Australia's top 250 researchers > Living legends > World beating strengths

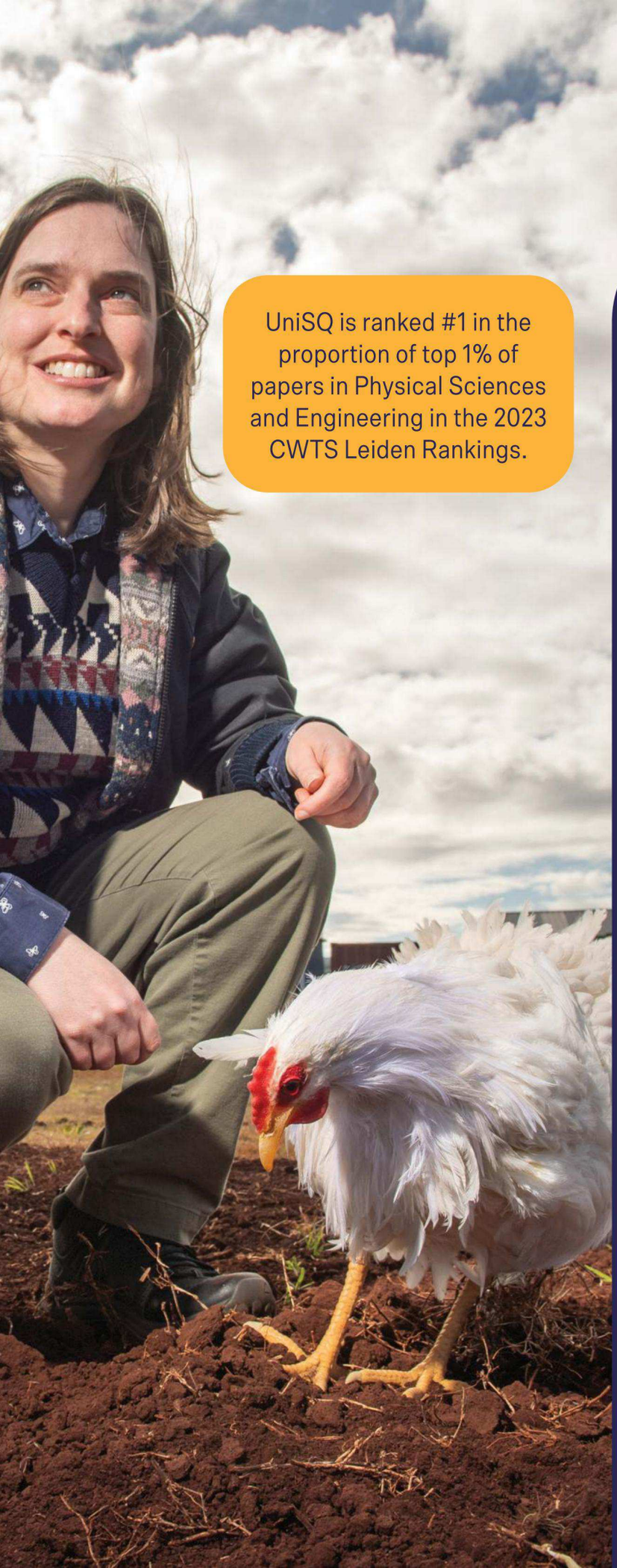
THE AUSTRALIAN

RESEARCH 2024

Big Ideas

Leaders of our 12 best research institutions speak

Pages 10-15



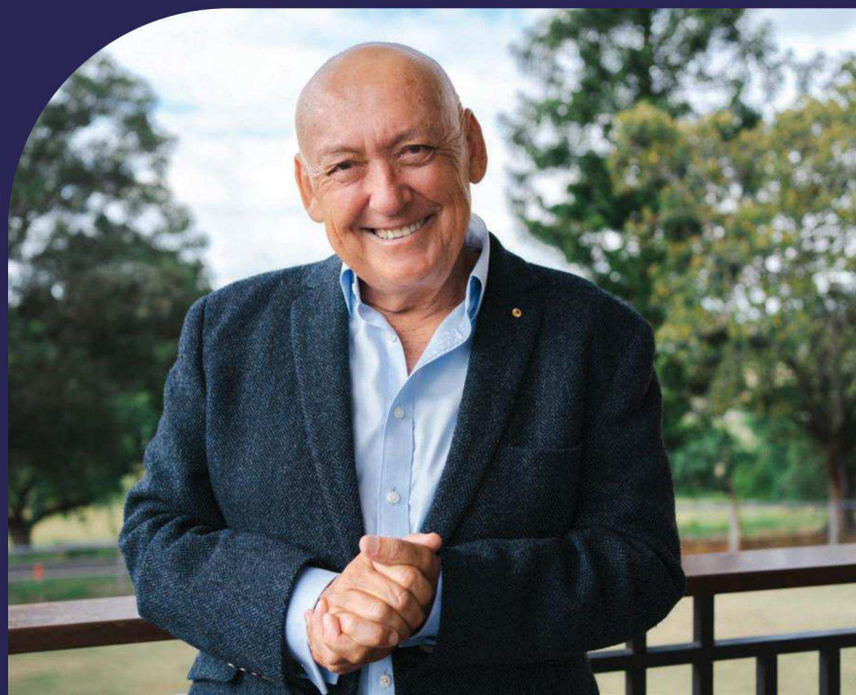
UniSQ is ranked #1 in the proportion of top 1% of papers in Physical Sciences and Engineering in the 2023 CWTS Leiden Rankings.

UniSQ

Local empowerment shaping global cancer control strategies

Professor Jeff Dunn AO has dedicated his career to improving survivorship and quality of life for people who have been diagnosed with cancer. Professor Dunn's research enables advocacy for patients living in regional and rural areas, who often experience poorer outcomes after diagnosis.

As current **President of the Union for International Cancer Control**, Professor Dunn's local efforts are shaping international cancer control by engaging policy makers and health professionals to adopt quality standards of care that are guided by the patient voice.



Foreword

Australian universities punch above their weight in research. Australia is only 0.3 per cent of the world's population, but we do 3 per cent of the world's research.

We are home to some of the world's most brilliant researchers and the most cutting-edge research. Research that has led to life changing inventions – like Wi-Fi, spray-on skin, a vaccine for HPV and polymer bank notes. And this magazine contains inspiring examples of Australian research excellence across 250 individual fields of research.

Last year I announced the first comprehensive review of the Australian Research Council (ARC), led by Professor Margaret Sheil AO, Professor Susan Dodds and Professor Mark Hutchinson. That ARC review found the legislation that underpins the ARC is old and needs updating, and we need to strengthen its governance arrangements. Over the past few years, the ARC has been bedevilled by political interference and ministerial delays.

That has made it harder for universities to recruit and retain staff, and it has damaged our international reputation. That's not good for our universities. It's not good for businesses either, which work with our universities, or the research community.

I promised last year to take the politics out of research and that's what we are doing.

That's why I have agreed in principle to all 10 recommendations and will introduce reforms that will set up the ARC to meet current and future needs and maintain the trust and confidence of the research sector.

The Australian Universities Accord will also provide us with a long-term plan that will help set up our higher education system for the next decade and beyond.

The next big, cutting-edge innovations are being developed in our universities right now through research and will help to change the world tomorrow.

Jason Clare
Federal Education Minister

Contents

Institution abbreviations

Austin Health **Austin**
Australian Catholic University **ACU**
Australian National University **ANU**
Baker Heart and Diabetes Institute **Baker**
Burnet Institute **Burnet**
Charles Darwin University **CDU**
Charles Sturt University **CSU**
Commonwealth Scientific and Industrial Research Organisation **CSIRO**
Edith Cowan University **ECU**
Heart Research Institute **HRI**
Peter MacCallum Cancer Centre **Peter Mac**
QIMR Berghofer Medical Research Institute **QIMR Berghofer**
Queensland University of Technology **QUT**
RMIT University **RMIT**
Royal Botanic Gardens Victoria **RBG Victoria**
Royal Children's Hospital Melbourne **RCH Melbourne**
University of New England **UNE**
University of New South Wales **UNSW**
University of South Australia **UniSA**
University of Southern Queensland **UniSQ**
University of the Sunshine Coast **USC**
University of Technology Sydney **UTS**
University of Western Australia **UWA**

RESEARCH THE AUSTRALIAN

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Professor Tobias Kretzschmar is trialling new coffee cultivars for a more sustainable Australian coffee industry.

Welcome to the 2024 Research Magazine

We delve deep into the data to reveal excellence

The Australian, and its partner League of Scholars, use innovative data analysis to discover our top researchers and research institutions in 250 fields

Welcome to the 2024 Research Magazine which again celebrates the excellence of Australian research by delving deep into the data and identifying our top researcher, and top research institution, in each of 250 fields of research.

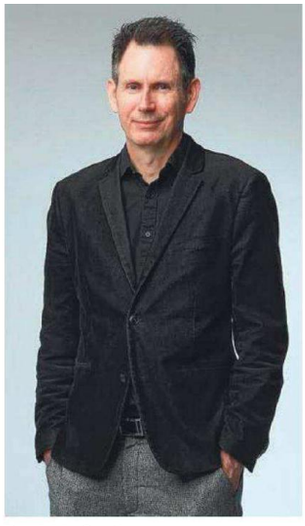
This is the sixth year in which The Australian has offered this unique view of the research landscape and, by looking for the best in relatively small areas of endeavour, we highlight the work of people and institutions who would otherwise be known only to a few. Our methodology uses what we call an "impact score" to rate all researchers and institutions in each field (see details at right). This takes into account both the quality of the research (by examining only top journals in each field) and the impact of the research (judged by the number of citations).

This detailed analysis is done by talent discovery and research analytics firm League of Scholars, which is The Australian's partner in producing the Research Magazine.

The magazine's genesis in its current form was in 2018 when League of Scholars CEO Paul McCarthy, a data specialist who is an industry fellow at the UTS Data Science Institute and an adjunct professor of computer science at UNSW, described to The Australian's higher education editor Tim Dodd the many ways in which the huge amounts of public data being accumulated about research could be utilised.

Paul, and League of Scholars co-founder Rasika Amarasiri went to work, and the result was the 2018 Research Magazine, in which our lists of top researchers and research institutions in 250 fields appeared for the first time. Since then Paul and Rasika have produced the data annually and we have been gratified to see the top 250 lists gain profile and increasing interest from universities and other research institutions.

This is not the only way such information can be used. There are many other valuable insights and conclusions to be drawn from the data troves that now exist. We note with interest that the federal government's Universities Accord panel also sees its value.



Paul McCarthy

Rasika Amarasiri

Tim Dodd

Regarding research, its interim report said "recent developments in data technology offer opportunities to move toward less labour-intensive processes for collecting performance data and assessing performance".

Over the years the Research Magazine has used big data analysis in other innovative ways, including identifying Australia's rising stars and lifetime achievers in research, lists of top academic books, and leaders in research collaboration, interdisciplinary research, and university-linked start-up companies.

In the 2024 Research Magazine we introduce three new data sets. One is a measure of how Australian research, in each of the 250 fields, compares with the rest of the world (page 16). The second examines software innovation, comparing the contributions of Australian research institutions, business and government to open source software (page 18), and the third uses Wikipedia data to identify Australia's most celebrated academics (page 20). We hope you enjoy the 2024 Research Magazine and we welcome your feedback.

Tim Dodd (doddt@theaustralian.com.au)
Higher education editor, The Australian

Paul McCarthy (paul@leagueofscholars.com)
CEO and co-founder, League of Scholars

How we use an impact score to choose the best

We give researchers and institutions an impact score in each of 250 fields of research. This score is equal to the number of citations for papers published in the past five years in the top 20 journals in the field (judged by H-index).

The individual with highest impact score (based on papers they authored) is the leading researcher in the field. The institution whose affiliated researchers in a particular field collectively have the highest impact score, is the leading institution in the field. See pages 23-42 for listings of the top 250 researchers and top 250 institutions in each field.

To create the impact score we use public data published by Google Scholar, and we largely follow its taxonomy to determine the 250 fields, although we leave out some fields which have little relevance to Australia.

The H-index of a researcher or journal is the highest number H, such that a given researcher or journal as published H papers which have been cited at least H times. For example, if a researcher has published 50 papers which each have at least 50 citations, but does not have 51 papers which have each been cited 51 times, then their H-index is 50.

Top 12 research institutions

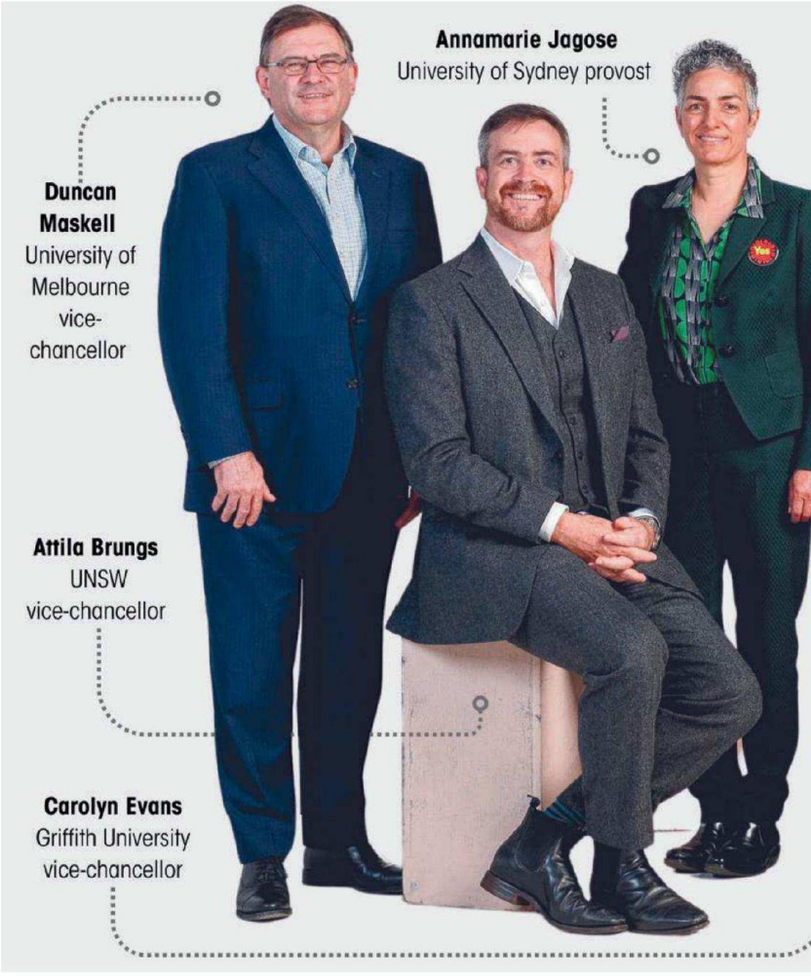
Big ideas to

Research leaders speak

We asked leaders from Australia's top 12 research institutions how their organisations build their research capacity. We also asked them to reflect on the things which make an institution great at its research mission.

We chose these 12 institutions because they are the ones which lead in more fields of research (out of the 250 analysed in this magazine) than their peers.

We found the leading research institution in each field using our impact score, which counts the citations of papers published in the top 20 journals (in that field) in the past five years by researchers affiliated with each institution. The institution with the most citations is the leader.



Duncan Maskell University of Melbourne

University of Melbourne vice-chancellor Duncan Maskell says an important part of creating a great research university is "a firm commitment to academic freedom ... allowing people to follow their nose".

"Most researchers are anarchic enough to want to do their own thing. I was certainly like that," says Maskell, whose research fields are microbiology and infectious disease.

But he says the university also has to support its researchers "so they are protected as much as possible from some of the mundane reporting and compliance and those kinds of things". Even, he says, if the researchers themselves sometimes don't know what is being done on their behalf! "When I was an active researcher, I was always moaning about filling forms and that sort of stuff," he confides.

Maskell says it's important to have strong research disciplines, so people have deep knowledge in them. "But also I'm very keen on trying to make sure that people from different disciplines can get together to address the big questions and the big problems of the world."

He says there's huge value in bringing scientists together with arts and humanities researchers, for example in finding solutions to climate change which is a social, as well as a technical, problem.

Maskell believes that a comprehensive university is ideally suited to dealing with these complex questions. Not only climate change and renewable energy, but also artificial intelligence and how it interacts with humanity. For example what legal frameworks are required in the world of AI?

For the future Maskell says a key strategy for the University of Melbourne is to try to attract the best people and support them to be successful. And to be active in seeking funding, especially for the sciences. "I think a lot of people just don't realise how much it costs to do the big science that we do."

The University of Melbourne leads in these 17 fields of research: Ecology; Economic History; Fluid Mechanics; Gender Studies; Geography & Cartography; History; Immunology; Mathematical Physics; Music & Musicology; Operations Research; Ophthalmology & Optometry; Psychology; Public Policy & Administration; Social Sciences (general); Sociology; Tropical Medicine & Parasitology; Urban Studies & Planning.

Attila Brungs University of NSW

UNSW vice-chancellor Attila Brungs reaches back to the founding of the university in 1949 to explain its research culture. "Coming out of the war, there were massive challenges. We (at UNSW) had two missions the government set us up for. One, educate a whole lot more people to give them the skills society needed, and be as inclusive as possible. Two, tackle some of the biggest research challenges the country needed, and really translate it into outcomes and impact. That has stayed all the way through."

Brungs says part of the secret to UNSW's research strength is what he calls the "and" effect. Research is not fundamental or applied, it's fundamental and applied, he says.

His challenge now is to build on UNSW's strengths. "How do I give our amazing academics and professional staff more time to do the big things?"

Brungs says he has a program to reduce bureaucracy in the university and "trust people more, give them time back to do the things that they do really well". It

drive the nation

Nikki Short

will help get a "better bang for our research buck," he says.

The next step is to replace the university's current 10-year strategy which ends in 2025. "We've actually started a big listening exercise," he says. "What are the big societal challenges that government, industry and our community want UNSW to tackle?"

UNSW leads in these 23 fields of research: Acoustics & Sound; Addiction; AIDS & HIV; Algebra; Archaeology; Architecture; Ceramic Engineering; Computational Mathematics; Computer Networks & Wireless Communication; Engineering & Computer Science (general); Gastroenterology & Hepatology; Hospice & Palliative Care; Humanities, Literature & Arts (general); Materials Engineering; Mechanical Engineering; Nanotechnology; Physics & Mathematics (general); Polymers & Plastics; Power Engineering; Psychiatry; Radar, Positioning & Navigation; Sex & Sexuality; Sustainable Energy.

Susan Elliott Monash University

Monash University interim vice-chancellor Susan Elliott says many factors underlie her institution's research success but she highlights two of them.

One was the university's decision to invest heavily in its research infrastructure – electron microscopes and other complex imaging equipment and platforms that attract top researchers. For example, Monash's Turner Institute for Brain and Mental Health has "state of the art" brain imaging equipment.

The other is the university's move to build its strength in medical research in the area of clinical research and clinical trials, which she credits to the executive dean of medicine, nursing and health sciences Christina Mitchell.

"She recruited deliberately for that. So now we're the number one site for clinical trials in the country, right across the full breadth of disciplines of medicine and health," Elliott says. Researchers are closely linked to nearby medical facilities. This year the Victorian Heart Hospital opened on the Monash campus.

The federal government will soon receive the final report from its Universities Accord panel which will recommend higher education policy changes. Elliott says there needs to be greater commitment to research infrastructure and a nationally co-ordinated plan to share use of equipment.

Elliott also says government research grants need to cover more of the indirect costs of research. "I know that is very challenging given the government's current financial situation, but (at Monash) student fees – as happens at every university – strongly cross-subsidises our research."

She said Monash's income to fund research last year was $672m but the university spent about $1.5bn on research, illustrating the gap which needs to be covered from other income, mainly student fees. "So there's very strong need to attract funding from other sources to support our research effort. And for the Commonwealth to develop a research strategy that looks to more funding so that we're not having to cross-subsidise the grants that we receive."

Monash University leads in these 53 fields of research: Analytical Chemistry; Anesthesiology; Biochemistry; Bioinformatics & Computational Biology; Business, Economics & Management (general); Cardiology; Communicable Diseases; Computer Graphics; Critical Care; Development Economics; Developmental Biology & Embryology; Diabetes; Discrete Mathematics; Economic Policy; Economics; Educational Technology; Emergency Medicine; Endocrinology; Environmental & Geological Engineering; Environmental Law & Policy; Epidemiology; Feminism & Women's Studies; Finance; Game Theory and Decision Science; Gynecology & Obstetrics; Health & Medical Sciences (general); Hematology; Human Resources & Organisations; International Business; Literature & Writing; Molecular Biology; Neurology; Neurosurgery; Obesity; Pharmacology & Pharmacy; Physiology; Probability & Statistics with Applications; Proteomics, Peptides & Amino Acids; Pulmonology; Pure & Applied Mathematics; Rehabilitation Therapy; Reproductive Health; Rheumatology; Science & Engineering Education; Software Systems; Special Education; Strategic Management; Surgery; Teaching & Teacher Education; Technology Law; Theoretical Computer Science; Vascular Medicine; Virology.

Top 12 research institutions

Big ideas to

Brian Schmidt
Australian National University

ANU vice-chancellor Brian Schmidt says his institution is "really focused on being the national university".

"There's no place for us to be mediocre. It's really important to do the things that Australia needs done that other people are not doing.

"You know we do nuclear physics, literally the only place that does that. We do a whole range of physics that other places don't do.

"We do Asian studies, we do political science and geoeconomics. These are things that are important for the nation to have a strong, regionally focused capacity in."

Based in Canberra, the ANU also performs a particular service for the federal government. "We do have

Brian Schmidt

proximity. We're six minutes away, and therefore, we do train and work and consult with the federal government – as we should – in a way that no other university can."

But he's very clear about the nature of this role. "We're not a think tank. We're not a consultancy firm. We need to give them what they need in what universities are excellent in."

Schmidt says the poor state of government research funding has got to the point of being perilous.

"Research has become so poorly funded in this country that we're all finding it pretty untenable. And the things we're doing as the national university are really not things you want to be cross-subsidising from foreign students. They're things of sovereign importance. And it's putting me and the university into a very uncomfortable position."

Schmidt believes it's important for the ANU's future research paths to be mapped both from the bottom up, responding to the initiative of its talented researchers, and the top down, to meet big strategic objectives.

"My researchers are coming up with all sorts of things in the traditional fields. So I try to provide a great environment where some of the best people come in and have an environment to do things bottom-up, like I did my Nobel prize."

Then there are broader research goals set at the top, in areas such as climate change and energy transition, which cut across the humanities, the sciences and engineering. Schmidt gives a shout out to cybernetics, the field which Genevieve Bell, who takes over from Schmidt as ANU vice-chancellor next year, has been building at the university since 2017. And he has a special mention for another program, the First Nations Portfolio, which aims to break the cycle of disadvantage for Indigenous people.

The ANU leads in 12 fields of research: Anthropology; Asian Studies & History; Astronomy & Astrophysics; Birds; Chinese Studies & History; Condensed Matter Physics & Semiconductors; Evolutionary Biology; Geophysics; International Law; Optics & Photonics; Plasma & Fusion; Political Science.

Harlene Hayne Curtin University

Curtin University vice-chancellor Harlene Hayne believes three factors have helped boost the university's rising research performance.

One is the history of the university, which goes back to the Western Australian School of Mines. "For a long time, we have been ranked second in the world in mining and mining engineering, and you know we've been ranked first in Australia for a very long time."

Now, she says, Curtin is adapting this expertise to the mining of critical minerals "which are the key really to a cleaner, greener future for Australia and for the rest of the world".

And the university is also investing in related areas which are becoming increasingly important to mining technology, such as data science.

Hayne says the second factor is her university's deliberate decision not to chasing rankings, "instead focusing on the big problems that are facing the world that we can address".

"The largest contribution is obviously right now around energy and energy transition, and the mining that will be required for that."

She says the final factor is the university's determination to work closely with industry.

"That strong relationship with industry has, I think, allowed us to both identify and solve some of the wicked problems that are facing the industries in our region, particularly in Western Australia, where mining

drive the nation

is such a fundamental part of our economy."

Hayne says university staff are strongly encouraged to engage with industry.

"Our students have been the great beneficiaries of that because, while they're studying here, they get the opportunity to have really industry-engaged experiences. They get a lot of exposure to hi-tech."

Curtin University leads in nine fields of research: Civil Engineering; Geochemistry & Mineralogy; Geology; Mathematical Analysis; Mathematical Optimisation; Mining & Mineral Resources; Oil, Petroleum & Natural Gas; Spectroscopy & Molecular Physics; Structural Engineering.

Deborah Terry University of Queensland

University of Queensland vice-chancellor Deborah Terry says that to perform at the highest level in research an organisation needs both scale and focus.

One of UQ's great assets, Terry points out, is that it is comprehensive, working across nearly all fields of research. It is also important, she says, to work seamlessly across the so-called "technology readiness levels" which range from fundamental discovery, through applied research, all the way to having a product ready for commercial production.

"We have a lot of our researchers who are doing quite applied, problem-focused work. We've got strengths from basic discovery science, right through to commercialisation," she says.

She pays tribute to former vice-chancellor Brian Wilson who established the university's research commercialisation arm, UniQuest, back in 1984. It has raised $700m

Deborah Terry

from taking university technology to market.

Terry stresses the importance of the "critical tripartite relationship between industry, government and universities" to create scale. "Our challenge as a nation," she says, "is to continue to punch above our weight in research outcomes and ensure we have the settings that support keeping more of the value chain in Australia to drive the jobs of the future and the industries of the future. That will continue to be a balancing act."

The University of Queensland leads in these 30 fields of research: Audiology, Speech & Language Pathology; Biodiversity & Conservation Biology; Biomedical Technology; Biotechnology; Cell Biology; Combustion & Propulsion; Dentistry; Dermatology; Dispersion Chemistry; Entrepreneurship & Innovation; Environmental & Occupational Medicine; Environmental Sciences; Ethics; Family Studies; Food Science & Technology; Genetics & Genomics; Life Sciences & Earth Sciences (general); Medical Informatics; Medicinal Chemistry; Metallurgy; Microbiology; Natural Medicines & Medicinal Plants; Organic Chemistry; Paleontology; Plant Pathology; Remote Sensing; Social Psychology; Sustainable Development; Tourism & Hospitality; Transplantation.

Annamarie Jagose University of Sydney

University of Sydney provost Annamarie Jagose, says her institution's high reputation is a stepping stone for further improvement and growth.

"The reputation of the university means that it's relatively easy for us to attract outstanding, high-performing academics who are passionate about their areas of research," she says.

"That halo effect means they build fantastically motivated teams who attract other excellent colleagues ... and you start getting a kind of a research concentration, almost a research ecosystem, that grows over time."

Jagose says that something which distinguishes Sydney is its long-term investment in multidisciplinary initiatives such as the Charles Perkins Centre (researching diabetes, obesity and cardiovascular disease), Sydney Nano (investigating nanoscience) and the Brain and Mind Centre.

Under the university's 10-year strategy launched last year more multidisciplinary research initiatives will be announced soon.

It has also stepped up its investment in medical research through the new Sydney Biomedical Accelerator.

The University of Sydney is also preparing for a key role in the defence research which will feature in pillar two of the AUKUS pact with the US and the UK. "We've got very strong research capability in cognate areas like quantum, AI, cyber and so on," Jagose says.

The University of Sydney leads in 20 fields of research: Bioethics; Biophysics; Computer Vision & Pattern Recognition; Gerontology & Geriatric Medicine; Health Policy & Medical Law; High Energy & Nuclear Physics; Inorganic Chemistry; Mycology; Orthopedic Medicine & Surgery; Pain & Pain Management; Pathology; Physical Education & Sports Medicine; Primary Health Care; Public Health; Radiology & Medical Imaging; Signal Processing; Soil Sciences; Transportation; Urology & Nephrology; Veterinary Medicine.

Top 12 research institutions

Big ideas to

Bronwyn Fox CSIRO

CSIRO chief scientist Bronwyn Fox says the organisation continues to make extraordinary breakthroughs to match the ones that have passed into Australian legend, such as myxomatosis to control rabbits, environmental improvement using dung beetles, and the invention of Wi-Fi and plastic banknotes.

As evidence she points to more recent work including the creation of precisely-engineered polymers, building metal organic frameworks which can store hydrogen, catalyse reactions and purify water, as well as LANDTEM, a device that uses quantum effects to find the magnetic signatures of ore bodies.

Fox says the CSIRO's science excellence is driven by four factors – its people and infrastructure, a clear future-focused purpose, collaboration, and translation of research into applications.

She says that science is a team sport. "Complex challenges require diverse thinking and diverse teams to solve them. We are all currently focused on how we can break down any barriers to collaboration. Collaboration is not only essential, for me, it's the most fun part of being a scientist."

Fox says much of the CSIRO's work is a part of large-scale science and research initiatives which rely on collaboration. "The benefits of coming together around a shared purpose means we bring together a broad range of perspectives and interests."

The CSIRO leads in these nine research fields: Agronomy & Crop Science; Atmospheric Sciences; Computer Security & Cryptography; Forests & Forestry; Hydrology & Water Resources; Insects & Arthropods; Marine Sciences & Fisheries; Oceanography; Zoology.

Iain Martin Deakin University

Deakin University vice-chancellor Iain Martin says his institution strikes a deliberate balance between its research and its teaching. "We haven't said we want to be a research-intensive university at the expense of our education mission; we've really tried to balance out the two, and for us it's a really important part of our makeup."

Deakin has taken a step-by-step approach to becoming a strong research university. Martin says that research in education was one of the first areas in which it made a mark, which continues today in work on assessment and the impact of artificial intelligence.

The university has also purposefully developed its health research. "It was a deliberate decision not to go head-to-head with Melbourne and Monash on the biomedical side, but to think about nutrition, population and health systems-based approaches, and mental health.

Iain Martin

Martin says the current research funding system, which heavily relies on cross-subsidies from university teaching revenues, is not liked. "But actually, as a nation, it's been incredibly successful," he says.

However, he says that for every dollar Deakin University receives in research funding it has to find another dollar to support the research infrastructure and other costs.

He says that, for a nation of 25 million people, Australia punches well above its weight in research output and research productivity. He wants the federal government's soon-to-be-announced Universities Accord to build on research strengths and not "lock in whatever hierarchy of research institutions we have now".

Deakin University leads in these 13 research fields: Academic & Psychological Testing; Child & Adolescent Psychology; Computing Systems; Diplomacy & International Relations; Education; Ethnic & Cultural Studies; Higher Education; Human Migration; Middle Eastern & Islamic Studies; Military Studies; Nutrition Science; Religion; Wood Science & Technology.

Carolyn Evans Griffith University

Griffith University vice-chancellor Carolyn Evan says that many factors are considered in deciding where to focus the university's research effort. National priorities are taken into account, as are potential sources of funding and possible research partnerships which could be established.

"You don't want to be wholly hostage to national priorities that will be the same for everybody, but it is something that we would take into account," she says.

Another factor is the potential to leverage other sources of funding by investing research effort in a particular area.

But not all decisions are made on a return-on-investment basis. The university gives researchers some scope to pursue what they are passionate about. And some projects get the green light "because they are critical to our values," says Evans.

"There are sometimes things ... that we might say we still need to invest in, even if you're not going to get that same degree of return."

Local and global priorities also figure. Locally, the university is part of a research project in the southern Brisbane district of Logan, working with the community to help break cycles of disadvantage.

The university also looks to have global impact. "We've put a lot of work into a malaria vaccine, for example, which will not directly benefit Australia but we are part of a global community," says Evans.

She says the door must always be left open for unexpected discoveries to emerge.

"Katalin Kariko has won the Nobel prize (this year) for the mRNA work that she did, which patently her university didn't value for a very long period of time. So you have to have the humility to acknowledge you won't always get it right – to leave some space for the flowers that you didn't even realise were going to bloom."

Griffith University leads in these six research fields: Criminology, Criminal Law & Policing; Evolutionary Computation; Fuzzy Systems; Marketing; Microelectronics & Electronic Packaging; Social Work.

drive the nation

Bruce Dowton Macquarie University

Macquarie University vice-chancellor Bruce Dowton says the university did several things to underpin its growing strength in research.

One was to "change around the internal cross-subsidisation of research to make it more focused around performance and excellence". Another was to commercialise part of Macquarie campus's extensive land area – located in the thriving business centre of Macquarie Park in Sydney – and use rental income to fund research. Today 20 companies are on campus. Notably Cochlear, but also including new start-ups.

Dowton says he moved this beyond a simple landlord-tenant relationship. Now, to be on campus, a company must have links with the university. "We work to target companies that have either interest in collaboration around research, or participation in our education with student placements and work integrated learning."

He says that for a university to reach the elite research level in Australia it must have either engineering or medicine, or both. While Macquarie is strong in telecommunications engineering – it played a major role in the development of Wi-Fi – its engineering expertise was narrow and so was deliberately broadened.

It also launched a medical degree and has an on-campus hospital, a rare thing in Australia. Dowton says the hospital has been "incredibly successful" in providing the environment for health and medical research to flourish. He praises former vice-chancellor Steven Schwartz and former deputy vice-chancellor (research), the late Jim Piper, for their role in Macquarie's research rise.

"We pay great tribute to Jim because he really was the architect of getting the university on a start to become research elite."

Macquarie University leads in these 11 research fields: Accounting & Taxation; Animal Behaviour & Ethology; Computational Linguistics; Early Childhood Education; English Language & Literature; Epistemology & Scientific History; Foreign Language Learning; Geometry; Otolaryngology; Philosophy; Plastic & Reconstructive Surgery.

Andrew Parfitt UTS

"One of the things that people who come to UTS say – academic staff particularly – is that they find they're really able to get things done here. And I think that really applies to the research," says UTS vice-chancellor Andrew Parfitt.

"There's an empowerment and a facilitation for people to get on with doing good things.

"It's been a very, very deliberate strategy to be focused on excellence, but not too diffuse, to make sure that we have really good people in disciplines that we want to be strong in and which we teach in as well."

He says it's also a critical part of the university's strategy to link closely with those outside the institution – industry and external partners.

Most people at UTS have a passion to make a difference, Parfitt says, not only in fundamental research but in connecting with business, and enjoying "the satisfaction that you get from seeing ideas move to reality."

Parfitt says many of the research strengths of UTS evolved out of the university's core areas of computer science, electrical engineering and biosciences. For example he says there is a natural evolution from information systems into artificial intelligence and quantum software.

Now, he says, UTS is building out from its expertise in artificial intelligence into research on AI applications, its ethics and its regulation.

UTS leads in these eight research fields: Artificial Intelligence; Databases & Information Systems; Electromagnetism; Forensic Science; Library & Information Science; Multimedia; Toxicology; Water Supply & Treatment.

Measuring up

Field by field, how competitive is Australia's research?

We use a measure based on the economic concept of revealed comparative advantage to find Australia's research strengths and weaknesses relative to the rest of the world

How good is Australia's research compared to the world? To find an answer we've looked at Australia's research impact in the 250 fields examined in the Research Magazine and compared them to the world as a whole. The graphs show the 15 fields in which Australia is strongest compared to the world and the 15 fields in which we are weakest. Fields which score greater than 1 are stronger than the world norm. Fields with scores less than 1 are weaker.

Higher education research is the area in which we lead the world by largest margin, closely followed by nursing, mining & mineral resources, and then Asian studies & history. The strength of nursing is significant because it is a large field in which research is highly important. Australia's world-leading mining industry is closely linked to research and so Australia's high performance there is not a surprise. And given our proximity to Asia, the strength of Asian studies is gratifying.

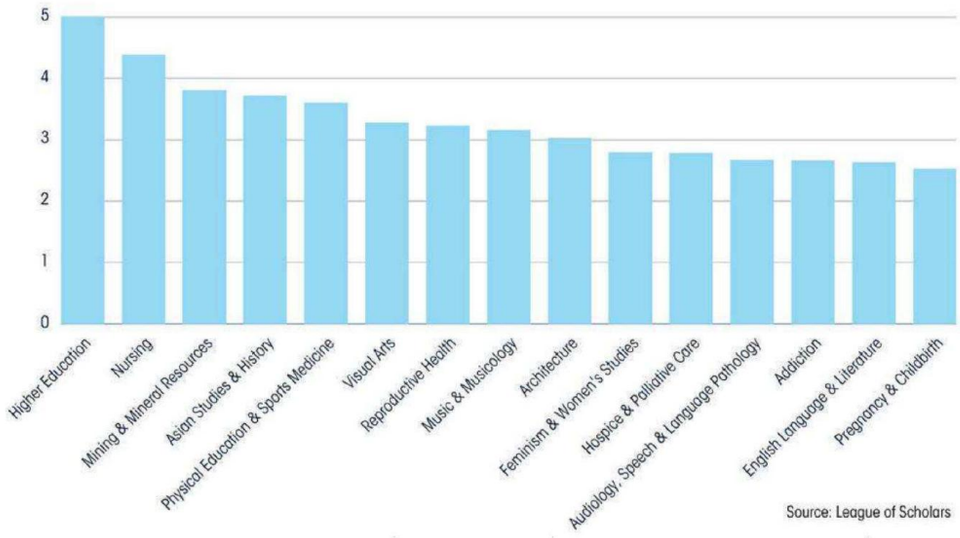
More concerning is the evidence of Australia's weakness in hard science areas such as plasma & fusion, spectroscopy & molecular physics, high energy & nuclear physics, and ceramic engineering.

How the scores are calculated

We use a method based on the economic concept of revealed comparative advantage, which has the advantage of adjusting for country size. To explain it by example, consider nursing. We take the impact score (see page 8) for Australia's nursing research and divide it by the impact score for all of Australia's research, This tells us the contribution which nursing makes to Australia's total research strength. We do the same for nursing research globally, which tells us the contribution of nursing to the world's research strength. Then we divide the first by the second. If less than 1 then Australia is under par in nursing compared to the world. If greater than 1 then Australia is over par in nursing. In fact, Australia is far stronger than the world in nursing, with a score of 4.37.

Our global research strengths

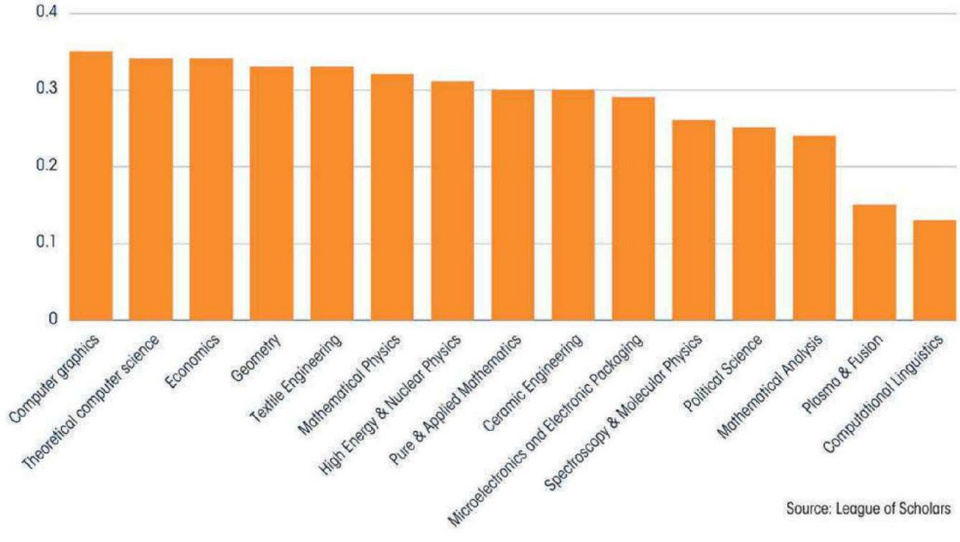
Australia's strongest 15 fields relative to the world



Source: League of Scholars

Our global research weaknesses

Australia's weakest 15 fields relative to the world



Source: League of Scholars

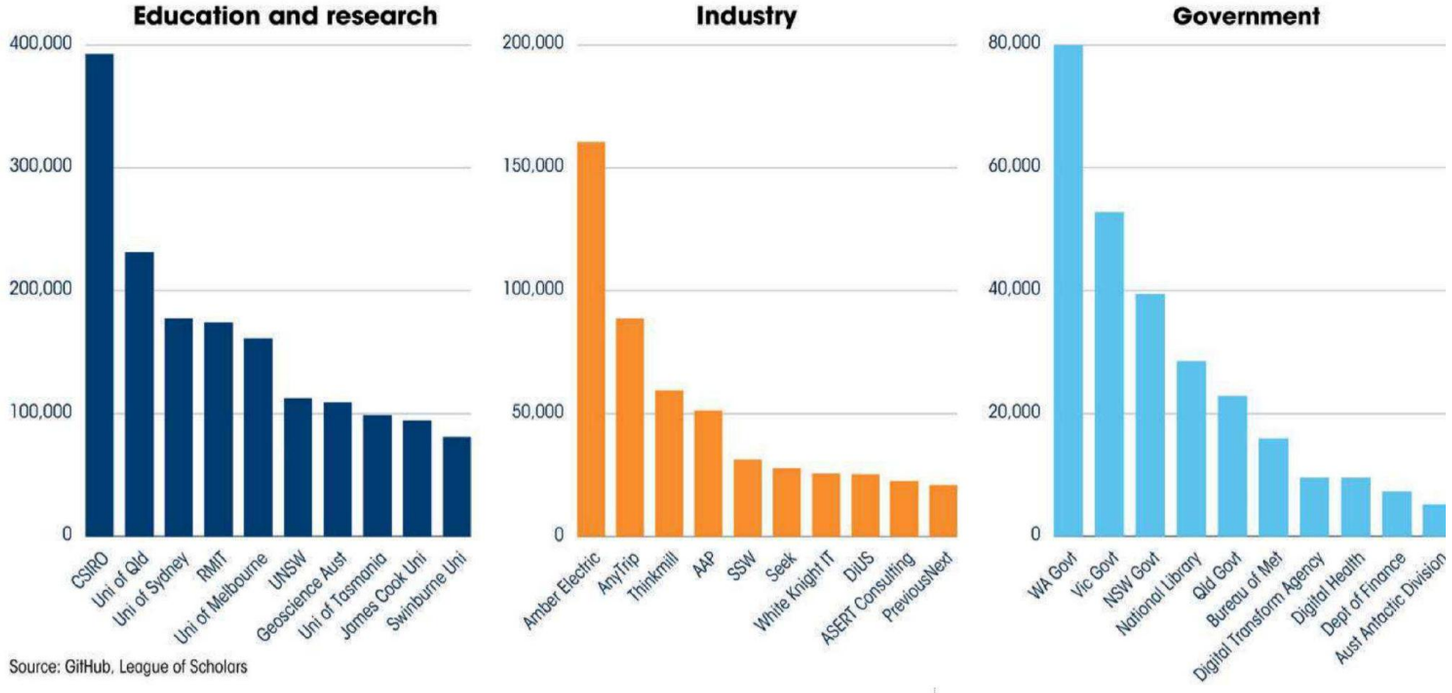
The coding country

We collaborate in building the world's software

Australia is a significant contributor to open source software, and education and research organisations lead the way

Australia's contribution to open source software development

Number of 'commits' to GitHub, 2012-2023



Source: GitHub, League of Scholars

How big is Australia's contribution to global software development and innovation, and who in Australia is active in doing it? We've tackled these questions by looking at activity on GitHub, an open source software platform which is the world's largest code host. Owned by Microsoft since 2018, it allows developers to make contributions, known as "commits", to collaborative software that is widely used globally, including by major companies and other organisations.

Australians are heavy contributors to GitHub, with one of the highest concentrations of GitHub users per number of internet users – higher than Asia and most of Europe, and on par with the US and Canada. In May this year GitHub – which allows developers to track changes to their code, create branches for parallel development, merge code changes and revert to previous versions if necessary – had about 100 million users.

GitHub was founded in 2008 and, to get a long-term view of which Australian organisations use GitHub and contribute to code development, we have looked at the number of commits from 2012 to 2023.

Australian organisations made 2.2 million commits over the period. By tracking the domain names of contributors, we know which organisations these code contributions came from and see the relative contributions of Australian universities and research organisations, government, and industry.

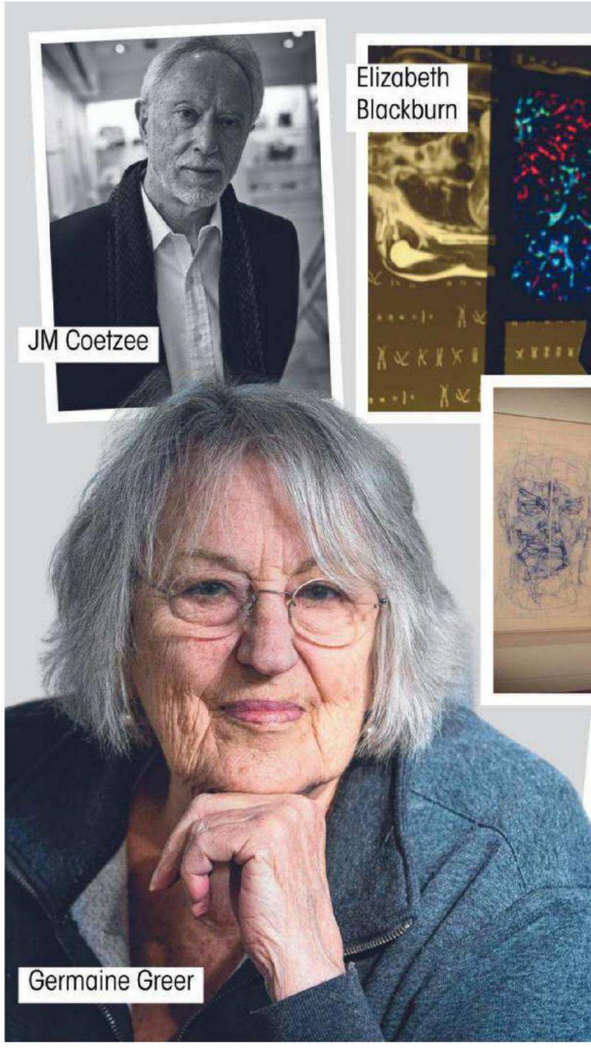
Universities and research groups lead the way. The CSIRO is the largest contributor of any Australian organisation with nearly 400,000 commits over the period. The major university contributors were the University of Queensland, the University of Sydney, RMIT, the University of Melbourne and UNSW.

In Australia, it's smaller rather than larger companies, in the main, which are the biggest contributors to GitHub. Most larger Australian companies take a proprietory or outsourced approach to their software needs rather than open source approach. Australia's top industry contributors are wholesale electricity reseller Amber Electric, followed by AnyTrip, which provides live public transport maps, and IT consultancy ThinkMill. In government, organisations such as the National Library, the Bureau of Meteorology and the Australian Antarctic Division are significant contributors.

Living legends
Academics in the spotlight

These are the Australian academics, researchers and scholars who loom largest in public discourse world-wide

Germaine Greer
Writer and feminist, formerly University of Cambridge
Peter Singer
Philosopher, Princeton University, University of Melbourne
J. M. Coetzee
Novelist and Nobel laureate, University of Adelaide
Barry Marshall
Scientist and Nobel laureate, University of Western Australia
David Chalmers
Philosopher, New York University
Thomas Keneally
Author, formerly New York University and University of New England
Elizabeth Blackburn
Scientist and Nobel laureate, University of California, San Francisco
Brian Schmidt
Astrophysicist and Nobel laureate, Australian National University
Raewyn Connell
Sociologist, University of Sydney
Christopher Clark
Historian, University of Cambridge
Bruce Pascoe
Writer, University of Melbourne
Sheila Jeffreys
Academic, formerly University of Melbourne
Fiona Wood
Surgeon, University of Western Australia
David Christian
Historian, Macquarie University
Anne Summers
Writer and editor, UTS
Marcia Langton
Anthropologist and geographer, University of Melbourne
Keith Windshuttle
Historian, formerly UNSW
John Hattie
Education researcher, University of Melbourne
McKenzie Wark
Writer, The New School
Geoffrey Blainey
Historian, University of Melbourne
Mem Fox
Author, Flinders University
Gillian Triggs
Law academic, University of Melbourne
Robin Warren
Pathologist and Nobel laureate. University of Western Australia
Ian Frazer
Immunologist, University of Queensland
Michelle Simmons
Quantum physicist, UNSW
Bill Mitchell
Economist, University of Newcastle
Cordelia Fine
Historian and philosopher, University of Melbourne
Philip Alston
Lawyer, New York University
Wang Gungwu
Historian, National University of Singapore
Ghil'ad Zuckermann
Linguist, University of Adelaide
Michael Nielsen
Physicist, Perimeter Institute for Theoretical Physics
Graham Priest
Philosopher, CUNY Graduate Center, University of Melbourne
Alan Finkel
Scientist and engineer, former Chief Scientist
Glyn Davis
Public servant and political scientist, formerly University of Melbourne, Griffith University
Clive Hamilton
Academic, Charles Sturt University
Peter Godfrey-Smith
Philosopher, University of Sydney, CUNY Graduate Center
Alexis Wright
Author, University of Melbourne
Burkard Polster
Mathematician, Monash University
Graham Oppy
Philosopher, Monash University
Kate Crawford
AI researcher, New York University, USC Annenberg
Frank Jackson
Philosopher, Australian National University
Paul James
Academic, Western Sydney University
Gustav Nossal
Biologist and medical scientist, formerly University of Melbourne
Genevieve Bell
Cyberneticist and anthropologist, Australian National University



Australia may be better known for celebrating sporting greatness than intellectual achievement but nevertheless it has produced a long list of academics, researchers and scholars who are well known nationally and internationally.

To decide who our best known intellectual achievers are, we counted Wikipedia page views (from 2015 to 2023) of living Australian academics, researchers and scholars to produce this list which is in order of page view count.

At the top is Germaine Greer with over 2.5 million views in the period. Animal liberation philosopher Peter Singer, who began his career at the University of Melbourne but has spent many years at Princeton, is close behind.

We have called the people on this list "living legends" because they attract worldwide attention by virtue of their ideas although many of them have little in common with each other, because they are in very different fields.

Some on the list have ideas which are in deep conflict. Dark Emu author Bruce Pascoe and history wars warrior Keith Windshuttle would not often find themselves in close company. However they are both on this list because their ideas attract public attention.

Interestingly, the ordering of the list is not

necessarily linked to how well these scholars are known in Australia. Some of those on the list are famous overseas than in Australia, which drives up their Wikipedia views.

The list does include people who have been in the public eye like Nobel prizewinners Barry Marshall, Elizabeth Blackburn, Robin Warren, J.M. Coetzee and Brian Schmidt. But it also includes eminent scholars such as David Chalmers, Raewyn Connell, Christopher Clark, David Christian, Bill Mitchell and Cordelia Fine, even though they are not by any means household names.

Of course many people with academic connections are well known, and attract Wikipedia views, for other reasons. We have tried to limit the list to people whose primary reason of being known is research and scholarship, and who have or have had an appointment at a university or research institution. If, for example, a former prime minister took a short university appointment, that would not quality them for the list. However we concede that judgments on this are subjective.

The list is also limited to Australians, but we have defined this generously. If someone was born here, or spent a substantial amount of their life here (particularly if they worked at an Australian university) we have included them.

Enduring legends
Powerhouses of the past

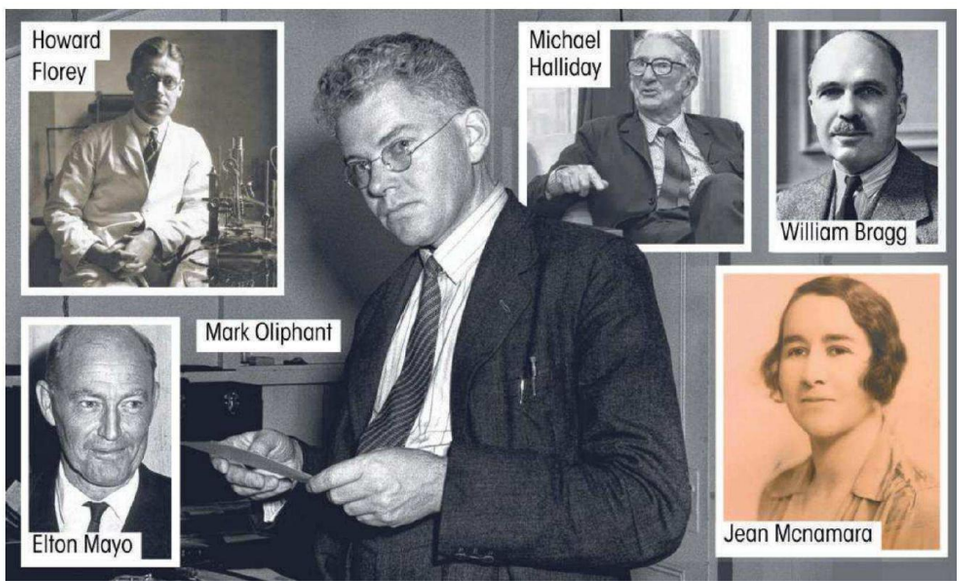
Our living legends list of academics and researchers is incomplete. It does not include the many eminent Australian researchers who have passed on.

Here is a list, ordered by number of Wikipedia page views, of dead Australian academics and researchers.

First on the list with most Wikipedia page views is Elton Mayo, a South Australian psychologist who began his academic career in Australia and later became a professor of industrial research at Harvard Business School. He is associated with the Hawthorne effect, the idea that people modify their behaviour in response to being watched.

Other enormously influential, now dead, Australian researchers include Howard Florey who developed penicillin, physicist Mark Oliphant who played a major role in the early development of the atomic bomb, British physicist William Bragg who spent many years at the University of Adelaide, physicist and ecologist Robert May who became president of the Royal Society, and eminent linguist Michael Halliday.

Elton Mayo Died 1949
Psychologist and organisational theorist, associated with the Hawthorne effect
Jean Macnamara Died 1968
Pediatrician, polio researcher and authority on polio treatments
Howard Florey Died 1968
Pharmacologist and Nobel laureate, key role in developing penicillin
Michael Halliday Died 2018
Linguist, developed the systemic functional linguistics model of language
Gordon Childe Died 1957
Archaeologist and Marxist political theorist
Mark Oliphant Died 2000
Physicist, key role in developing radar and the atomic bomb
William Bragg Died 1942
Physicist and Nobel laureate, pioneered X-ray crystallography
J. L. Mackie Died 1981
Philosopher, advocate of moral scepticism and defender of atheism
Walter Murdoch Died 1970
Educator, founding professor of English at the University of Western Australia.
Robert May Died 2020
Physicist and ecologist, developed theoretical biology and chaos theory



Elise Derwin

Dr James Sippo (left) and Professor Damien Maher of Southern Cross University

Waterworld: catchment sciences supporting the growth of Western Sydney

The Hawkesbury River winds like a crinkled ribbon through the fertile Darug lands north of Greater Sydney. It is central to life here – supporting wildlife, farms, businesses and providing a playground for endless recreation.

Less romantically, it's also the place where most of Sydney's treated effluent is discharged. Understanding the river's ability to cleanse itself as Sydney grows is the key to its future.

With the population of Western Sydney projected to increase by more than two million over the next decade, a team from Southern Cross University is working with Sydney Water to make sure the mighty Hawkesbury can cope.

Lack of attention to this balance elsewhere in the world has had dire environmental consequences.

"We're looking particularly at the cleansing capacity of the river system to process nutrients. A big increase in population will bring a big increase in treated effluent and stormwater run-off, and a big increase in associated nutrients," lead researcher Professor Damien Maher said.

"At the moment, the modelling is theoretical, based on models from other river systems. We're trying to build a picture from the actual data so we can base future river management on what is really happening."

The research team can already draw a stunningly accurate picture of what is in the river, thanks to technology that can tell how much Covid-19, caffeine or even oestrogen is in a glass of treated wastewater.

At the height of the pandemic, critical public health decisions were made on the back of this technology – now infrastructure planning for Greater Sydney will also benefit.

The research zone is 80km long with four separate sampling stations, stretching from North Richmond to Wiseman's Ferry. The team's motto? "We science the crap out of water."

Professor Maher says the scale of the sampling is something to behold.

"We collect thousands of samples on each field trip and we take them back to our temporary accommodation where we process what we can on-site.

"Then we truck about two tonnes of water samples up to our lab in Lismore where we have the more advanced diagnostic equipment."

Lismore is the location of Southern Cross University's Northern Rivers campus, where cutting-edge sampling and analysis has resulted in the university consistently ranking among the top environmental science universities in the world (QS Rankings 2023 – Top 450 Environmental Sciences).

The research findings will help inform many of the infrastructure requirements for water in Western Sydney's expansion.

"The Hawkesbury has a high amount of nitrogen, but we can already see that it also has a high capacity for processing it, with ideal conditions for microbes in the sediment that process nitrogen into inert gas," Professor Maher said.

"It's a very deep river compared to other systems – similar to Sydney Harbour's topography, in some ways, with a sandstone-drowned river basin.

"This gives it particular characteristics as a filtering system, but increasing residential and industrial areas located along the river will affect this capability."

Last year, the university launched a new Coasts, Catchments and Communities Research Impact Cluster, bringing together expertise and activity in the areas of biogeochemistry, riverine and estuarine science, as well as the integration of social science and Indigenous knowledge.

Deputy vice-chancellor (Research and Academic Capability) Professor Mary Spongberg said the Hawkesbury project was a clear example of this expertise and capacity at the service of communities.

"It's also a model for how we can work together with industry while providing strongly supportive environments for early career researchers," she said.

One of those early career researchers is Dr James Sippo, a PhD graduate who is working with Professor Maher, supported by an industry fellowship jointly funded by the university and Sydney Water.

Dr Sippo has worked for the past six years in the area of blue carbon, or the ability of natural systems like the Hawkesbury River catchment to capture, transform and store carbon.

He says the Hawkesbury project is an opportunity to take the science to a new level and scale.

"It's also a chance to expand our knowledge of how carbon from the landscape is processed and stored in these enormous rivers and estuaries," Dr Sippo said. "The Hawkesbury is an iconic river so many people depend on. We want to make sure it stays that way."

Lee Adendorff

Health & Medical Sciences
Australia's research field leaders

Thes are Australia's top researchers and institutions in the 66 fields of health and medical sciences

Nikki Short

Naomi Hammond
George Institute for Global Health
Field leader in Critical Care

Naomi Hammond's research collaborations have focused on the care of critically ill patients who are often unconscious.

She has taken part in research that has found an intravenous fluid widely used in much of the world increases acute kidney injury and has other adverse reactions. A sister clinical trials group in Scandinavia found this IV fluid actually increases the likelihood of death in patients critically ill with sepsis.

A registered nurse, with a master's degree in

Continued on Page 24

Addiction
Field leader: Louisa Degenhardt, UNSW
Lead institution: UNSW

AIDS & HIV
Field leader: Andrew Grulich, UNSW
Lead institution: UNSW

Alternative & Traditional Medicine
Field leader: Amie Steel, UTS
Lead institution: Western Sydney

Anaesthesiology
Field leader: Lis Evered, Uni of Melb
Lead institution: Monash

Audiology, Speech & Language Pathology
Field leader: Sharynne McLeod, CSU
Lead institution: Uni of Queensland

Bioethics
Field leader: Miles Little, Uni of Sydney
Lead institution: Uni of Sydney

Cardiology
Field leader: Andrew Coats, HRI
Lead institution: Monash

Child & Adolescent Psychology
Field leader: Ronald Rapee, Macquarie
Lead institution: Deakin

Clinical Laboratory Science
Field leader: Emmanuel Favaloro, NSW Health
Lead institution: NSW Health

Communicable Diseases
Field leader: David Paterson, Uni of Queensland
Lead institution: Monash

Critical Care
Field leader: Naomi Hammond, George Institute
Lead institution: Monash

Dentistry
Field leader: Sašo Ivanovski, Uni of Queensland
Lead institution: Uni of Queensland

Dermatology
Field leader: Rod Sinclair, Uni of Melb
Lead institution: Uni of Queensland

Developmental Disabilities
Field leader: Cheryl Dissanayake, La Trobe
Lead institution: La Trobe

Diabetes
Field leader: Dianna J Magliano, Monash
Lead institution: Monash

Emergency Medicine
Field leader: Dieter Weber, UWA
Lead institution: Monash

Endocrinology
Field leader: Peter Ebeling, Monash
Lead institution: Monash

Epidemiology
Field leader: Mark Howard, Austin
Lead institution: Monash

Gastroenterology & Hepatology
Field leader: Benjamin Cowie, Peter Doherty Institute
Lead institution: UNSW

Genetics & Genomics
Field leader: Sarah Medland, QIMR Berghofer
Lead institution: Uni of Queensland

Gerontology & Geriatric Medicine
Field leader: Christopher Rowe, Austin
Lead institution: Uni of Sydney

Gynaecology & Obstetrics
Field leader: Ben Willem Mol, Monash
Lead institution: Monash

Health & Medical Sciences (general)
Field leader: Sheikh Mohammed Shariful Islam, Deakin
Lead institution: Monash

Heart & Thoracic Surgery
Field leader: Rob Baker, Flinders
Lead institution: RCH Melbourne

Haematology
Field leader: Emmanuel Favaloro, NSW Health
Lead institution: Monash

Hospice & Palliative Care
Field leader: Lauren Breen, Curtin
Lead institution: UNSW

Immunology
Field leader: Robyn O'Hehir, Alfred Health
Lead institution: Uni of Melb

Molecular Biology
Field leader: Edward Holmes, Uni of Sydney
Lead institution: Monash

Continued on Page 24

Health & Medical Sciences continued

Continued from Page 23

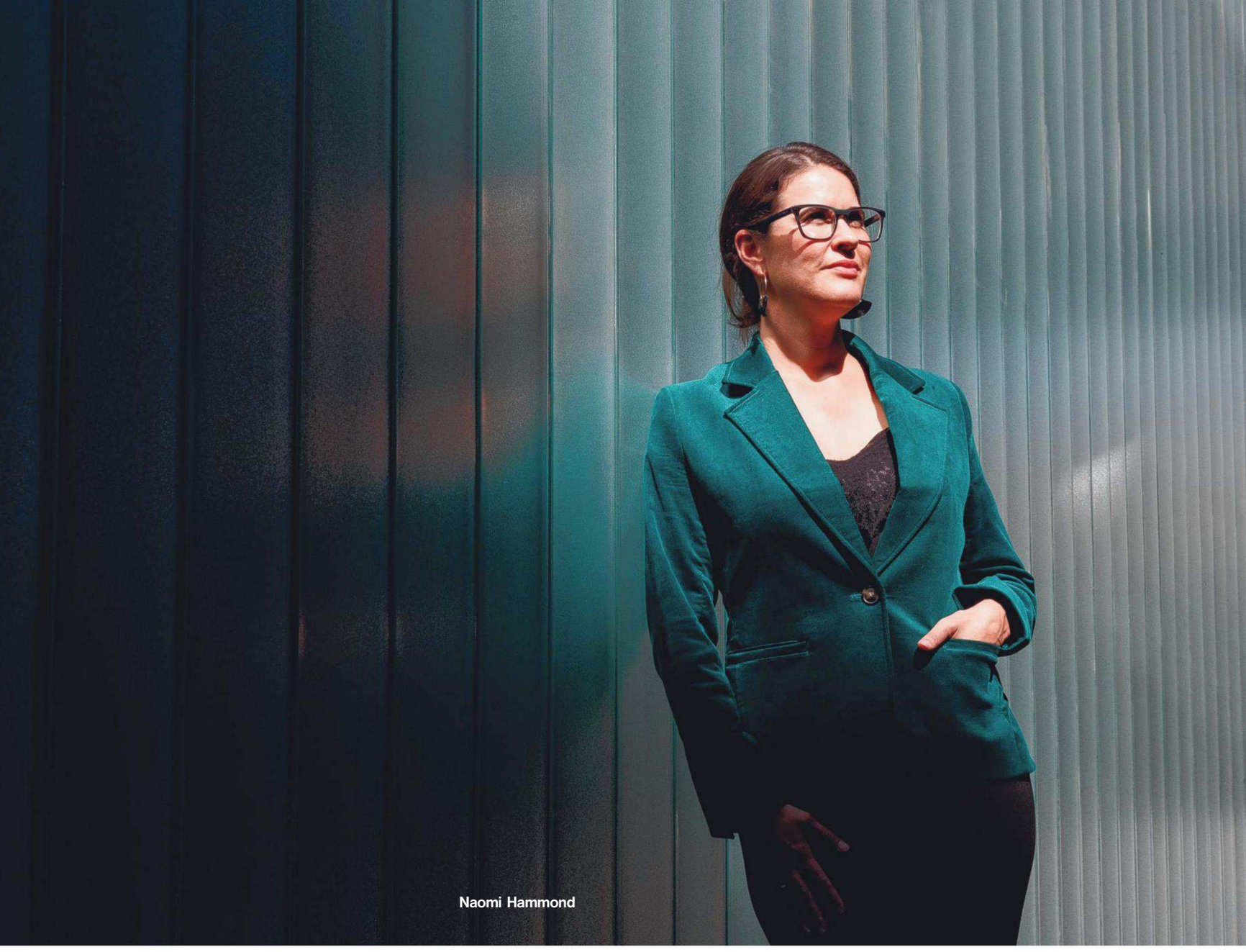
Natural Medicines & Medicinal Plants
Field leader: Jerome Sarris, Western Sydney
Lead institution: Uni of Queensland
Neurology
Field leader: Graeme Hankey, UWA
Lead institution: Monash
Neurosurgery
Field leader: Jeffrey Rosenfeld, Monash
Lead institution: Monash
Nuclear Medicine, Radiotherapy & Molecular Imaging
Field leader: Michael Hofman, Peter Mac
Lead institution: Peter Mac
Nursing
Field leader: Debra Jackson, Uni of Sydney
Lead institution: Uni of Wollongong
Nutrition Science
Field leader: Omar Boukhris, La Trobe
Lead institution: Deakin
Obesity
Field leader: John Dixon, Swinburne
Lead institution: Monash
Oncology
Field leader: Georgina Long, Uni of Sydney
Lead institution: Peter Mac
Ophthalmology & Optometry
Field leader: Robyn Guymer, Uni of Melb
Lead institution: Uni of Melb
Oral & Maxillofacial Surgery
Field leader: Zohaib Akram, UWA
Lead institution: UWA
Orthopaedic Medicine & Surgery
Field leader: Kate Webster, La Trobe
Lead institution: Uni of Sydney
Otolaryngology
Field leader: Richard Harvey, Macquarie
Lead institution: Macquarie
Pain & Pain Management
Field leader: Michael Nicholas, Uni of Sydney
Lead institution: Uni of Sydney
Pathology
Field leader: Anthony Gill, Uni of Sydney
Lead institution: Uni of Sydney
Pediatric Medicine
Field leader: Nigel Curtis, Uni of Melb
Lead institution: RCH Melbourne
Pharmacology & Pharmacy
Field leader: Christopher Sobey, La Trobe
Lead institution: Monash
Physical Education & Sports Medicine
Field leader: Emmanuel Stamatakis, Uni of Sydney
Lead institution: Uni of Sydney
Physiology
Field leader: Jiake Xu, UWA
Lead institution: Monash
Plastic & Reconstructive Surgery
Field leader: Anand Deva, Macquarie
Lead institution: Macquarie
Pregnancy & Childbirth
Field leader: Caroline Homer, Burnet
Lead institution: Western Sydney
Primary Health Care
Field leader: Sarah Dennis, Uni of Sydney
Lead institution: Uni of Sydney
Psychiatry
Field leader: Helen Christensen, UNSW
Lead institution: UNSW
Psychology
Field leader: Quentin Gronau, Uni of Newcastle
Lead institution: Uni of Melb
Public Health
Field leader: Adrian Bauman, Uni of Sydney
Lead institution: Uni of Sydney
Pulmonology
Field leader: Scott Bell, Uni of Queensland
Lead institution: Monash
Radiology & Medical Imaging
Field leader: Thomas Marwick, Baker
Lead institution: Uni of Sydney
Rehabilitation Therapy
Field leader: Jennie Ponsford, Monash
Lead institution: Monash
Reproductive Health
Field leader: Ben Mol, Monash
Lead institution: Monash
Rheumatology
Field leader: Peter Nash, Griffith
Lead institution: Monash
Social Psychology
Field leader: Roy Baumeister, Uni of Queensland
Lead institution: Uni of Queensland
Surgery
Field leader: Dieter Weber, UWA
Lead institution: Monash
Toxicology
Field leader: Kamal Dua, UTS
Lead institution: UTS
Transplantation
Field leader: Daniel Chambers, Uni of Queensland
Lead institution: Uni of Queensland
Tropical Medicine & Parasitology
Field leader: Una Ryan, Murdoch
Lead institution: Uni of Melb
Urology & Nephrology
Field leader: David Johnson, Uni of Queensland
Lead institution: Uni of Sydney
Vascular Medicine
Field leader: Aletta Schutte, UNSW
Lead institution: Monash
Veterinary Medicine
Field leader: Paul McGreevy, UNE
Lead institution: Uni of Sydney
Virology
Field leader: David Jans, Monash
Lead institution: Monash

We have realised over the last two decades that intravenous fluids should be treated like any drug

Continued from Page 23

critical care nursing, a master's degree in public health and a doctorate focused on intensive care and fluid resuscitation practices (such as hydrating patients with intravenous drips), Hammond credits collaboration with her mentors and colleagues and co-operation with multinational networks for the success of the research.

"We have realised over the last two decades that intravenous fluids should be treated like any drug; they do have different outcomes for different patient populations," she says. "The work our group has done at the critical care program at the



Naomi Hammond

Nikki Short

George Institute for Global Health, in collaboration with the Australian and New Zealand Intensive Care Society clinical trials group, has included large-scale randomised trials comparing commonly used fluids."

This body of collaborative research work around the world has transformed how medical staff use fluids for resuscitation and the types of fluids that are used, Hammond adds.

Head of the critical care program at the George Institute, a public health research institute affiliated with the University of NSW, Hammond is also conjoint associate professor at UNSW's faculty of medicine and the intensive care clinical research manager at the Royal North Shore hospital in Sydney.

Patients in intensive care units usually require life support for serious illness and life-threatening injuries and they often need a large volume of IV fluid to keep their blood volume up and their hearts pumping, Hammond says. Replacing the total volume of lost blood with whole blood is usually not possible, she adds, because such large volumes of fluid are required.

Normal saline, a sterile salt and water solution, is predominantly used in Australia and elsewhere for IV resuscitation. Albumin, a solution derived from human blood, is also commonly used, particularly for critically ill patients.

Hydroxyethyl starch, a synthetic product, was previously the most commonly used fluid for resuscitation globally but broadscale research studies, including those Hammond has worked on, have found it can have dangerous side-effects. "Hydroxyethyl starch is still used in India and throughout Asia," she adds. "Even though there's clear evidence of harm, there's still a market for it."

Hammond and her colleagues have just completed another large trial of resuscitation fluids. The trial compared normal saline IV fluids with a balanced salt solution to determine which was more suitable for critically ill patients, she says. When this trial data was combined with international collaborators' trial data, the results suggested balanced salt solutions were more likely to be beneficial than normal saline. Other research suggests albumin might be a better alternative for patients with sepsis.

A key part of Hammond's work, she says, is a series of translational studies both nationally and internationally to determine how research findings have changed clinical practice around the world. "We have found that practice is very much clinician-dependent and hospital-dependent," she says, "rather than necessarily based on best evidence."

Sian Powell

Engineering & Computer Science

Australia's research field leaders

These are the top researchers and institutions in the 50 fields of engineering and computer science

Architecture
Field leader: Samad Sepasgozar, UNSW
Lead institution: UNSW

Artificial Intelligence
Field leader: Seyedali Mirjalili, Torrens
Lead institution: UTS

Automation & Control Theory
Field leader: Peng Shi, Uni of Adelaide
Lead institution: Swinburne

Aviation & Aerospace Engineering
Field leader: Michael Smart, Uni of Queensland
Lead institution: RMIT

Bioinformatics & Computational Biology
Field leader: Geoff Webb, Monash
Lead institution: Monash

Biomedical Technology
Field leader: Cuie Wen, RMIT
Lead institution: Uni of Queensland

Biotechnology
Field leader: Huu Hao Ngo, UTS
Lead institution: Uni of Queensland

Civil Engineering
Field leader: Hao Hong, Curtin
Lead institution: Curtin

Computational Linguistics
Field leader: Sridha Sridharan, QUT
Lead institution: Macquarie

Computer Graphics
Field leader: Tim Dwyer, Monash
Lead institution: Monash

Computer Hardware Design
Field leader: Xinghuo Yu, RMIT
Lead institution: RMIT

Computer Networks & Wireless Communication
Field leader: Derrick Wing Kwan Ng, UNSW
Lead institution: UNSW

Computer Security & Cryptography
Field leader: Helge Janicke, Edith Cowan
Lead institution: CSIRO

Computer Vision & Pattern Recognition
Field leader: Dacheng Tao, Uni of Sydney
Lead institution: Uni of Sydney

Computing Systems
Field leader: Seyedali Mirjalili, Torrens
Lead institution: Deakin

Data Mining & Analysis
Field leader: Geoff Webb, Monash
Lead institution: QUT

Databases & Information Systems
Field leader: Jie Lu, UTS
Lead institution: UTS

Educational Technology
Field leader: Dragan Gasevic, Monash
Lead institution: Monash

Engineering & Computer Science (general)
Field leader: Mamoun Alazab, CDU
Lead institution: UNSW

Environmental & Geological Engineering
Field leader: Annan Zhou, RMIT
Lead institution: Monash

Evolutionary Computation
Field leader: Seyedali Mirjalili, Torrens
Lead institution: Griffith

Food Science & Technology
Field leader: Bhesh Bhandari, Uni of Queensland
Lead institution: Uni of Queensland

Fuzzy Systems
Field leader: Seyedali Mirjalili, Torrens
Lead institution: Griffith

Human Computer Interaction
Field leader: Marc Adam, Uni of Newcastle
Lead institution: Uni of Newcastle

Library & Information Science
Field leader: Ivan Lee, UniSA
Lead institution: UTS

Manufacturing & Machinery
Field leader: Ang Liu, UNSW
Lead institution: Uni of Wollongong

Mechanical Engineering
Field leader: Jie Yang, RMIT
Lead institution: UNSW

Medical Informatics
Field leader: Anthony Smith, Uni of Queensland
Lead institution: Uni of Queensland

Metallurgy
Field leader: Huijun Li, Uni of Wollongong
Lead institution: Uni of Queensland

Microelectronics & Electronic Packaging
Field leader: Xi Zhu (Forest), UTS
Lead institution: Griffith

Mining & Mineral Resources
Field leader: Ranjith Pathegama Gamage, Monash
Lead institution: Curtin

Multimedia
Field leader: Wanqing Li, Uni of Wollongong
Lead institution: UTS

Continued on Page 28

Tim Dwyer
Monash University
Field leader in Computer Graphics

The day will come when comfortable augmented reality headsets will replace mobile phones and be worn nearly all the time, says Tim Dwyer, leader of Monash University's data visualisation and immersive analytics lab.

Gardeners wearing one of these headsets might gaze into a garden and see a variety of plants with an overlay of Latin botanical names and habits. Shoppers might see lists of product ingredients, use-by dates and kilojoule content as they move down a supermarket aisle. Gamers might see a dragon peeping around a nearby corner.

"In the last seven or eight years, a new wave of virtual reality and augmented reality technology is taking off and it's really exciting because it's realising something we've wanted to do for a long, long time," Dwyer says.

The potential applications are endless. One of Dwyer's doctoral students is collaborating with pathologists at the Victorian Institute of Forensic Medicine to develop and evaluate prototype augmented reality systems which could potentially obviate the need for a physical autopsy.

In what is likely to be a world first, these AR tools allow pathologists to explore imagery floating in front of them which replicates the physical cadaver, Dwyer says, and allow them to precisely measure the organs and wounds to establish cause of death.

Continued on Page 28

Revolutionising the Traditional Approach to Medicine

Recce Pharmaceuticals Ltd (ASX:RCE, FSE:R9Q)

is a clinical stage biotech company with a new class of unique and innovative synthetic anti-infectives in multiple Phase I and Phase II clinical opportunities.
Recce aims to address the global health threat of antimicrobial resistance, by revolutionising the existing treatment paradigm.

Not derived from nature, no preformed natural superbugs

Purposely designed to overcome the hypercellular mutation of bacteria including superbug forms

Broad spectrum capability - Maintains activity with repeated use

Unique Mechanism of Action

Sepsis

UTI/ Urosepsis

Burn Wounds

Diabetic Foot Infections

recce.com.au
ASX: RCE, FSE: R9Q

Recce Pharmaceuticals

Aaron Francis

Continued from Page 26

"CT imaging and AR tools could recreate the autopsy experience, but virtually," he says. "It could reduce trauma for families."

Dwyer's team is also working on virtual reality projects. Unlike augmented reality systems, VR headsets block out the view of the outside world which can be disconcerting if a user reaches for something that isn't there, he says, so one project will attempt to recreate the feel of things that are not physically present.

His interest in data visualisation began in the late '90s as a frustrated young computer science graduate working on the Dutch yellow pages in the Netherlands. He was developing what at the time seemed to be complicated software, although it would be considered trivial by today's standards.

"I wanted to be able to visualise where all the complexity was and where all the relationships between the different parts of this complex system were," he says. "That got me thinking and inspired me to go back to Australia and do a PhD."

He found a doctorate supervisor who was an expert in visualisation at the University of Sydney and completed his degree, moving to Monash University for his postdoctoral research. He then ducked over to the US for a few years to work at Microsoft in Seattle, where he built data visualisation tools for developers.

"That was really exciting," he says. "I was realising the dream I had back in the late '90s when I was trying to visualise what I was working on. I finally got to do it for real at Microsoft and build tools for developers to help them see the complexity of their code and talk about it and communicate about it."

Sian Powell

Engineering & Computer Science continued

Continued from Page 26

Ocean & Marine Engineering
Field leader: Dong-Sheng Jeng, Griffith
Lead institution: Uni of Tasmania

Operations Research
Field leader: Guilherme Luz Tortorella, Uni of Melb
Lead institution: Uni of Melb

Plasma & Fusion
Field leader: Boyd Blackwell, ANU
Lead institution: ANU

Power Engineering
Field leader: Joe Zhu, Uni of Sydney
Lead institution: UNSW

Quality & Reliability
Field leader: Paul Salmon, USC
Lead institution: USC

Radar, Positioning & Navigation
Field leader: Jinling Wang, UNSW
Lead institution: UNSW

Remote Sensing
Field leader: Biswajeet Pradhan, UTS
Lead institution: Uni of Queensland

Robotics
Field leader: Michael Milford, QUT
Lead institution: QUT

Signal Processing
Field leader: Dacheng Tao, Uni of Sydney
Lead institution: Uni of Sydney

Software Systems
Field leader: Rajkumar Buyya, Uni of Melb
Lead institution: Monash

Structural Engineering
Field leader: Hao Hong, Curtin
Lead institution: Curtin

Sustainable Energy
Field leader: Martin Green, UNSW
Lead institution: UNSW

Technology Law
Field leader: Roger Clarke, Xamax Consultancy
Lead institution: Monash

Textile Engineering
Field leader: Lijing Wang, RMIT
Lead institution: RMIT

Theoretical Computer Science
Field leader: Nicholas Wormald, Monash
Lead institution: Monash

Transportation
Field leader: David Hensher, Uni of Sydney
Lead institution: Uni of Sydney

Water Supply & Treatment
Field leader: Bing-Jie Ni, UTS
Lead institution: UTS

Wood Science & Technology
Field leader: Xin Wang, RMIT
Lead institution: Deakin

Chemical & Material Sciences
Australia's research field leaders

These are the top researchers and institutions in the 17 fields of chemical and material sciences

Analytical Chemistry
Field leader: Nam-Trung Nguyen, Griffith
Lead institution: Monash
Biochemistry
Field leader: Michael Jennings, Griffith
Lead institution: Monash
Ceramic Engineering
Field leader: Shujun Zhang, Uni of Wollongong
Lead institution: UNSW
Chemical & Material Sciences (general)
Field leader: Shi Zhang Qiao, Uni of Adelaide
Lead institution: Uni of Adelaide
Chemical Kinetics & Catalysis
Field leader: Shaobin Wang, Uni of Adelaide
Lead institution: Uni of Adelaide
Combustion & Propulsion
Field leader: Evatt Hawkes, UNSW
Lead institution: Uni of Queensland
Composite Materials
Field leader: Tuan Ngo, Uni of Melb
Lead institution: RMIT
Crystallography & Structural Chemistry
Field leader: Dylan Jayatilaka, UWA
Lead institution: UWA
Dispersion Chemistry
Field leader: Stefan Iglauer, Edith Cowan
Lead institution: Uni of Queensland
Electrochemistry
Field leader: Shi Xue Dou, Uni of Wollongong
Lead institution: Uni of Wollongong
Inorganic Chemistry
Field leader: Philip Gale, UTS
Lead institution: Uni of Sydney
Materials Engineering
Field leader: Shi Xue Dou, Uni of Wollongong
Lead institution: UNSW
Medicinal Chemistry
Field leader: Christoph Nitsche, ANU
Lead institution: Uni of Queensland
Nanotechnology
Field leader: Shi Xue Dou, Uni of Wollongong
Lead institution: UNSW
Oil, Petroleum & Natural Gas
Field leader: Ranjith Gamage, Monash
Lead institution: Curtin
Organic Chemistry
Field leader: Xun Hu, Curtin
Lead institution: Uni of Queensland
Polymers & Plastics
Field leader: Cyrille Boyer, UNSW
Lead institution: UNSW

Jane Dempster

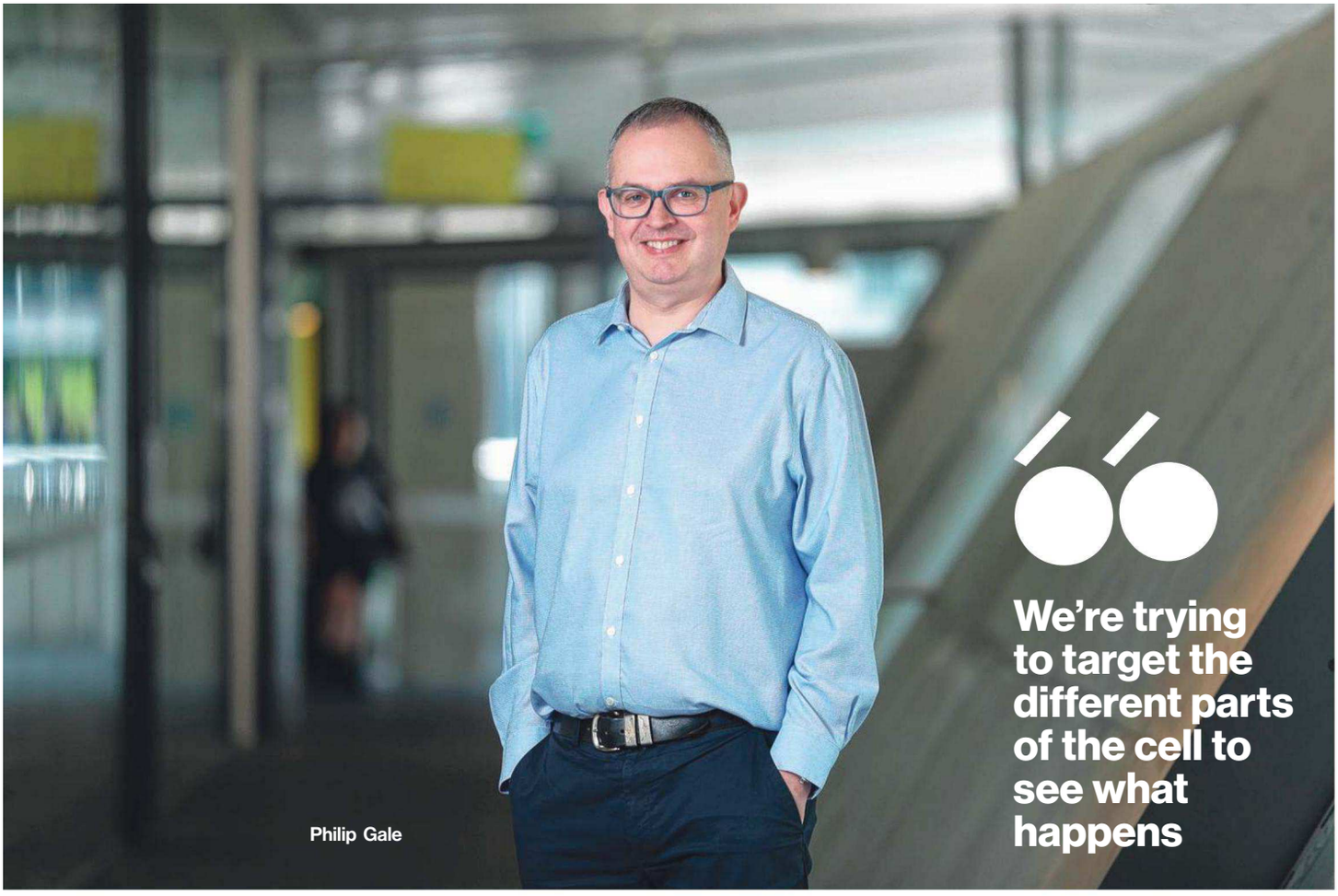
Philip Gale
University of Technology Sydney
Research leader in Inorganic Chemistry

Philip Gale and his research colleagues are working on chemistry fundamentals that could pave the way for the molecular-level treatment of diseases such as cancer and cystic fibrosis.

Molecules can be seen as little machines that perform certain functions, he says, and understanding how these tiny "machines" operate and interact provides an essential foundation of knowledge for further research into a variety of crippling diseases.

"We're very much at the fundamental end of this," he says. "We're

Continued on Page 30



Philip Gale

Jane Dempster

Continued from Page 29

designing molecules and looking at how they transport anions like chloride: fundamental foundations that may in the future be useful."

Cystic fibrosis, for example, is caused by a genetic problem with chloride channels in the cell membranes in the lungs which prevents chloride from crossing the cell membrane, he says. Gale's research group, along with others, is working on the idea of replacing the function of the faulty chloride channel with a small molecule that would allow chloride to move through the cell membrane into the lungs, which may ameliorate the debilitating illness's symptoms.

Now deputy dean of science at the University of Technology, Sydney, Gale first came to grips with supramolecular chemistry at Oxford University, in his fourth year of a chemistry degree, a year specifically devoted to research. Originally from Liverpool in England, where he attended a comprehensive high school, he continued his Oxford research in the field for a further three years and completed his doctoral degree in chemistry at the university.

Since his first forays into molecular chemistry, Gale has been interested in anions – negatively charged ions, rather than the positively-charged cations that were then absorbing the interest of many other chemistry researchers. As a Fulbright postdoctoral scholar at the University of Texas in Austin, he expanded his research into anions.

"Over the years my work has gone from just making receptors for things that are negatively charged through to making compounds that can transport them through cell membranes," he says, adding that it can be difficult to get something that is charged through these membranes.

"What we're trying to do is make molecules that will bind to chloride and wrap it up in an oily coat and then allow that molecule chloride complex to diffuse across a cell membrane."

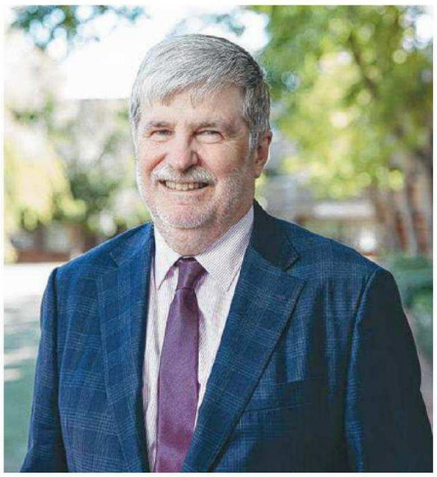
Changing the concentration of anions and cations in cells could also trigger cell death, and might potentially be a new approach to treating cancer, Gale says. He and his colleagues are trying to make compounds that switch on under the chemical conditions found in a tumour, which should be different to the conditions found in healthy tissue.

"We're trying to target our transporters to different parts of the cell; different sub-cellular compartments do different things," he says. "We're trying to target the different parts of the cell to see what happens."

Gale devotes about a fifth of his time to research to keep his research group going. The rest of his effort is absorbed by administrative duties.

"I'm one of those strange academics who actually like being in administrative roles," he says. "It's eaten into the time I have available to do research, but I've been very fortunate to work with really talented people in my research group."

Sian Powell



Professor John Bell Celeste Humphrey

Supporting university research for a prosperous future

In the search for answers to an unpredictable climate, urban population demands and the need to meet net-zero carbon emissions commitments, regional institutions, communities and industries are delivering solutions to the issues that affect us all. A steadily growing skills shortage poses a looming threat to our ability to embrace the challenges and opportunities that abound in the resource-rich areas of Australia.

As a leading educational and research institution, the University of Southern Queensland (UniSQ) has a long track record of building workforce capacity and delivering the technological innovation our nation needs for future prosperity.

Proof that great research doesn't just happen in metropolitan universities is our No.1 ranking for the proportion of top 1 per cent of publications in Physical Sciences and Engineering in the 2023 CWTS Leiden Rankings.

At the core of UniSQ's targeted approach to education and research excellence are our four flagships: space and defence; health, agriculture and the environment; and regional development. These enable the university to clearly identify areas of strength and differentiate ourselves from other institutions. Although the communities that we are immersed in are diverse, our research activities are clearly focused and have been built on the foundation of longstanding partnerships.

These partnerships have been fostered by our capacity to address critical social and economic needs and by working directly with our local communities. However, this capacity is also identifiable and accessible to national and international partners.

UniSQ's health flagship is underpinned by our strong expertise in delivering evidence-based interventions for community wellbeing. UniSQ is a founding member of the Manna Institute, a collaborative initiative supported by the Department of Education, based on a three-year strategy to improve mental health and wellbeing in rural, remote and regional Australia.

A dedicated team of university researchers, industry, and community partners actively collaborate with service providers and agencies, First Nations people and those with lived experience of mental illness.

A key focus of the institute is the expansion of mental health workforces to fill the critical shortage of care providers in regional communities. From clinical health professionals and peer workers to community advocates and regional researchers, the institute is building workforce capacity, diversity, and sustainability through promising new collaborations.

Our world-renowned expertise in climate science and drought mitigation has been refined through direct engagement with our farming communities.

UniSQ leads the Southern Queensland and Northern NSW Innovation Hub, one of eight national Drought Resilience and Adoption and Innovation Hubs established through the federal government's Future Drought Fund.

The success of the hub is supported by UniSQ's agriculture and environment and regional development flagships, which combine to deliver applied climate science and drought-resilience research through a co-design approach, enabling communities to be resilient, adaptive, liveable and prosperous in the face of change.

If universities are to continue to meet the current and future needs of our nation, it is essential that the higher-education sector receives the support it needs to maintain momentum, and to deliver even more value to our economy.

For the research sector, this means transforming current funding models that are steadily reducing our capacity to support agile and responsive research.

There is a clear and urgent need to increase Australia's PhD-qualified workforce to build capacity in industry and produce the next generation of skilled research leaders. Yet the funding model for PhD candidates via the Research Training Program block grants is eroding the stipend and number of scholarships available.

Current commonwealth-funded PhD stipends are too low to attract enough domestic students and are increasing the risk that our workforce will not meet the future demands of the economy.

The potential for university research to be a catalyst for industry innovation, economic growth and social cohesion is immense. We need to focus on unique strengths and ensure that universities are supported adequately to be engines of social and industrial development and growth. Universities should be positioned as one of the first ports of call for research and development endeavours, enabling them to focus on strategic priorities and be responsive to industry needs.

UniSQ's vision for the future is ambitious, but it is reinforced by our focused flagships that have shaped our institution to be a dynamic research ecosystem, achieving industry engagement and community impact on a local, national and global scale.

Professor John Bell
Deputy Vice-Chancellor (Research and Innovation)
University of Southern Queensland

Humanities, Literature & Arts
Australia's research field leaders

These are the top researchers and institutions in the 21 fields of humanities, literature and arts

Asian Studies & History
Field leader: Marcus Mietzner, ANU
Lead institution: ANU

Chinese Studies & History
Field leader: Ligang Song, ANU
Lead institution: ANU

Communication
Field leader: Jasmine Fardouly, UNSW
Lead institution: QUT

Drama & Theater Arts
Field leader: Luke Hopper, Edith Cowan
Lead institution: Edith Cowan

English Language & Literature
Field leader: Margaret Merga, Uni of Newcastle
Lead institution: Macquarie

Epistemology & Scientific History
Field leader: Michael Kirchhoff, Uni of Wollongong
Lead institution: Macquarie

Ethnic & Cultural Studies
Field leader: Yin Paradies, Deakin
Lead institution: Deakin

Feminism & Women's Studies
Field leader: Molly Dragiewicz, Griffith
Lead institution: Monash

Film
Field leader: Sean Redmond, Deakin
Lead institution: RMIT

Foreign Language Learning
Field leader: Neomy Storch, Uni of Melb
Lead institution: Macquarie

Gender Studies
Field leader: Leah Ruppanner, Uni of Melb
Lead institution: Uni of Melb

History
Field leader: Laura Panza, Uni of Melb
Lead institution: Uni of Melb

Humanities, Literature & Arts (general)
Field leader: Xuesong Gao, UNSW
Lead institution: UNSW

Language & Linguistics
Field leader: Mark Antoniou, Western Sydney
Lead institution: Western Sydney

Literature & Writing
Field leader: Paul Dawson, UNSW
Lead institution: Monash

Middle Eastern & Islamic Studies
Field leader: Ihsan Yilmaz, Deakin
Lead institution: Deakin

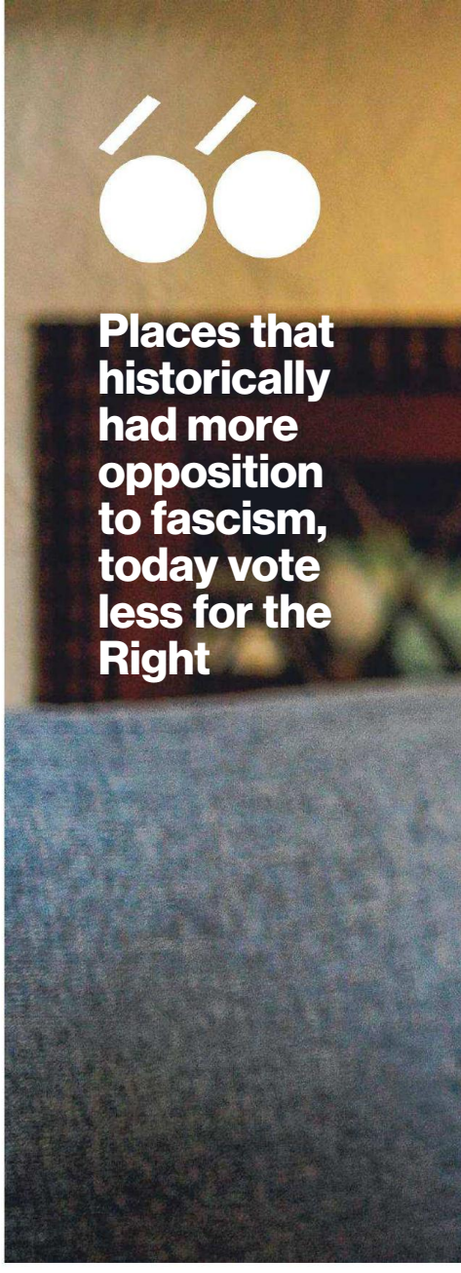
Music & Musicology
Field leader: Paul Evans, UNSW
Lead institution: Uni of Melb

Philosophy
Field leader: Michael Kirchhoff, Uni of Wollongong
Lead institution: Macquarie

Religion
Field leader: Ihsan Yilmaz, Deakin
Lead institution: Deakin

Sex & Sexuality
Field leader: Eric Chow, Monash
Lead institution: UNSW

Visual Arts
Field leader: Toby Gifford, USC
Lead institution: QUT



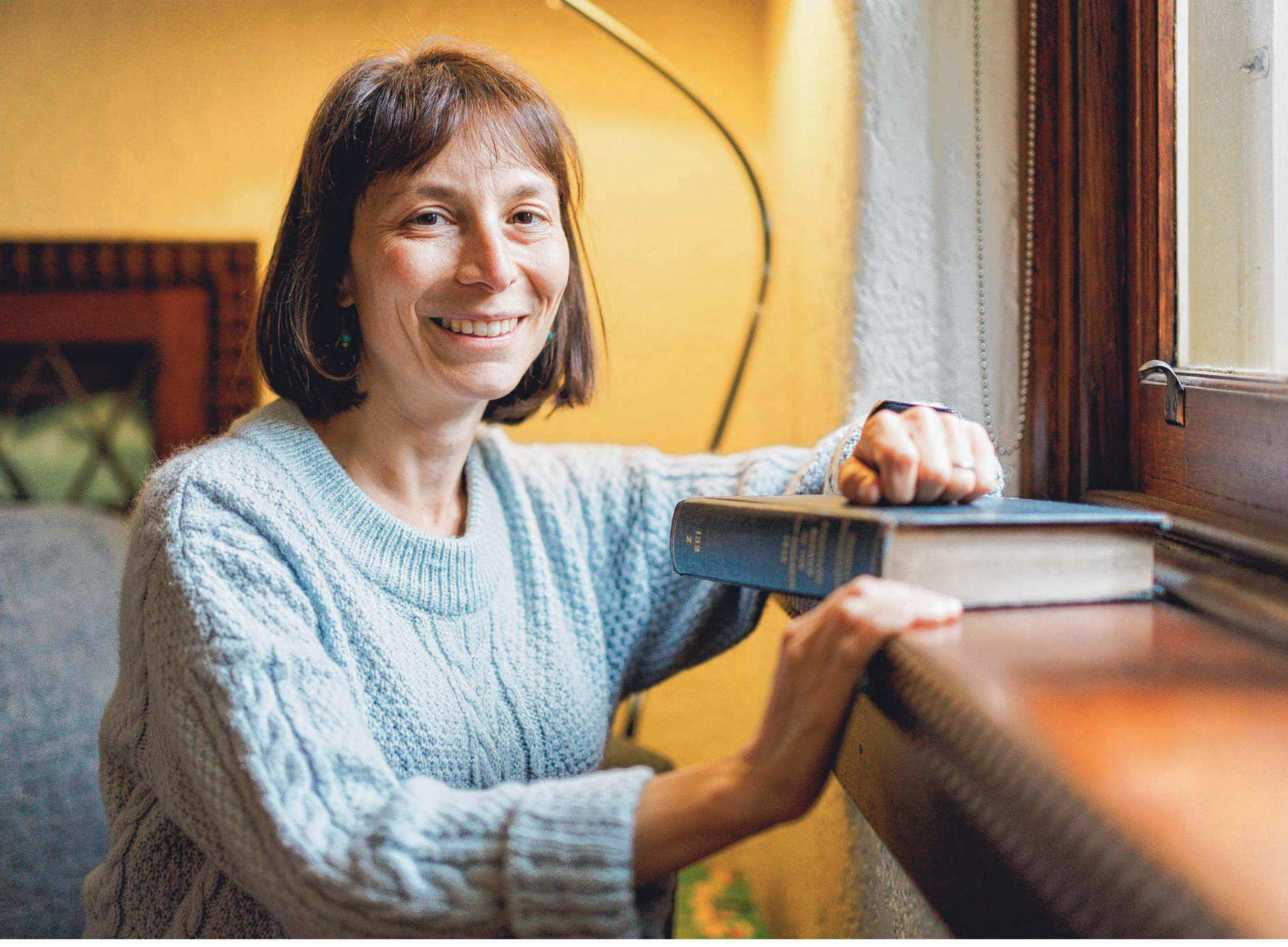
Places that historically had more opposition to fascism, today vote less for the Right

Laura Panza
University of Melbourne
Field leader in History

Laura Panza looks to the past to understand the growth of economic development in various nations, largely in the Near East: Egypt, Turkey, Syria and Palestine, with a particular focus on the latter.

It's difficult work because usable data is hard to come by in the Near East, she says.

"There are very few sources; it's a very under-explored area of the



Aaron Francis

world when it comes to history."

Born in Italy, the bilingual economic historian first studied at the 1000-year-old University of Bologna and then worked on her master's degree at Pavia University, followed by an internship in Bethlehem, Palestine. Fluent in Italian and English, she also has a working knowledge of Arabic.

With a doctorate from La Trobe University, Panza joined Melbourne University in 2013 as a postdoctoral scholar, where she is now an associate professor of economics and working on a research project looking at the birth of Israel.

"There was a social laboratory in the 1920s before the creation of the state of Israel, where we had massive migrations of Jews to Palestine because of persecution and discrimination in Europe and the Middle East," she says.

"Within two decades, people from everywhere in the world were coming to a land which was already inhabited by Indigenous people – the Arabs – and they were able to build a very strong state."

One question she and her colleagues are considering is how social diversity affected nation-building. "We find that places that are more ethnically diverse are more able to build a state," she says.

The work of Panza and her colleagues measured state-building success in terms of the number of military leaders and political leaders who would go on to run the state of Israel. She has also researched inequality among white settlers in Australia. Similar work on Indigenous peoples was stymied by the sheer lack of historic information about them.

"It was almost impossible to get any data on Indigenous people," she says. "In the 19th century, they were still counted as flora and fauna. I'm an economist, I need numbers."

Panza and her colleagues are also delving into post-World War II voting patterns in Italy – research triggered by the Italian elections in 2022 and the question of why extreme right-wing parties are returning to power.

"We began looking at how it all started in the 1920s. We looked at the role of opposition back then and how it is continuing to impact voting behaviour over time," she says. "Places that historically had more opposition to fascism, today vote less for the Right. So, there's a persistence in voting patterns."

In some parts of Italy, there are lingering memories of the World War II battle against fascism, Panza says. Streets are named for partisans and memorials dedicated to the Italians who fought against fascism.

So, as well as voting inclinations passed on through generations, there is a continuous reminder of the bloody history of the region.

"It's a bit of mix," Panza says. "There are the families and the transmission of values, and the community you live in impacts the way you think and vote."

Sian Powell

Physics & Mathematics
Australia's research field leaders

These are the top researchers and institutions in the 21 fields of physics and mathematics

Acoustics & Sound
Field leader: Jie Yang, RMIT
Lead institution: UNSW

Algebra
Field leader: Aidan Sims, Uni of Wollongong
Lead institution: UNSW

Astronomy & Astrophysics
Field leader: Joss Bland-Hawthorn, Uni of Sydney
Lead institution: ANU

Computational Mathematics
Field leader: Seyedali Mirjalili, Torrens
Lead institution: UNSW

Condensed Matter Physics & Semiconductors
Field leader: Daniel Brown, Uni of Adelaide
Lead institution: ANU

Discrete Mathematics
Field leader: David Wood, Monash
Lead institution: Monash

Electromagnetism
Field leader: Yingjie Jay Guo, UTS
Lead institution: UTS

Fluid Mechanics
Field leader: Ivan Marusic, Uni of Melb
Lead institution: Uni of Melb

Geometry
Field leader: Xuan Duong, Macquarie
Lead institution: Macquarie

Geophysics
Field leader: Dietmar Müller, Uni of Sydney
Lead institution: ANU

High Energy & Nuclear Physics
Field leader: Peter Skands, Monash
Lead institution: Uni of Sydney

Mathematical Analysis
Field leader: Yihong Du, UNE
Lead institution: Curtin

Mathematical Optimisation
Field leader: Fred Roosta, Uni of Queensland
Lead institution: Curtin

Mathematical Physics
Field leader: Ian Marquette, Uni of Queensland
Lead institution: Uni of Melb

Nonlinear Science
Field leader: Samaneh Sadat Sajjadi, RMIT
Lead institution: UWA

Optics & Photonics
Field leader: David Moss, Swinburne
Lead institution: ANU

Physics & Mathematics (general)
Field leader: Md. Rabiul Awual, Curtin
Lead institution: UNSW

Probability & Statistics with Applications
Field leader: Rob Hyndman, Monash
Lead institution: Monash

Pure & Applied Mathematics
Field leader: David Wood, Monash
Lead institution: Monash

Spectroscopy & Molecular Physics
Field leader: Giuseppe Barca, ANU
Lead institution: Curtin

Thermal Sciences
Field leader: Maziar Arjomandi, Uni of Adelaide
Lead institution: Uni of Adelaide

David Moss
Swinburne University of Technology
Field leader in Optics & Photonics

David Moss and his colleagues set a world record in 2020: the fastest data transmission down an optical fibre from a single chip. Published in Nature Communications, the paper on this record-setting research almost immediately attracted huge worldwide attention.

Moss first saw an article about it on the BBC website and it took a few seconds before he realised it was about his research. "It got a lot of traction, which was a bit of a surprise," he says of the mainstream media attention.

Now a distinguished professor of photonics and the director of the optical sciences centre at Swinburne University, he is also deputy director of the newly-funded Australian Research Council Centre of Excellence called COMBS: the Centre for Optical Microcombs for Breakthrough Science.

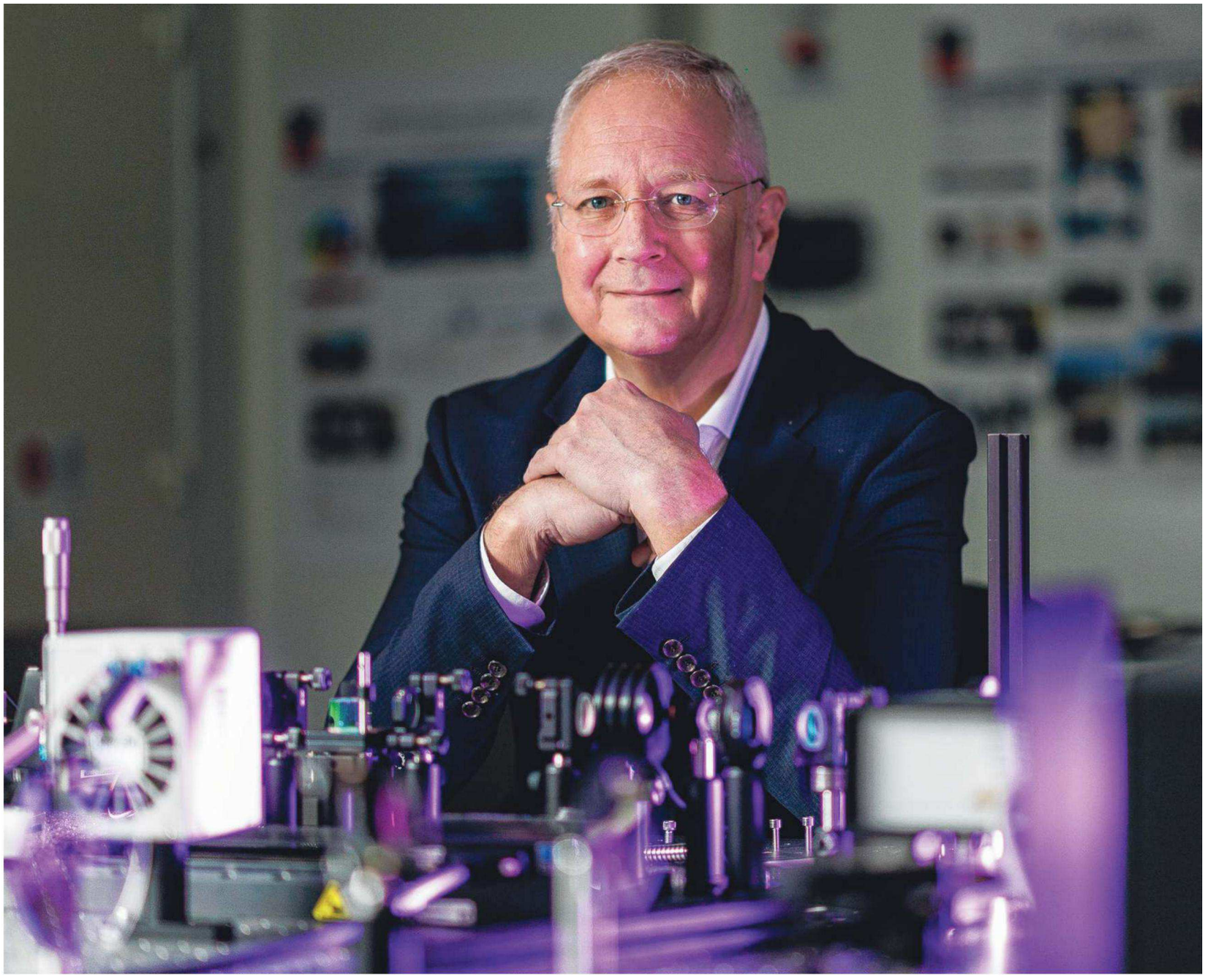
Born and educated in Canada, with a doctorate from Toronto University, Moss gravitated to physics, he says, after he decided mathematics was too difficult. As a child he had a vague idea of becoming an astronomer but toward the end of his undergraduate degree he met his future doctorate supervisor and developed an interest in lasers and then photonics.

Photonics might not be very well known or understood, he says, but it's foundational to our modern world. "In a sense it's right under everyone's nose because the fabric of the internet we use every day is laser-based, it's optical fibre and high-speed lasers," he says.

"It's enabled the modern technological society, the internet and communications, that almost defines our modern age."

From photonics Moss moved into exploring the potential of optical microcombs, where he has been working for 15 years. Simply put, a microcomb is a regular array of precisely spaced frequencies of light, like the teeth of a comb, he says.

Optical clocks, which are 100,000 times more accurate than anything else we have developed, are now based on optical frequency combs, and ultimately,



Aaron Francis

he believes, they will be based on optical microcomb chips.

"It sounds boring but it's actually incredibly enabling to be able to measure time to that accuracy," Moss says. "Time is fundamental – the base we measure everything else from."

Almost all optical measurements use light frequencies and the microcomb is almost infinitely adaptable, with applications ranging from bio-related imaging to space exploration: astrocombs, for instance, are a type of frequency comb used to increase the accuracy of astronomical observations.

The fabric of the internet we use every day is laser-based

"Now it's getting to the point where we're using it for all kinds of different applications, and one is astrocombs for calibrating astronomical spectra," he says. "I find myself working with our astronomers and astrophysicists and so I may end up getting some papers in astronomy after all, after all these years."

Moss first came to Australia in 1994 to take up a position with the University of Sydney but after a couple of years the telecom boom took hold and scientists left academia in droves to make their fortunes. He went back to Canada and worked in the private sector, he says, until "the music stopped, which it did very dramatically and very abruptly, in 2002".

He came back to the University of Sydney to join one of the first ARC centres of excellence which was just then starting, CUDOS: the Centre for Ultra High Bandwidth Devices for Optical Systems. He's been in Australia ever since, exploring the frontiers of microcomb science and its many applications.

"I really think these microcombs are going to be a gamechanger."

Sian Powell

Social Sciences
Australia's research field leaders

These are the top researchers and institutions in the 29 fields of the social sciences

Academic & Psychological Testing
Field leader: David Boud, Deakin
Lead institution: Deakin

Anthropology
Field leader: Michael Petraglia, Griffith
Lead institution: ANU

Archaeology
Field leader: Jonathan Palmer, UNSW
Lead institution: UNSW

Cognitive Science
Field leader: Quentin Gronau, Uni of Newcastle
Lead institution: Uni of Newcastle

Criminology, Criminal Law & Policing
Field leader: Bridget Harris, Monash
Lead institution: Griffith

Diplomacy & International Relations
Field leader: Shahar Hameiri, Uni of Queensland
Lead institution: Deakin

Early Childhood Education
Field leader: Rauno Parrila, ACU
Lead institution: Macquarie

Education
Field leader: David Boud, Deakin
Lead institution: Deakin

Educational Psychology & Counselling
Field leader: Richard Ryan, ACU
Lead institution: ACU

Environmental & Occupational Medicine
Field leader: Yuming Guo, Monash
Lead institution: Uni of Queensland

Environmental Law & Policy
Field leader: Russell Smyth, Monash
Lead institution: Monash

Ethics
Field leader: Alexander Newman, Uni of Melb
Lead institution: Uni of Queensland

Family Studies
Field leader: Janeen Baxter, Uni of Queensland
Lead institution: Uni of Queensland

Forensic Science
Field leader: Duncan Taylor, Forensic Science SA
Lead institution: UTS

Geography & Cartography
Field leader: Neil Coe, Uni of Sydney
Lead institution: Uni of Melb

Health Policy & Medical Law
Field leader: Peter Bragge, Monash
Lead institution: Uni of Sydney

Higher Education
Field leader: David Boud, Deakin
Lead institution: Deakin

Human Migration
Field leader: Fethi Mansouri, Deakin
Lead institution: Deakin

International Law
Field leader: Anthea Roberts, ANU
Lead institution: ANU

Military Studies
Field leader: Marianne Hanson, Uni of Queensland
Lead institution: Deakin

Political Science
Field leader: Edward Aspinall, ANU
Lead institution: ANU

Public Policy & Administration
Field leader: Allan McConnell, Uni of Sydney
Lead institution: Uni of Melb

Science & Engineering Education
Field leader: Annette Burgess, Uni of Sydney
Lead institution: Monash

Social Sciences (general)
Field leader: Jolanda Jetten, Uni of Queensland
Lead institution: Uni of Melb

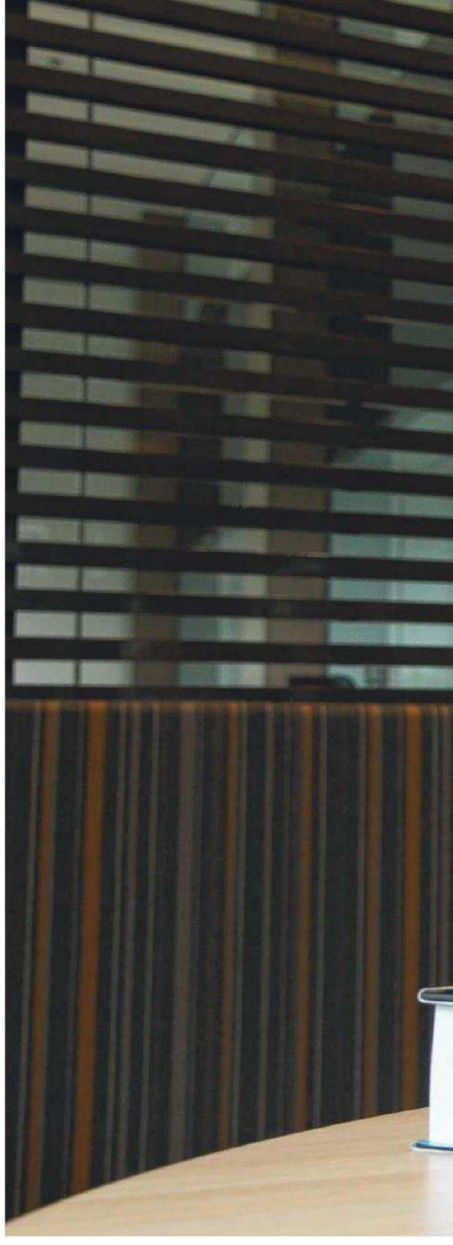
Social Work
Field leader: Hui Li, Macquarie
Lead institution: Griffith

Sociology
Field leader: Leah Ruppanner, Uni of Melb
Lead institution: Uni of Melb

Special Education
Field leader: Umesh Sharma, Monash
Lead institution: Monash

Teaching & Teacher Education
Field leader: Umesh Sharma, Monash
Lead institution: Monash

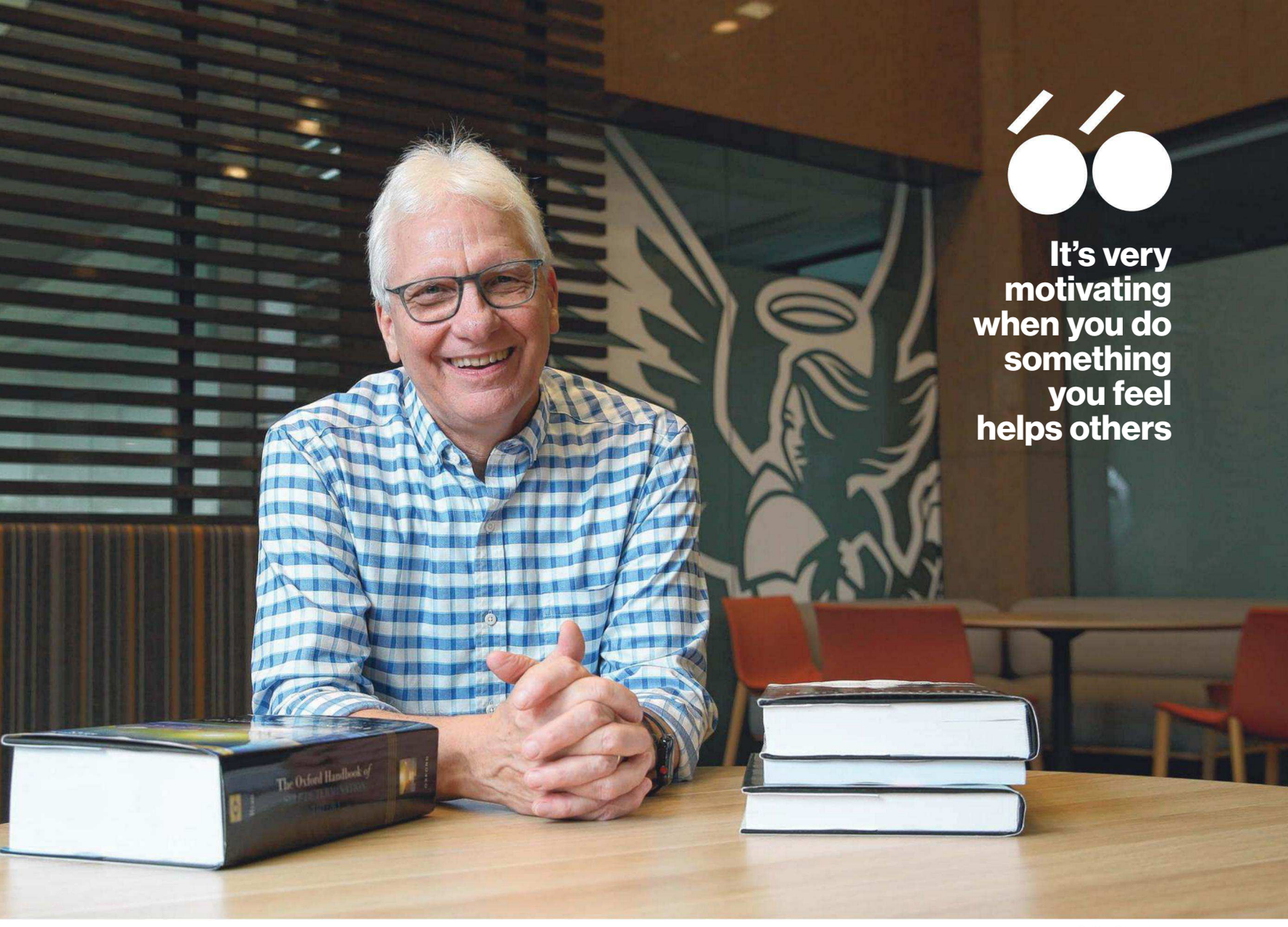
Urban Studies & Planning
Field leader: Tan Yigitcanlar, QUT
Lead institution: Uni of Melb



Richard Ryan
Australian Catholic University
Field leader in Educational Psychology & Counselling

Richard Ryan has spent a lot of time researching motivation: understanding why people do what they do, why they choose certain courses of action and why they reject others.

A clinical psychologist, Ryan jointly developed the self-determination theory of motivation,



Britta Campion

which he says is applicable in the workplace, in education, in healthcare systems and even in sports organisations.

"The old motivation theories are all carrot and stick," he says. "They are really about incentives and avoiding punishments. We focus on the reasons that inherently satisfy people at work. Most of us want some purpose in our work, we want to feel we're effectively doing something, we want to experience some collegiality."

Ryan completed his doctoral degree at the University of Rochester in the US, where he then taught for more than 30 years before moving to Australia in 2014. Now a professor at the Institute for Positive Psychology and Education at the Australian Catholic University in Sydney, he has published widely on motivation.

The pandemic and the upheaval of lockdowns and remote working focused attention on worker satisfaction and how to best keep remote workers feeling they are connected to their organisations, Ryan says. His research has focused on various topics, such as how best to listen as a manager, how to best respond to input from staff, and on the sorts of recognition that are most appreciated by employees.

The pandemic has given people a sense that there are alternatives to the old way of doing things, he says, particularly in terms of working from home. "So we really look at people's sense of autonomy, their sense of competence, sense of relatedness in a classroom or workplace; what are the conditions in the way of that, what are the conditions that foster that," he says. "That's really what's important to people's sustained work."

Ryan and his colleagues have also been engaged in understanding the effectiveness of wider messaging during and after the pandemic and why some messaging fails with some groups: why some people chose not to get Covid vaccinations, why they refused to wear masks at various times, and what fostered the conspiracy theories which grew from vaccination and mask edicts.

"There's a lot of misinformation out there, so there's an even bigger burden on policymakers and governments to know how to message and know how to say something that will inspire people to listen, rather than paying attention to fringe conspiracy theories," he says.

He has found that threats simply don't work; but people who resist a shove might be amenable to a nudge. "The messaging has to be trustworthy and informative," he says, "because if people feel like they're not getting the straight scoop, then they're not going to follow."

Ryan's research has found that people are motivated by self-interest far less than is commonly thought, and care for others is a powerful driver. There are always a few who refuse and they tend to get all the publicity, he says. "Our research has shown benevolence makes people happy," he says. "It provides a larger sense of purpose and a way of feeling effective. It's very motivating when you do something you feel helps others."

Sian Powell

Life Sciences & Earth Sciences
Australia's research field leaders

Here are the top researchers and institutions in the 30 fields of life science and earth sciences

Agronomy & Crop Science
Field leader: Kadambot Siddique, UWA
Lead institution: CSIRO

Animal Behaviour & Ethology
Field leader: Martin Whiting, Macquarie
Lead institution: Macquarie

Animal Husbandry
Field leader: Robert Swick, UNE
Lead institution: UNE

Atmospheric Sciences
Field leader: Pep Canadell, CSIRO
Lead institution: CSIRO

Biodiversity & Conservation Biology
Field leader: Kris Wyckhuys, Uni of Queensland
Lead institution: Uni of Queensland

Biophysics
Field leader: Sharon Robinson, Uni of Wollongong
Lead institution: Uni of Sydney

Birds
Field leader: Leo Joseph, CSIRO
Lead institution: ANU

Botany
Field leader: Sergey Shabala, Uni of Tasmania
Lead institution: UWA

Cell Biology
Field leader: Edward Holmes, Uni of Sydney
Lead institution: Uni of Queensland

Developmental Biology & Embryology
Field leader: Rebecca Lim, Monash
Lead institution: Monash

Ecology
Field leader: David Lindenmayer, ANU
Lead institution: Uni of Melb

Environmental Sciences
Field leader: Huu Hao Ngo, UTS
Lead institution: Uni of Queensland

Evolutionary Biology
Field leader: Bui Quang Minh, ANU
Lead institution: ANU

Forests & Forestry
Field leader: David Forrester, CSIRO
Lead institution: CSIRO

Geochemistry & Mineralogy
Field leader: Ian Graham, UNSW
Lead institution: Curtin

Geology
Field leader: Peter Cawood, Monash
Lead institution: Curtin

Hydrology & Water Resources
Field leader: Ashish Sharma, UNSW
Lead institution: CSIRO

Insects & Arthropods
Field leader: Ary Hoffmann, Uni of Melb
Lead institution: CSIRO

Life Sciences & Earth Sciences (general)
Field leader: Edward Holmes, Uni of Sydney
Lead institution: Uni of Queensland

Marine Sciences & Fisheries
Field leader: Jianguang Qin, Flinders
Lead institution: CSIRO

Microbiology
Field leader: Brajesh Singh, Western Sydney
Lead institution: Uni of Queensland

Mycology
Field leader: Tom May, RBG Victoria
Lead institution: Uni of Sydney

Oceanography
Field leader: Jessica Benthuysen, Aust Institute of Marine Science
Lead institution: CSIRO

Palaeontology
Field leader: Anthony Romilio, Uni of Queensland
Lead institution: Uni of Queensland

Pest Control & Pesticides
Field leader: Bhagirath Singh Chauhan, Uni of Queensland
Lead institution: UWA

Plant Pathology
Field leader: Donald Gardiner, Uni of Queensland
Lead institution: Uni of Queensland

Proteomics, Peptides & Amino acids
Field leader: David Greening, Baker
Lead institution: Monash

Soil Sciences
Field leader: Budiman Minasny, Uni of Sydney
Lead institution: Uni of Sydney

Sustainable Development
Field leader: Carina Wyborn, ANU
Lead institution: Uni of Queensland

Zoology
Field leader: Adam Slipinski, CSIRO
Lead institution: CSIRO

Jessica Benthuysen
Australian Institute of Marine Science
Field leader in Oceanography

A physical oceanographer, Jessica Benthuysen monitors real-time data on the temperature, salinity and currents of oceans thousands of kilometres from her desk in Perth.

She has worked with the Australian Institute of Marine Science for the past decade, first in Townsville and now in Western Australia, using ocean observations and ocean models to understand more about marine heatwaves and the movement of the great ocean currents.

"Australia has one of the most unique currents in the world, the Leeuwin current, off the west coast, just off Perth," she says. "It's one of the only currents in the world that flows pole-ward against the winds; usually currents off west coasts flow with the winds towards the equator with cooler water which is very nutrient-rich. The Leeuwin current is very warm and low in nutrients."

The Leeuwin current brought Benthuysen to Australia. Originally from the US, she completed her doctorate in physical oceanography in the Massachusetts Institute of

AIMS

Technology–Woods Hole Oceanographic Institution Joint Program.

"It really set me on my path to understanding the coastal oceanography around the US," she says. "But then my interest extended beyond that to understanding what is happening in the southern hemisphere. I wanted to come to Australia to find out why the Leeuwin current flows the way it does."

She wanted to test theories on how ocean currents along the bottom of continental shelves are affected by changes in density and topography and how these bottom currents can cause upwelling, which pushes nutrients up into sunlit areas where they support marine ecosystems.

Benthuysen arrived in Australia in 2010 and began her research as a postdoctoral fellow with the CSIRO in Tasmania. She had been living in Australia for less than a year when there was a marine heatwave off the coast of Western Australia and waters of up to five degrees above normal were measured over a month, she says.

"That's truly phenomenal – that doesn't really happen. We discovered this warm water event was related to a surge of warm water from the Leeuwin current reaching record strength speeds, bringing warm fresh tropical water along the coast."

The marine heatwave had devastating effects, including coral bleaching and the death of sea grass meadow. It affected aquaculture and fisheries in Western Australia, such as the western rock lobster industry, worth hundreds of millions of dollars.

Australia has one of the most unique currents

Benthuysen wanted to know why the record strength Leeuwin current had brought a surge of warm freshwater down the West Australian coast. On the other side of Australia, she has also investigated how the East Australian Current can bring cooler waters to the Great Barrier Reef via "upwelling".

She now monitors data from a range of scientific equipment immersed in the oceans around Australia, which can track temperatures and salinity at varying depths.

"The data is critical to understanding long-term changes around Australia," she says. "And we can use it to determine whether a marine heatwave is related to atmospheric changes or changes in the currents, such as the Leeuwin current."

Sian Powell

Business, Economics & Management
Australia's research field leaders

These are the top researchers and institutions in the 16 fields of business, economics and management

Accounting & Taxation
Field leader: John Dumay, Macquarie
Lead institution: Macquarie
Business, Economics & Management (general)
Field leader: Rob Raven, Monash
Lead institution: Monash
Development Economics
Field leader: Paul Raschky, Monash
Lead institution: Monash
Economic History
Field leader: Laura Panza, Uni of Melb
Lead institution: Uni of Melb
Economic Policy
Field leader: Paresh Narayan, Monash
Lead institution: Monash
Economics
Field leader: Yves Zenou, Monash
Lead institution: Monash
Educational Administration
Field leader: Jessica Holloway, ACU
Lead institution: ACU
Emergency Management
Field leader: Jonatan Lassa, CDU
Lead institution: QUT
Entrepreneurship & Innovation
Field leader: Morgan Miles, Uni of Queensland
Lead institution: Uni of Queensland
Finance
Field leader: Dirk Baur, UWA
Lead institution: Monash
Game Theory and Decision Science
Field leader: Anton Kolotilin, UNSW
Lead institution: Monash
Human Resources & Organisations
Field leader: Alexander Newman, Uni of Melb
Lead institution: Monash
International Business
Field leader: Paresh Narayan, Monash
Lead institution: Monash
Marketing
Field leader: Catherine Prentice, UniSQ
Lead institution: Griffith
Strategic Management
Field leader: Catherine Prentice, UniSQ
Lead institution: Monash
Tourism & Hospitality
Field leader: Brent Ritchie, Uni of Queensland
Lead institution: Uni of Queensland

Catherine Prentice
University of Southern Queensland
Field leader in Marketing
Field leader in Strategic Management

The use of artificial intelligence for marketing and in commercial enterprises such as hotels and restaurants has become the focus of Catherine Prentice's current research.

She plans to further explore how AI can improve the consumer experience and foster consumer loyalty to a brand or an organisation as well as how it can improve employee efficiency. She is currently particularly interested in the cobot – a collaborative robot designed to directly interact and work with humans.

A marketing professor at the University of Southern Queensland, Prentice lived in Malaysia, China and the UK before moving to Australia. With a bachelor's degree in European literature, an MBA from Lincoln University in the UK and a doctorate in marketing from Victoria University, she has wide-ranging academic interests.

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Awards to recognise our unsung heroes

One of the things I love most about Australians is our pride in national achievement – our robust celebration of success and talent as well as the grit and determination it takes to get to the top.

We love watching Australians win, but we also love seeing them give whatever it is a red-hot go.

From the Matildas to Kylie Minogue and Nicole Kidman, Ian Thorpe and Emma McKeon – their success is our success.

And why shouldn't we celebrate? For a nation with a small population, we punch well above our weight, with so many shining stars.

But we're also a nation of unsung heroes, and Australia's universities are full of them. Individuals going the extra mile, day in, day out, to shape the future of the nation.

Teachers forming creative, flexible minds, ready to tackle the biggest challenges.

Researchers coming to grips with the world's complexity, curing disease, calming conflict, looking over the horizon navigating the future.

Whole teams of highly skilled people, serving their local community, in good times and bad.

This is what our universities, the staff and students in them, do, and they do it on behalf of the nation and for all Australians.

We know that the Australian population turns to universities as sources for truth, innovation, enterprise and skilled graduates. Covid-19 made that abundantly clear. University researchers were relied on to help Australians navigate the pandemic by providing advice on everything from mask-wearing and vaccines to social distancing and panic buying.

Yet, the full scale of what universities do for the nation continues to be under-recognised.

Sure, university work doesn't take place before 100,000 spectators or on a spotlight stage, but university wins take place every day, across the nation, and make us all stronger economically, socially and technologically. This is worth celebrating, and we intend to do that.

To level up the playing field, Universities Australia has launched the Shaping Australia Awards to applaud the contribution universities and the people in them make to our nation.

The higher education sector is an engine for economic growth, addresses inequality through access to education, educates about 1.5 million people each year, runs a multibillion-dollar export industry, supports more than 250,000 jobs and underpins small businesses through the supply chains it generates.

From the transformative research the sector undertakes to the world-class teaching our universities provide to future members of our skilled workforce and the community spirit they build and foster, Australia is stronger for these efforts.

As our nation navigates a series of multigenerational challenges – including the energy transition, national security and an ageing population – universities, as they always have, will continue to play a key role as a trusted partner of government and community in delivering national priorities.

These are the national challenges and opportunities we simply can't rise to without universities – either through the research and development we undertake, by the skilled workers we educate, or through the helping hand we lend.

The Shaping Australia Awards will recognise excellence across research, teaching and community service, celebrating the wonderful contributions universities and individuals make to Australia and Australians.

- The Problem Solver Award will recognise an individual or a team's work or research that has changed or has the potential to change the lives of Australians for the better.
- The Future Builder Award will recognise an individual or a team that has gone over and above to equip their students with the knowledge and skills they need to make a positive impact in the world.
- The Community Champion Award will recognise an individual, team or university with strong links to its community and the people who call it home, not just those who attend the institution.

A panel of eminent Australians will judge the awards, including:

- Ms Lisa Paul AO PSM, former secretary of the Department of Education
- Sir Peter Cosgrove AK CVO CNZM MC, former governor-general of Australia
- Mr Kurt Fearnley AO PLY, three-time paralympic gold medallist
- Ms Michelle Gunn, editor-in-chief of The Australian
- Mr Nicholas Moore AO, Special Envoy for Southeast Asia
- Professor Brian Schmidt AC FAA FRS, vice-chancellor of the Australian National University and Nobel laureate

Nominations for the Shaping Australia Awards close on November 20, 2023. Visit https://shapingaustraliaawards.com.au for more information.

Catriona Jackson
Chief Executive
Universities Australia

Catherine Prentice

David Martinelli, UniSQ

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In recent years, she has published widely on emotional intelligence, but now her interest has turned to AI. "My current project is identifying the optimal cobot model to maximise the use of robots as well as human employees and to optimise the collaboration," she says, adding that she wants to understand why the cobot model is not more popular in Australia though it has been widely adopted in other nations such as China.

Prentice is also interested the potential for AI to improve employees' task efficiency and in how it may affect their "turnover intention" – their willingness to stay in the job. The cobot model, she says, could address labour shortages in difficult-to-staff locations, such as remote hotels and tourist destinations. She wants to understand more about consumer perception of an organisation's use of AI and whether AI is thought to assist the consumer.

"The customer experience should be measured from different dimensions," she says, "from the service encounter experience with the company, the experience with the employees, and the experience with the physical facilities."

Humans, of course, react in different ways to different types of robots, which range through varying degrees of humanoid and non-humanoid types, Prentice says. "We don't have enough research to provide evidence on which one works better," she adds.

She is interested in further understanding exactly how a cobot model could work and determining how best to deploy AI in the workplace: whether cobots work more efficiently than human employees, and in optimising the advantages of both.

In China, the FlyZoo hotel in Hangzhou, 100km south of Shanghai and owned by the Ali Baba group, is managed with AI. There is automated smartphone check-in, facial recognition software in the elevator and at the door to get into the room, and robot room service. Humans are nowhere to be found.

"The hotel is new, and there is academic research on it," says Prentice, noting that companies will have to find a balance between robots and human staff to avoid alienating customers, and the balance may be different in different nations.

"Too many robots can cause the 'uncanny effect'," she says. "This is the customer's reaction to interacting with robots. Sometimes they feel happy about the novelty, but sometimes it's a spooky feeling." She says she and her colleagues have found the uncanny effect in other fields. "For this hotel particularly, we're still doing research on it," she says.

Sian Powell