes have a higher quality of life, to manage better," Wickramasinghe says. "There's also a large and growing prediabetic community, 16% of Australian adults, that hopefully we might be able to help avoid developing diabetes."

Ahead of their time

DiaMonD is a creative acronym from the term 'DIAbetes MONitoring Device', but it was also seen as an appropriate name, explains Wickramasinghe, because the disease diabetes, like the gem, is multi-faceted. It incorporates a lot of lifestyle factors, such as activity levels, food intake, and genetic factors, so is very hard to manage.

The idea behind DiaMonD harks back to the late 1990s, when Wickramasinghe was completing her PhD at Case Western Reserve University in Cleveland, in the United States.

"That's where I started my focus on digital health," she recalls, explaining that although her PhD was in the business school at Case Western, it was about managing technology in healthcare. Wickramasinghe had moved to the US after completing a string of qualifications at the University of Melbourne — a Bachelor of Science in mathematics and computer sciences, an MBA focused on technology management.

With a background like that, she laughs, I knew "I couldn't cure cancer", but she became increasingly aware that her tech management expertise could support superior healthcare delivery. Applying technology to health and medical problems was only just emerging.

Wickramasinghe was at a conference in Texas when she ran into Steve Goldberg, who had recently founded the Canada-based tech company INET International, which provides online data collection services to researchers. As the pair talked, the idea of developing a technology solution for people with diabetes began to take shape. While Goldberg was, and remains, very technology focussed, diabetes was "kind of a hobby subject", says Wickramasinghe. "And I said I think if you're really keen on this area you should focus on a mobile solution, not a desktop solution."

Smart glucometers help track blood-sugar levels.

▶ TYPE 2 DIABETES, REPRESENTS 85% OF ALL CASES, BUT IS LARGELY PREVENTABLE

"This was 2001 and mobile solutions were almost unheard of, but I thought that's the way the industry is going. Steve said he would work on one if I helped him, and we developed one of the first mobile solutions, pre-smartphone, to support patient empowerment and self-management of diabetes." At first, it was a simple texting and tracking system.

When smartphones became available, the pair repurposed their solution to work with the new technological interface and DiaMonD emerged as a downloadable app for smart phones, available across all platforms.

Earlier versions of DiaMonD have been trialled successfully with Type 2 diabetes and gestational diabetes in China, Germany, Canada, Australia and the United States.

But DiaMonD has never been a project Goldberg saw as a potentially lucrative income stream. "It's been about using informatics in healthcare and it's just been interesting to support research in this area," Goldberg explains. "The reason we chose diabetes was to touch something well documented and widely impactful." There was also medical consensus that diabetes could benefit from improved self-care and management.

"From an industry standpoint, there are very few business models that are very successful at commercialising mobile technology in healthcare," says Goldberg, explaining why DiaMonD, despite clinical success, is not yet widely available.

Taking DiaMonD public

How far then is DiaMonD from taking off into the real world? That's where Swinburne comes in.

To integrate the latest artificial intelligence into the DiaMonD system and raise commercial and clinical support for adoption in an Australian healthcare setting, in 2019 the project was chosen as the first Swinburne Cloud Innovation Centre (CIC) Data for Social Good project, powered by Amazon Web Services (AWS), a subsidiary of the tech giant that provides cloud computing and platform services.

Wickramasinghe was last year appointed as Swinburne's Professor of Digital Health and Deputy Director of its Iverson Health Innovation Research Institute. Her other key external appointments are also seen as highly valuable to the project, particularly her role as Professor of Health Informatics Management at Epworth HealthCare. Her connections and collaborations have also brought in Northern Health diabetes expertise, led by Professor Peter Brooks and Dr Michael Kirk, joining Swinburne's Professor Penny Schofield and Dr John Zelcer.

The CIC, the first project of its type in the southern hemisphere, brought together collaborators in a 10-week project to develop the concept for a new prototype app incorporating artificial intelligence able to predict a patient's future blood glucose levels, based on prior activity and food intake, and to give salient advice on food and exercise. Once developed, the prototype will be tested in a clinical trial at Northern Health in Melbourne. "One of the current barriers, however, is about making clinicians feel comfortable with the informal language and regular nature of feedback via smartphone," says Wickramasinghe. However, as diabetes incidence grows, so does the motivation to spend significant time and resources preventing hospitalisations.

Goldberg, who is still involved, is anticipating a positive impact from the clinical trial. He believes it will provide the impetus to see this sort of technology embraced.

"I'm perpetually optimistic that it will happen," he says about the technology reaching patients. "It's now just a matter of time and I think it will be on a grand scale."

An indigenous woman in Melbourne wears a shawl designed to make her feel more at ease during a breast screening.

Listening like a life depends on it

Professor Richard Osborne's Ophelia process is helping the World Health Organisation to listen, improving health for the disadvantaged.

"The trouble, as Richard Osborne sees it, is that too often initiatives designed to address diseases fail, because they overlook one crucial factor: real people. The usual pattern, says the professor of health sciences at Swinburne, is that funding agencies finance studies in good faith, and scientists develop treatments that work in the lab and in clinical trials. But problems emerge when you try to tell people which vaccinations to take, what exercises to perform, which hygiene practices to employ, what to eat, what bad habits to avoid, and so on. It could be that the right people don't hear the advice, or choose to ignore calls to change. He's aware that his public criticisms of traditional health programs may annoy. "This is blasphemy," he points out. But if the public doesn't engage with health interventions, these are sometimes brought to an abrupt end. "Every year we spend billions of dollars on failed programs that come and go," says Osborne. "That's a waste of taxpayers' money."

GLOBAL IMPACT

Professor Richard Osborne moved to Swinburne from Deakin University's Health Systems Improvement Unit in 2019. He brought with him intellectual property (IP) in the form of questionnaires, indexes and tools used in his OPtimise HEalth LIteracy and Access (Ophelia) process, which helps improve healthcare and health literacy within disadvantaged communities. This IP is now managed by Swinburne's new Centre for Global Health and Equity. The idea behind licensing, says Ranjit Nadarajah, who manages the centre's Strategic Research, Programs, Partnerships and Development work, is to be able to apply quality control and to track outcomes and areas in need of further research and development.

Six Centre for Global Health and Equity products are currently licensed to third parties

1. HLQ
Health Literacy Questionnaire

Helps identify how people understand and manage their health, use health services and talks with health workers. Develops health literacy profiles or patterns for groups.

2. eHLQ
eHealth Literacy Questionnaire

Helps identify how people seek, find, understand, remember, appraise and use health information from electronic sources.

3. heiQ
Health Education Impact Questionnaire

Helps understand the outcomes of chronic disease self-management courses.

4. ISHA-Q
Information and Support for Health Actions Questionnaire

Measures how people find, understand and manage their health in communal cultures, where decision-making about health is shared by a group or a community.

5. READHY
Readiness and Enablement Index for Health Technology

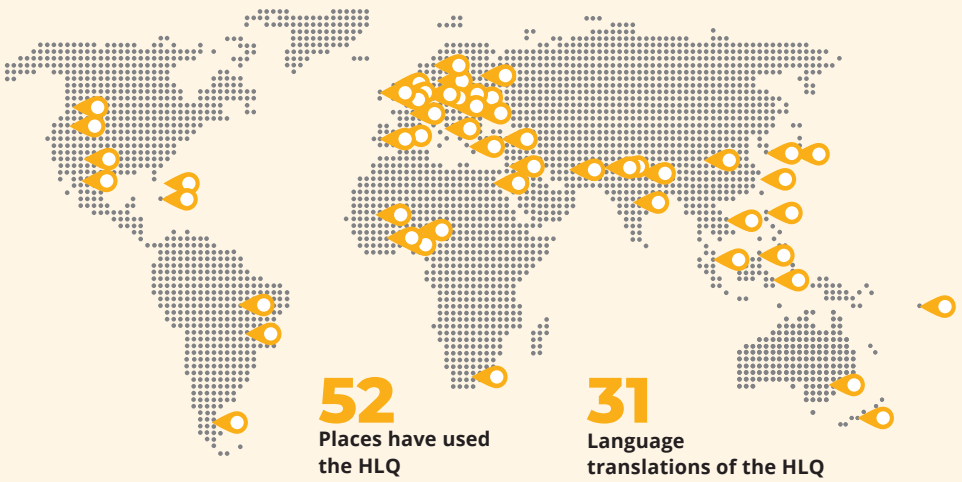
Provides profiles about people's health technology readiness and their ability to use digital health technologies and services.

6. Org-HLR
Organisational Health Literacy Responsiveness Tool

Helps service providers to assess their organisation's strengths and weaknesses in relation to the practices required to identify and respond to health literacy.

PLACES USING THE HEALTH LITERACY QUESTIONNAIRE (HLQ)

The starting point of the OPtimise HEalth LIteracy and Access (Ophelia) process is often the HLQ, which helps show the strengths and gaps in groups with regards to health literacy.

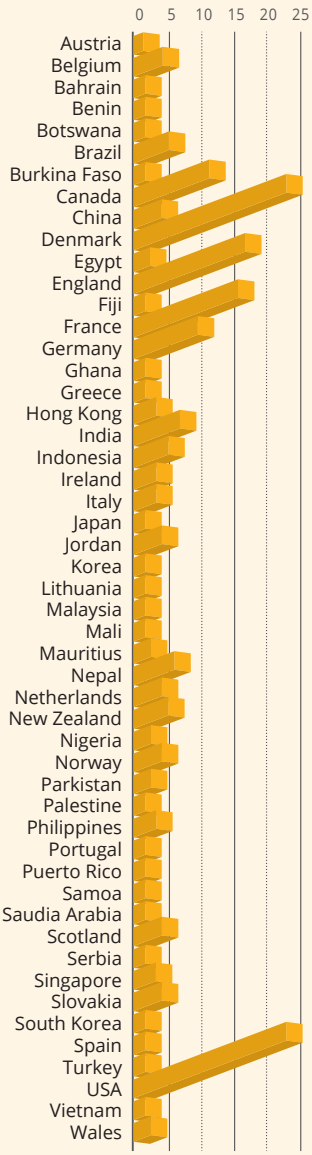


52
Places have used the HLQ

31
Language translations of the HLQ

Note: Australian registrations exceed 100

HLQ registrations by location 2015–2019



Osborne argues that it's usually the most vulnerable who slip through the system; those living in poverty, minorities who don't speak the prevailing language, or disabled people, for example. So, he has pioneered a method for canvassing ordinary people about their health needs — one that involves them in designing solutions using questionnaires, workshops, feedback and evaluation.

His 'Ophelia (OPtimise HEalth LIteracy and Access) process' has been taken up by the World Health Organisation (WHO) through the National Health Literacy Demonstration Projects (NHLDP), part of a global strategy tackling lifestyle-driven diseases, one of the world's leading causes of death. The NHLDPs are designed to demonstrate how to go about addressing health literacy, with the hope that the solutions can later be scaled up. Osborne's basic advice: "Listen to people like your life depends on it."

Osborne grew up on a small dairy farm in North Central Victoria. He didn't realise it at the time, but he was severely dyslexic and as a result, he hated school. Nonetheless he was inspired to study science by a family friend and scientist, who kept asking him probing questions about nature. "I always knew I wanted to help people, and science would be a good way," he says.

It was his doctorate, which he earned in 1991, that would transform his thinking. His thesis looked at factors in breast cancer survival, a complex tangle of genetics, psychology, and behaviour. During post-doctoral work he surveyed patients, and was struck by how bad the standardised questionnaire was. Women were routinely confused and Osborne admitted that even he couldn't understand some questions. Many used medical jargon. Others bundled multiple vague ideas together; a typical question might ask: "How confident are you that you can keep the emotional distress caused by your disease from interfering with the things you want to do?" Since the women weren't clear about what they were answering, such surveys yielded little. "Asking such vulnerable people questions they couldn't understand seemed cruel, unethical, and immoral," says Osborne.

Staff at BreastScreen Victoria (BSV) noticed that women from some cultural groups ignored letters advising they were due for a scan. Simple changes saw attendance go up tenfold.

Thinking back to his childhood schooling struggles, Osborne vowed to ask straight out: "What would help you?" People immediately opened up and offered meaningful and honest answers. Since then, Osborne has developed the Ophelia process, a structure through which researchers and participants jointly design health solutions. The explicit aim of Ophelia is to listen to those who are usually ignored, due to race, gender, poverty, disability, or other issues. "Health education programs *en masse* mainly catered for worried white people, Mr and Mrs Average, not the disempowered," says Osborne.

The Ophelia process begins with one-on-one interviews with people about their needs. These are followed up with workshops, bringing those people, and often their carers, doctors and sometimes relevant government representatives, together in groups for brainstorming. Ideas are gathered and the participants group them as they see fit. Discussion

The HLQ is available in the following languages

- Afrikaans
- Arabic
- Chinese (Simplified)
- Chinese (Traditional)
- Czech
- Danish
- Dutch
- English
- French (Canada)
- French (France)
- German
- Greek
- Hindi
- Indonesian
- Italian
- Malaysian
- Nepali
- Norwegian
- Portuguese (Brazil)
- Portuguese (Portugal)
- Romanian
- Serbian
- Slovak
- Somali
- Spanish (Argentina)
- Spanish (Spain)
- Turkish (Australian)
- Twi
- Vietnamese
- Waray
- Yoruba (Nigeria)

FISHING FOR ANSWERS NEAR BOROLLOS LAKE IN EGYPT

A team at Ain Shams University in Cairo are looking into the health of the fishermen and families subsisting off of Borollos Lake in north-eastern Egypt. The area's waterways have faced a number of pollution problems, mostly stemming from poor wastewater treatment. So much so that the region was identified by the European Commission Horizon 2020 initiative as a major source for pollution discharged into the Mediterranean Sea. Swinburne's straightforward Health Literacy Questionnaire (HLQ) was used to determine the community's health literacy strengths and limitations. It found that the challenges for older people and women were greater, as most were illiterate and had limited internet skills. However, the community was found to have great strengths in social support for health. A series of subsequent workshops resulted in suggestions for improving health literacy, including the idea that health messages could be delivered directly to homes by female change champions, known as *raadat refeat*. This ongoing project is part of a series of WHO initiatives known as National Health Literacy Demonstration Projects.

One solution that was implemented involved hiring bilingual staff to call women directly. As a result, screening attendance went up tenfold.

leaders then organise the ideas using concept-mapping software, which allows participants to visualise the options and how they may be connected. This could involve helping healthcare practitioners or local authorities find solutions aimed at them, while categorising advice for community groups separately.

Participants can react emotionally. Osborne recounts a man suffering from back pain who drove three hours to attend a workshop in Melbourne and cried during the session. "He felt that this was the first time his experiences and opinions had been taken seriously," says Osborne. Diversity is a strength of these working groups. Osborne recalls one held in the north of England that brought a young Muslim woman together with an ex-army officer, to drum up ideas for dealing with pain management for chronic diseases. "They were so inspired and wanted to be actively involved in implementing the solution, that they actually became angry that they hadn't been asked already," he says.

FROM SMALL THINGS, BIG THINGS GROW

Ophelia's most resounding success to date has been to encourage more women from minority groups in Victoria, Australia, to attend routine mammogram scans. Staff at BreastScreen Victoria (BSV) had noticed that indigenous, Arabic-speaking, and Italian-speaking women tended to ignore letters calling them in. A major issue was that the entire program was in English, says Mel Davis, BSV's health promotion manager. Through a series of workshops, women from these communities generated almost 250 possible solutions. One that was implemented involved hiring bilingual staff to call women directly; as a result, screening attendance went up tenfold. Just having that personal touch and giving women the chance to talk through their worries made a huge difference, says Davis. "When someone makes that extra effort to reach out, you feel that you, your health and your well-being are considered important." BSV has expanded the

In Cambodia (above), the government has had a tough time promoting good hygiene practices despite outbreaks of swine and avian flu in rural areas. The outcome of work by the Cambodian Ministry of Health with the OPtimise HEalth LIteracy and Access (Ophelia) process has been to give information to respected village elders and vets, and to set up regular village meetings in which farmers share knowledge.

program to include Mandarin and Greek, and is sharing the strategy with other states in Australia.

Women from the Aboriginal community also described their unease about being undressed during the screenings. So the women identified a strategy that had proven successful in New Zealand: inviting artists from the indigenous community to create a traditional shawl for draping over the participant. Women welcomed the move, telling staff they felt "comfortable", "secure", "beautiful" and "proud of who I am".

Ophelia's philosophy is backed by the WHO, which now funds Osborne to run masterclasses around the world. In Egypt, for example, his group and a team at Ain Shams University in Cairo are supporting a large fishing community, which lives and works on a polluted lake (see box, at left). Swinburne has licensed its Health Literacy Questionnaire (HLQ) to help build health literacy profiles for groups within the community to help identify and target relevant solutions (see infographic).

Osborne has another Australian government-supported project underway in Cambodia. Many families in poor rural areas live very closely with animals, sometimes eating an animal that gets sick. This is where major global health threats, such as swine flu, can start. Chhea Chhordaphea, a medical doctor and researcher working for the Cambodian Ministry of Health, says that the government has had a tough time promoting good hygiene practices because farmers either distrust or forget information. The key has been to feed information to respected village elders and vets, and to set up regular village meetings in which farmers share knowledge. "This is the way to keep knowledge alive, instead of being quickly forgotten," says Chhordaphea.

Osborne's plans for the future involve sharing Ophelia more widely, by creating videos and online manuals. He was excited to join Swinburne, in March 2019, because it is a "uber technology university with global reach," and is thus the ideal place to work on digitalising the process. If Ophelia is cloud-based, it could be useful everywhere, says Osborne, from the "hill tribe, to Manhattan". It will also save organisations from repeating the mistakes that Ophelia seeks to eradicate. It's not just a case of saving them from re-inventing the wheel, says Osborne, laughing, but preventing them from "re-inventing the flat tyre".

Professor Niki Frantzeskaki, Director of Swinburne's Centre for Urban Transitions, and Dr Stephen Glackin, a Senior Research Fellow at the centre, are both working on how to make cities greener and more livable.

CITY TREE CHANGERS

Nature can help our fast-growing cities develop sustainably and create better places to live.

© Eamon Gallagher

The movement of people into cities has accelerated over the past 40 years. In 1999, 47% of people lived in cities, but by 2030 it's expected to be 61%. Meanwhile, cities account for 70% of global greenhouse gas emissions. Since 2007, the Economist Intelligence Unit has reported that average liveability scores across 1240 cities declined year-on-year. The most recent report pointed to an overall deterioration in culture and environment scores, reflecting problems such as increasing air pollution.

Fortunately, cities are "mobilising to take the lead in the battle against climate change, while at the same time ensuring they are livable places for a fluid population," says Professor Niki Frantzeskaki, Director of Swinburne's Centre for Urban Transitions.

Frantzeskaki says that the importance of greenery in urban areas is becoming more apparent in efforts to make them more equitable, healthy and productive. She points out that street trees and parks intercept dust, toxins and noise. They also have cooling properties, create carbon sinks, buffer flooding, contribute to species conservation, increase biodiversity, and can be useful for waste management. Socially, they provide opportunities for healthy recreation and spaces that can help build resilient communities.

Creating more of this in cities, "can mean anything from creating green corridors of parks and cycleways linked in ways that help species to move across urban spaces, to building floating gardens that help filter water and support biodiversity".

AUSTRALIA'S GREEN AND GOLD

Social economist, Associate Professor Andi Nygaard, says that nature has long been seen as valuable in Australian cities. At the Centre for Urban Transitions, he's compared property prices and green spaces in Melbourne over more than 150 years.

There is a clear geological and wealth divide between east and west, explains Nygaard. This reflects areas of sedimentary geology in the east, and basalt and volcanic geology in the western plains. It's no coincidence that the sedimentary geology of Melbourne is home to its wealthier citizens, and has been as far back as the 1840s, because the sedimentary east sustains more vegetation, says Nygaard.

"We know that trees and vegetation are good for absorption of carbon, and evidence suggests it also has a beneficial impact on people's wellbeing, on levels of stress and their ability to relax," he explains.

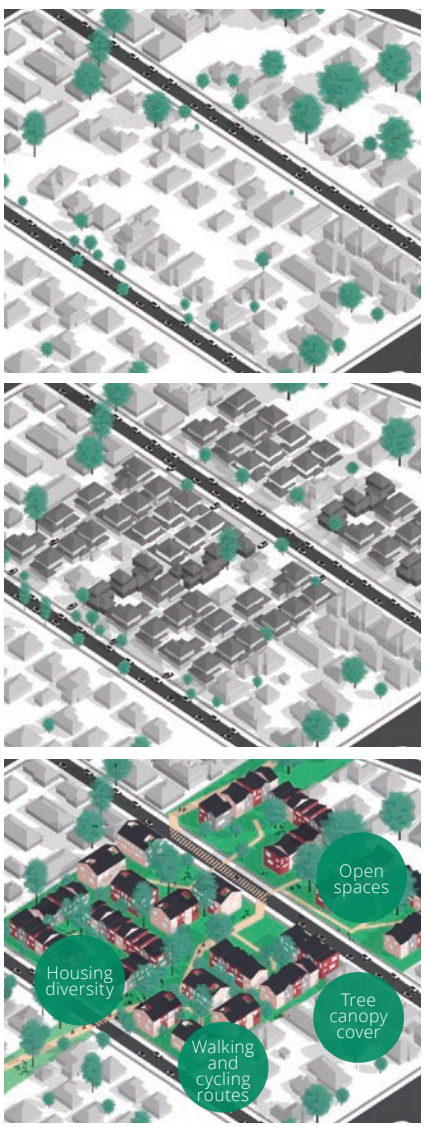
He also stresses that Melbourne needs to work with its environment. "The western plains are not great at absorbing water, but if we are also putting houses on them and sealing the surface completely, we are restricting the ability of that water to penetrate. This means the ground will sustain an even lower level of biodiversity."

Europe also recognises these natural values. Until recently, Frantzeskaki helped lead one of Europe's most ambitious research programs aimed at creating more space for nature in cities. In 2016, while at Erasmus University Rotterdam in southern Holland, she helped found the Connecting Nature research project. This AUD$22 million (€14 million) program was funded by the European Commission's Horizon 2020 Innovation Action Program and is a partnership of 31 organisations across 16 European countries, as well as Brazil, China, Korea and The Caucasus.

Among other initiatives, the project is creating a group of 'front-runner' cities that are working to restore natural values to cities, and foster peer-to-peer learning to deliver these large-scale solutions elsewhere. For example, the Polish city of Poznań created a corridor of urban gardens in public areas, such as schools and housing estates, connecting existing parks, green walls and rooftop gardens — all of which will help flora and fauna propagate more successfully. "Instead of having pockets of green, they introduced new green areas to connect all these different patches," explains Frantzeskaki. Another Connecting Nature project created municipal 'beaches' for the community along Poznań's Warta River.

Connecting Nature plans to use these projects as case studies to look at how networks can create change, and figure out what works, looking at everything from financing and digital resources to mustering community support for research. The group also recognises the need to identify the potential for introducing problems, such as exacerbating gentrification or providing habitat for disease vectors. In 2019, the Connecting Nature team

"It's hard to prioritise green space in a city that suffers from an increasing shortage of affordable housing."



In middle suburbia (top), subdivision can create 'greyfields', where concrete is replacing greenery (middle). The Greening the Greyfields project supports developments that are mid-rise and maximises land use for livability (bottom).

was invited to speak at the United Nations about how various business models can underpin these projects and the process of translating research into practice.

Frantzeskaki, who moved to Swinburne in 2019, says that Australia is now a particularly exciting place to work, with four cities, Melbourne, Perth, Brisbane and Sydney, currently among the most rapidly growing in the Organisation for Economic Co-operation and Development (OECD). Because of this, she says, Australia has the opportunity to forge a new path, and for cities to develop unique ways of dealing with rapid growth to stay on top of liveability rankings.

The right responses could mean Australia is also better prepared for pending global change, she adds. "It's also about taking into consideration that we are going to face big disruption in cities and the global economy, with automation, biotechnology, digital fabrication, virtual reality, for example. So how cities can embrace these changes and prepare for new urban economies is very important."

GREENING THE GREYFIELDS

Guiding the millions of people in a metropolis towards sustainable development isn't easy, Frantzeskaki acknowledges. It's a particular challenge in Melbourne, she says, for example, where the median cost of a house is now 7.1 times the median annual household income, an increase of more than 470% since 2001. "It's hard to prioritise green space in a city that suffers from an increasing shortage of affordable housing," she points out.

Researchers working on Swinburne's 'Greening the Urban Greyfields' project are collaborating with communities, urban planners and local councils, a process called co-creation, to find ways to allow for green space alongside housing growth.

'Greyfields' refers to parts of middle suburbia where infill (altering existing, developed land to densify development) and subdivision are reducing green space and trees to make way for driveways and concrete. But to maximise infrastructure resources, such as schools and roads, the State Government of Victoria has set Melbourne a target of increasing housing on developed land by 70% by 2051.

The strategy faces problems on two fronts: it's creating concrete greyfields, and Melbourne, like many other Australian capital cities, is also struggling to achieve its infill targets. The vast majority of development is either high or low density, rather than a sometimes desirable middle ground. From 2005 to 2016, greyfields accounted for 46% of infill projects, yet only amounted to a 19% net increase in dwellings. "A nostalgia exists for freestanding houses and backyard barbecues," explains Dr Stephen Glackin, a Senior Research Fellow at the Centre for Urban Transitions.

One solution to improving infill, says Glackin, is to amalgamate smaller blocks of land into bigger lots that are sold to developers. "If you have more houses together you don't need four driveways anymore, you only need one," he explains. "You don't need to have a division of land to get a tiny little garden, you can make decent-sized ones." It can also mean sellers make more money than if they had sold their block individually. Generally, statutory regulations are the biggest bottleneck to innovative design, says Glackin, who, with his colleagues, has been working closely with the Maroondah City Council, 25 km east of Melbourne's CBD, to find solutions.

The challenges — and there are many — include finding adjacent homeowners who are willing to amalgamate and sell, and ensuring any building on that amalgamated land serves the needs of the local community.

Recently, illegal tree removal due to building has also been a concern for the Council. In a few years, Maroondah will introduce statutory planning regulations

Maroondah City Council in Melbourne wants to move to more dwellings per hectare to maximise infrastructure, while using clever lot amalgamation and design (bottom) to avoid 'greyfields' (top) and create a very livable environment.

for amalgamated blocks that favour community-minded developers. The council will also mandate more trees, an aim being incorporated into Maroondah's housing strategy and is in the process of being introduced as a planning scheme amendment.

"We've done an incredible amount of community engagement, and we're pleased with the responses," says Dale Bristow, team leader of strategic planning and sustainability at Maroondah City Council. Getting the community, politicians, bureaucrats and property owners on board with changes to planning schemes and regulations hasn't been easy, he says. But this support is key to prevent conflict, delays and negative feedback loops that block their plans.

"Planning control alone will not make this a successful project," says Bristow. "We recognised that right from the outset, so we established a community advisory group to test the academic and planning ideas that we're all coming up with."

CULTIVATING CLEVER BUILDS

The right incentives for developers can also help with what's called 'precinct additionality', says Glackin, where the right plans for developments can be leveraged to improve the whole local area. This can help win over reluctant neighbours.

Incentives for developers to engage in research consultation processes are being piloted in two precincts — Maroondah, and the City of Blacktown in Sydney. The hope is that they will create buildings that actually offer solutions. "You can amalgamate as much as you like, but if you don't build the right stuff you don't get the benefits," says Glackin.

Glackin gives the example of a neglected park in the inner-city suburb of North Melbourne that was hardly used by the majority of local residents. He spent time talking with locals to understand the issues with the parkland, which included a sense that the space was not for general recreation. Then, as part of a research project collaboration with Monash University's architecture school, Masters students were asked to develop ways to address this challenge that could also help overcome community resistance to development.

One solution was to face a new development towards the park, instead of away from it, making it a more natural place for the residents to spend time. "The residents thought this was really good idea," he says. "The architects did five or six different designs, and locals went from being opposed, to deciding they were all good ideas for the area.

The incentives for developers are still under negotiation, but could include allowing for taller buildings — which could increase profits for developers — parking concessions, and faster preapprovals.

Frantzeskaki argues that a combination of rapid local urbanisation, and a changing global landscape, means that Australia's urban sustainability experts will need to be both pragmatic and innovative: "We need to be more open to leap-frog, not to replicate the mistakes of other cities, and to rely on Australian innovation."

Glackin agrees that pragmatism is vital. "It's about getting it out of academia into something that follows a sort of business plan or set of steps that people can follow clearly."

Swinburne researchers aren't rushing in, he adds, pointing out that the Greening the Greyfield project first got off the ground in 2010. Nonetheless, he says the Centre for Urban Transitions is now preparing to have a bigger impact on Australian cities. "We have our playbooks, we have our design guides, we have our feasibility tools, and people are starting to get in touch, because we have something tangible."

Tangible technologies

Swinburne's most recent products range from a one-shot solution for cattle ticks, to implant coatings, and gold detectors using cosmic rays.

TICKING OFF A COST WITH SINGLE-DOSE LIVESTOCK VACCINES

An immune boosting formula developed at Swinburne is helping control cattle ticks and other parasites.

A vaccine formulation has been developed to avoid the cost of expensive vaccine booster shots in Australian cattle production, while preventing the spread of infectious diseases.

Developed by Swinburne biomaterial researchers, Professor David Mainwaring and Dr Mohammad Al Kobaisi, the patented technology slowly releases immune-boosting components, which prolongs and increases the effectiveness of a single vaccine injection.

"The real innovation is the formulation that enables the controlled release of the bioactive constituent to provide the same immunological protections as multi-dose vaccines," said Dr Elicia Wong, Capsular Technologies' Chief Operating Officer.

Capsular was founded in 2017 as a spin off from the Cooperative Research Centre for Polymers to commercialise the outcomes of the Swinburne project.

The biopolymer-based vaccine emulsion involves immune-stimulating parasitic proteins tethered to hydrogel particles that are readily transported and broken down slowly in the lymphatic system. The emulsion is formulated in pharmacological oils, which further boosts immune responses, producing a product for subcutaneous or muscular injection.

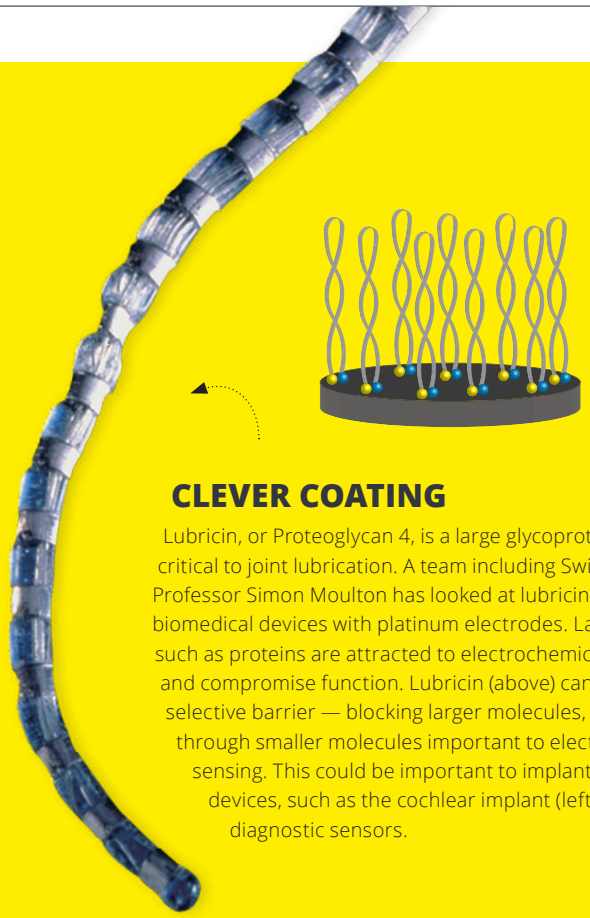
In early testing funded by Meat and Livestock Australia (MLA), Mainwaring and his collaborators from the University of Queensland showed that a single dose triggered strong and sustained immune responses against cattle ticks, a parasite that costs the Australian beef and dairy industries approximately $175 million a year. The new vaccine was also shown to control active tick infestations in Australian cattle, killing about 80% of the tick parasites over 40 days — a level of disease protection greater than the conventional multi-dose immunisation strategy.

"This formulation is now ready for further testing at longer durations of anti-tick immunity with free-ranging cattle of Australia's northern herd," said Mainwaring.

Capsular is planning a longer follow-up study in herds of high-quality beef type cattle, replacing the Brahman breeds, the mainstay of northern Australian beef production. Here it is especially difficult and expensive to muster animals for frequent booster injections. As such, said Wong, the industry is really telling them that the market needs a one-and-done anti-tick vaccine.

The research program of Capsular also has two targets in active testing for pig health: one involves a vaccine for highly contagious viral illnesses that leave livestock weak; the other is aimed at controlling the respiratory pathogen pleuropneumonia, a bacterium often responsible for the sudden death of pigs. For now, however, the anti-tick vaccine remains the company's top priority, according to Wong. The company hopes to begin pivotal testing of its cattle tick vaccine next year, a vital step towards certification and commercialisation. If all goes well, it's expected the innovation could reach the market in the next two to five years.

>> www.capsulartechnologies.com



CLEVER COATING

Lubricin, or Proteoglycan 4, is a large glycoprotein critical to joint lubrication. A team including Swinburne's Professor Simon Moulton has looked at lubricin use on biomedical devices with platinum electrodes. Large molecules such as proteins are attracted to electrochemical implants and compromise function. Lubricin (above) can act as a size-selective barrier — blocking larger molecules, while allowing through smaller molecules important to electrochemical sensing. This could be important to implantable medical devices, such as the cochlear implant (left) and diagnostic sensors.

GOLD DETECTOR

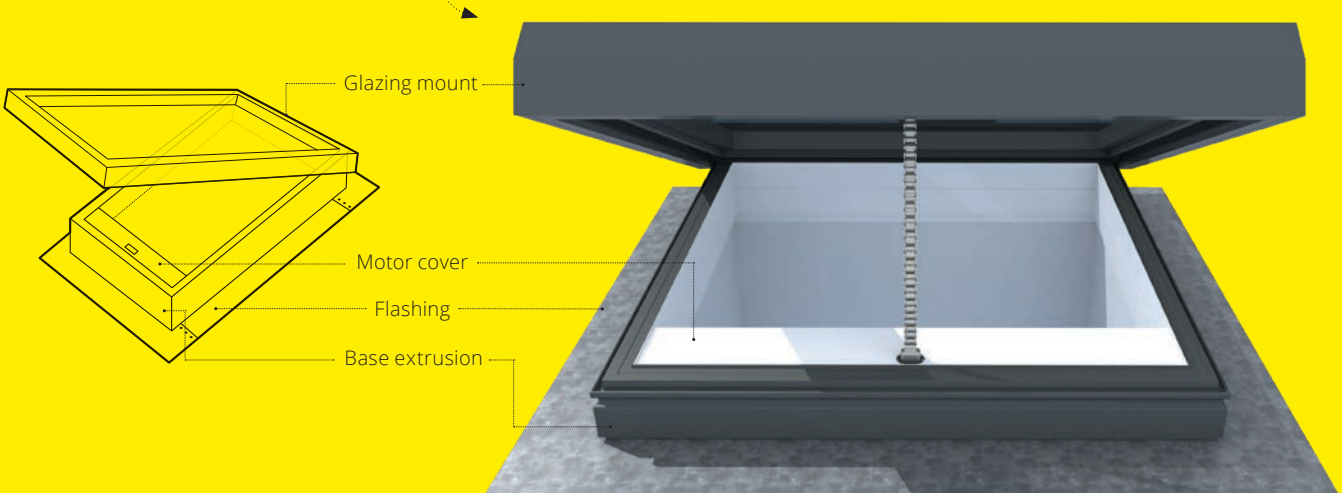
Swinburne researchers are developing a gold detector for the mining industry that uses muons, sub atomic particles created when cosmic rays hit Earth's atmosphere. A 10cm x 10cm prototype, which will be scaled up for commercial use, contains a piece of plastic scintillator, which re-emits energy absorbed from ionizing radiation as light, explains Professor Alan Duffy, who is developing the detector with Deputy Director of the Factory of the Future Shanti Krishnan and Technical Officer Craig Webster. The plastic glows slightly when hit by muons, says Duffy. Bespoke software then draws on astrophysics calculations to identify the muons' trajectory and the impact of dense rock on this path. Underground detectors use this to create 3D tomography maps, revealing gold.

ATLITE BUSHFIRE SKYLIGHT

A team led by Professor Blair Kuys, Director of Swinburne's Centre for Design Innovation, has designed the first Australian skylight that is bushfire, hail, cyclone and leak resistant.

The innovation is a combination of a robust aluminium frame with two layers of glass, a strong outer double-glazed glass and an inner low emissivity (low-e) glass, which minimizes the amount of ultraviolet and infrared light (or radiant heat from a bushfire) that can pass through, without compromising visible light. The product has been tested for bushfire resistance at 900°C.

>> www.atlite.com.au



Digital Precinct

Close ties with industry delivering social and economic impact.

The Swinburne Innovation Precinct supports our bold Research and Innovation Strategy — bridging research and industry to catalyse applied innovation at Swinburne and beyond.

The Innovation Precinct hosts start-up incubators and accelerator programs that run alongside masterclass series, open mic nights, hackathons and more. It is co-located with one of its pillars, the Design Factory Melbourne, itself part of the Global Design Factory Network delivering innovative education, research and partnerships. The Data for Social Good Cloud Innovation Centre, powered by Amazon Web Services and one of Swinburne's own digital start-ups, The Data Experience, also resides with the Precinct — working together within our incredible Innovation Hub.

And this is just the tip of the iceberg. The industry-leading Factory of the Future, another pillar of the Innovation Precinct, is host to both the Siemens Mindsphere Centre for Australia and the Advanced Manufacturing Industry 4.0 SME Hub, and is one of just six university nodes in the government's National Industry 4.0 Testlab Network Pilot Program.

Digital industry partners are embedded across our Hawthorn campus, working closely with us on all aspects of the fourth industrial revolution. The DXC Digital Transformation Centre, Cisco Network Lab, Wipro AI Innovation Centre and the Capgemini Swinburne Blockchain Centre of Excellence form a key part of our vibrant research culture.

Working side-by-side in partnership with this diverse array of international industry leaders enables our research to have a real world focus and application, driving both social and economic impact in all we do.

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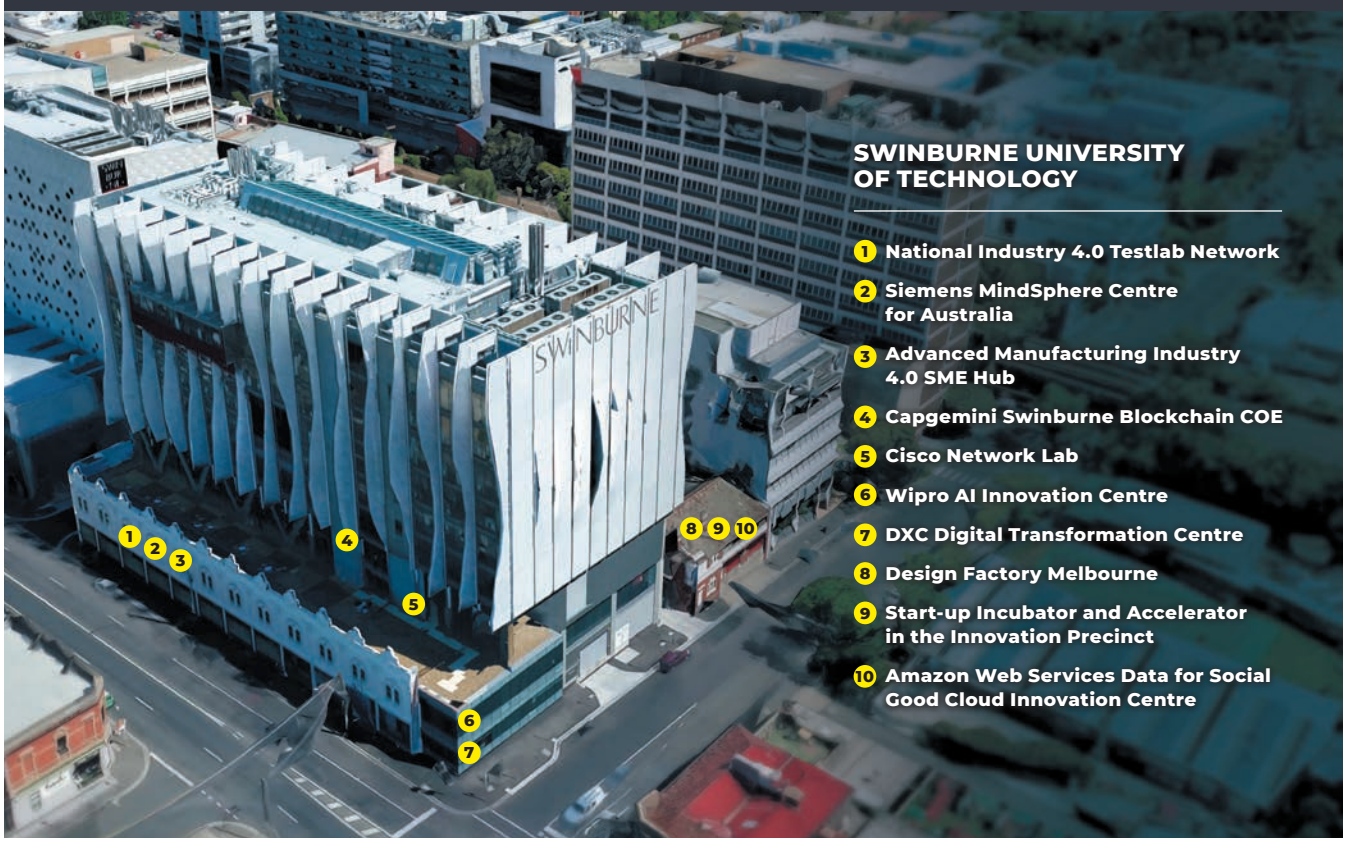

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1. National Industry 4.0 Testlab Network
2. Siemens MindSphere Centre for Australia
3. Advanced Manufacturing Industry 4.0 SME Hub
4. Capgemini Swinburne Blockchain COE
5. Cisco Network Lab
6. Wipro AI Innovation Centre
7. DXC Digital Transformation Centre
8. Design Factory Melbourne
9. Start-up Incubator and Accelerator in the Innovation Precinct
10. Amazon Web Services Data for Social Good Cloud Innovation Centre

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